

Constructing a School Life Table

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How do we construct a School Life Table?

- We must fit a Matrix Model to Enrollment Data
- Model parameters will allow us to define life table functions

- 1 Data
- 2 The Candidate Models
- 3 Best-Fit and Residual Plots
- 4 Selecting a Model via AIC
- 5 Bootstrapping
- 6 Life Tables

National Center for Education Statistics

Using the **IPEDS Data Center** we constructed a data set that:

- Gives enrollment totals institutions for the 50 U.S. states and D.C.
 - We exclusively looked at full-time enrollments
 - **Public, 4-year** schools were the only institutions considered
- An additional data set was gathered to reflect freshmen enrollment numbers

Model 2

$$\begin{bmatrix} x_1(n+1) \\ x_2(n+1) \\ x_3(n+1) \\ x_4(n+1) \end{bmatrix} = \begin{bmatrix} q_1 & 0 & 0 & 0 \\ p_1 & q_2 & 0 & 0 \\ 0 & p_2 & q_3 & 0 \\ 0 & 0 & p_3 & q_4 \end{bmatrix} \begin{bmatrix} x_1(n) \\ x_2(n) \\ x_3(n) \\ x_4(n) \end{bmatrix} + \begin{bmatrix} u(n) \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

- This model features two distinct probabilities
 - The q_i parameters give probability of staying in the i th group
 - While the p_i values denote the probability of progression
- Constraints of the form $p_i + q_i < 1$ must be introduced

Model 3

$$\begin{bmatrix} x_1(n+1) \\ x_2(n+1) \\ x_3(n+1) \\ x_4(n+1) \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 & 0 \\ p_1 & 0 & 0 & 0 \\ 0 & p_2 & 0 & 0 \\ 0 & 0 & p_3 & q \end{bmatrix} \begin{bmatrix} x_1(n) \\ x_2(n) \\ x_3(n) \\ x_4(n) \end{bmatrix} + \begin{bmatrix} u(n) \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

- The matrix in this model has one nonzero entry on its diagonal
- The groups are defined by the number of years a student has been in school
- The p_i values denote probability of enrolling during next year

Model 4

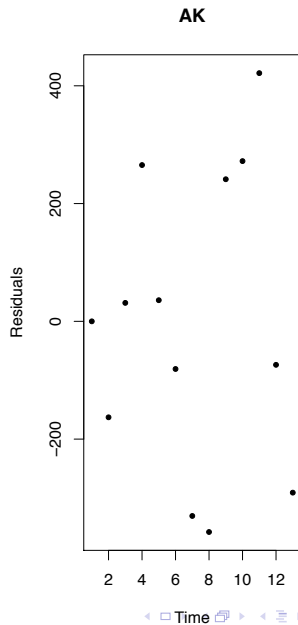
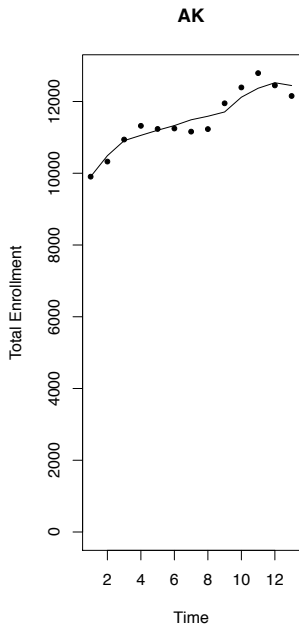
- The groups in Model 4 also describe a student age by number of years in school
- Also features an immigration term for students of age one, two and three

$$\begin{bmatrix} x_1(n+1) \\ x_2(n+1) \\ x_3(n+1) \\ x_4(n+1) \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 & 0 \\ p_1 & 0 & 0 & 0 \\ 0 & p_2 & 0 & 0 \\ 0 & 0 & p_3 & q \end{bmatrix} \begin{bmatrix} x_1(n) \\ x_2(n) \\ x_3(n) \\ x_4(n) \end{bmatrix} + \begin{bmatrix} \alpha_1 + \beta_1 n \\ \alpha_2 + \beta_2 n \\ \alpha_3 + \beta_3 n \\ 0 \end{bmatrix}$$

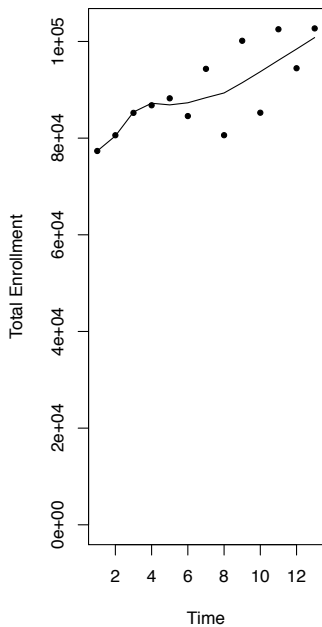
Model 5

$$\begin{bmatrix} x_1(n+1) \\ x_2(n+1) \\ x_3(n+1) \\ x_4(n+1) \end{bmatrix} = \begin{bmatrix} q_1 & 0 & 0 & 0 \\ p_1 & q_2 & 0 & 0 \\ 0 & p_2 & q_3 & 0 \\ 0 & 0 & p_3 & q_4 \end{bmatrix} \begin{bmatrix} x_1(n) \\ x_2(n) \\ x_3(n) \\ x_4(n) \end{bmatrix} + \begin{bmatrix} u(n) \\ \alpha_2 + \beta_2 n \\ \alpha_3 + \beta_3 n \\ 0 \end{bmatrix}$$

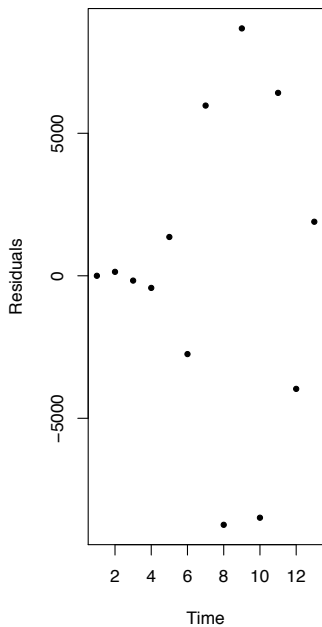
- Model 5 is a hybrid of Models 2 and 4
- Incorporates input data for freshman numbers and linear immigration



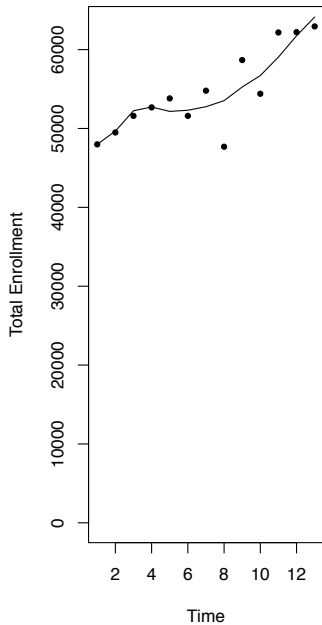
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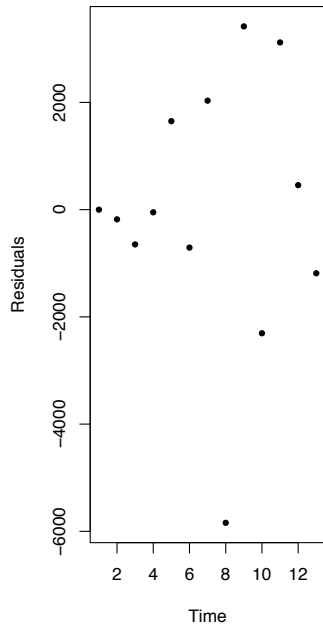
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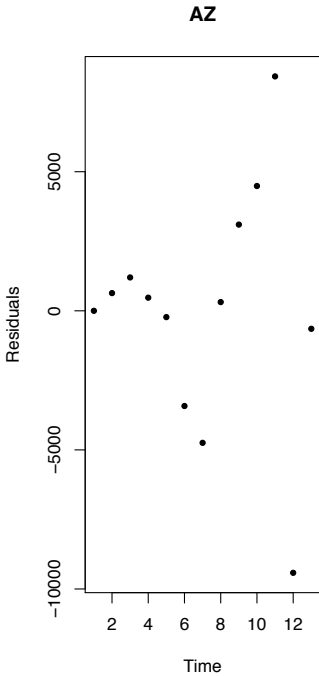
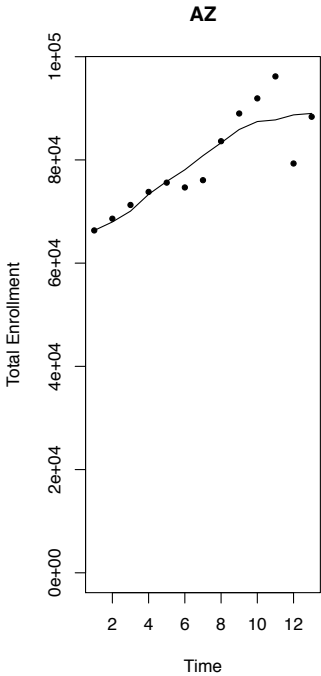


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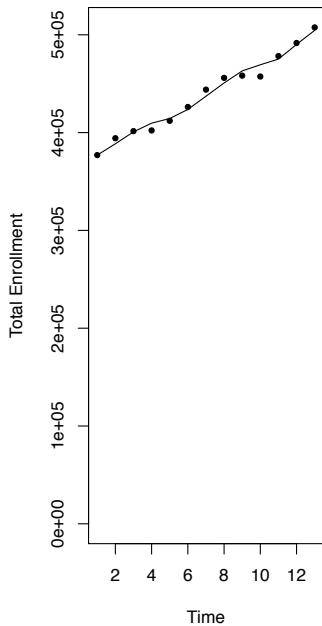


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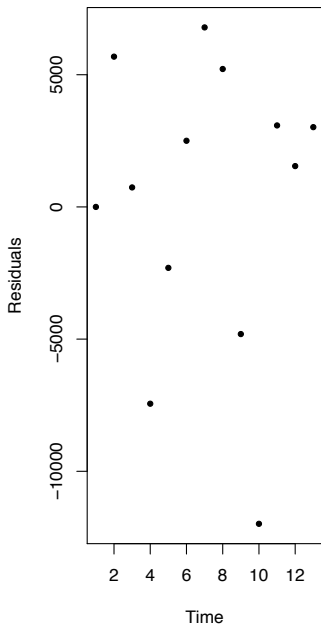




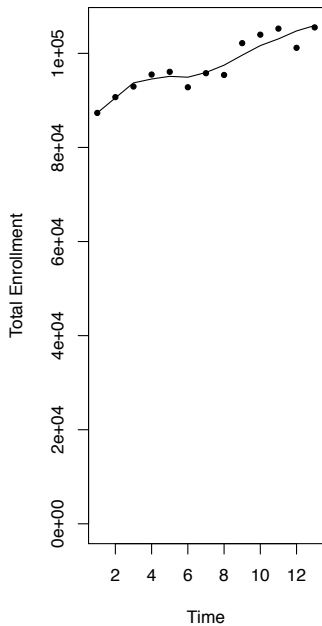
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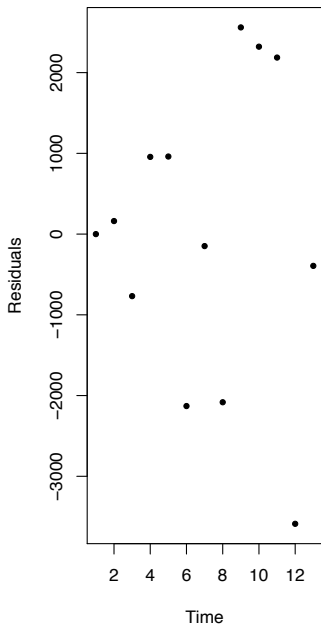
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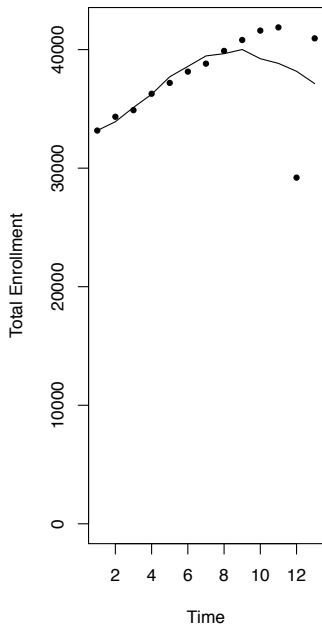
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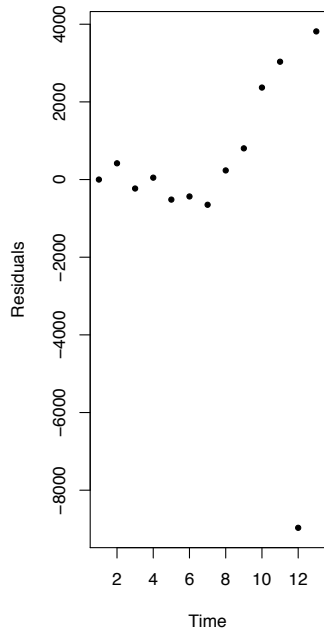
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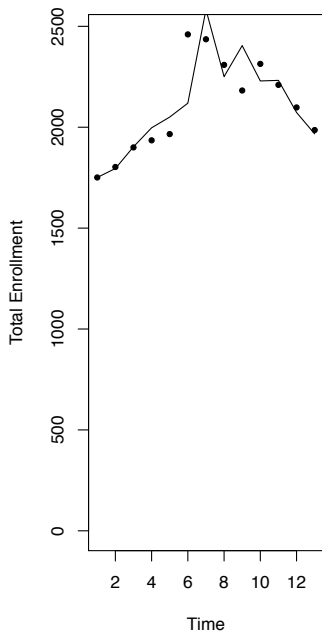
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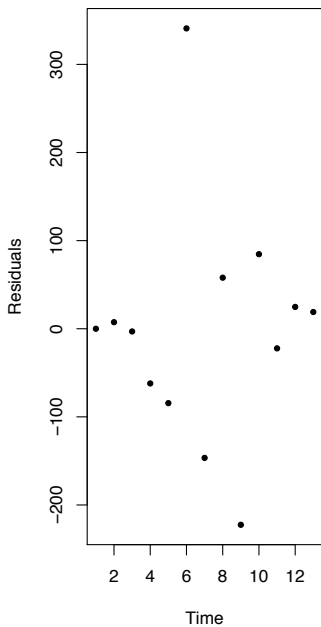
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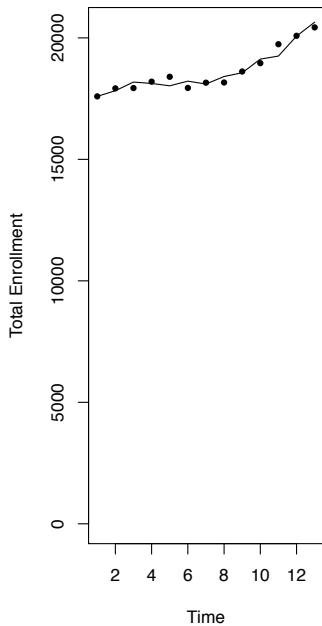
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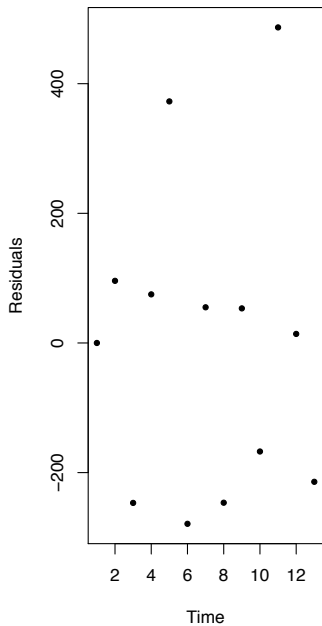
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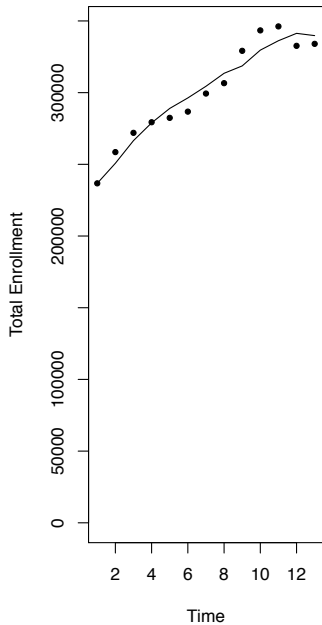
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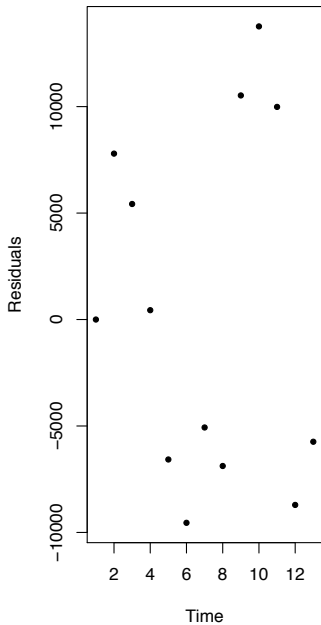
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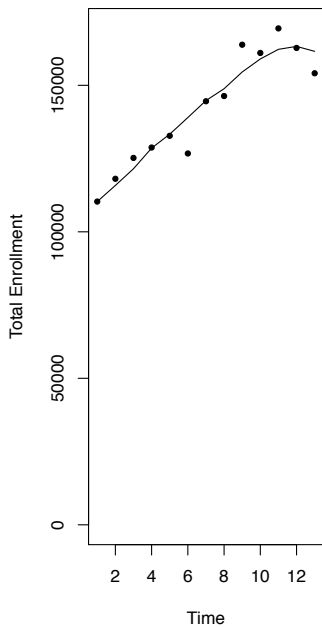
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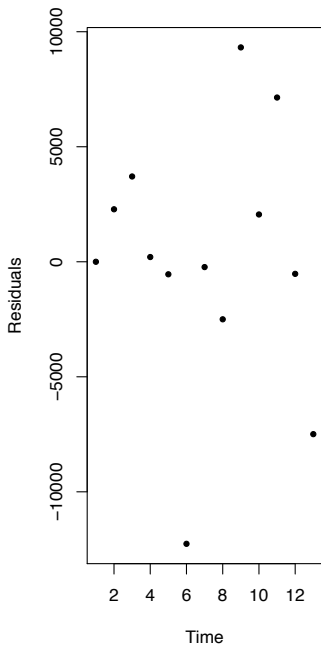
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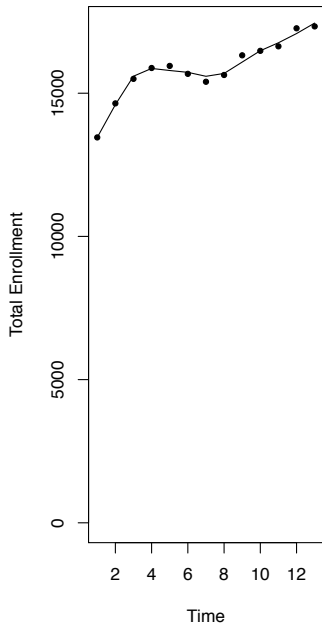
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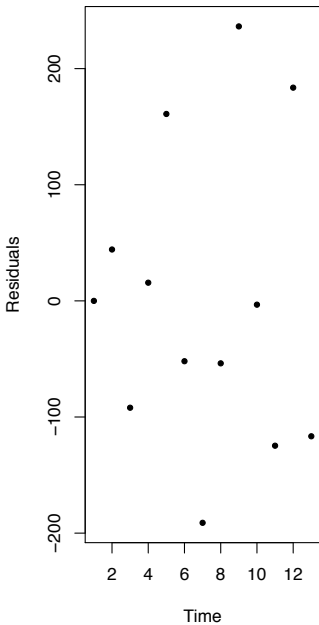
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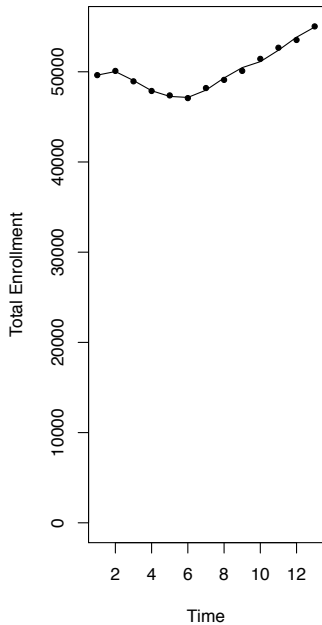
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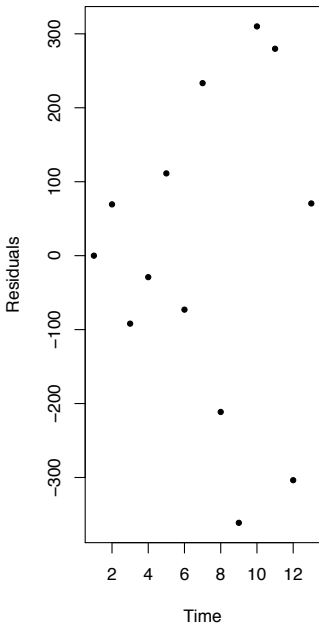
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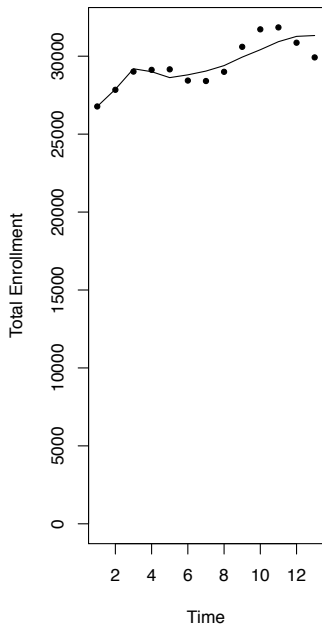
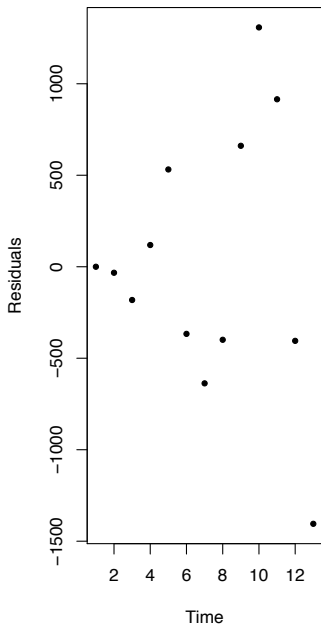


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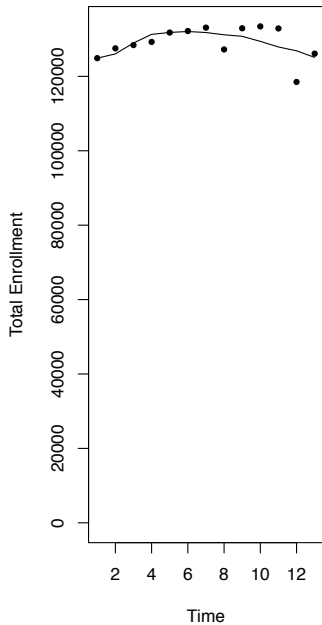


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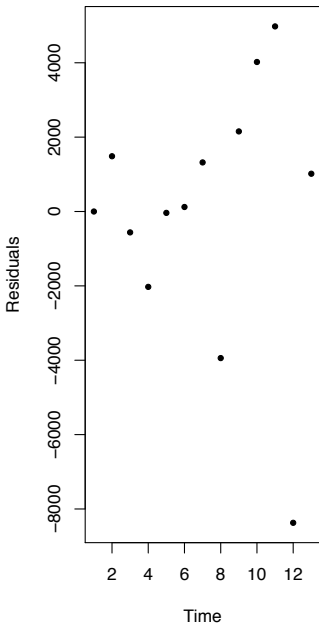


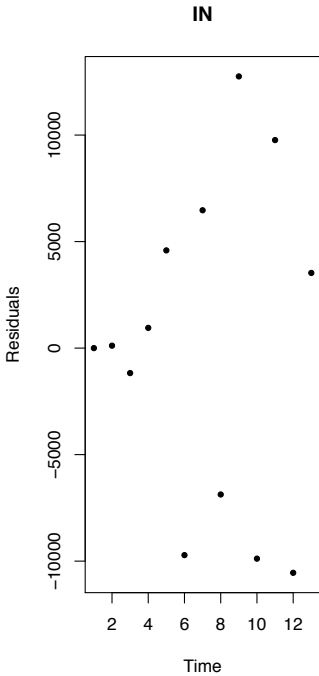
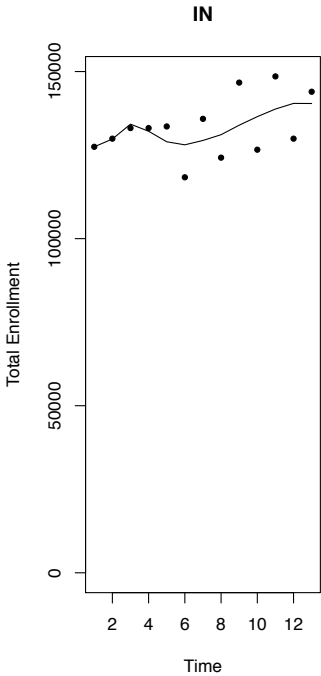
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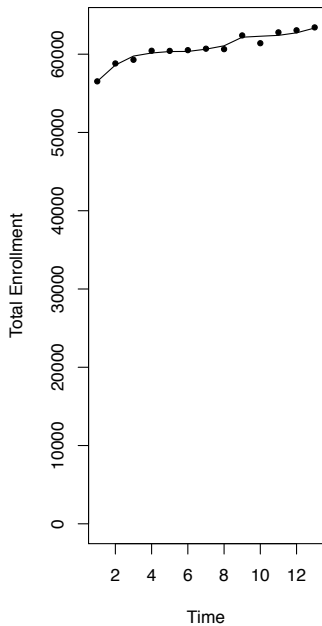


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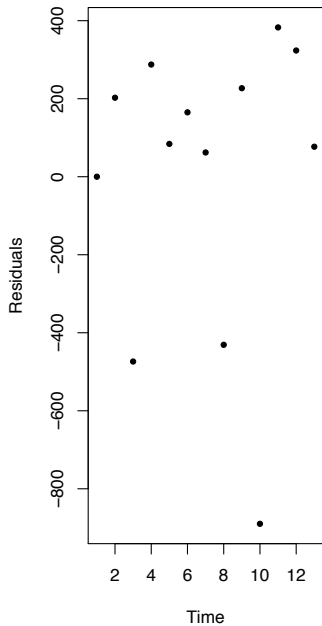




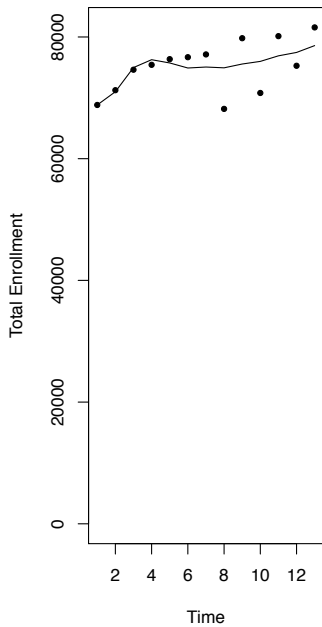
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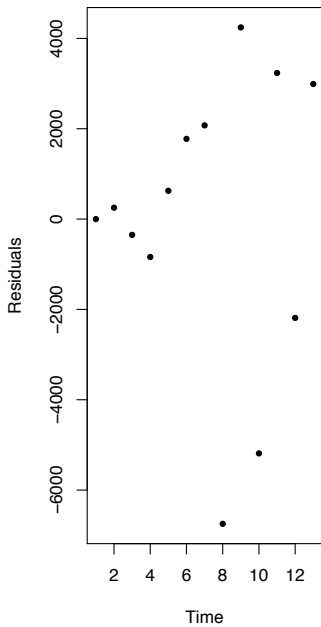
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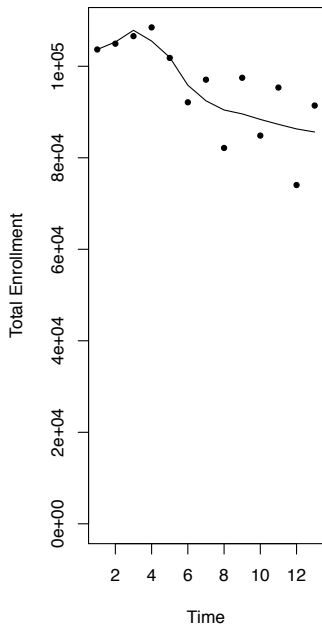
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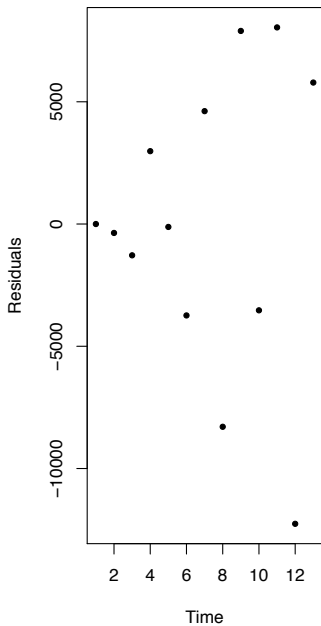
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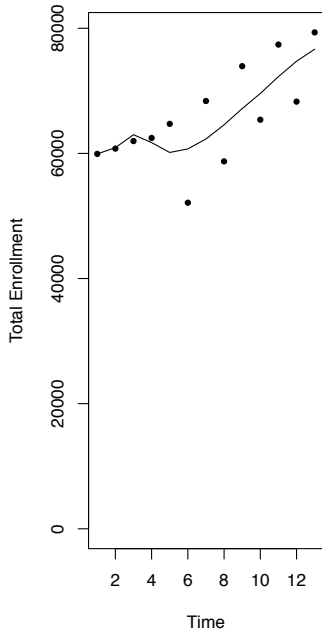
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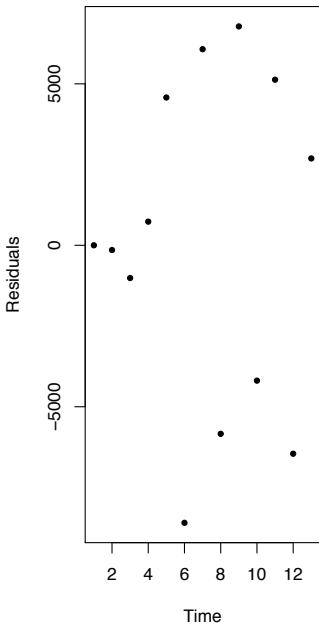
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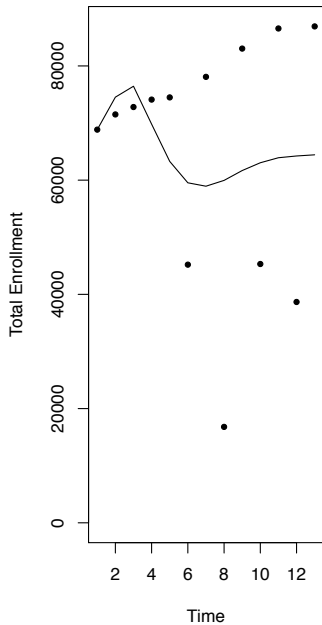
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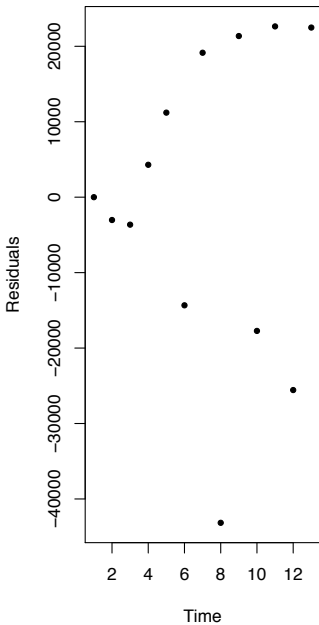
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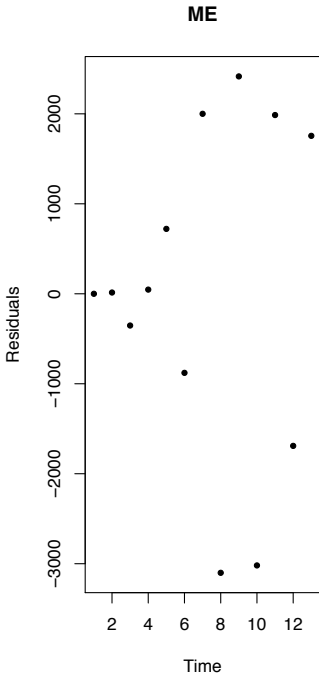
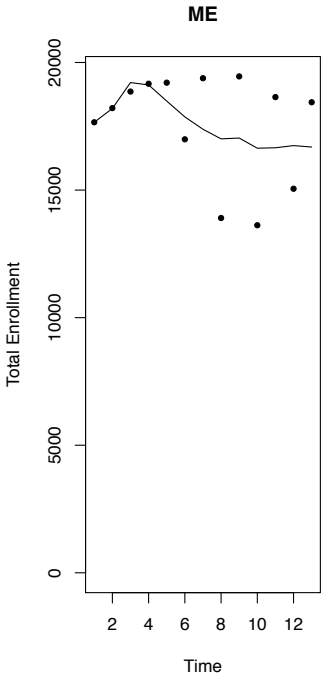


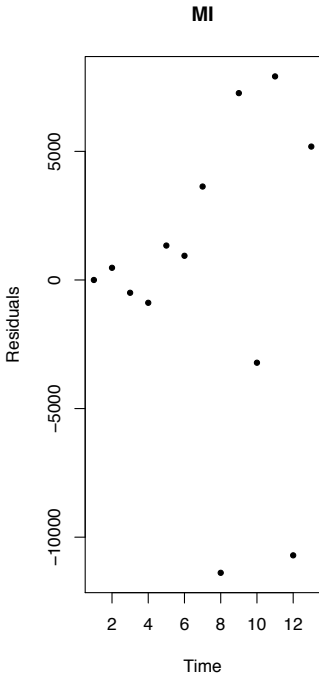
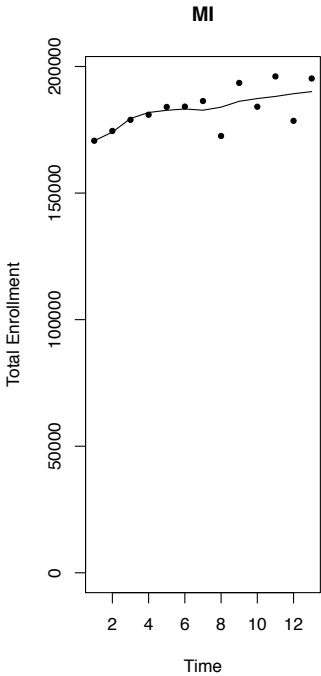
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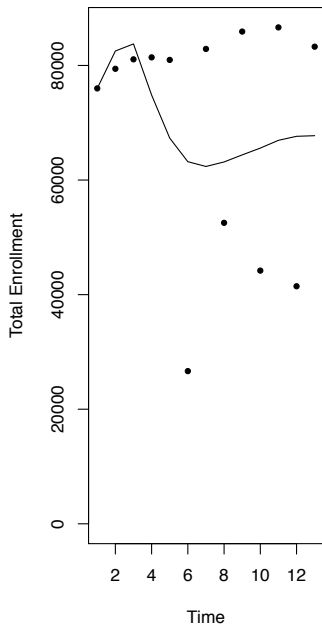
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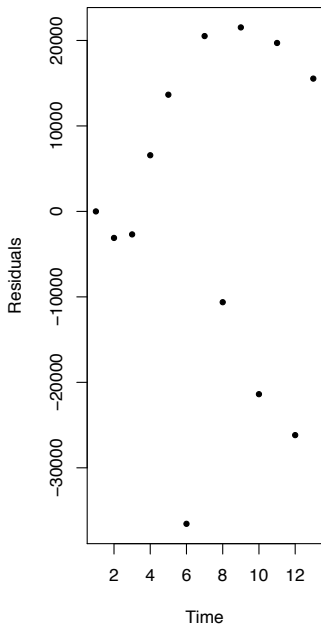




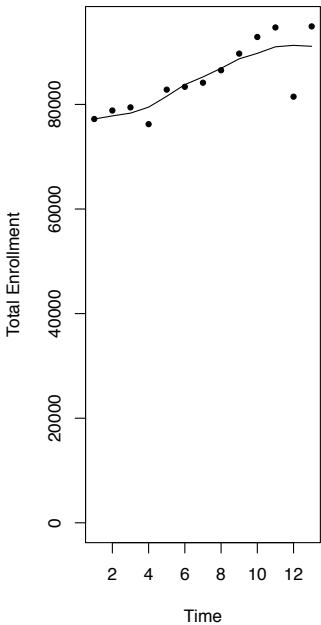
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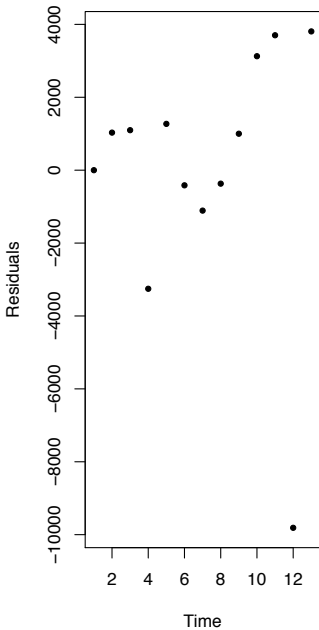
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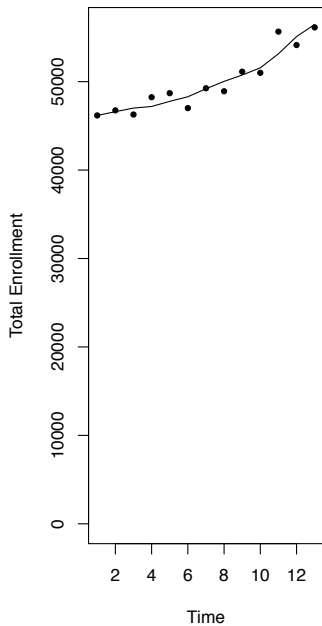
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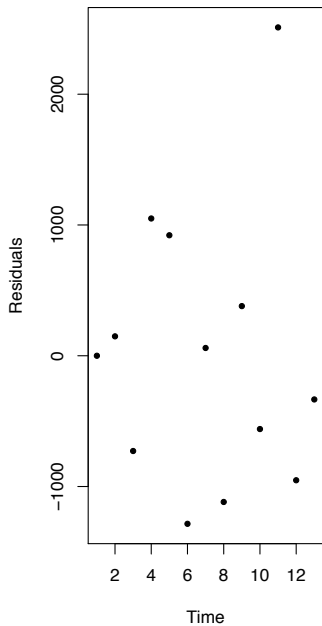
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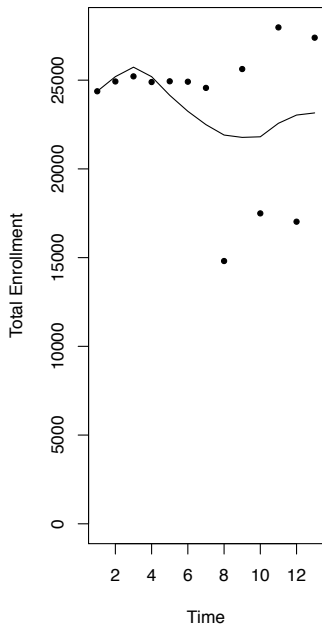
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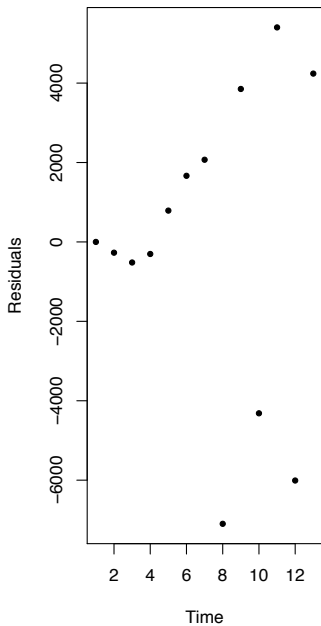
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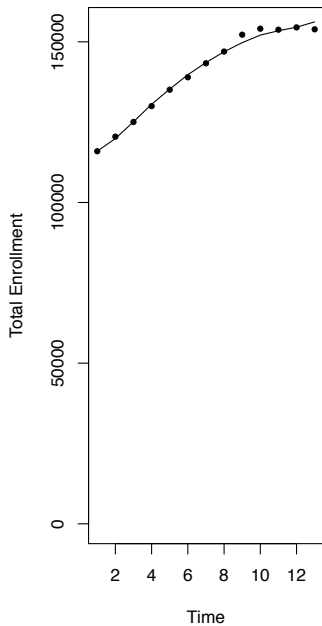
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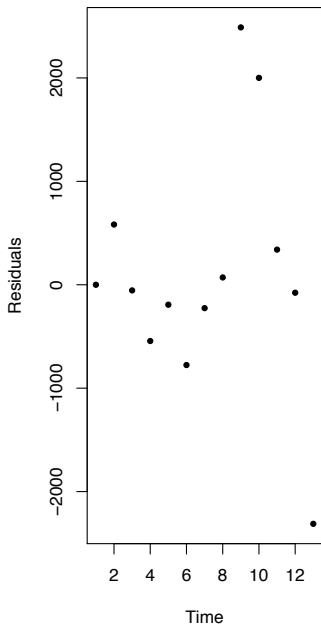
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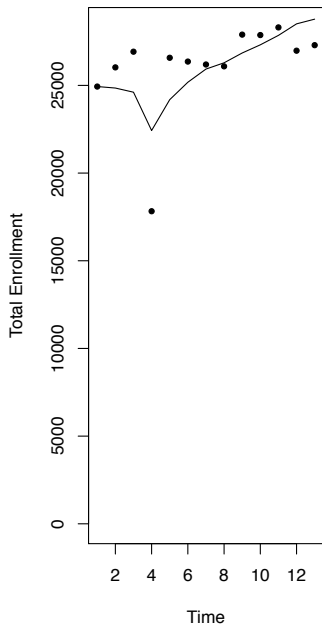
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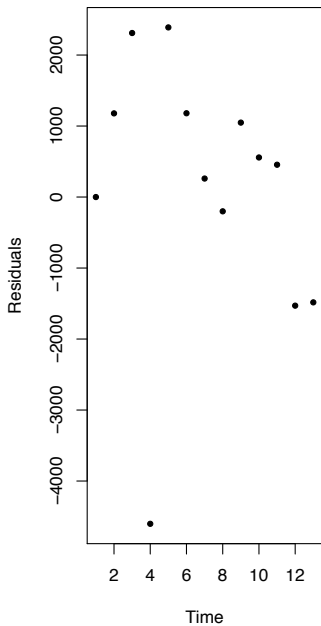
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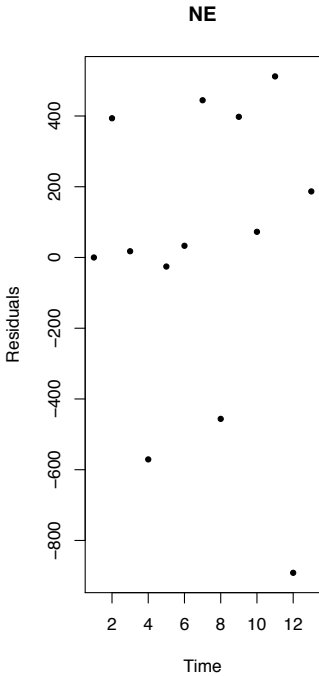
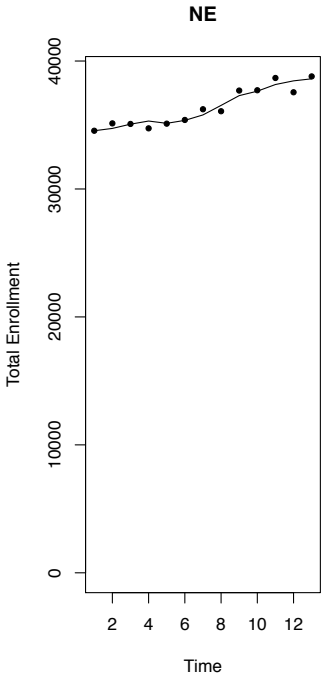


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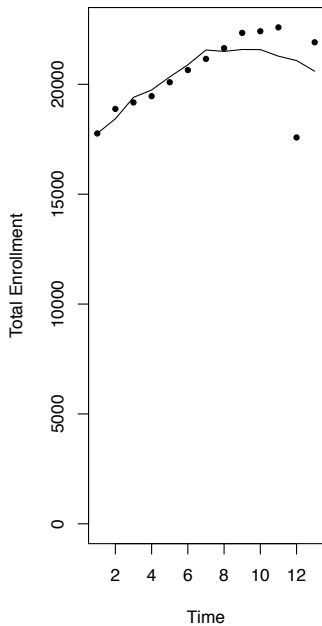


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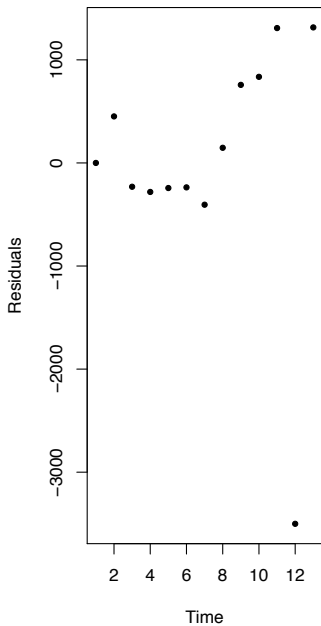




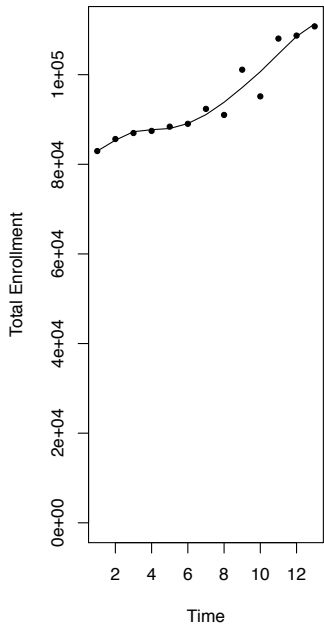
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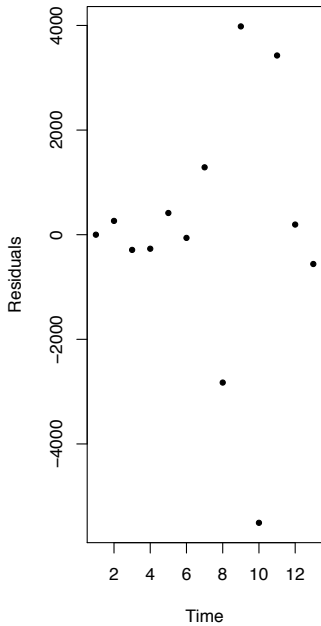
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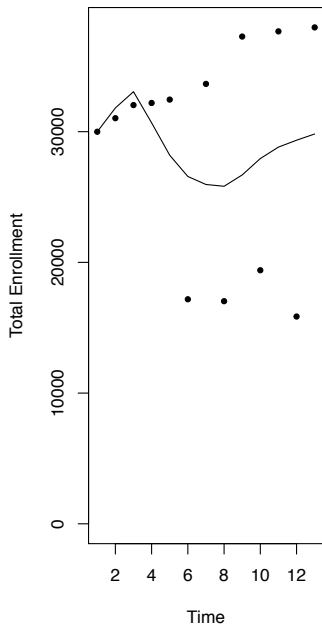
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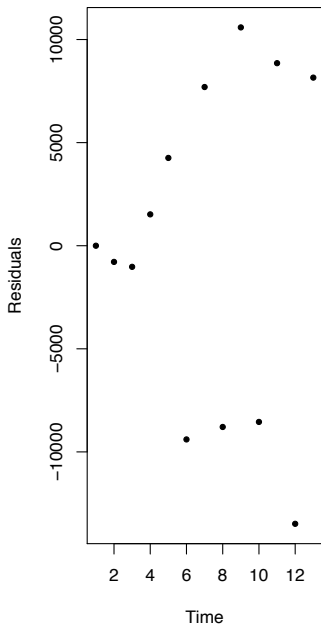
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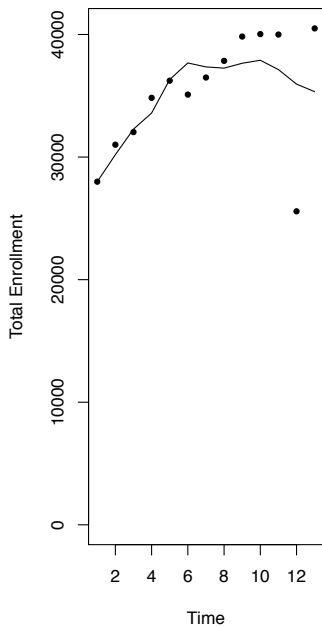
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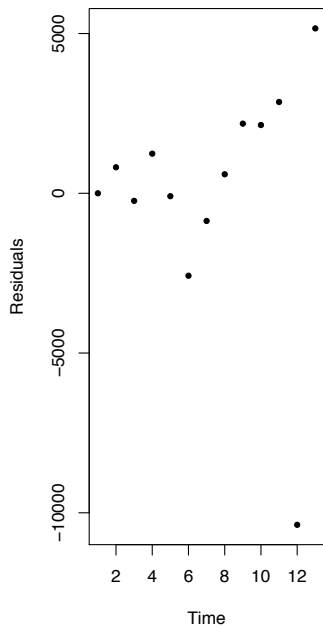
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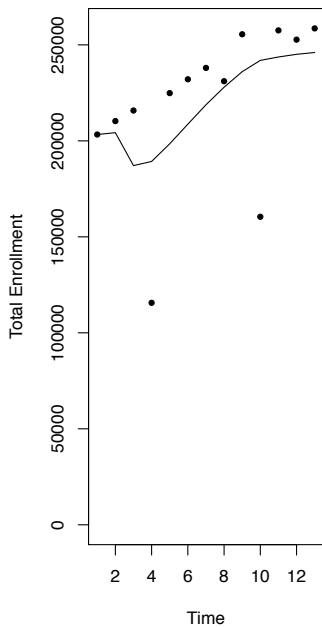
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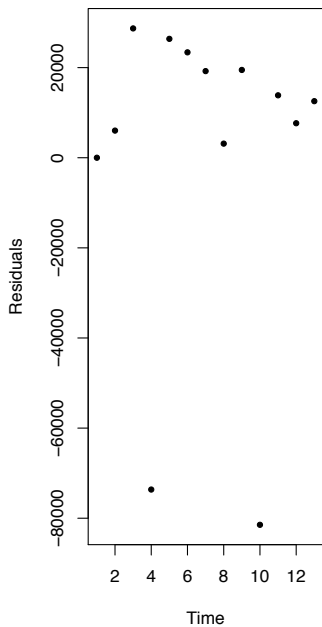
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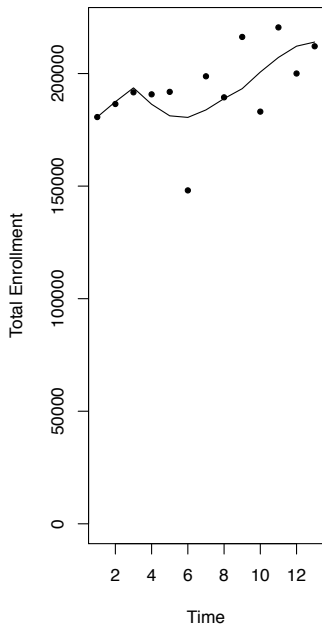
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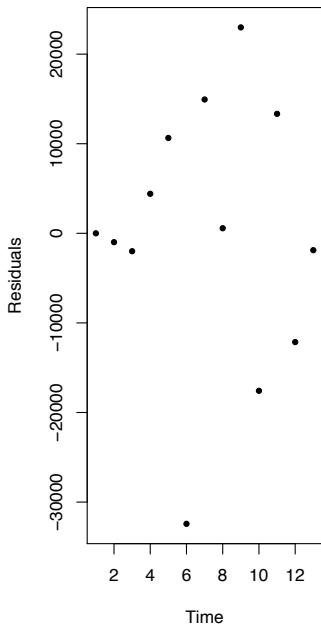
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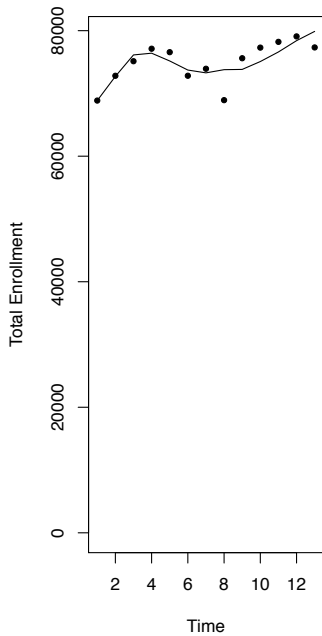
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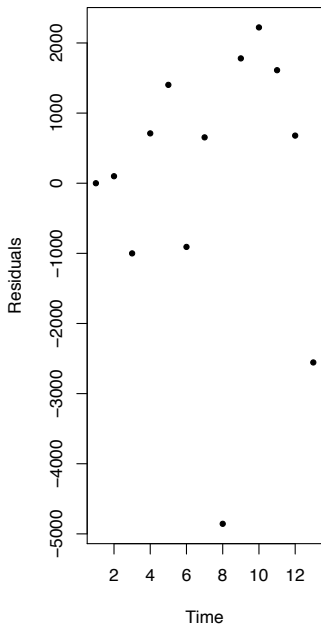
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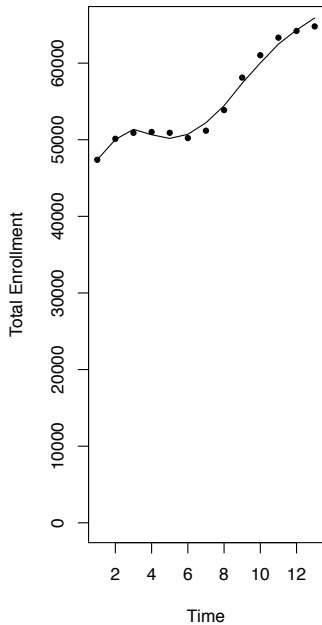
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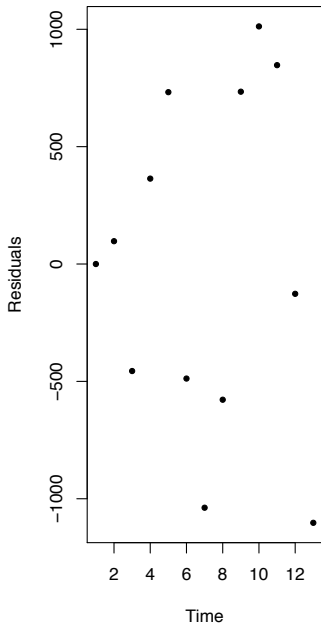
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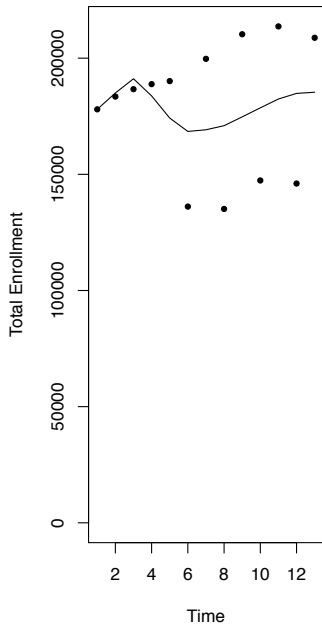
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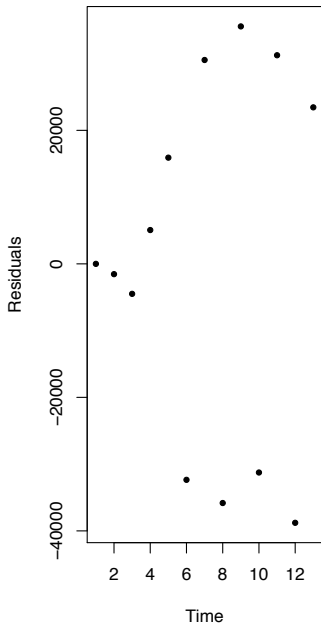
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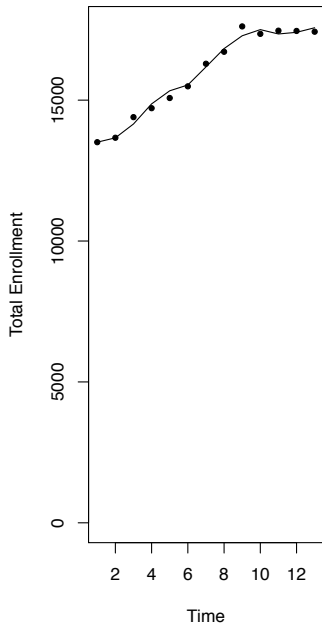
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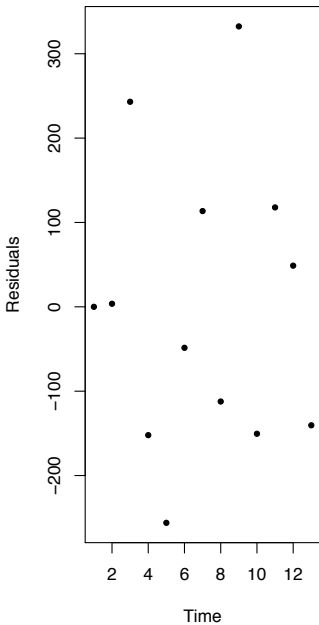
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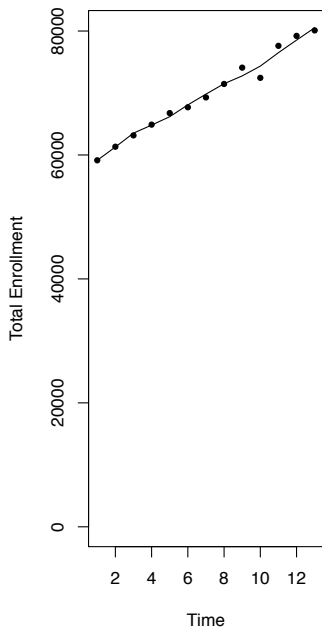
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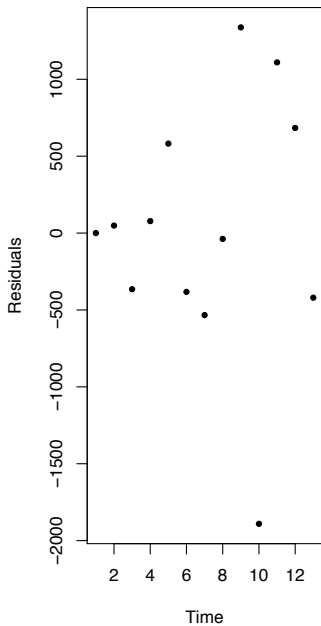
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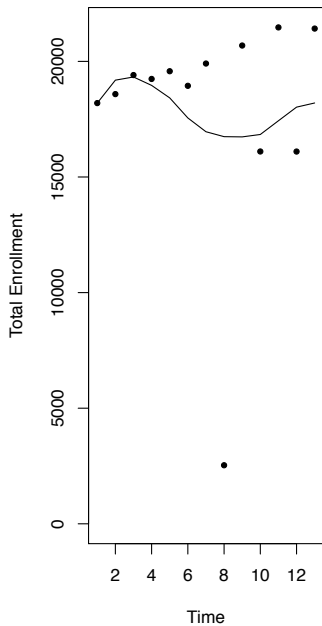
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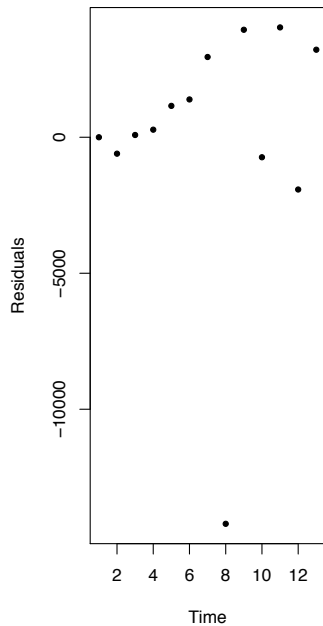
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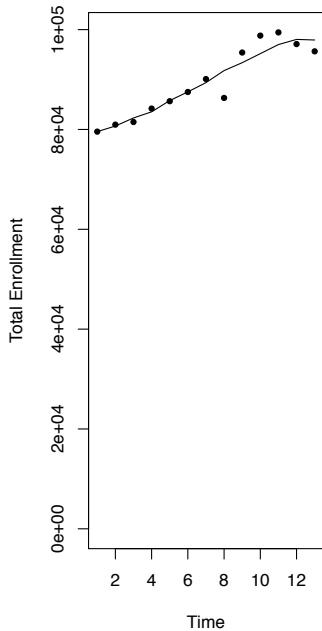
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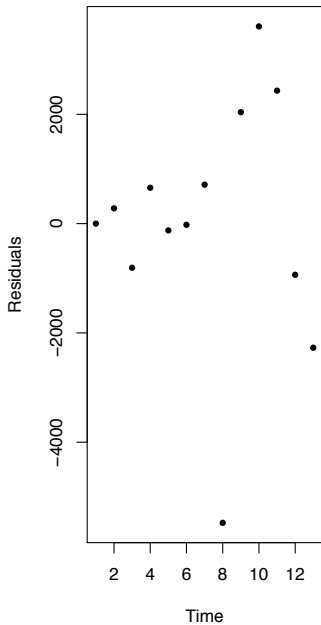
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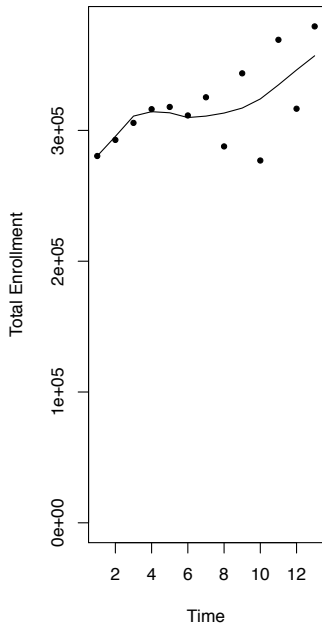
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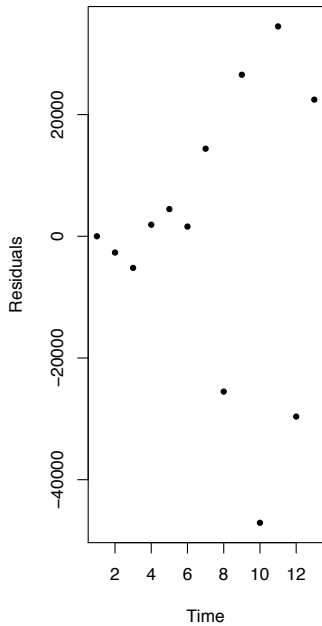
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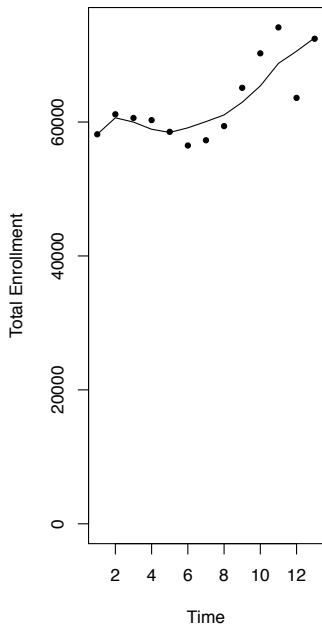
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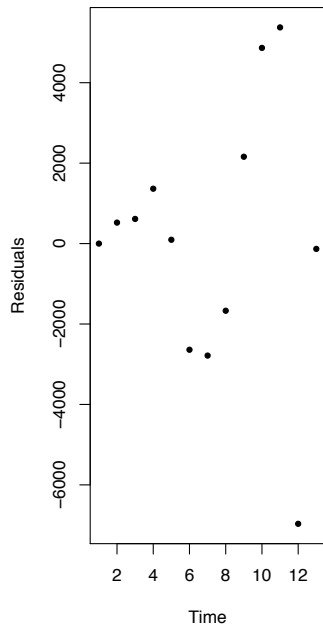
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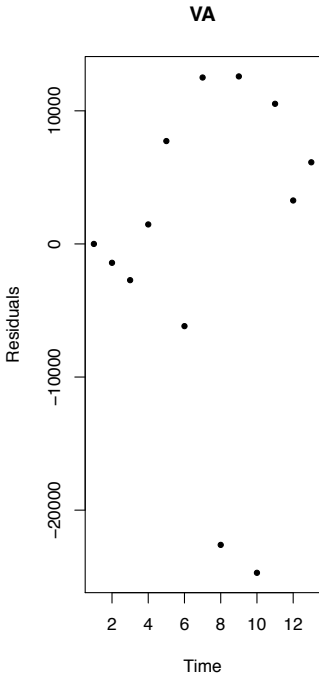
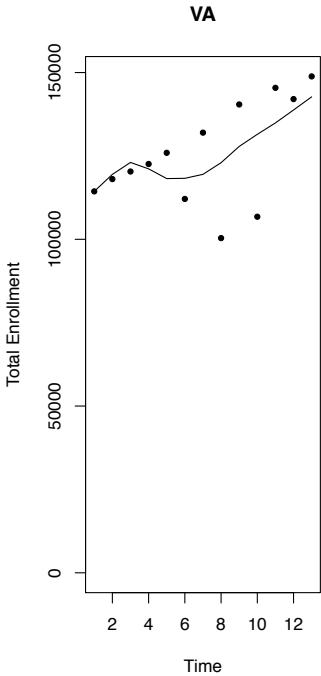


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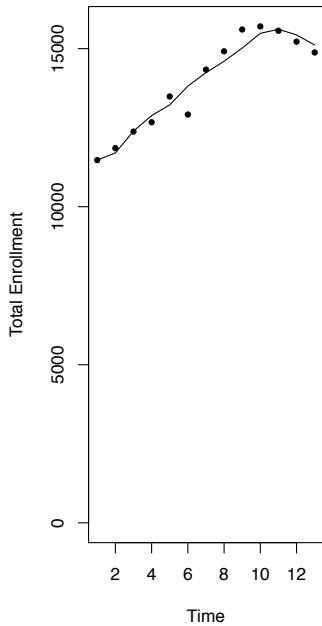


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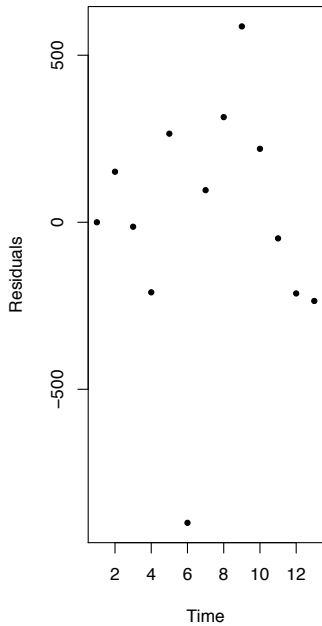




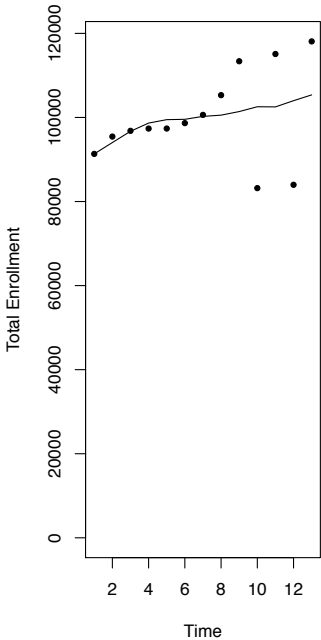
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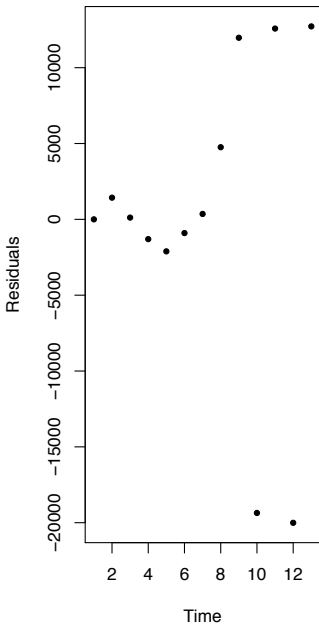
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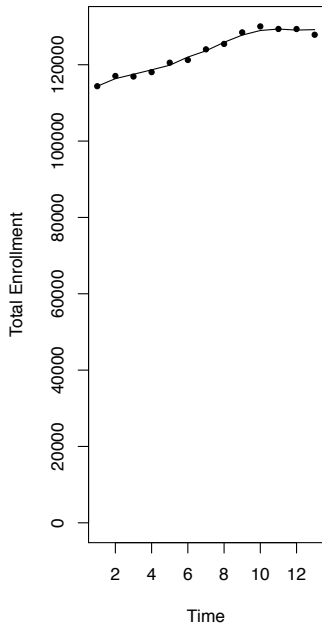
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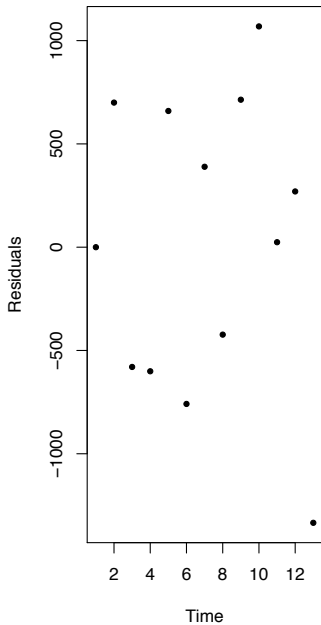
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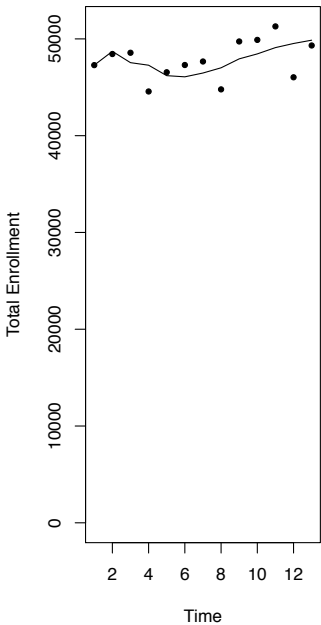
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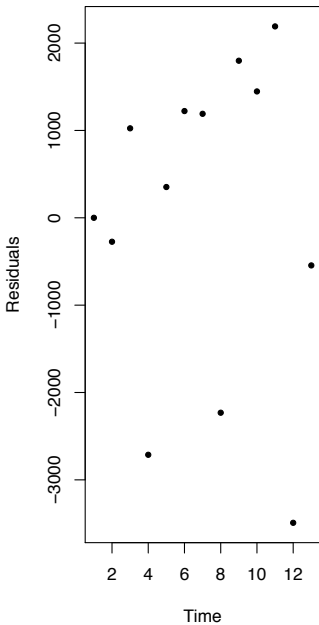
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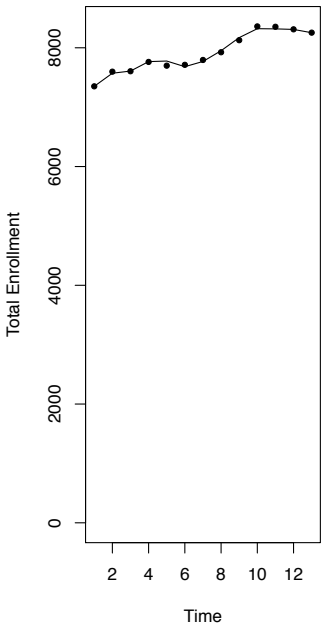
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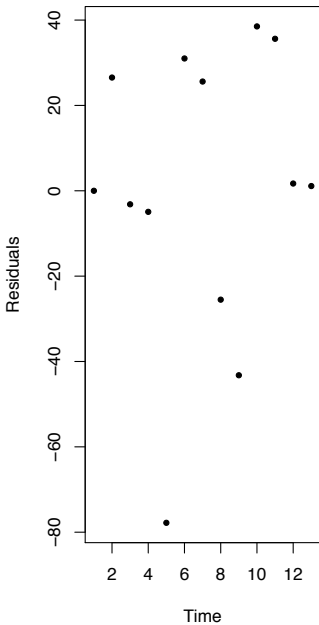
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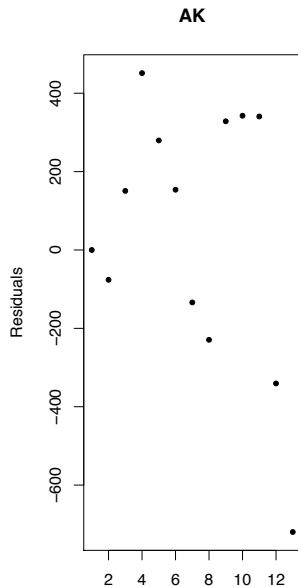
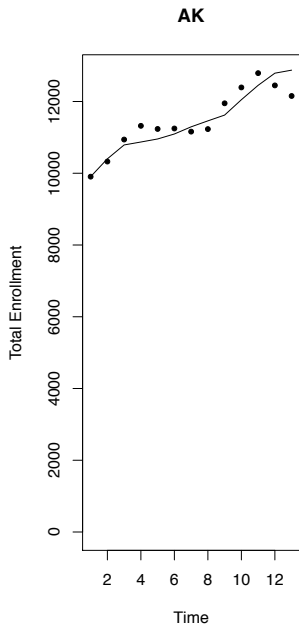


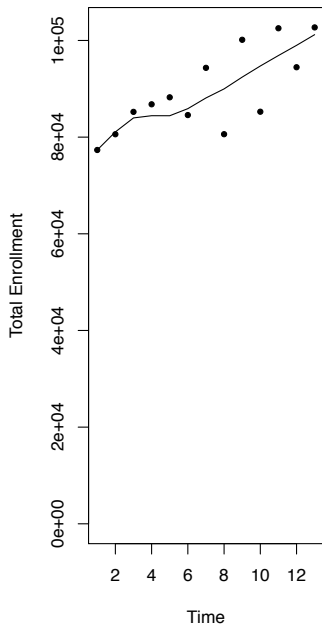
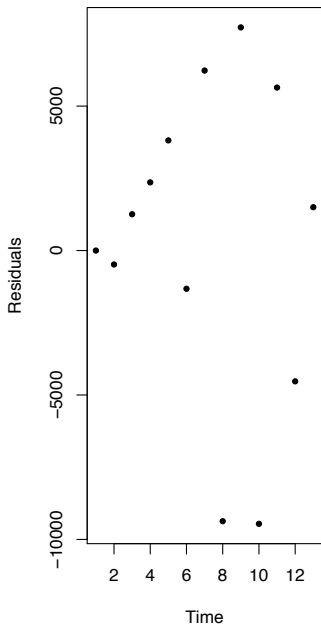
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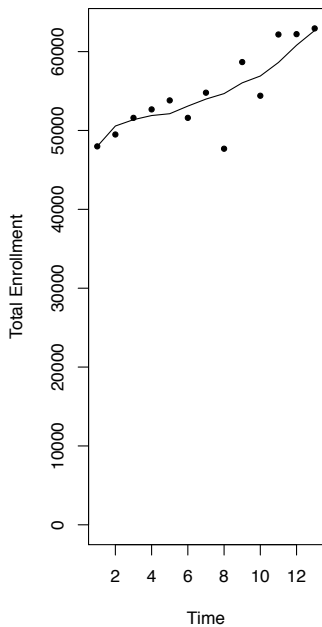
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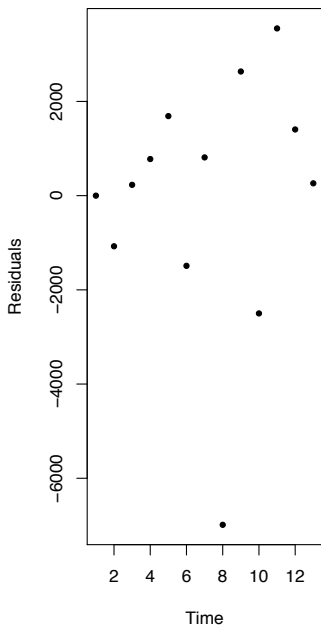


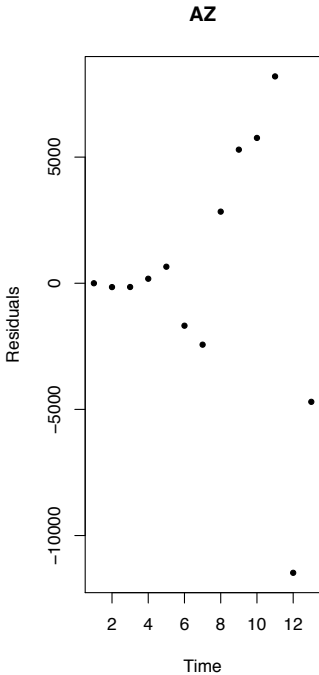
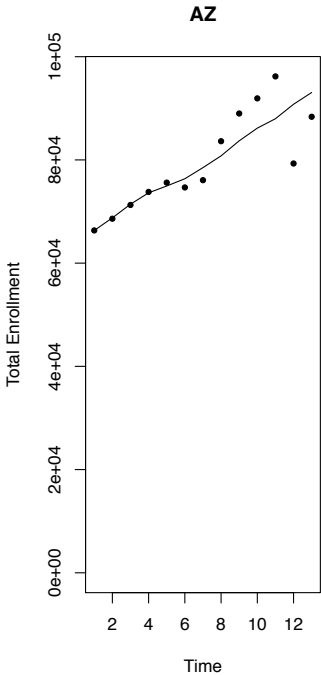
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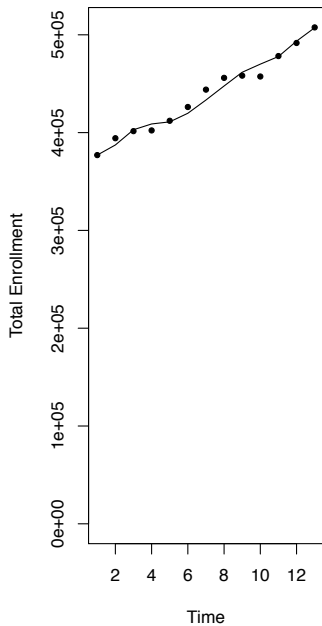


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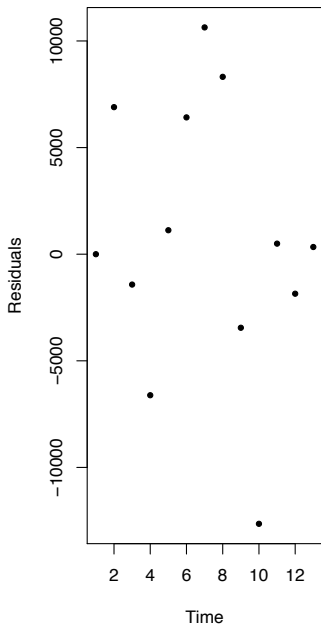




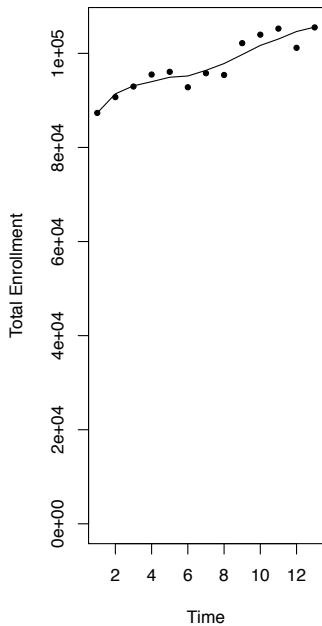
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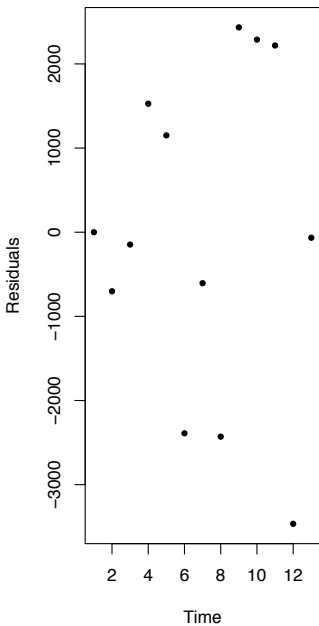
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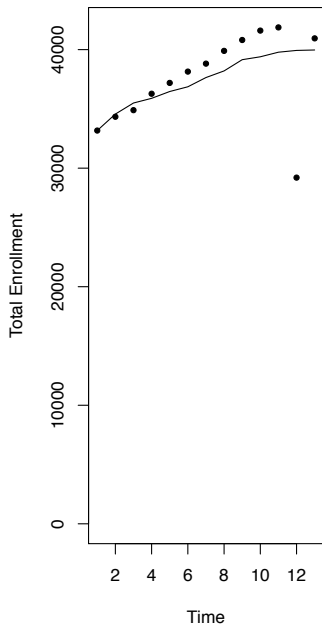
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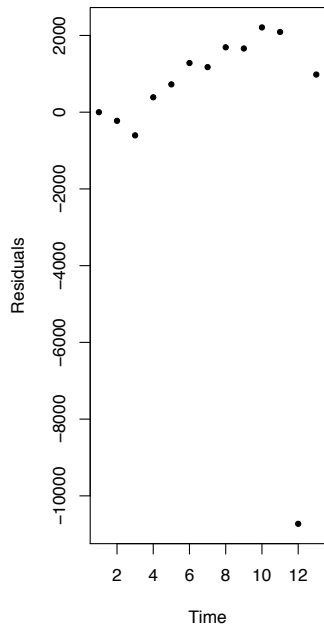
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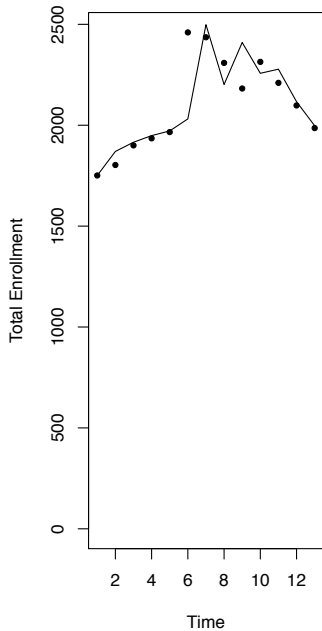
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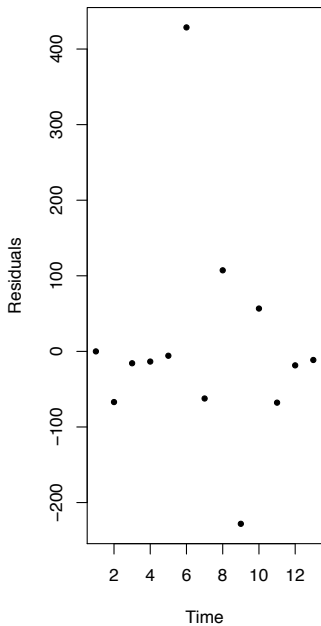
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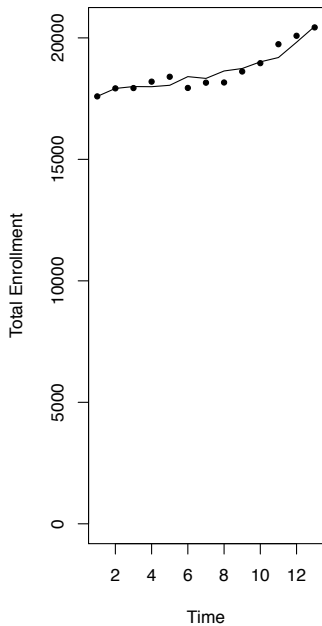
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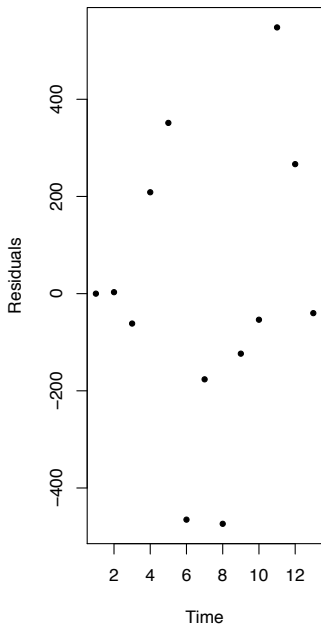
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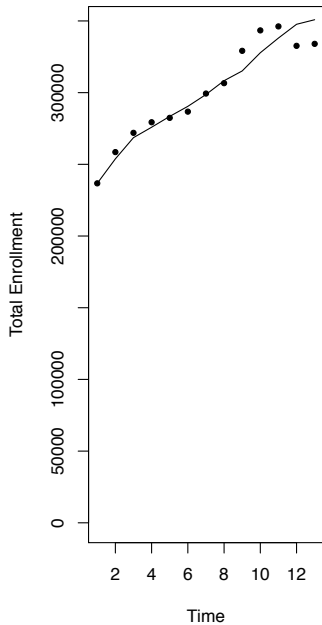
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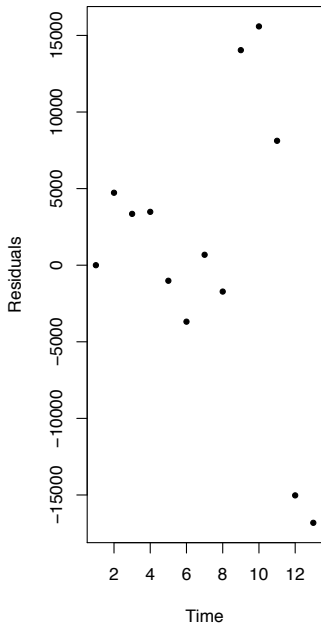
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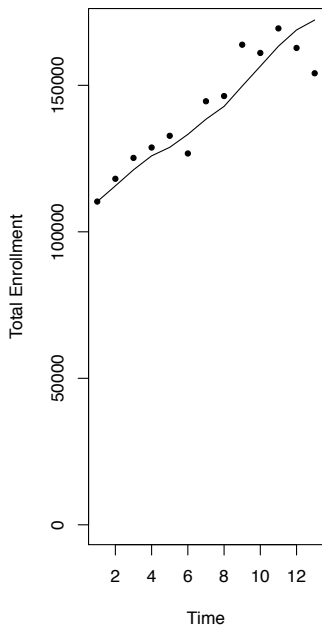
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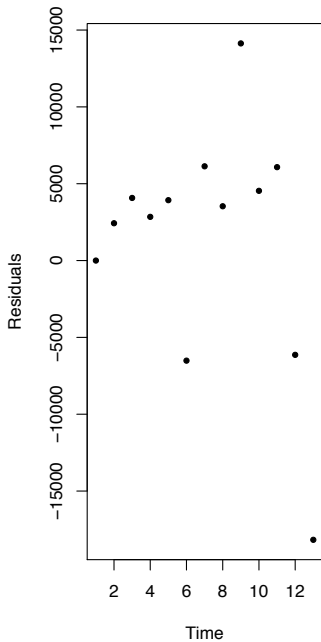
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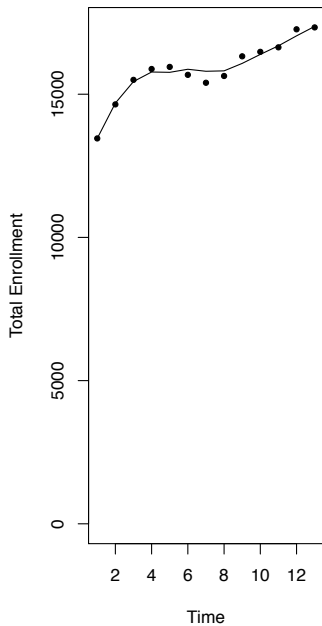
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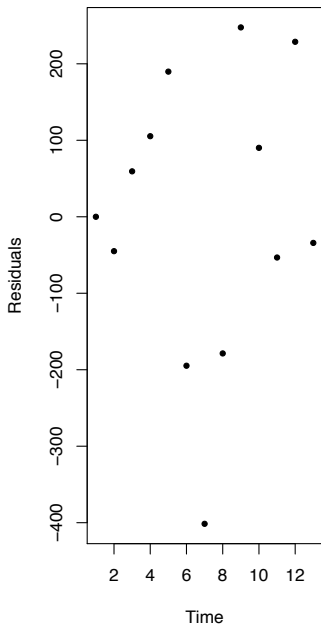
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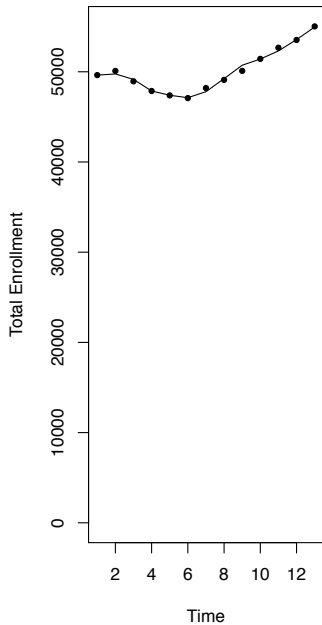
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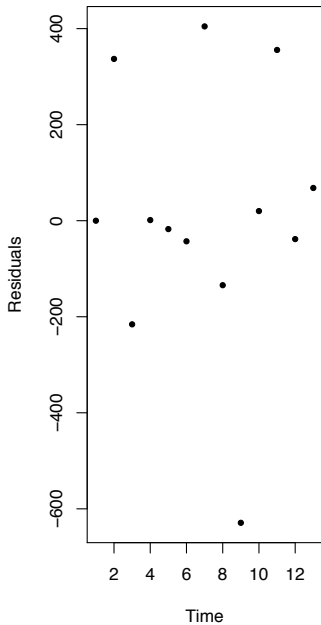
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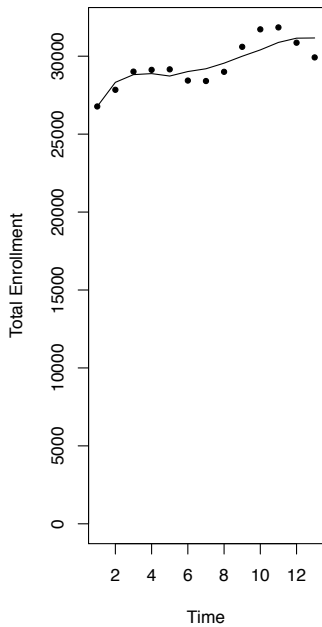
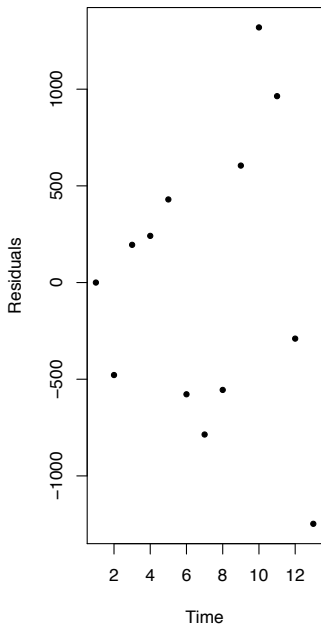


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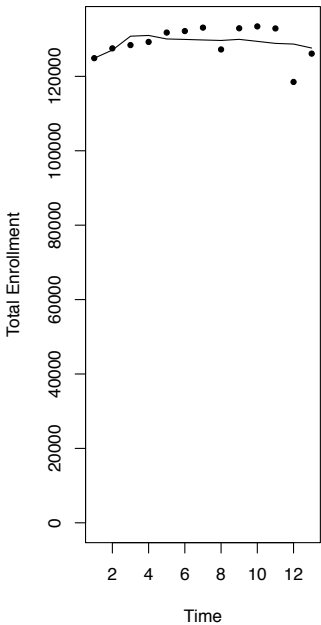


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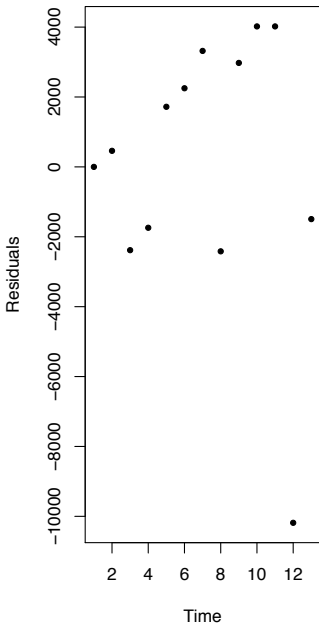


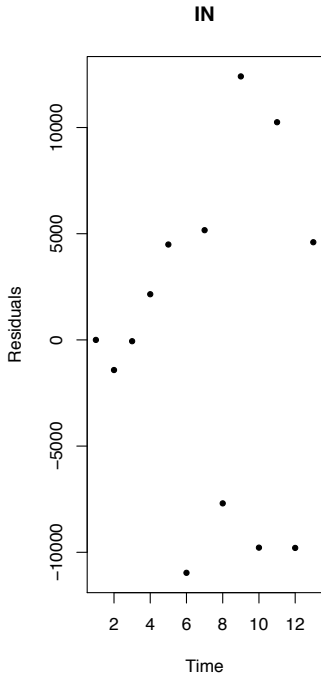
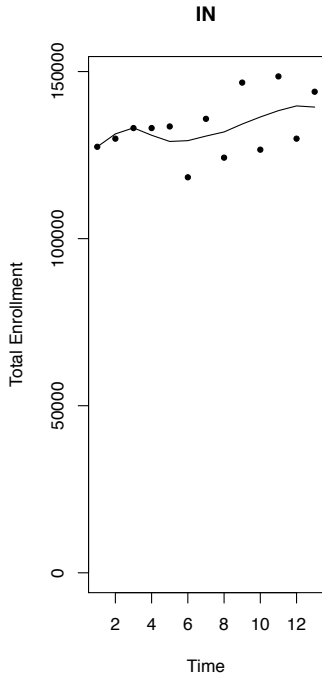
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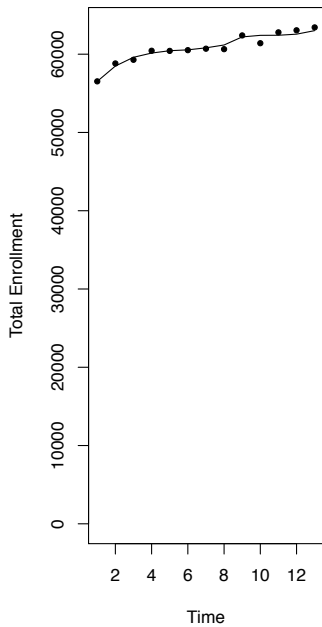


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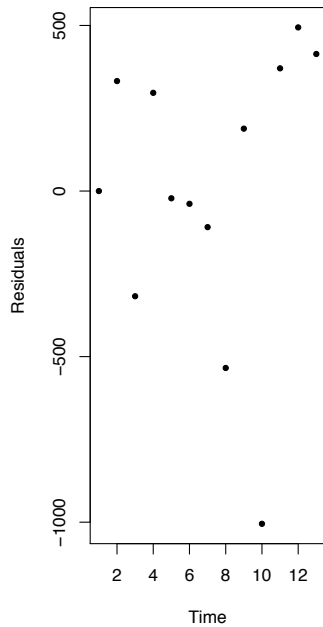




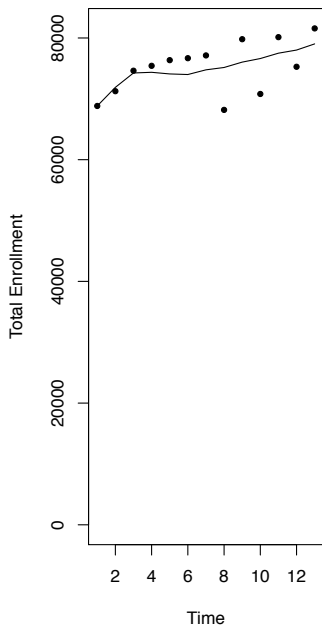
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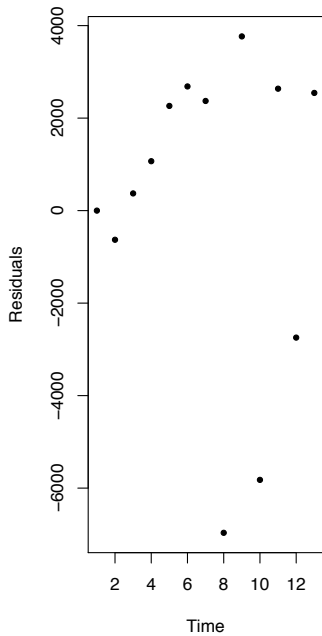
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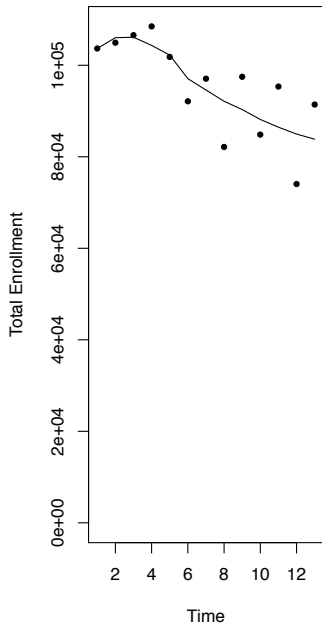
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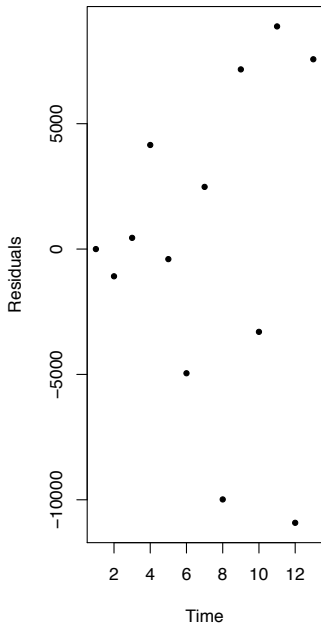
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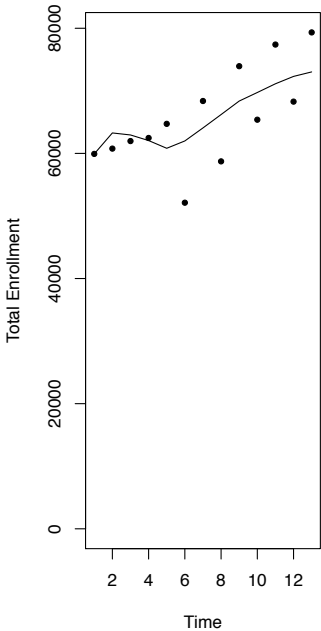
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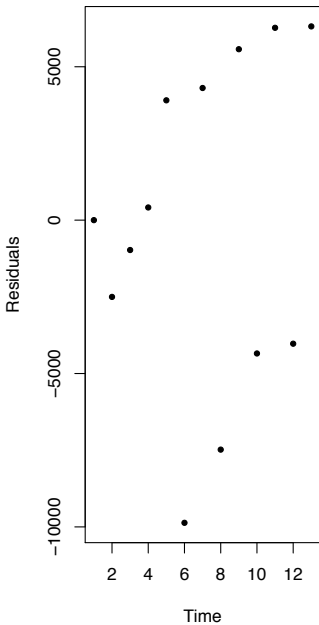
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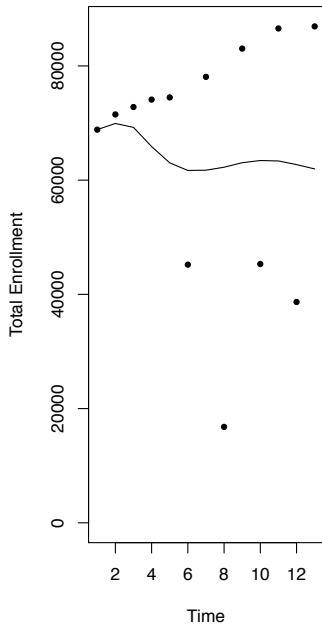
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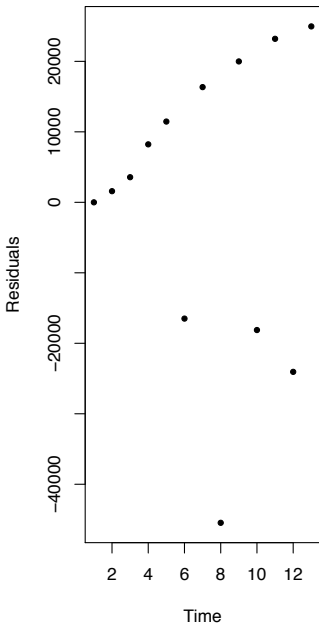
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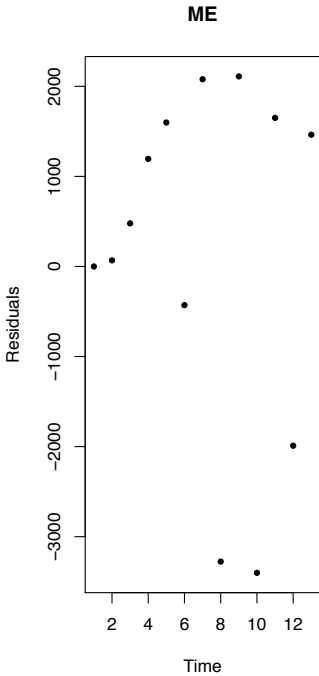
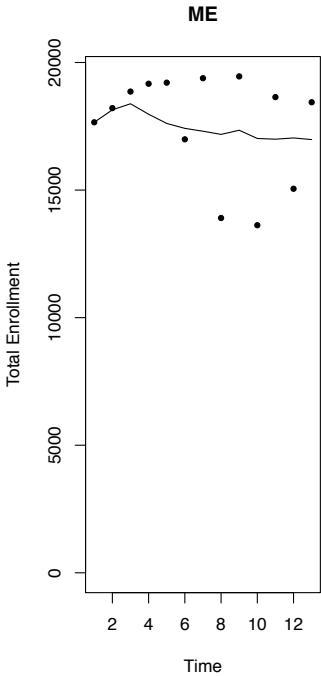


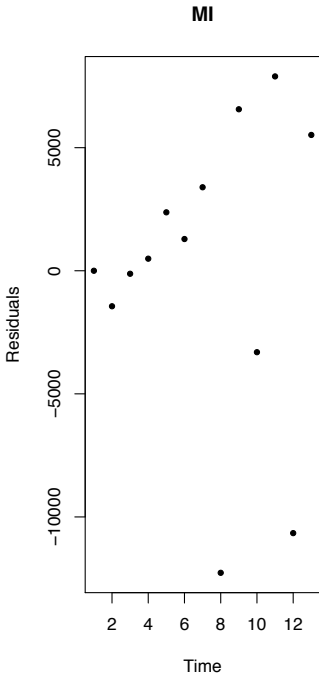
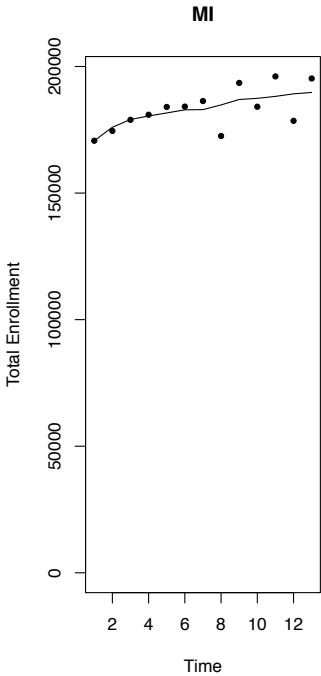
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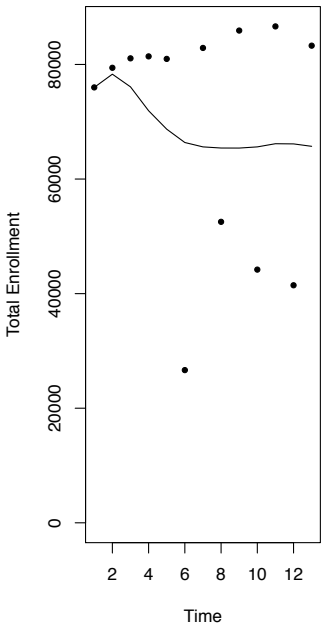
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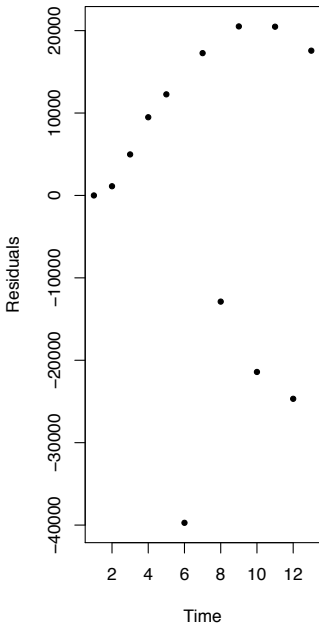




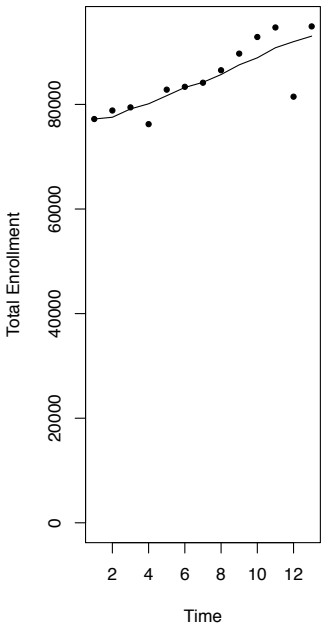
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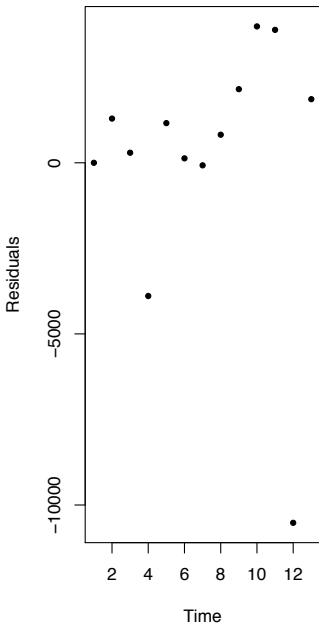
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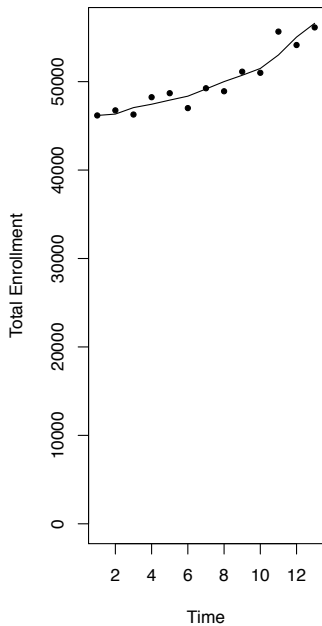
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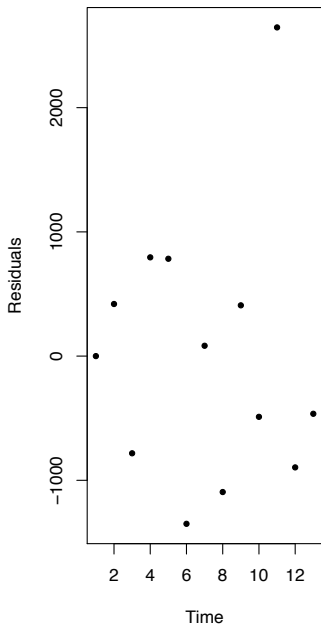
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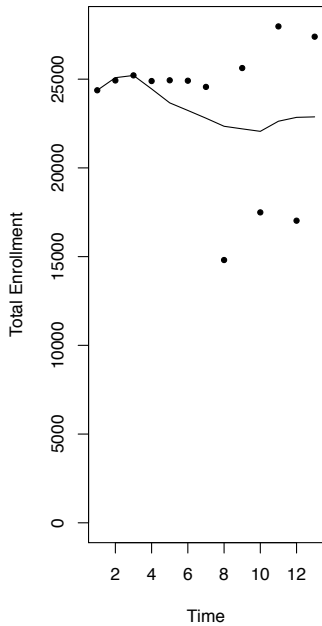
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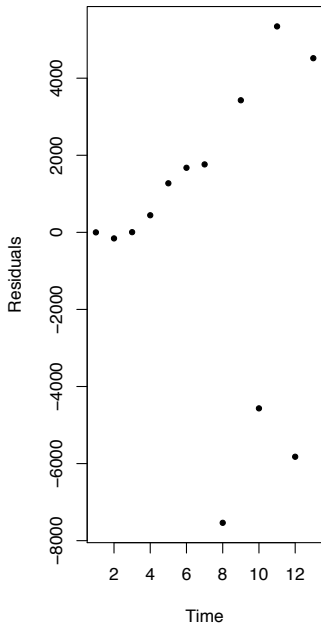
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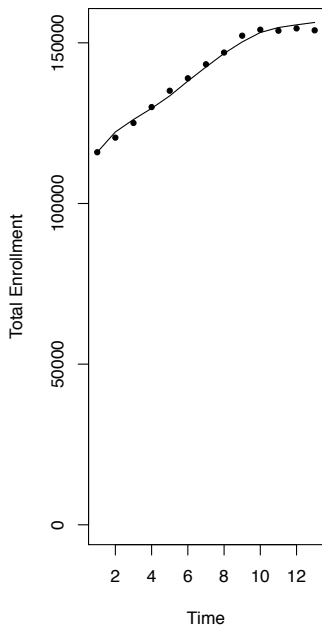
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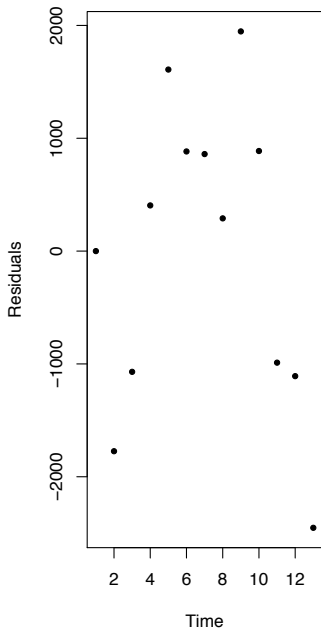
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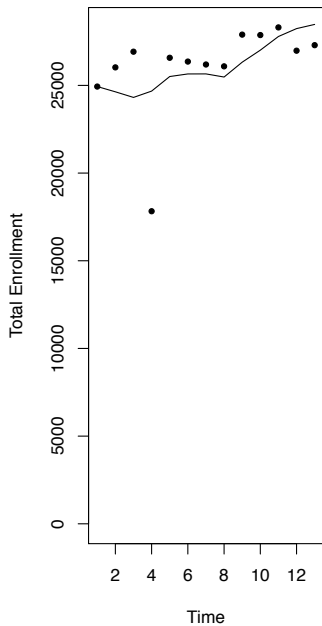
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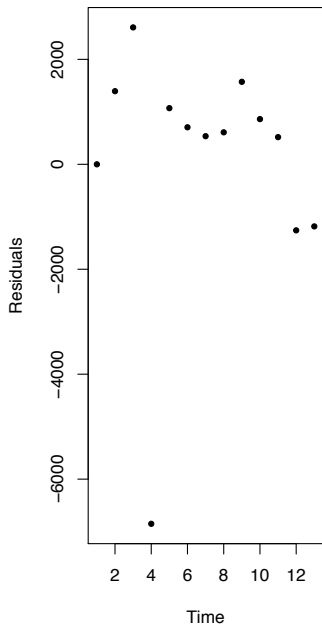
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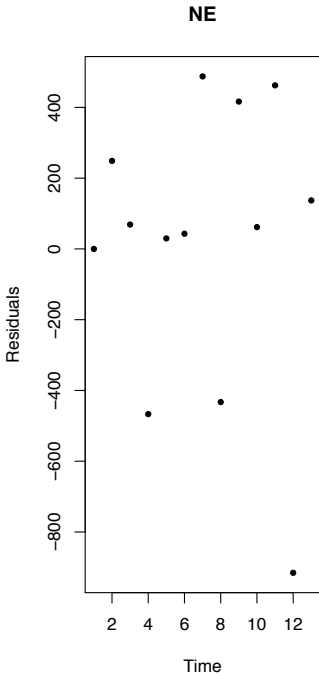
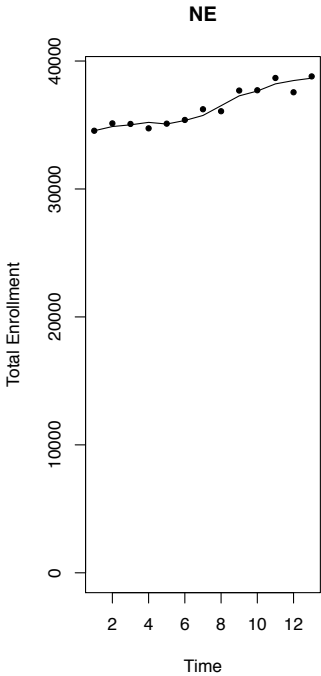


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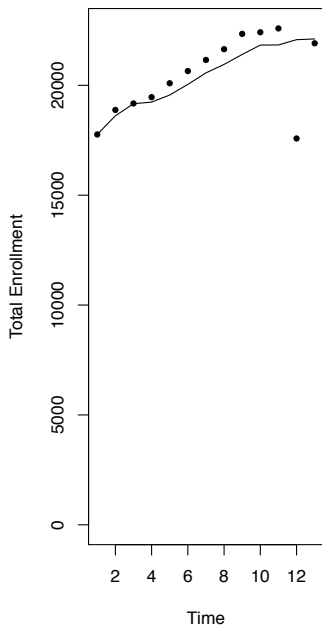


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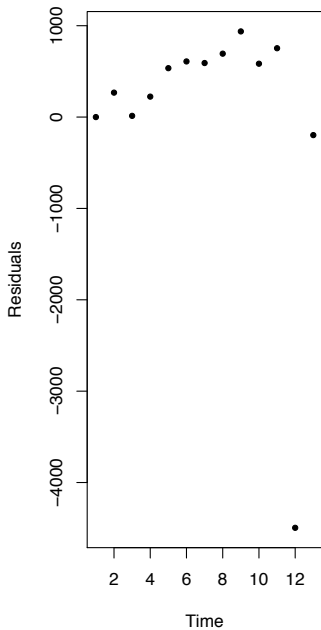




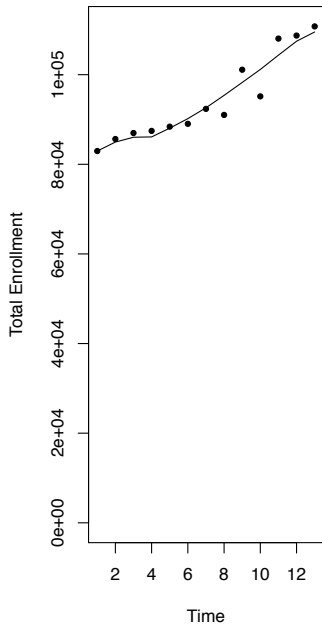
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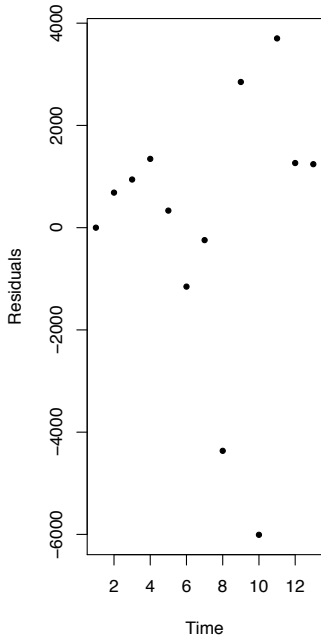
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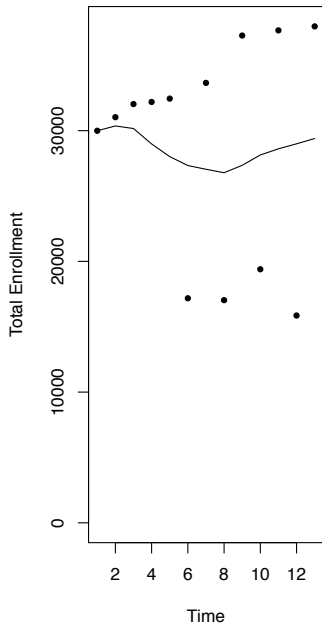
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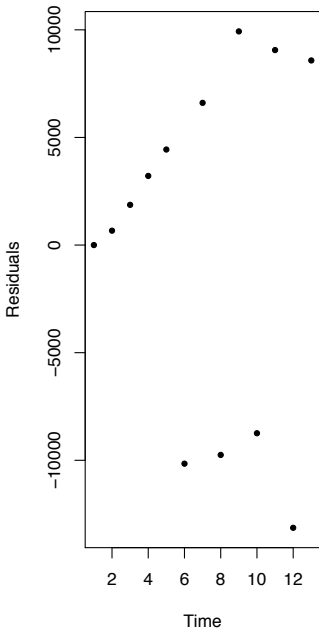
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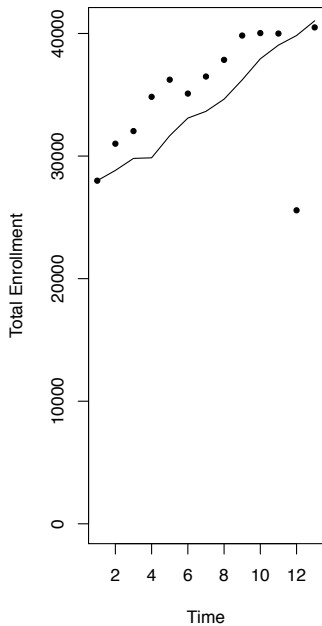
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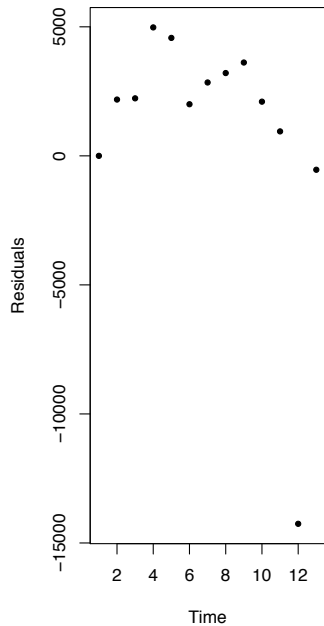
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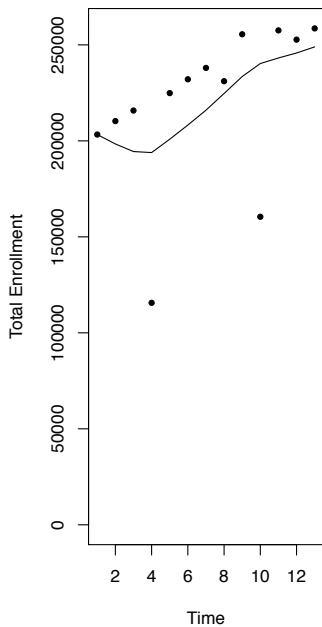
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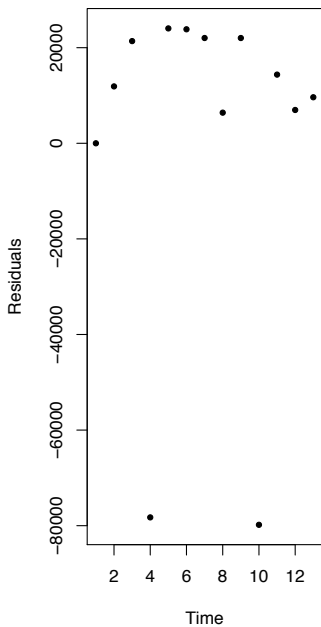
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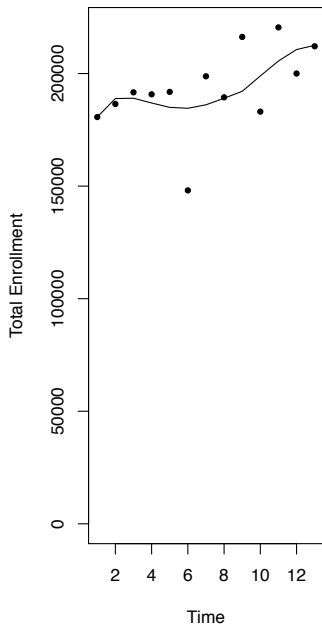
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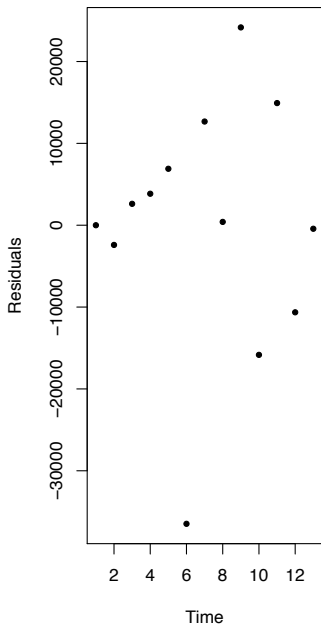
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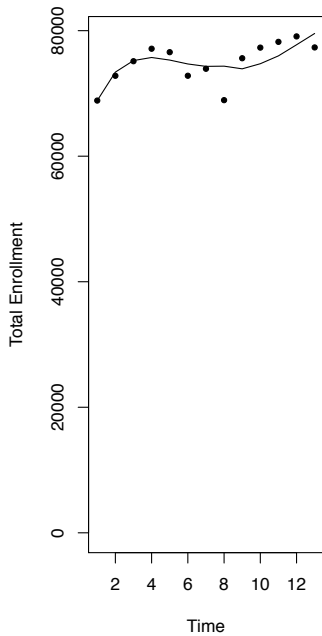
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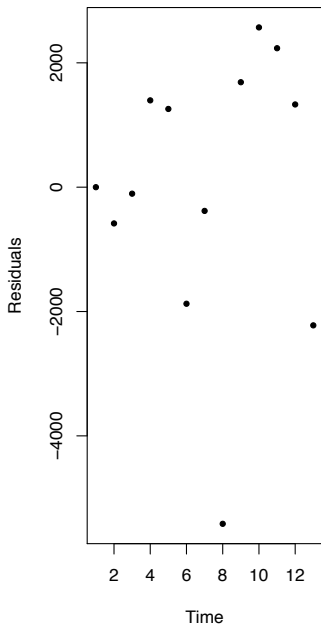
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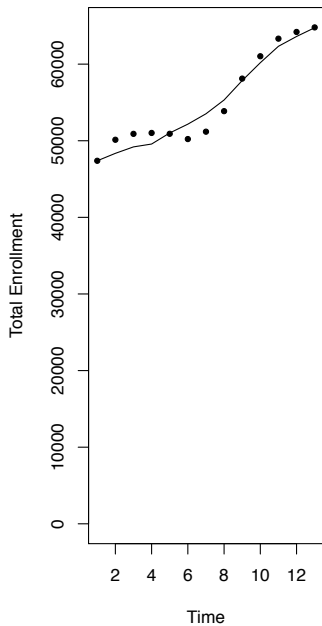
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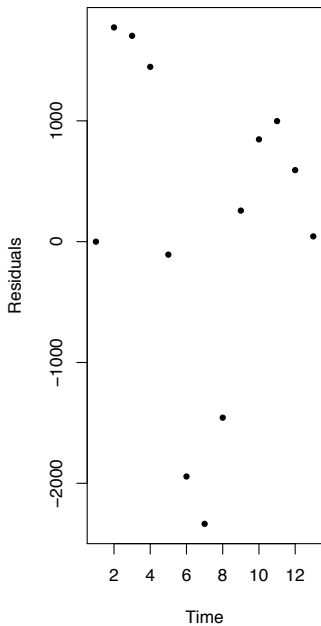
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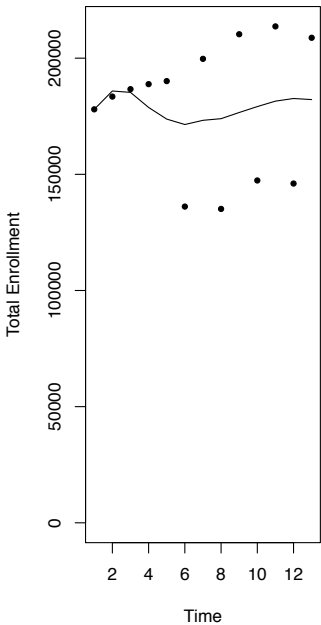
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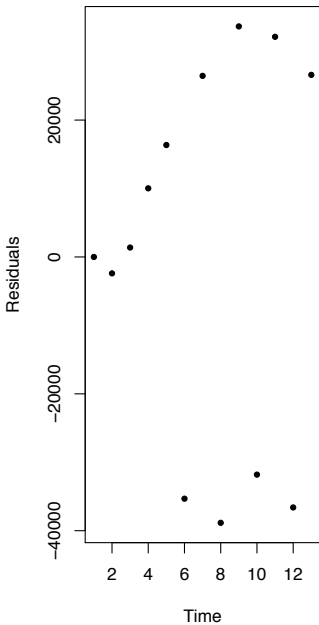
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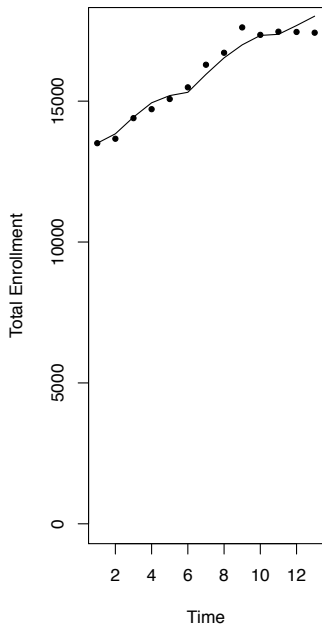
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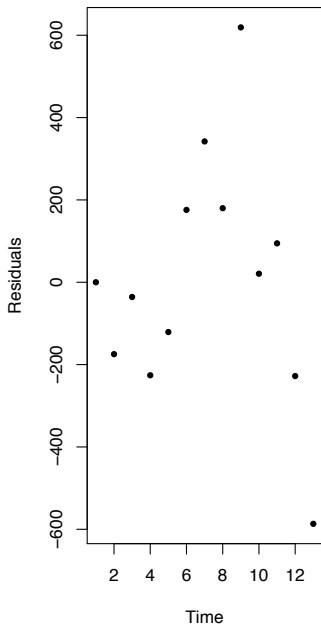
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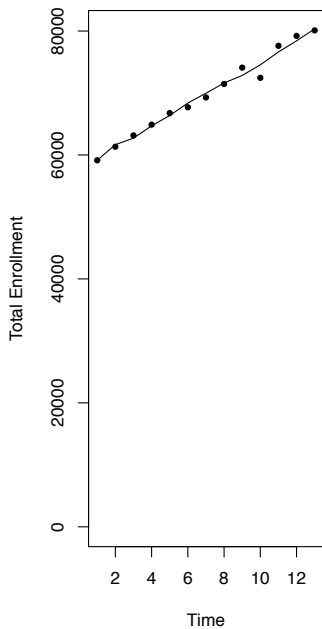
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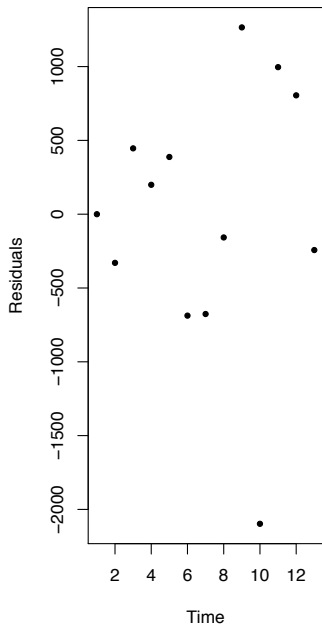
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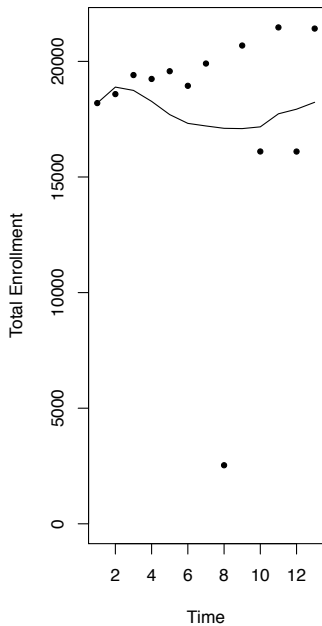
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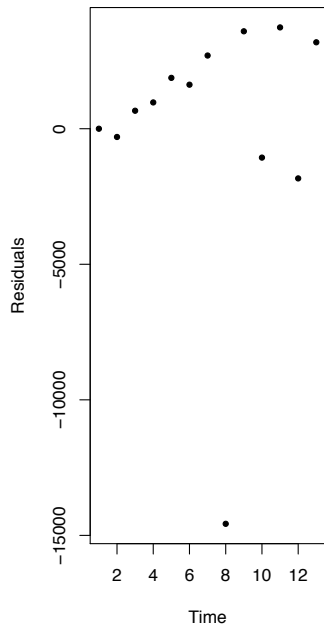
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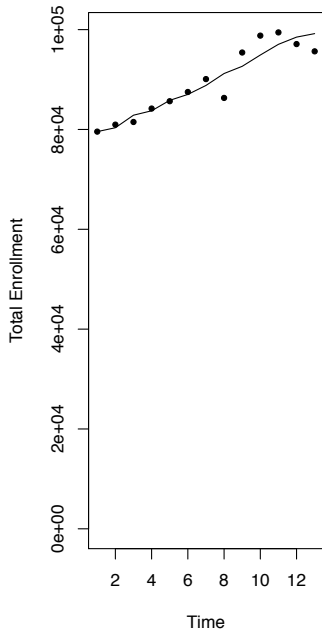
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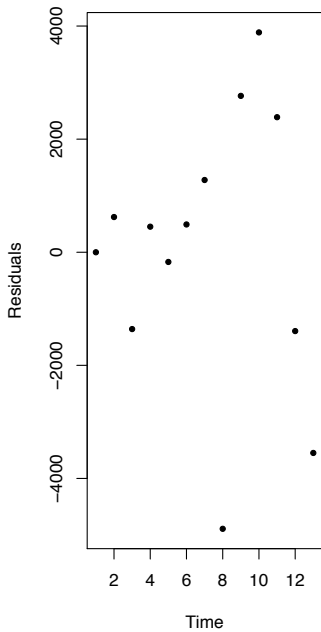
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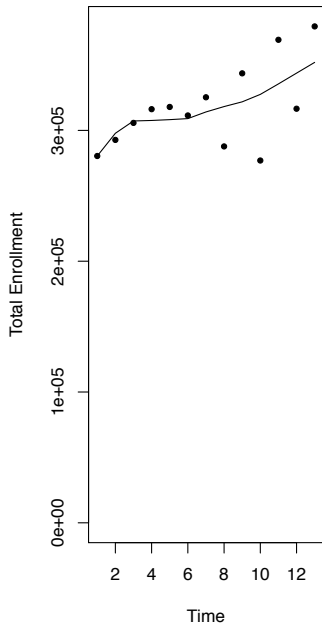
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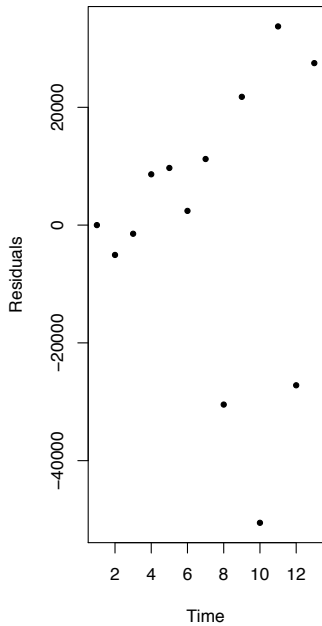
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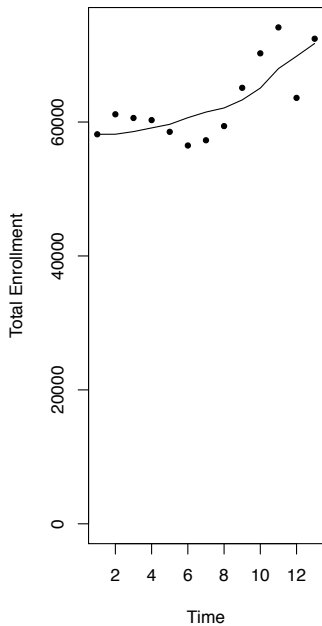
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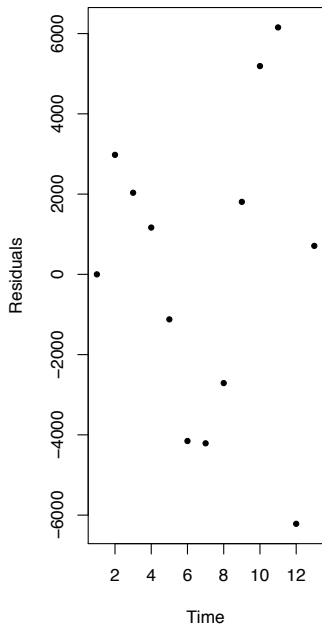
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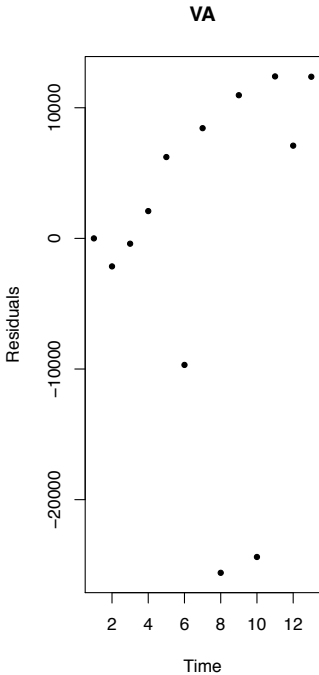
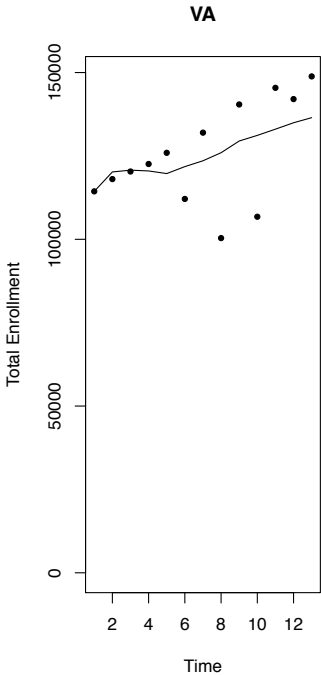


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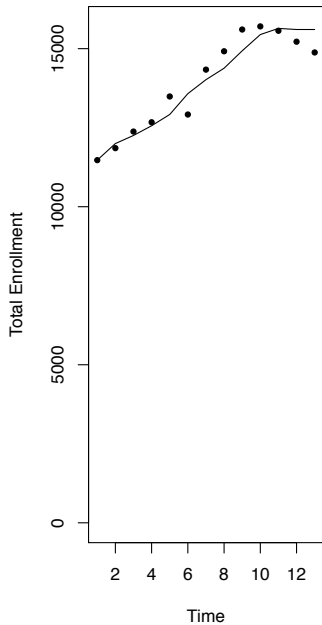


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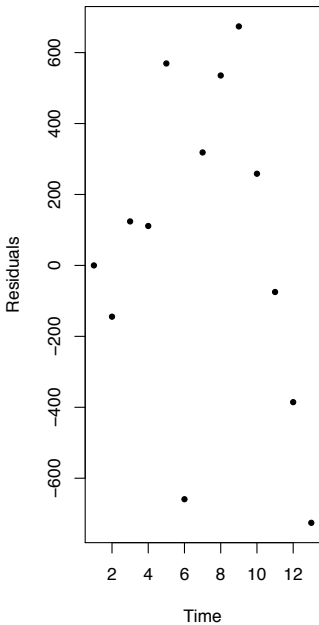


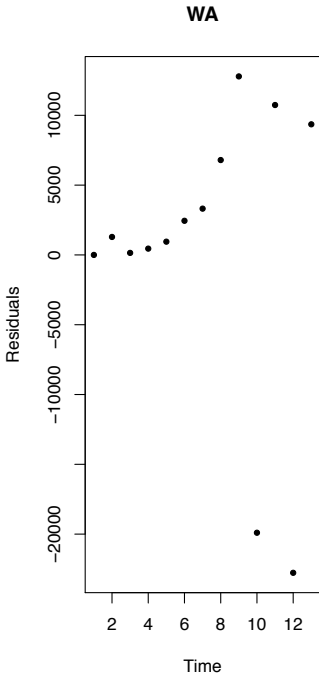
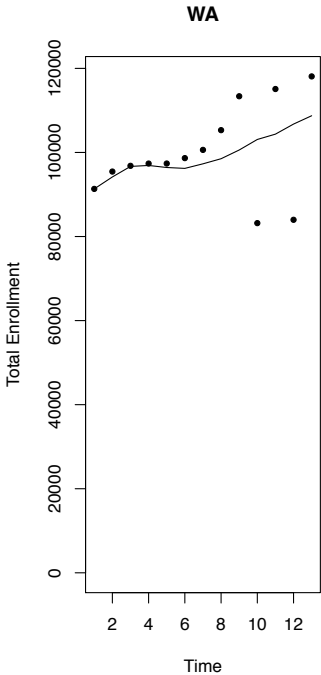


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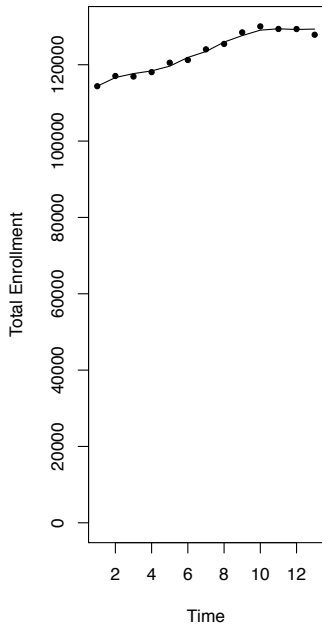


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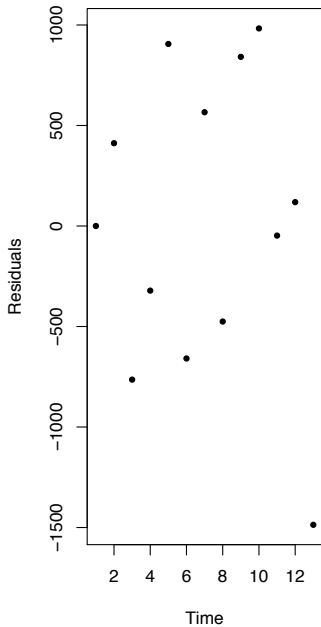




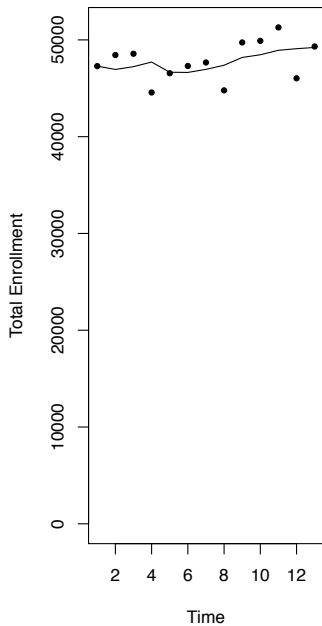
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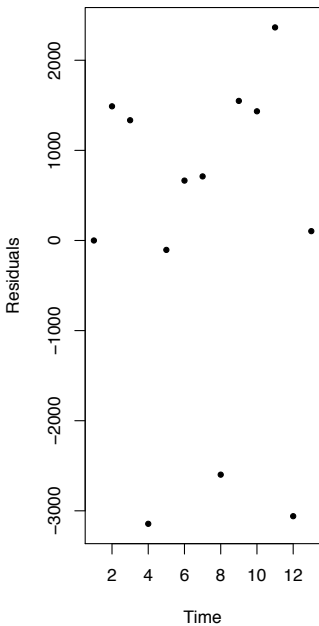
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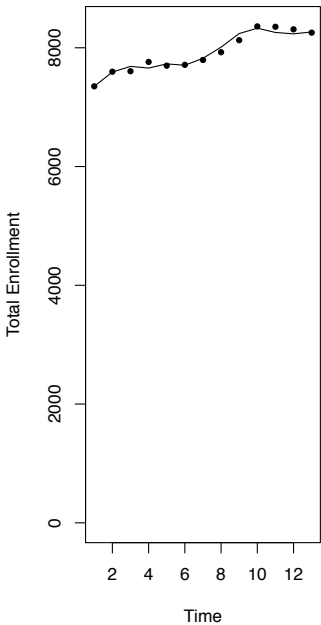
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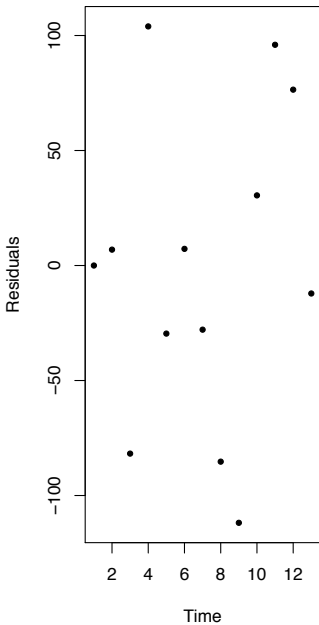
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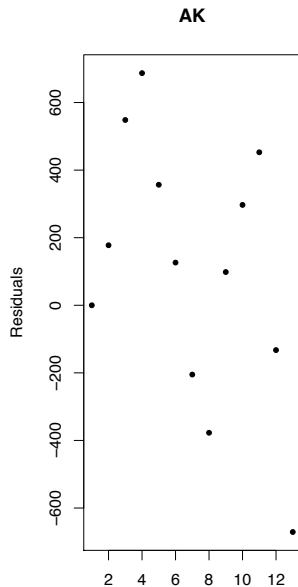
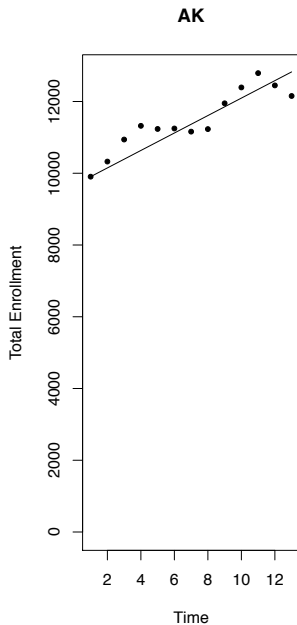


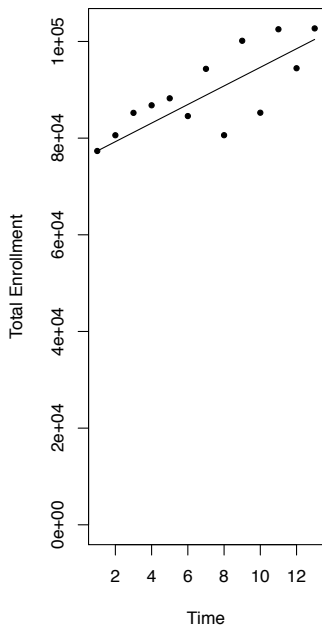
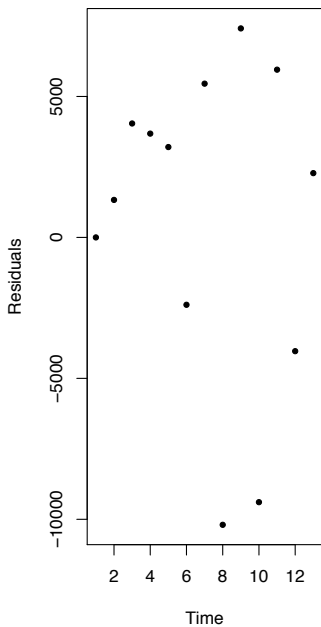
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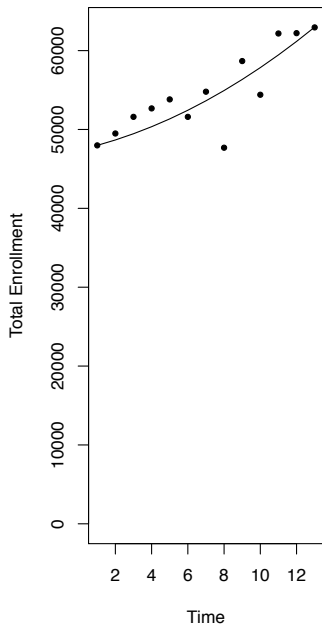
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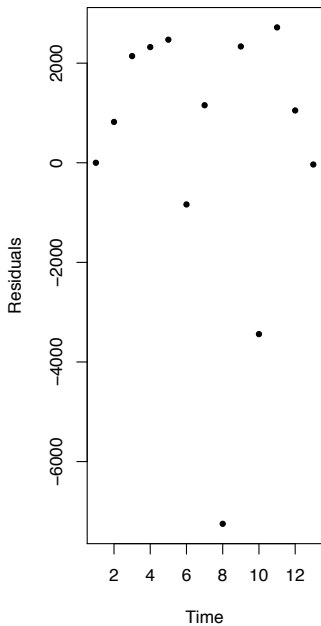


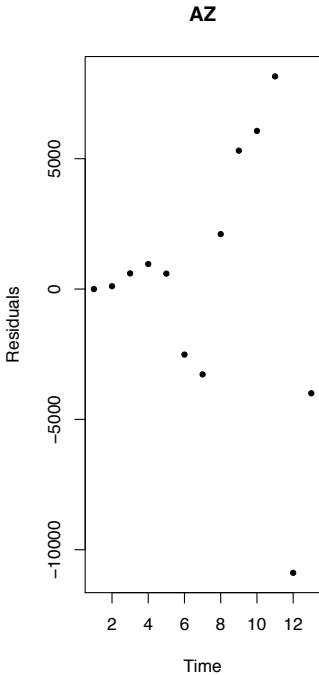
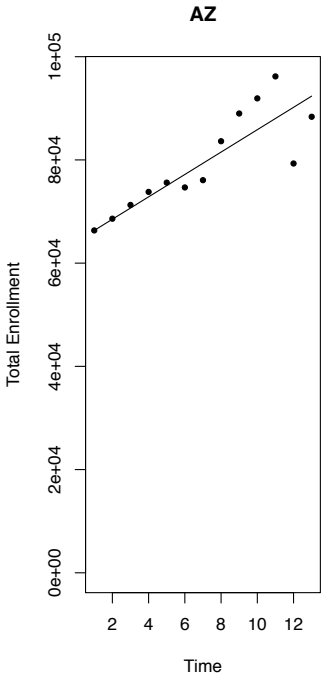
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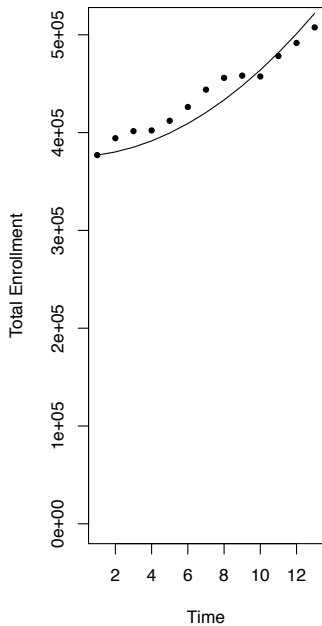


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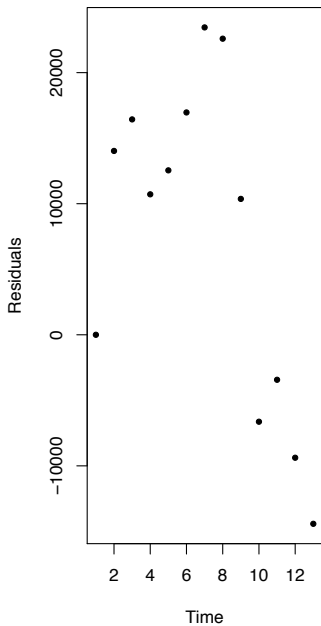




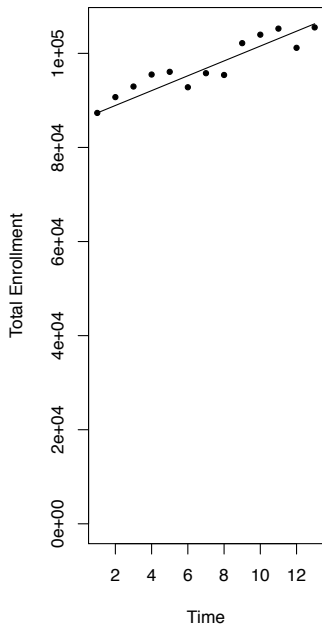
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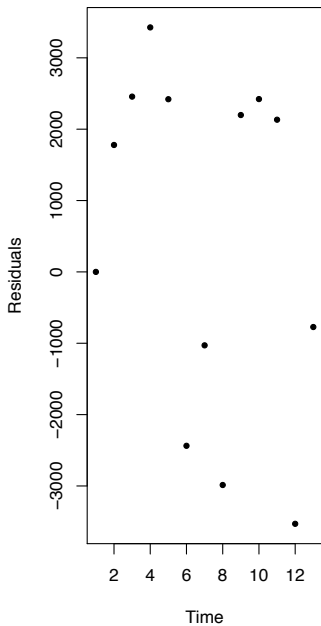
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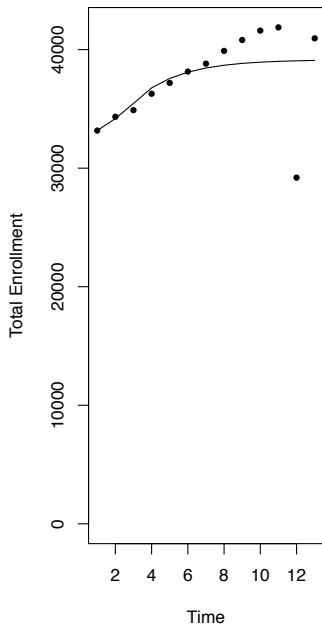
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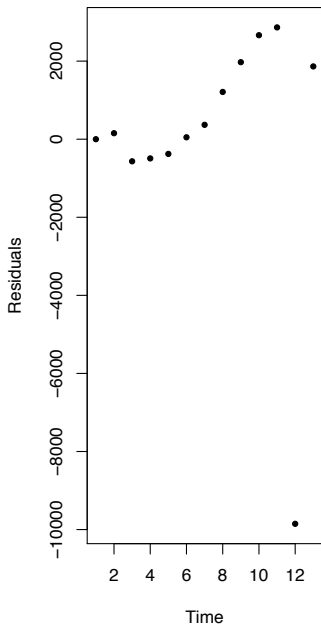
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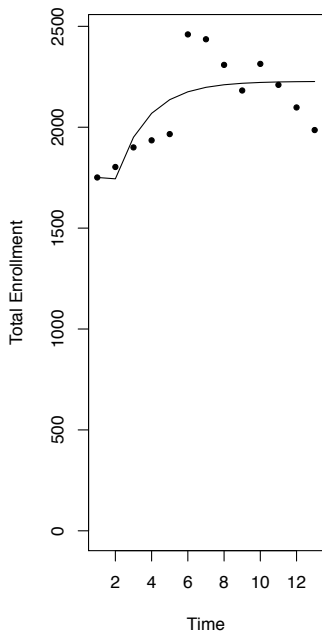
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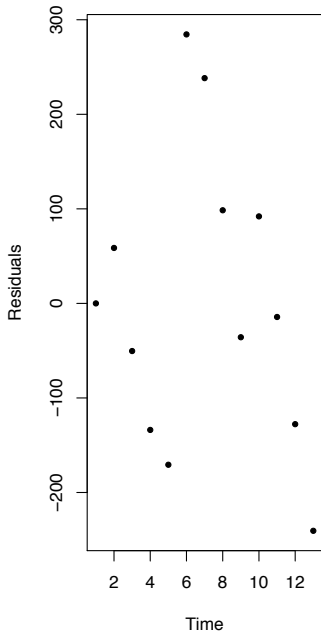
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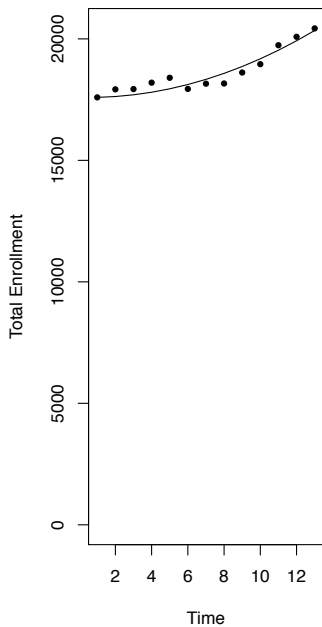
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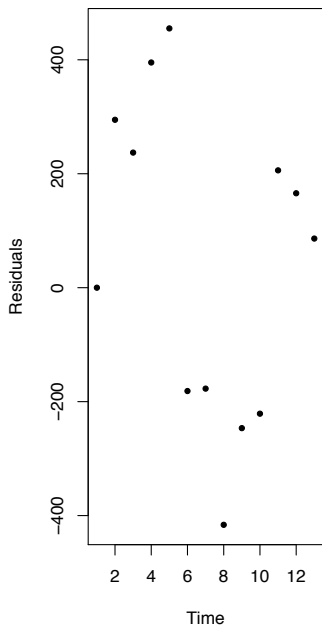
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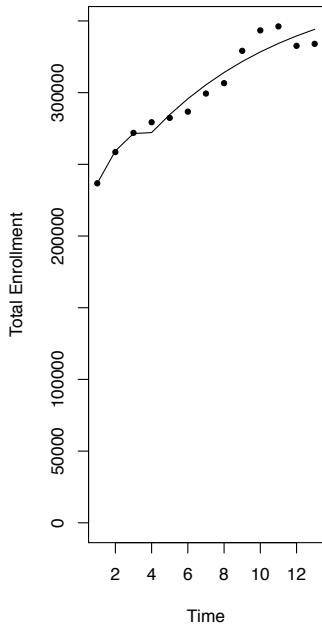
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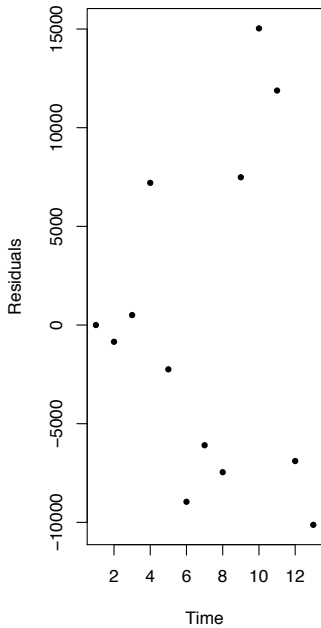
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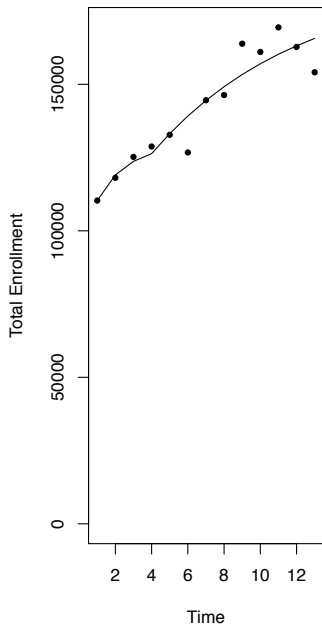
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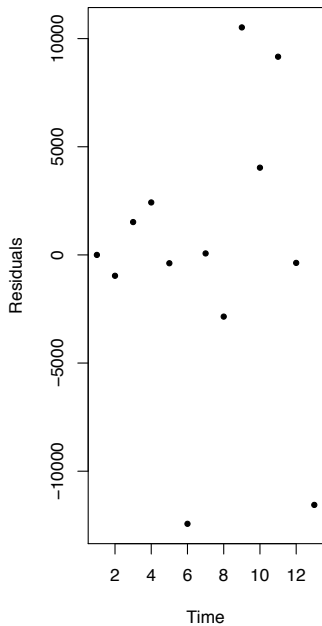
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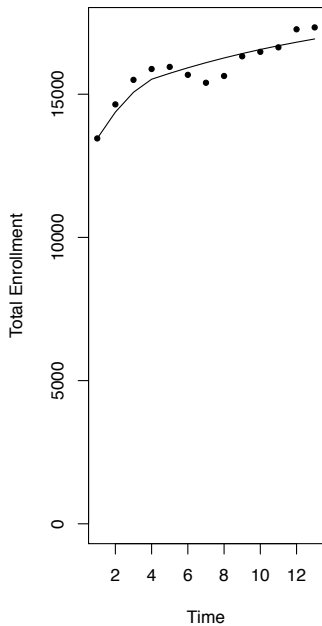
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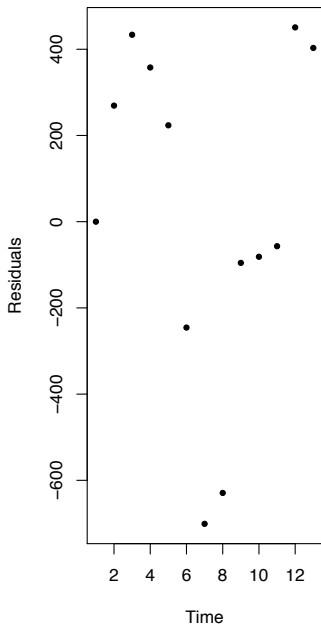
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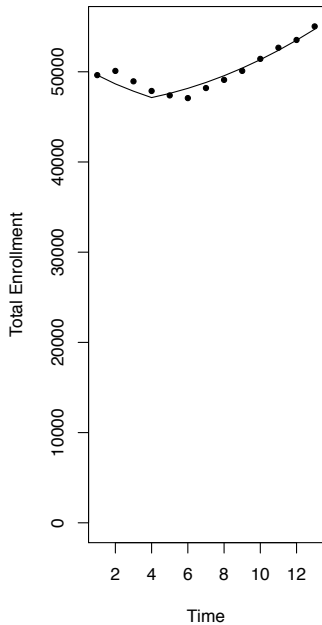
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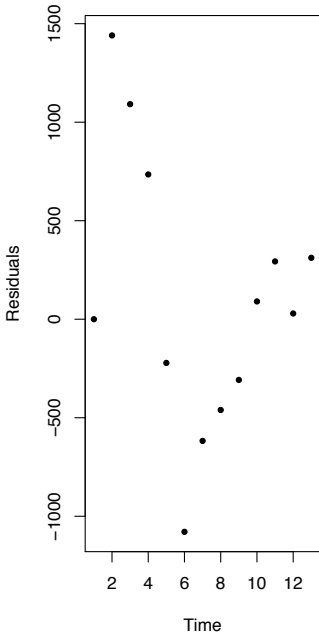
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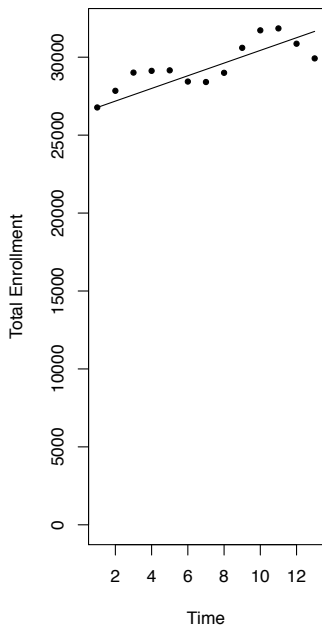
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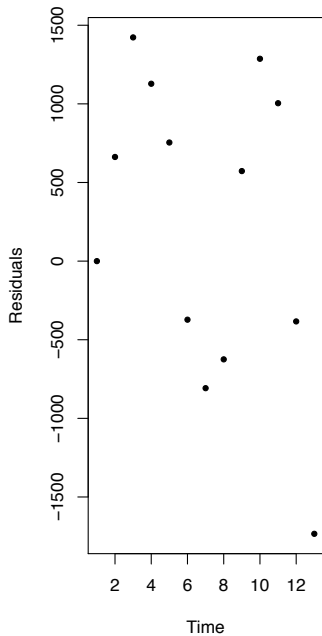
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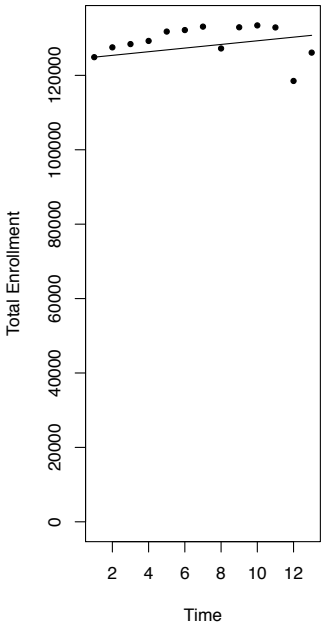
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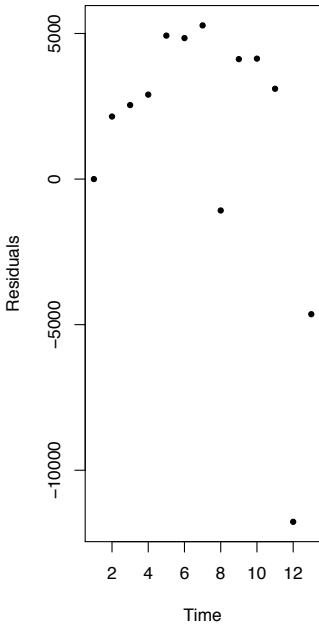
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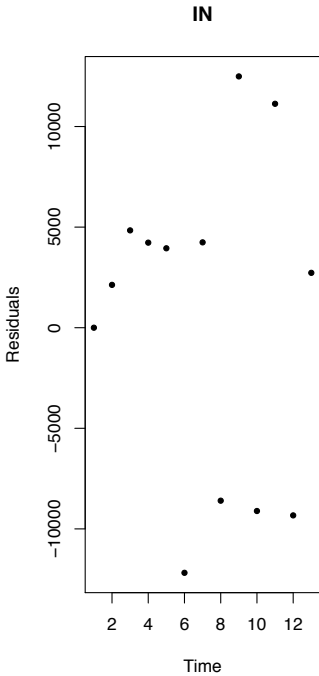
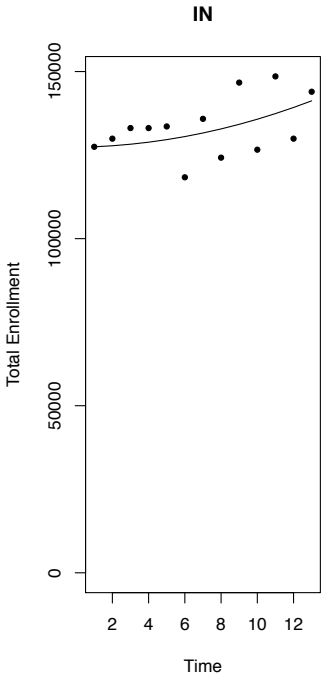


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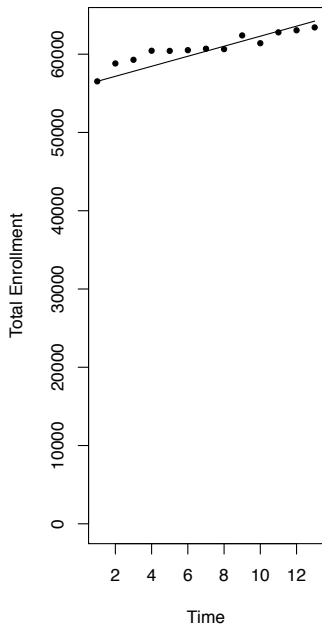


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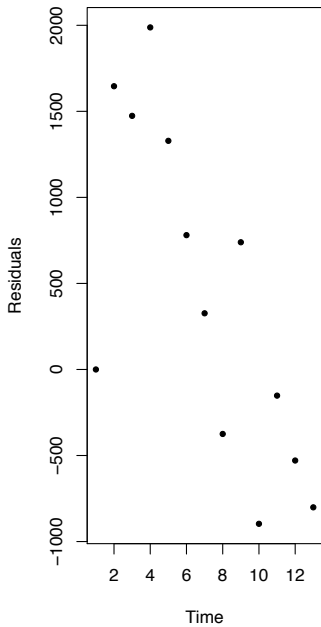




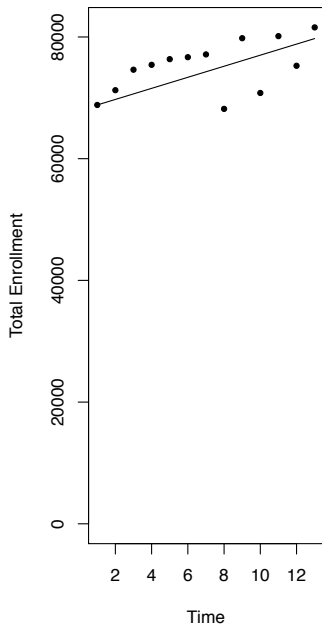
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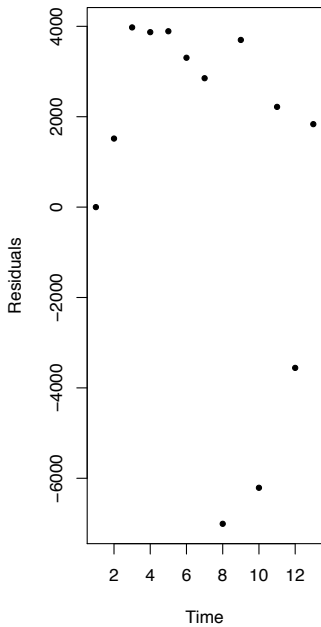
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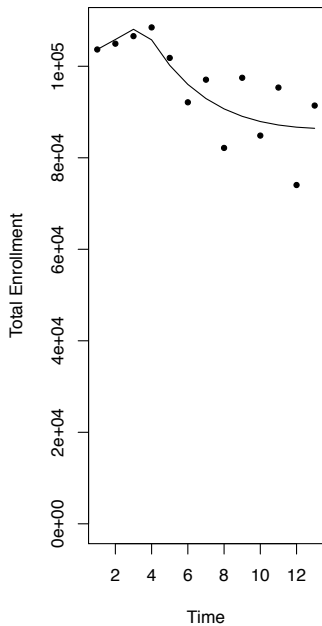
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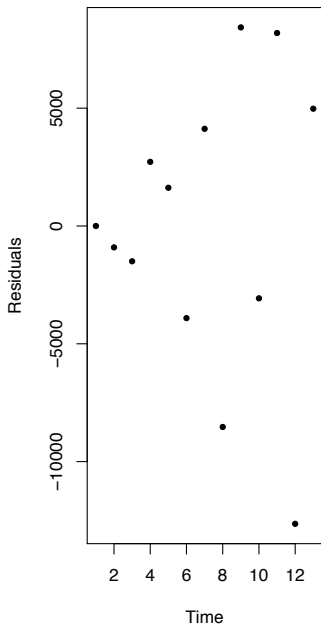
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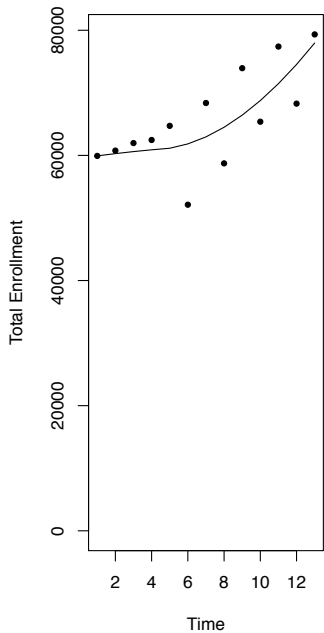
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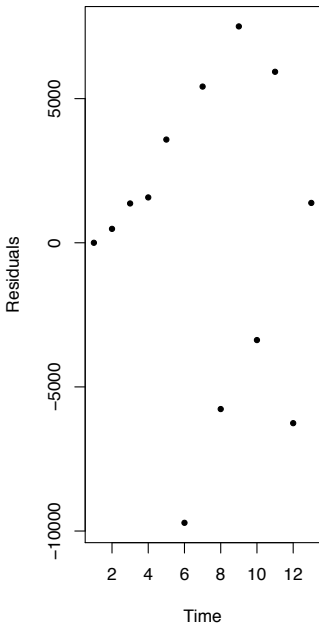
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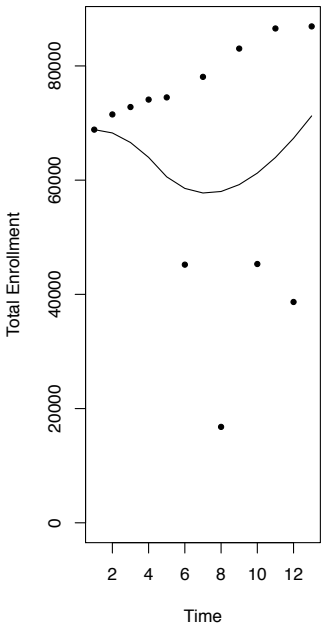
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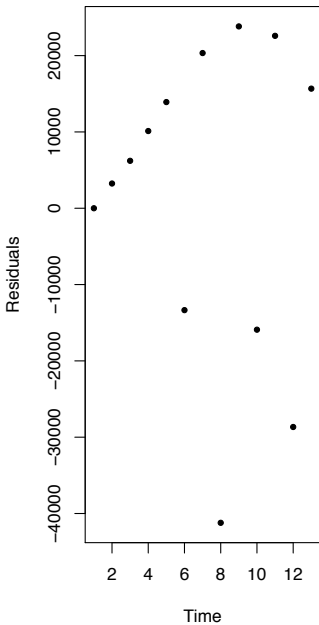
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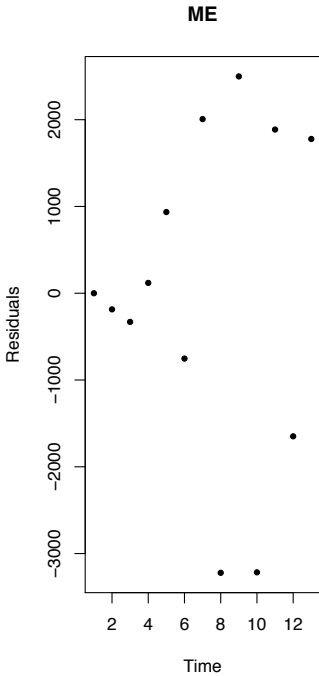
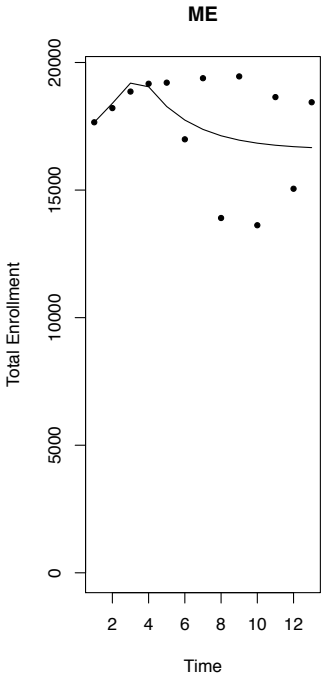


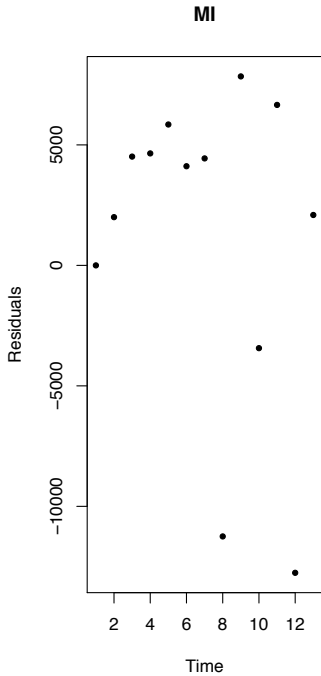
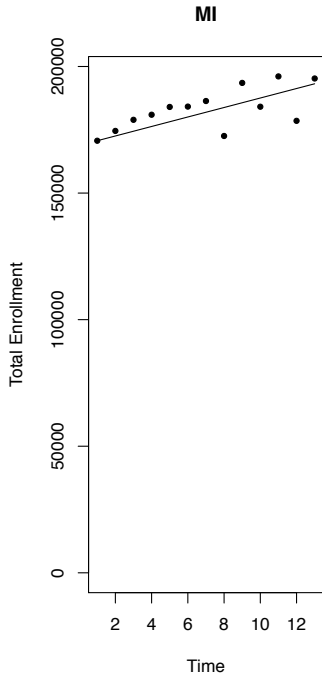
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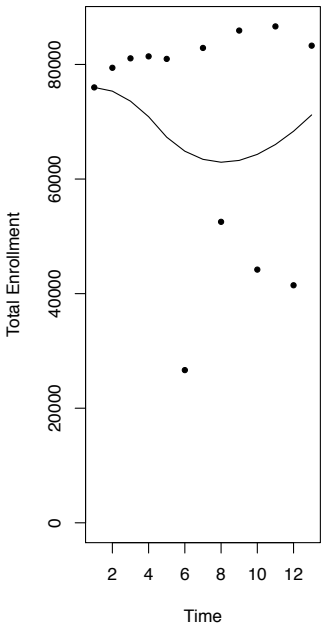
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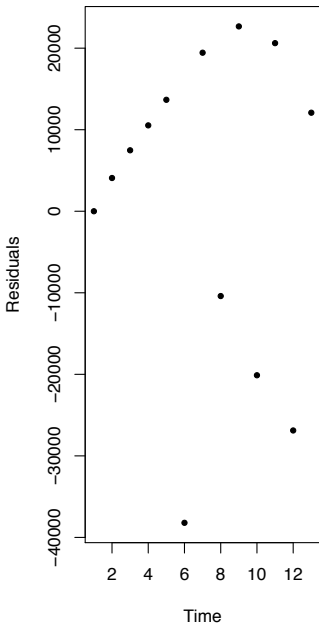




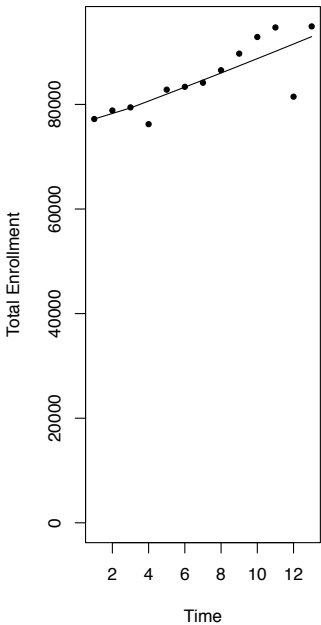
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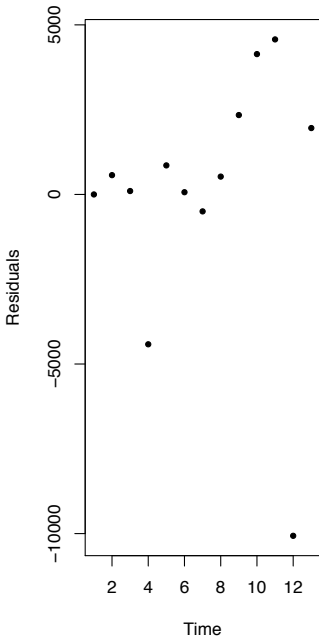
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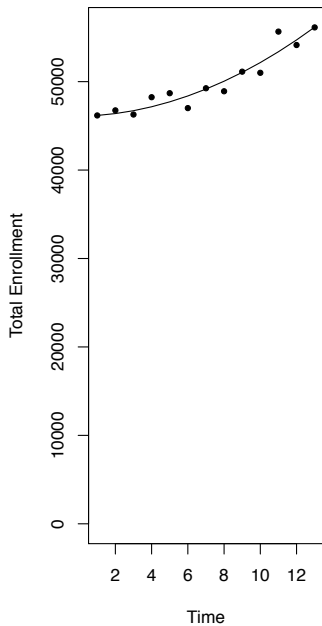
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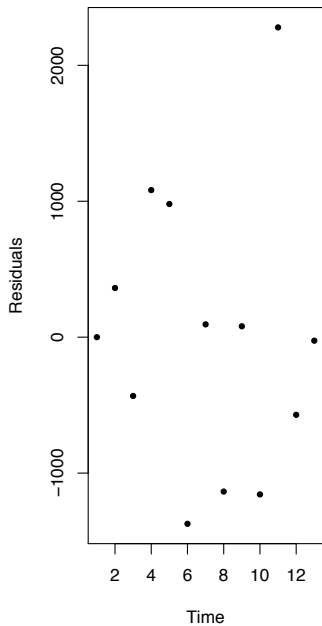
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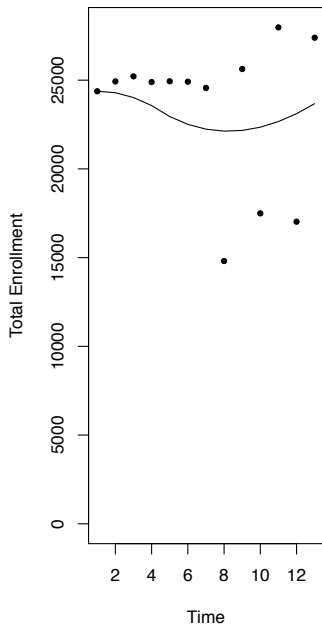
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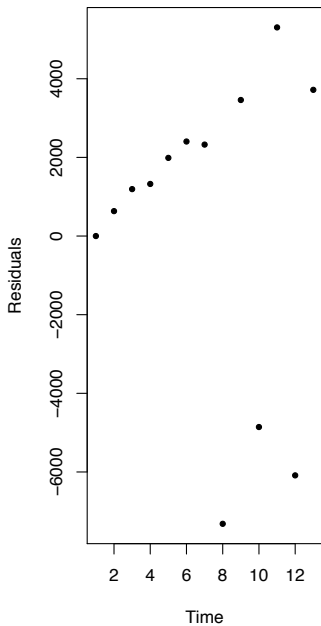
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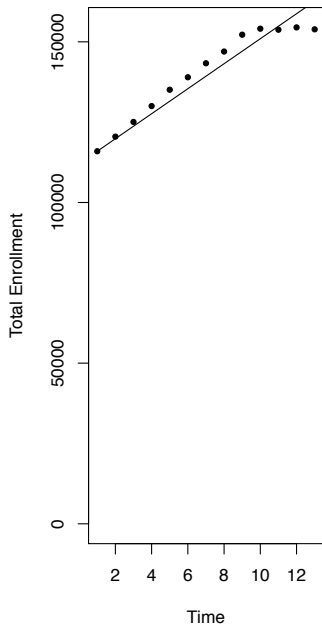
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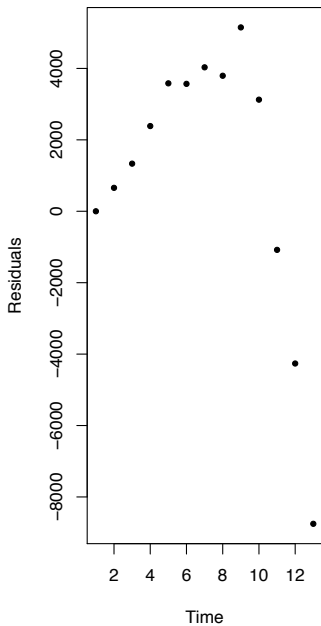
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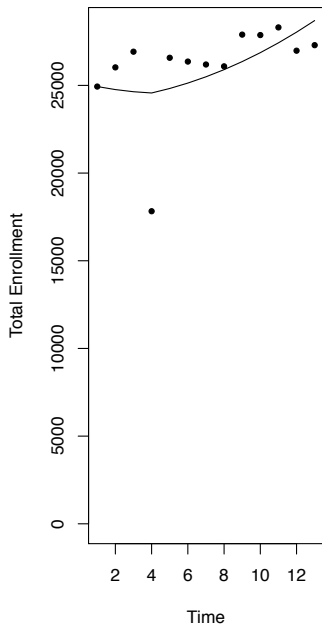
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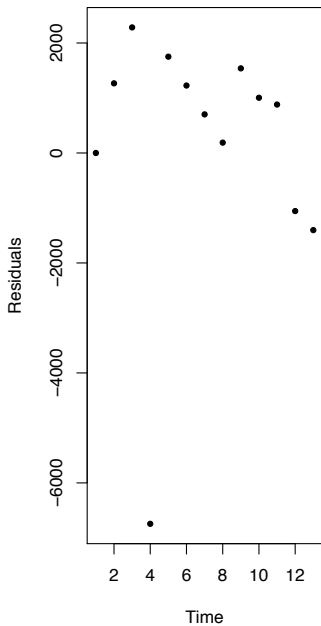
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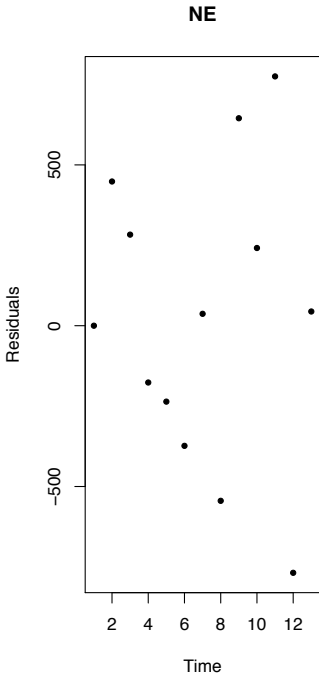
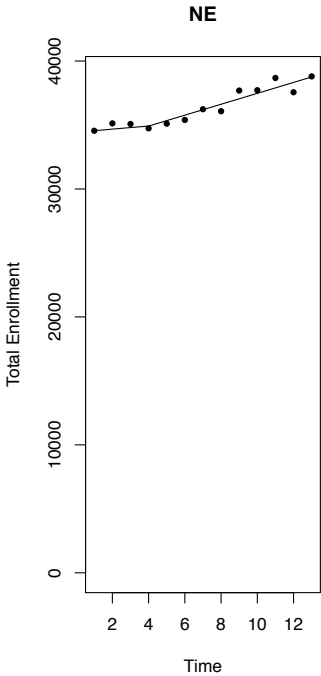


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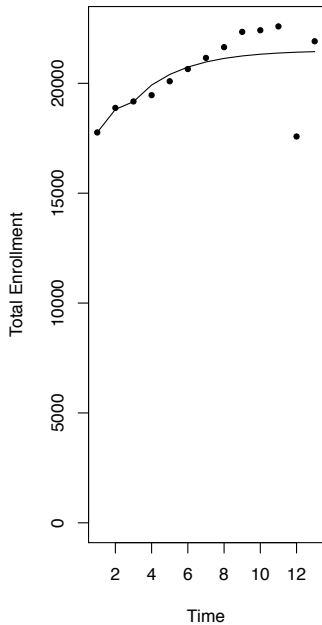


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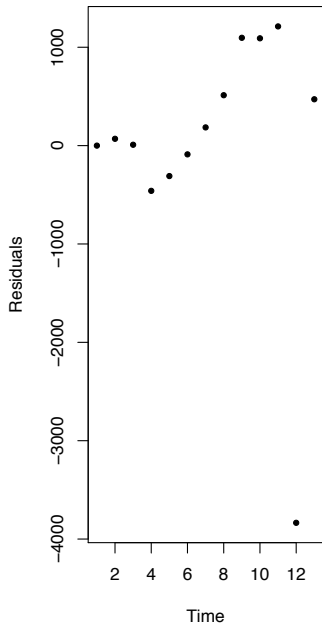




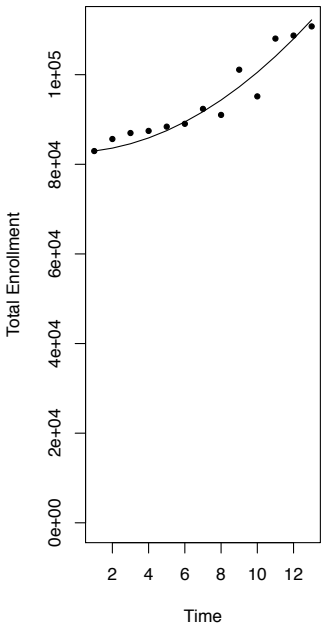
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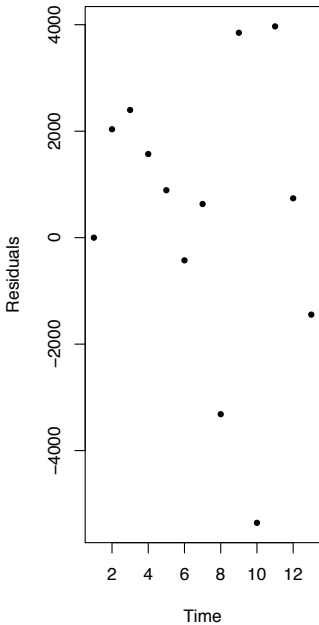
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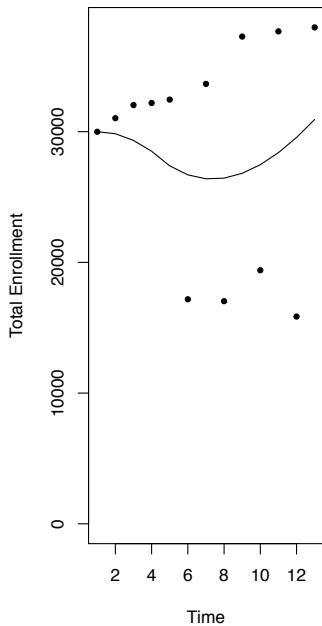
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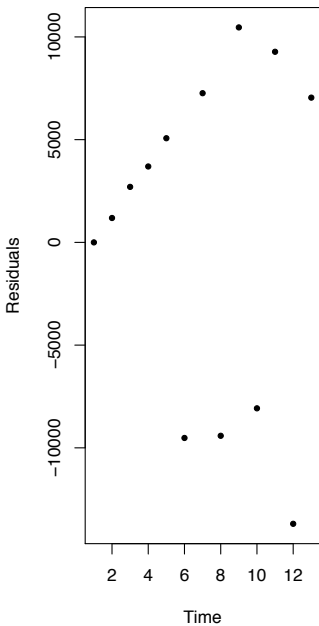
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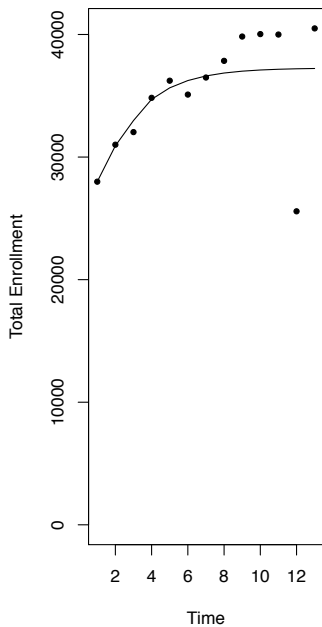
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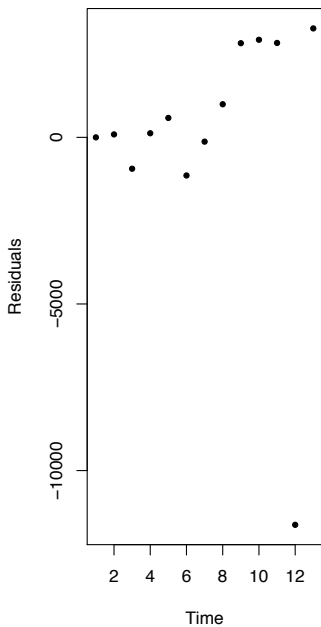
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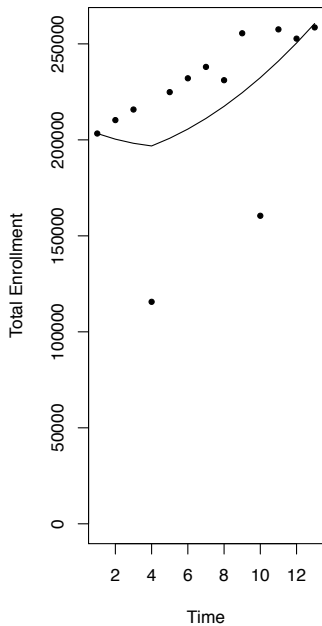
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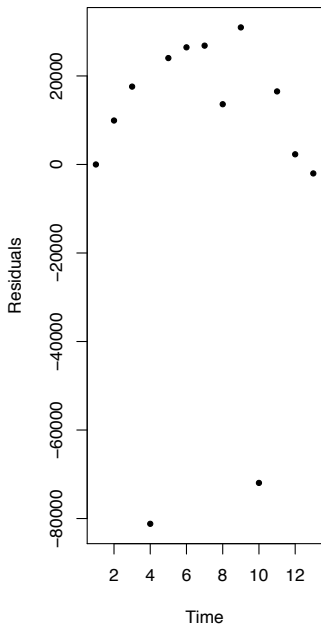
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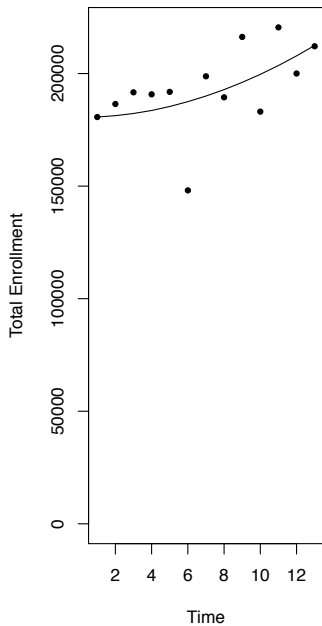
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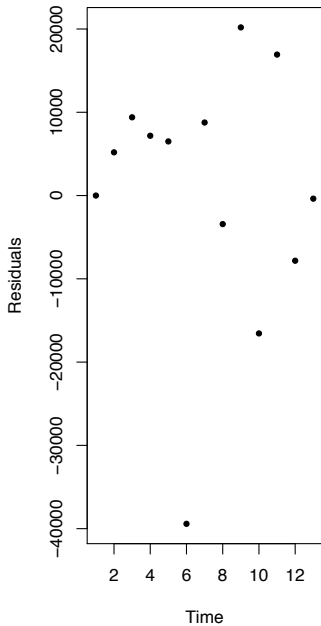
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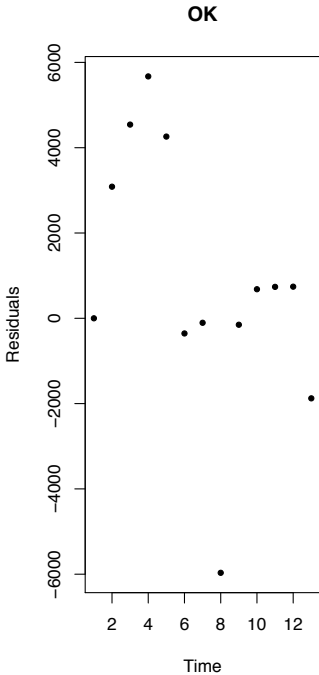
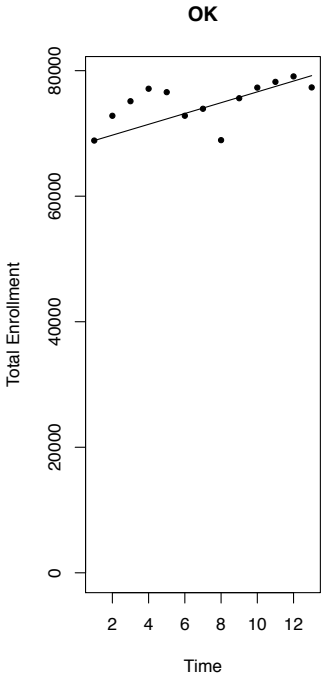


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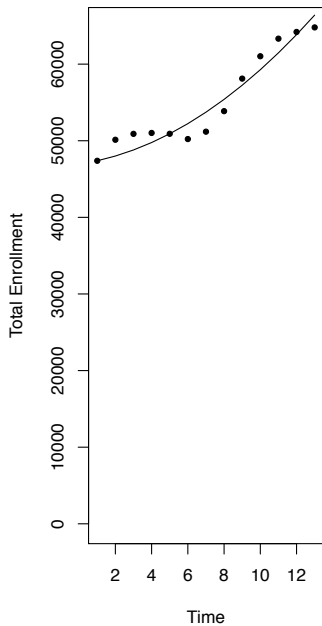


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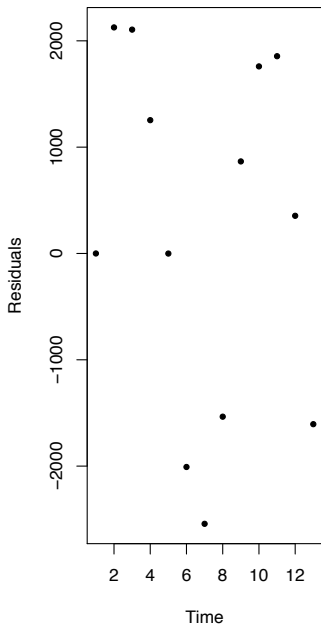




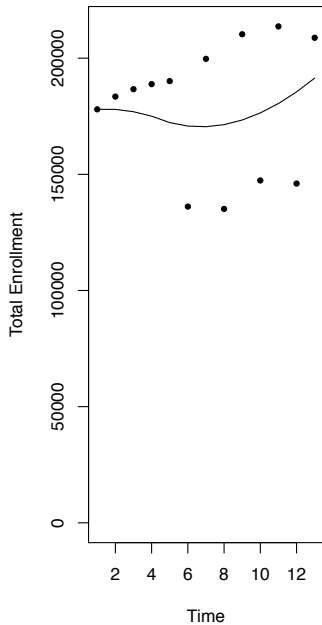
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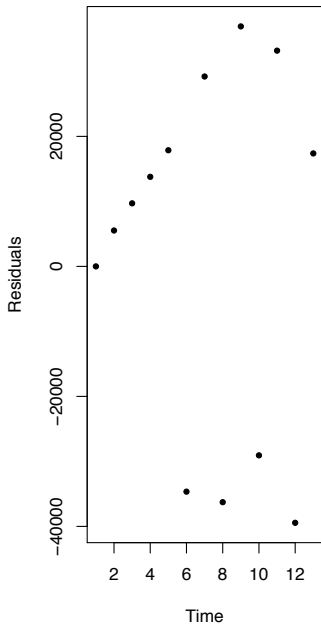
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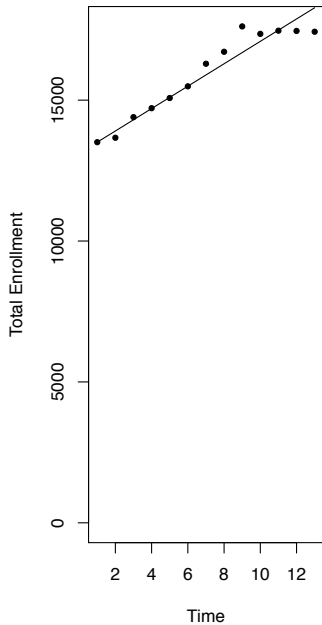
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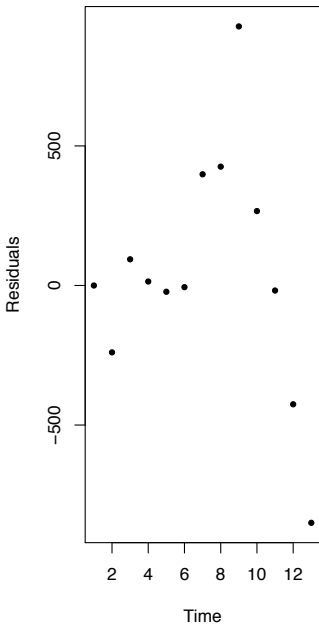
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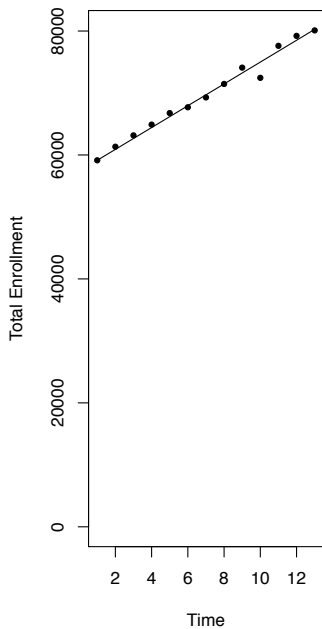
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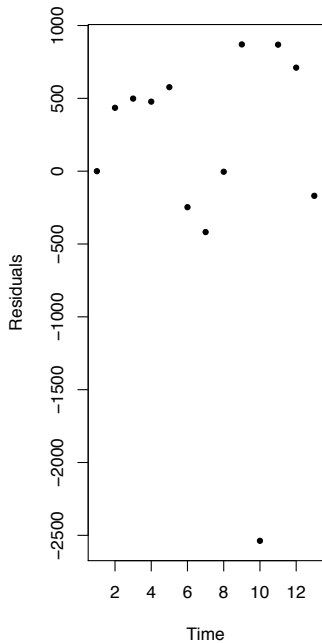
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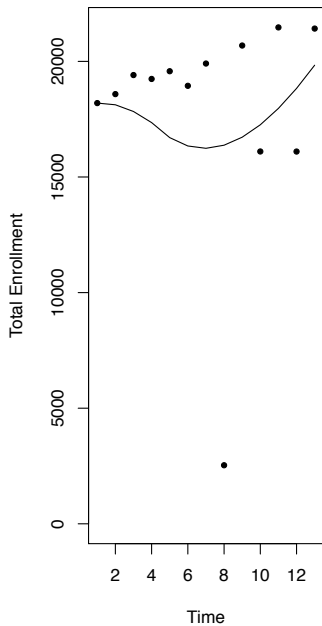
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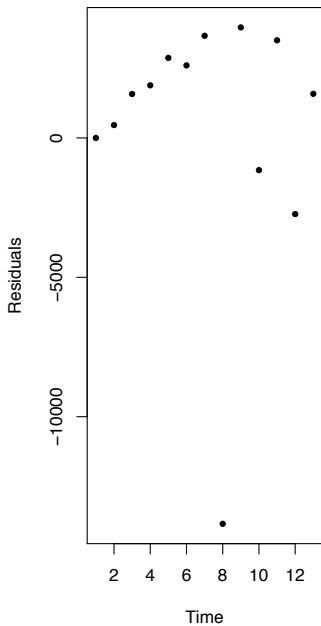
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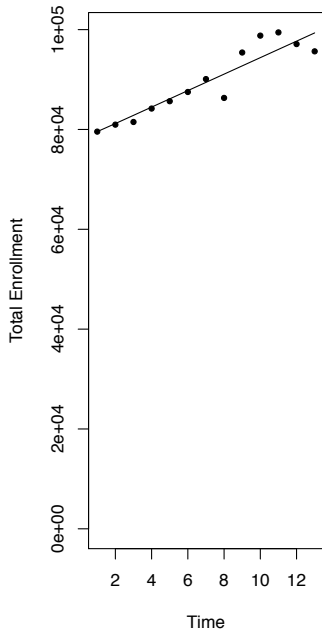
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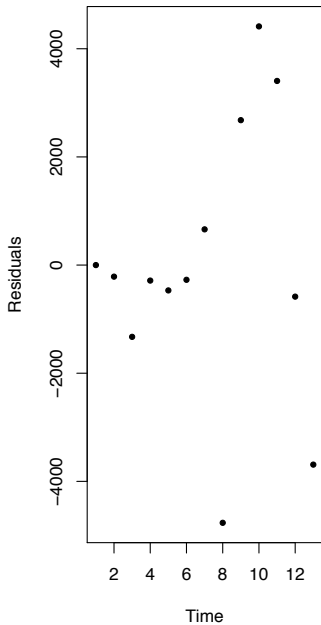
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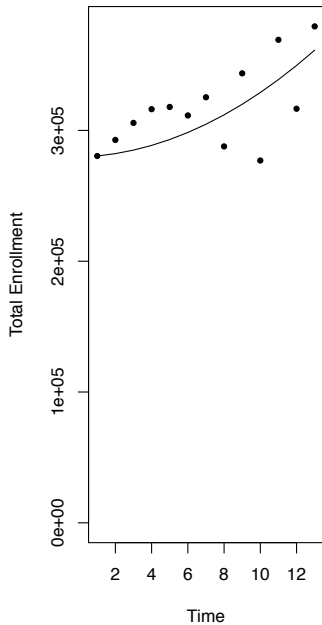
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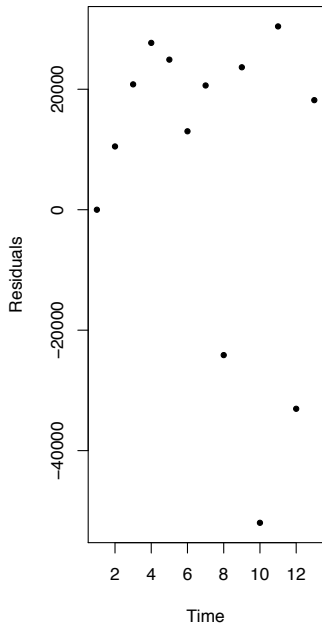
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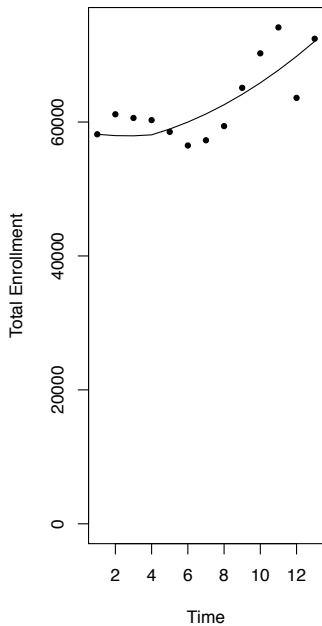
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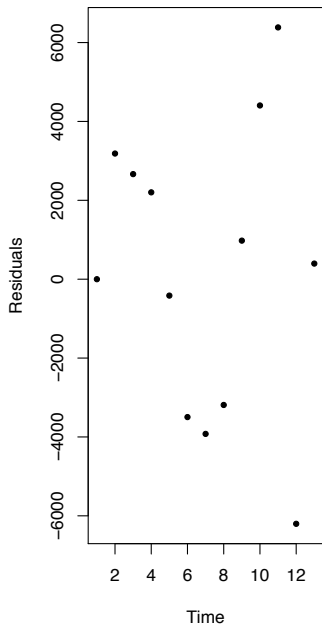
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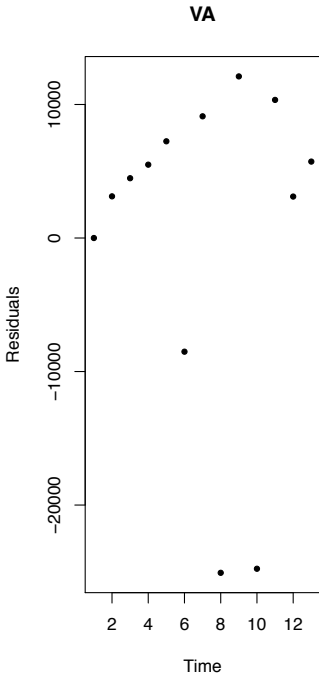
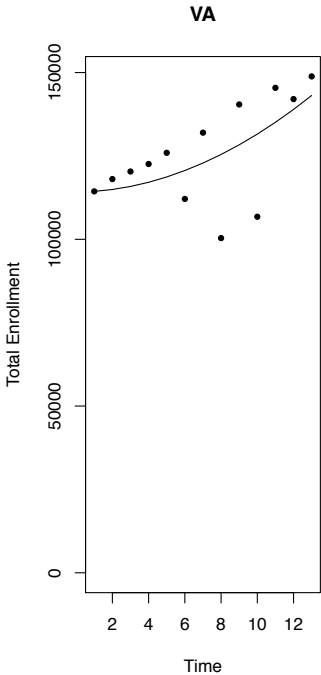


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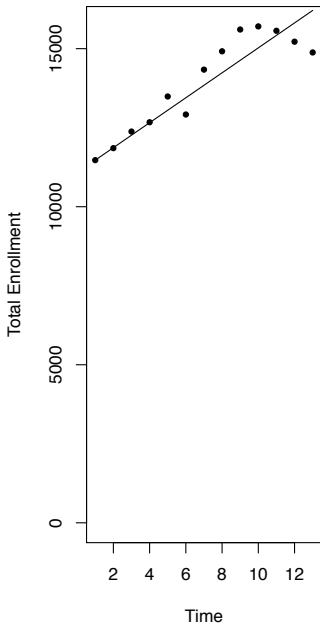


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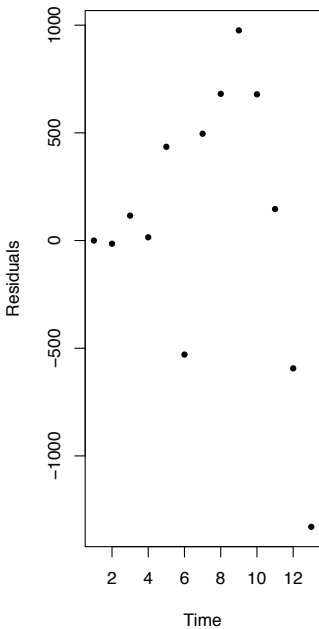




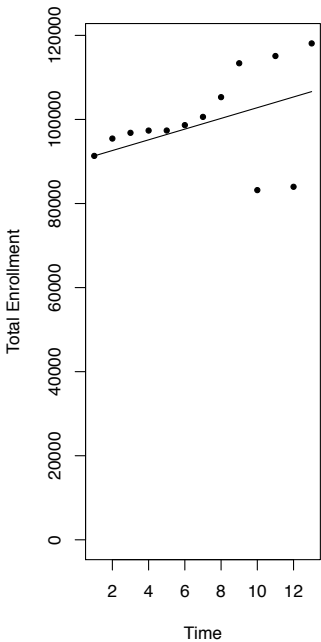
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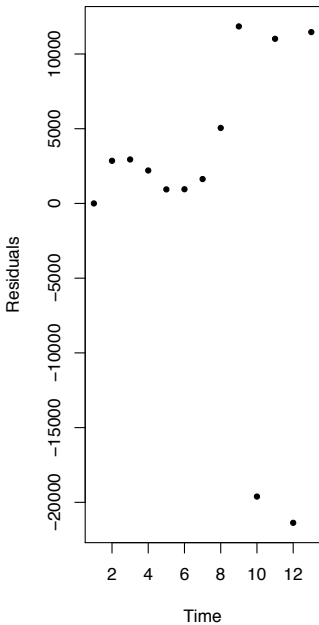
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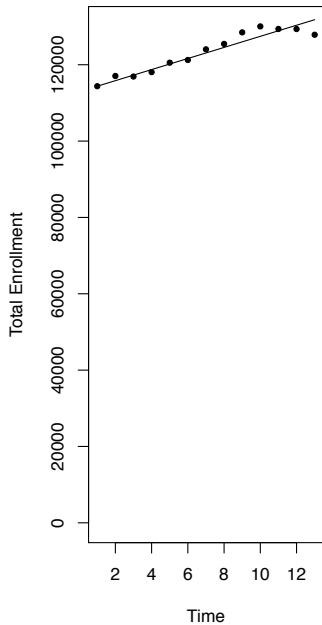
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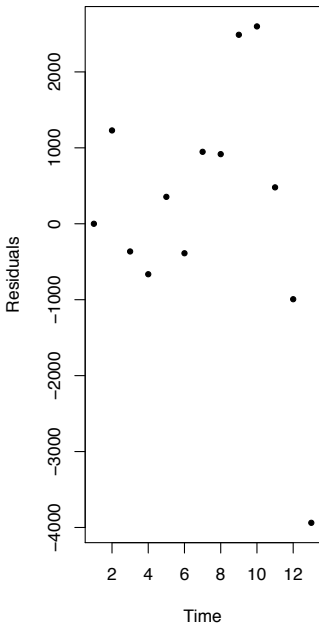
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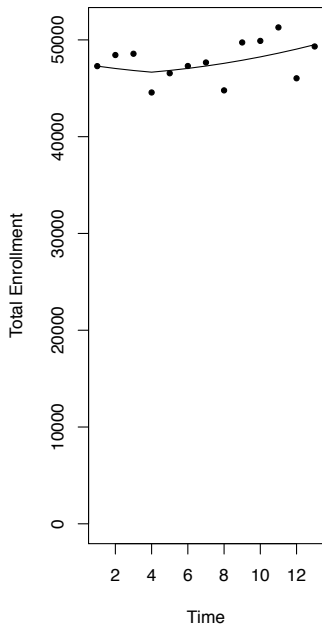
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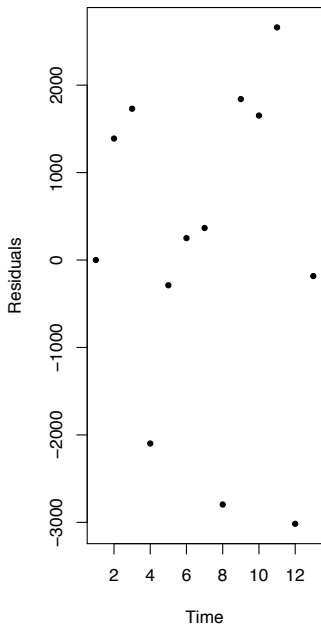
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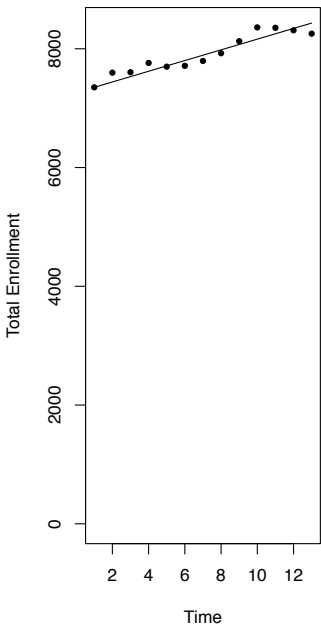
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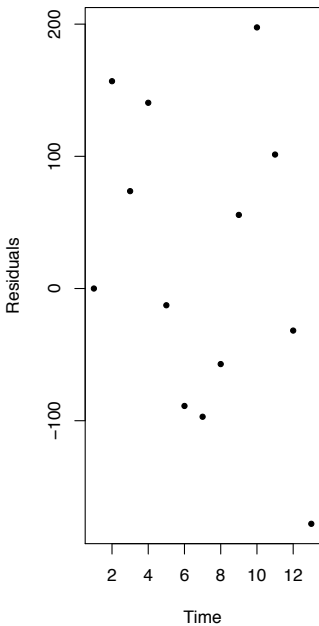
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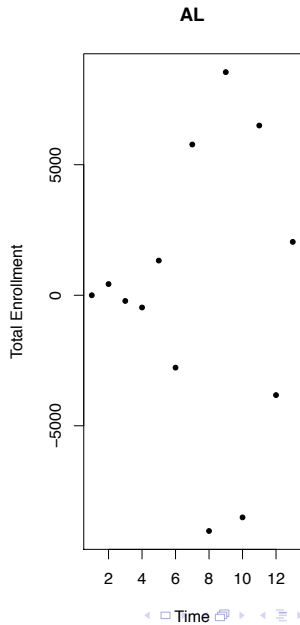
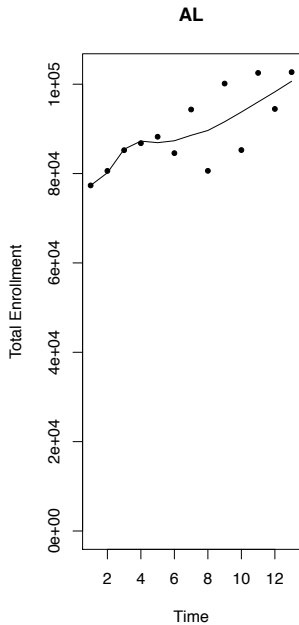


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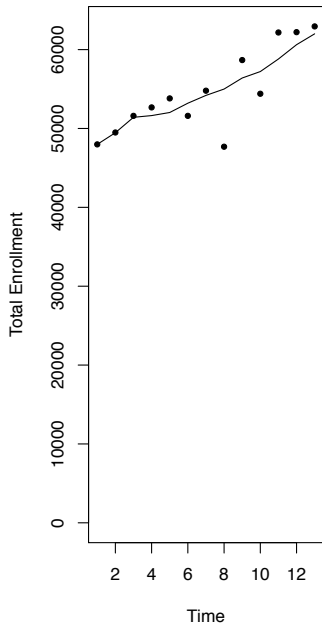


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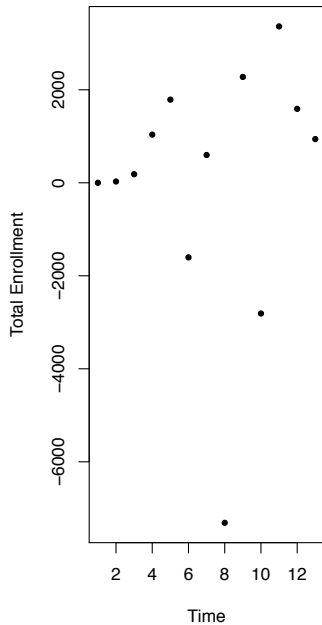


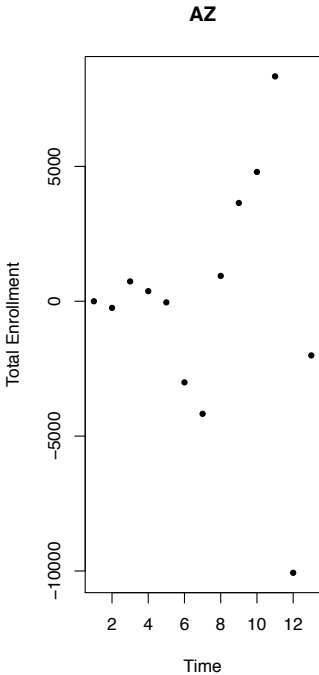
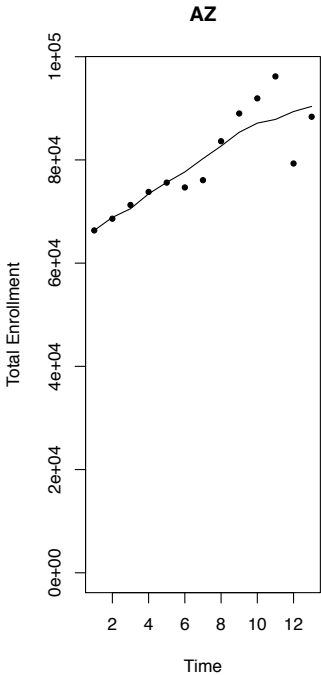


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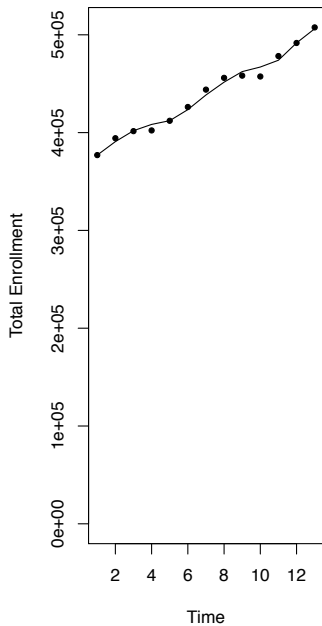


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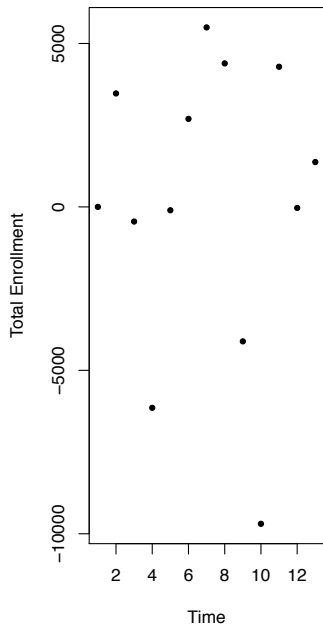




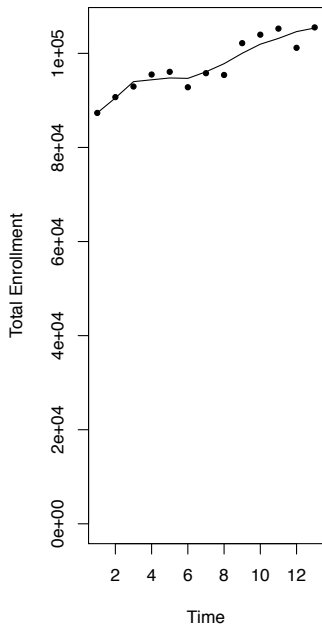
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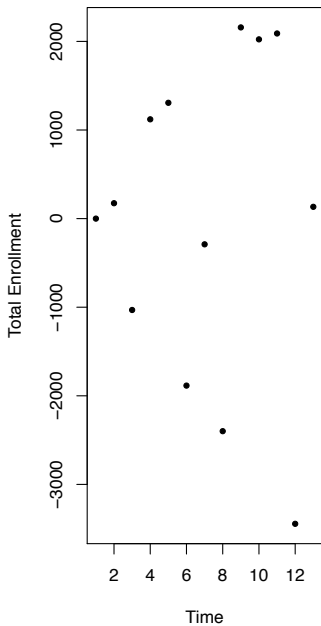
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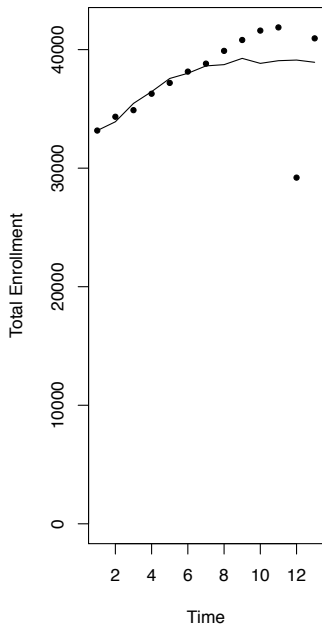
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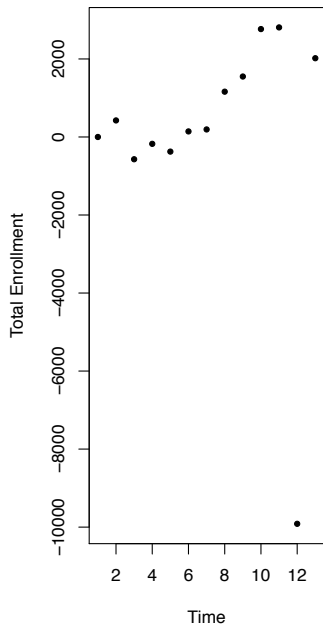
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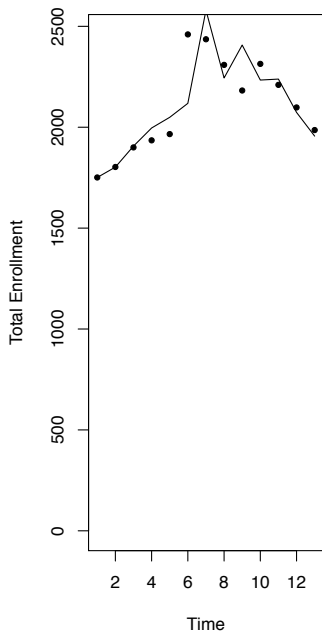
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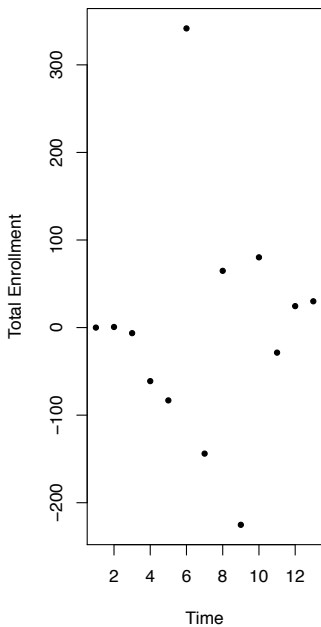
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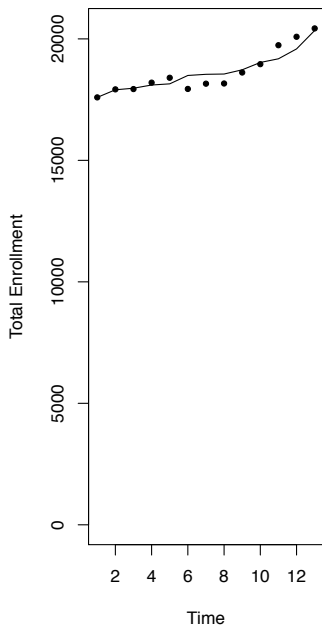
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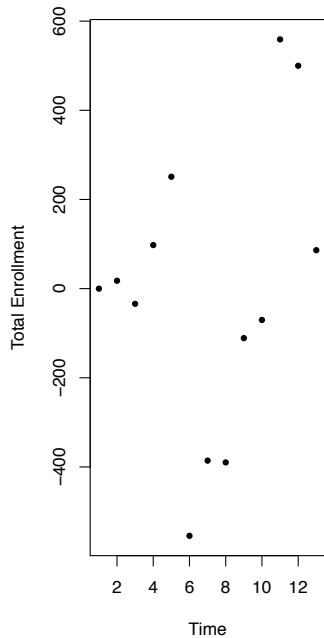
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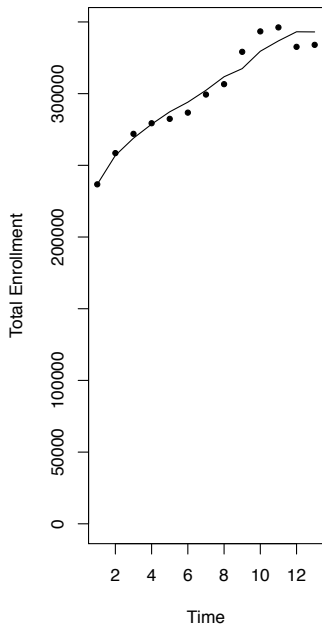
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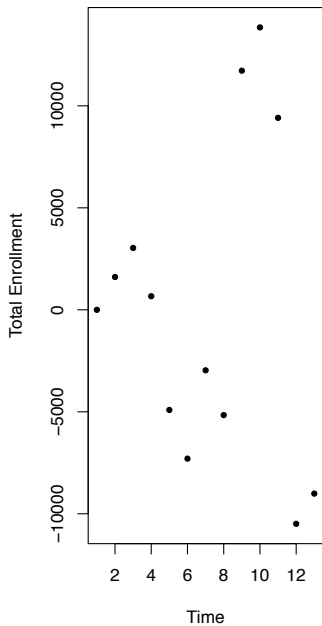
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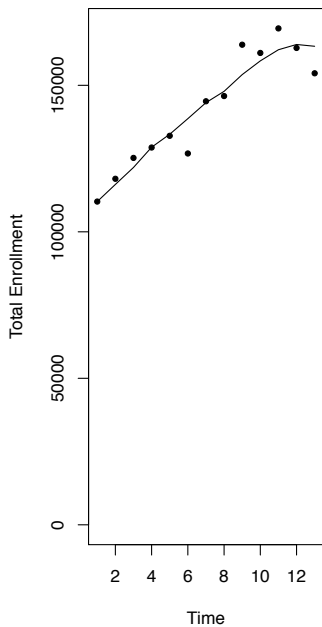
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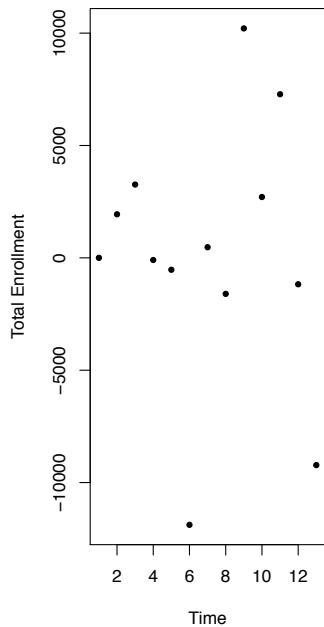
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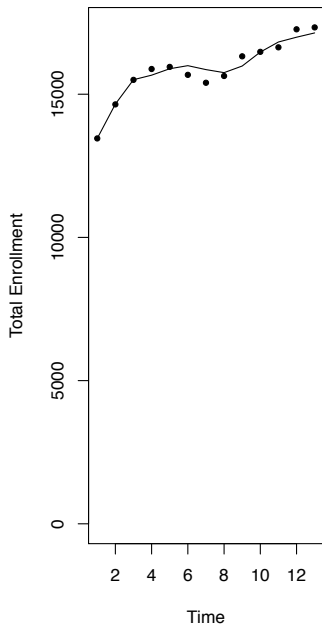
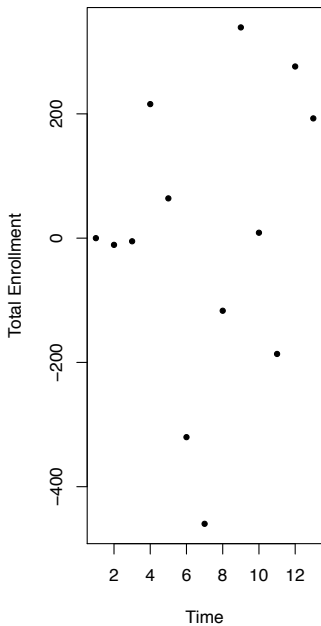


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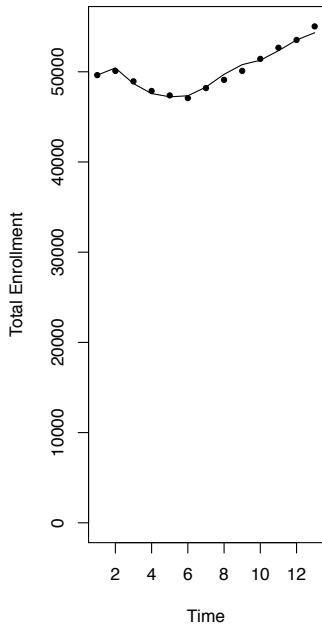


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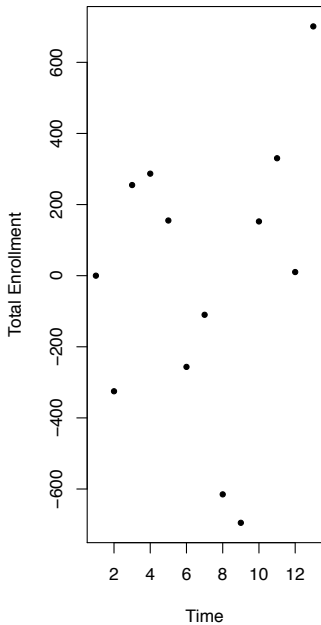


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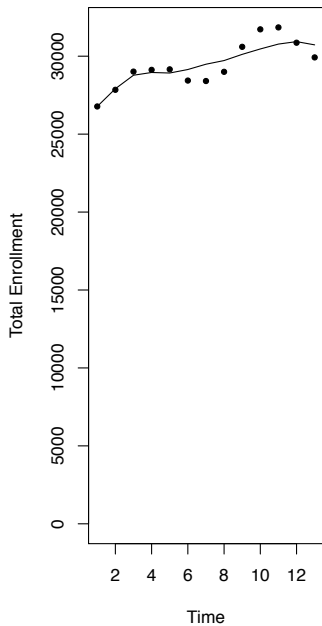
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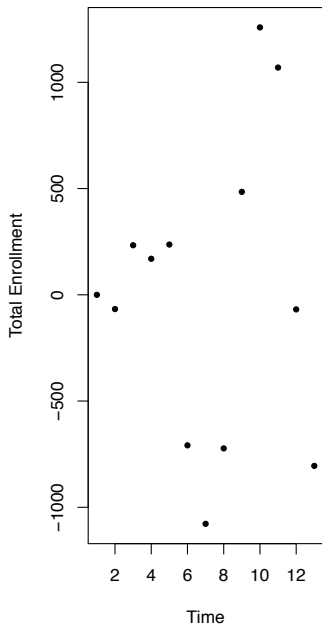
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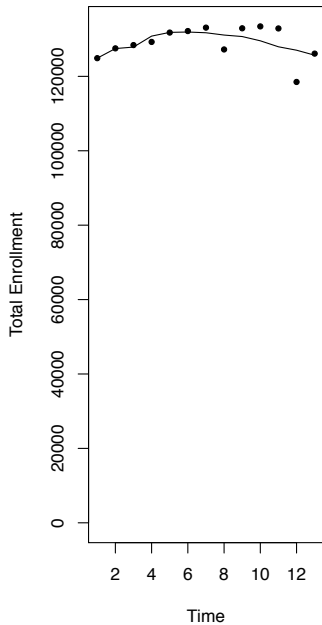
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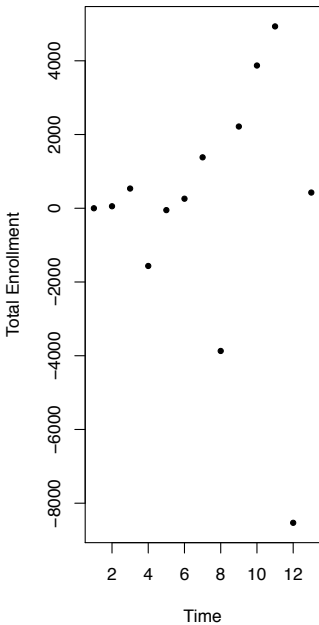
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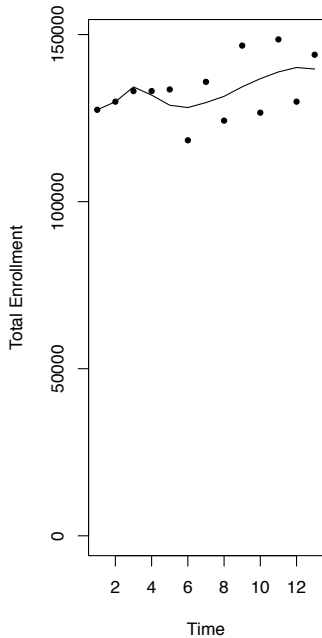
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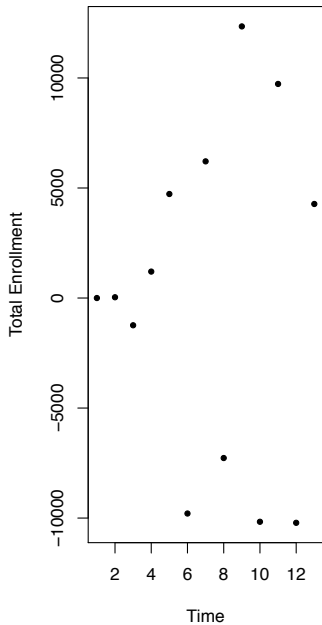
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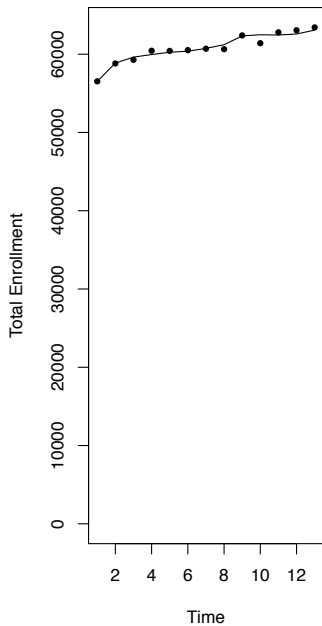
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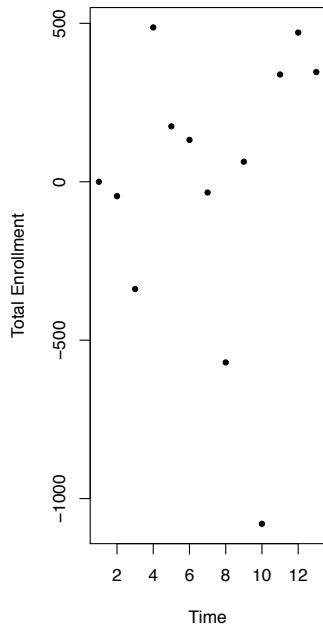
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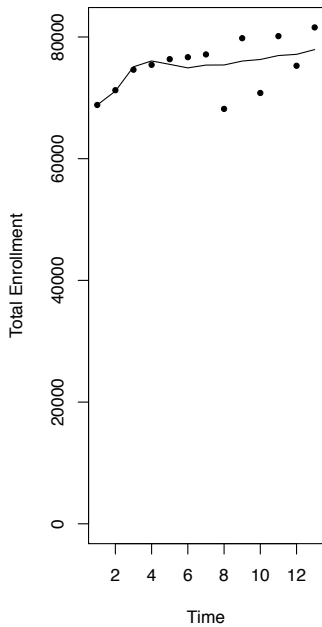
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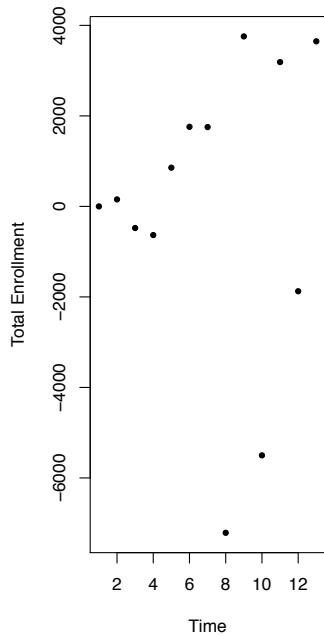
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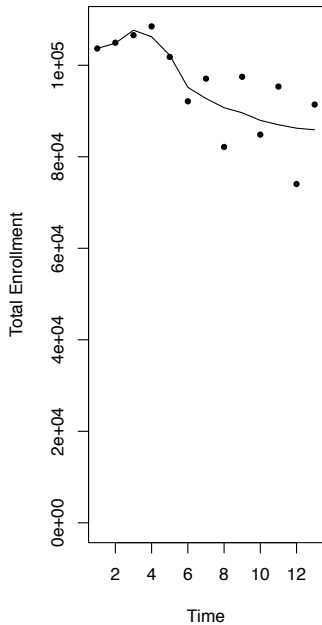
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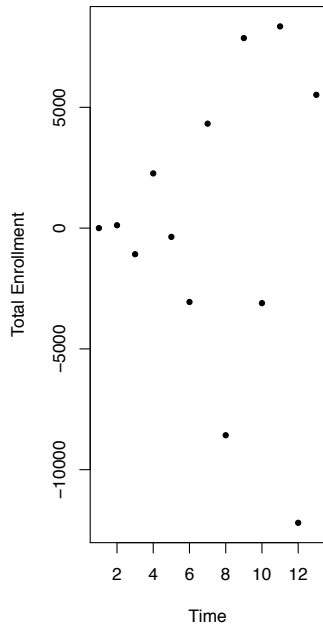
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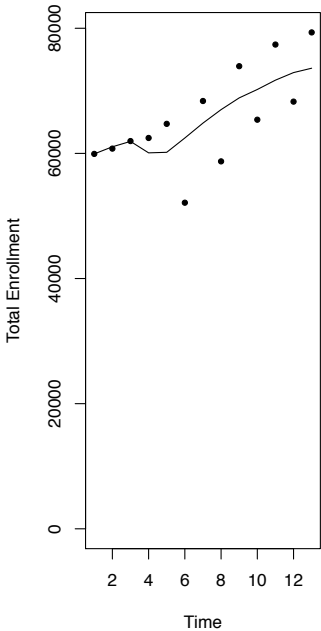
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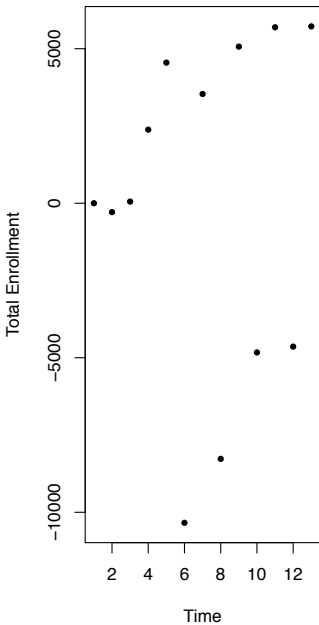
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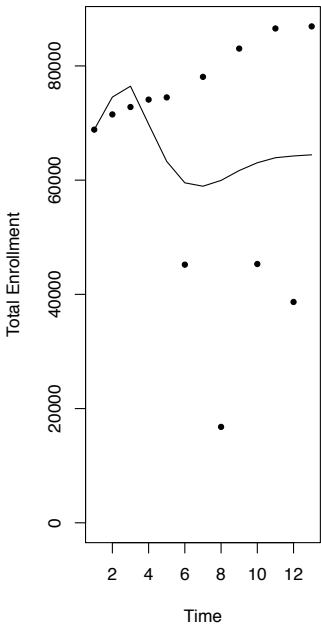
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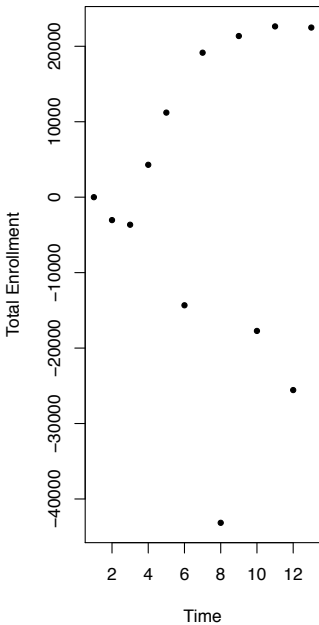
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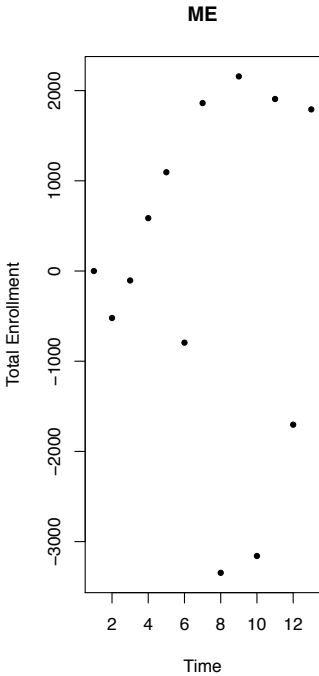
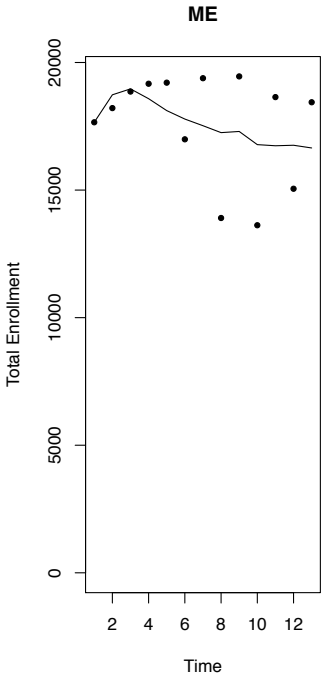


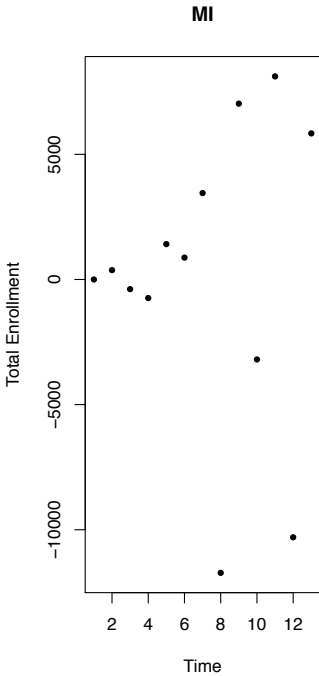
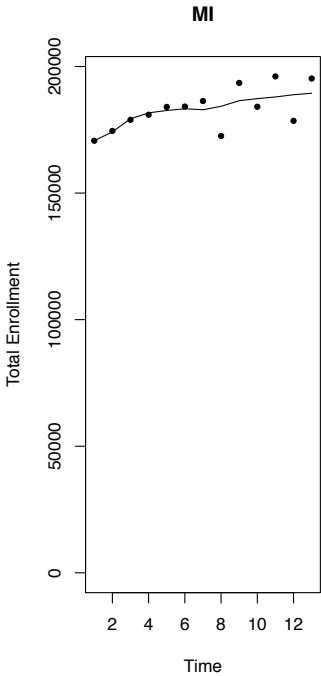
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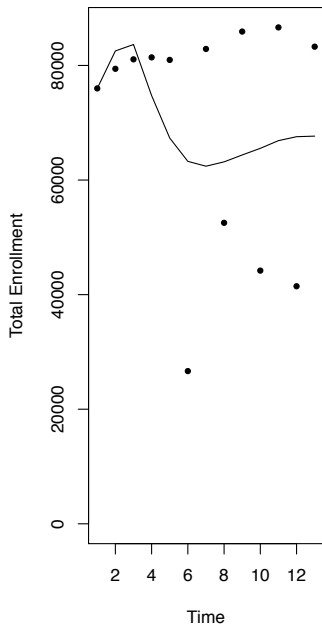
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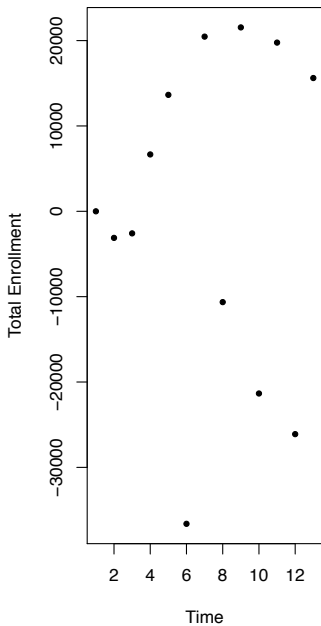




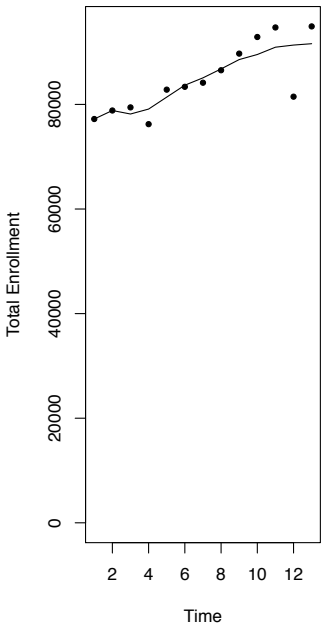
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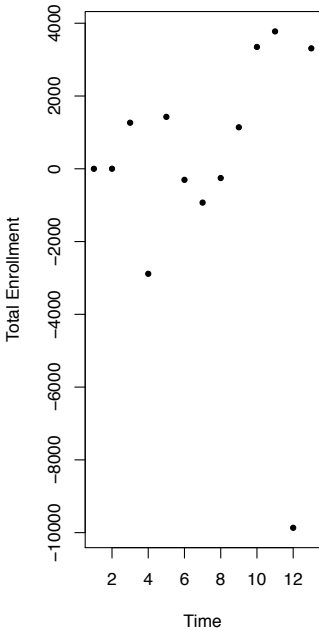
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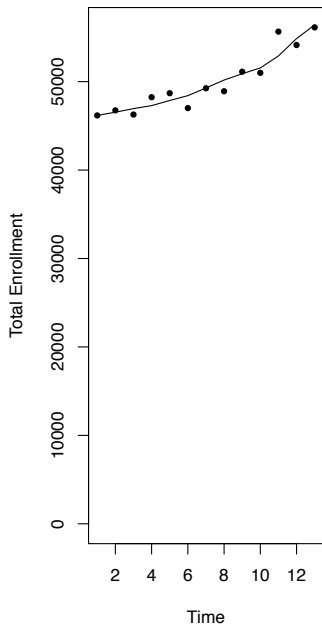
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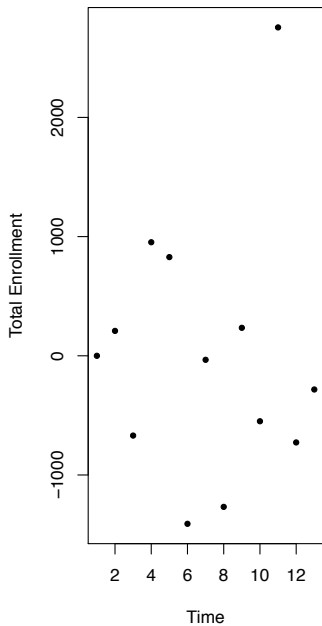
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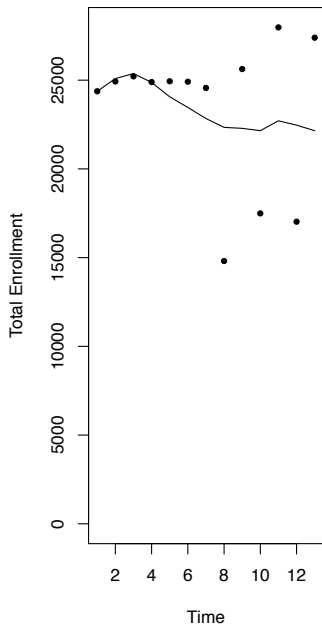
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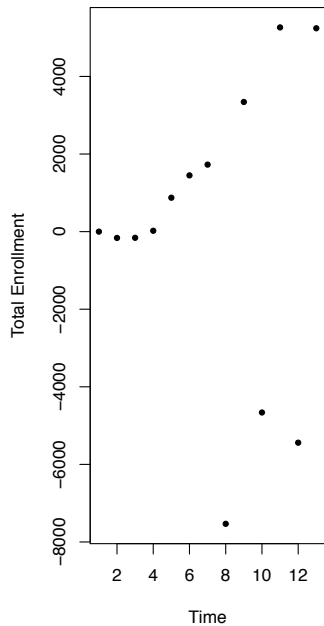
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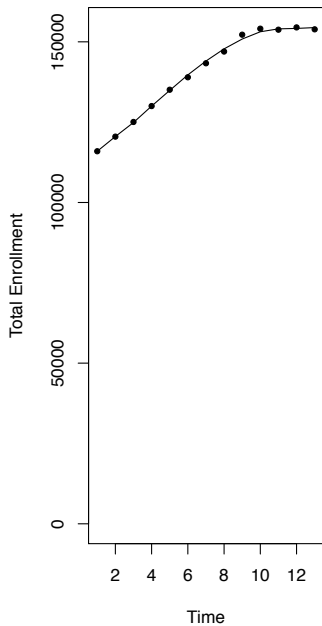
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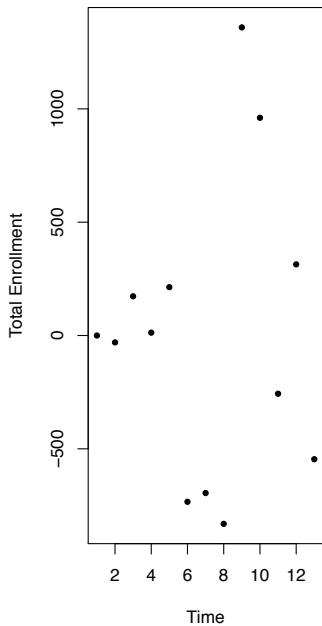
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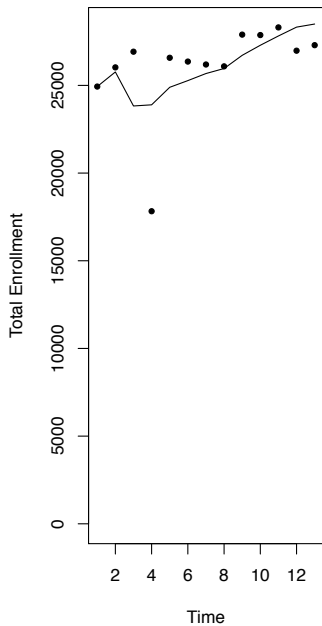
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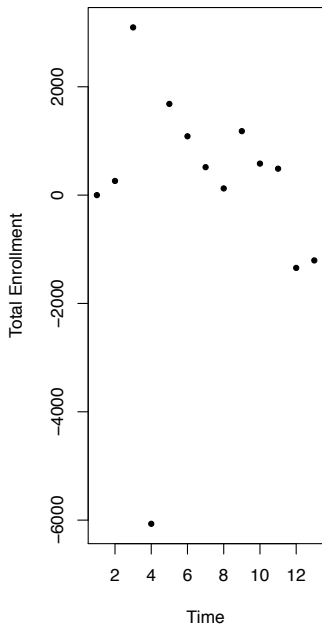
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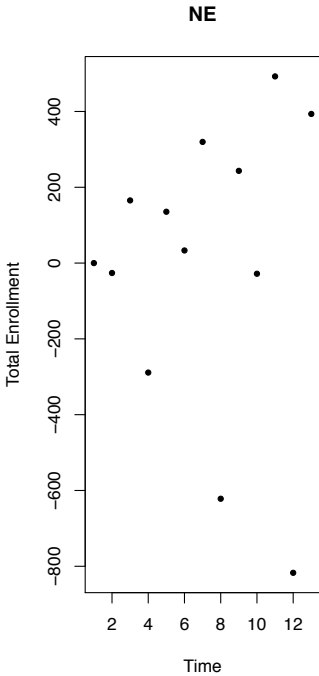
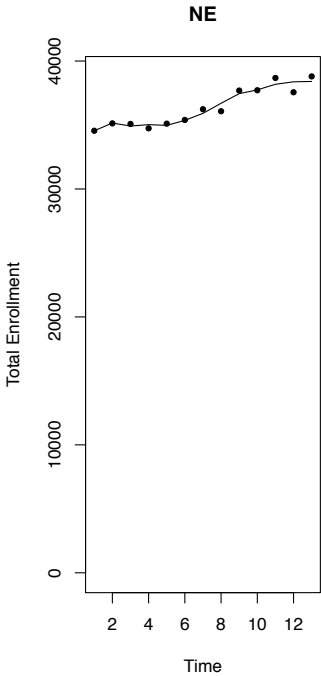


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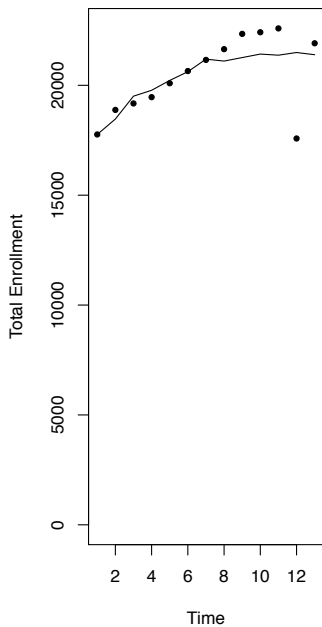


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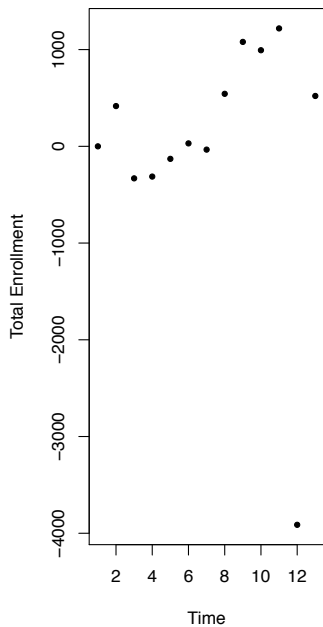




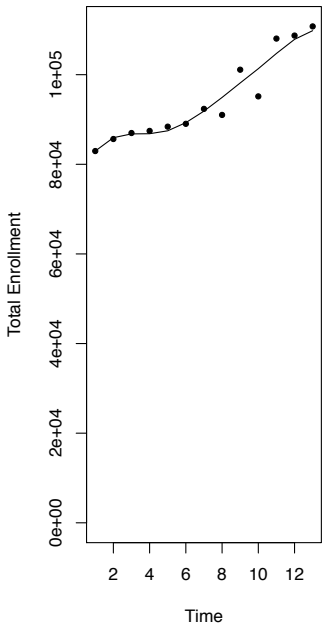
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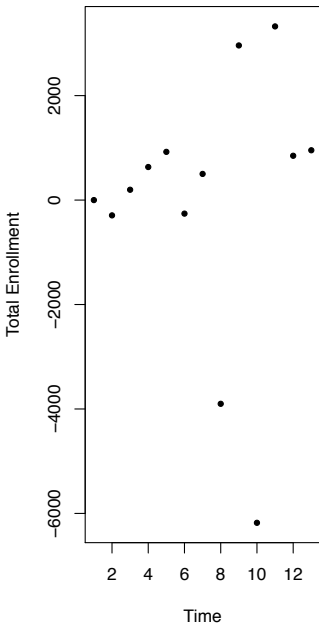
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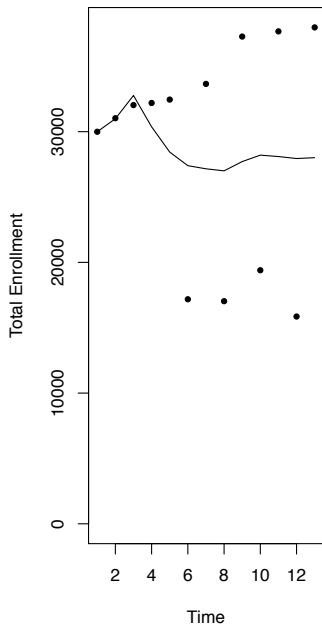
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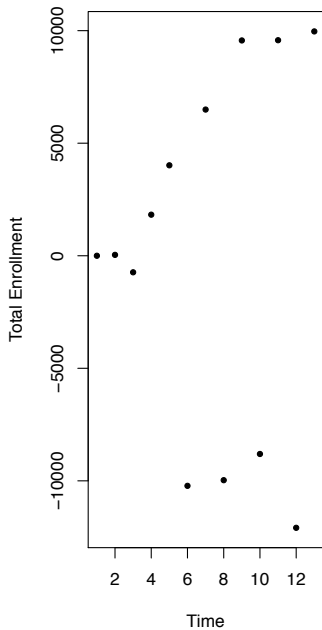
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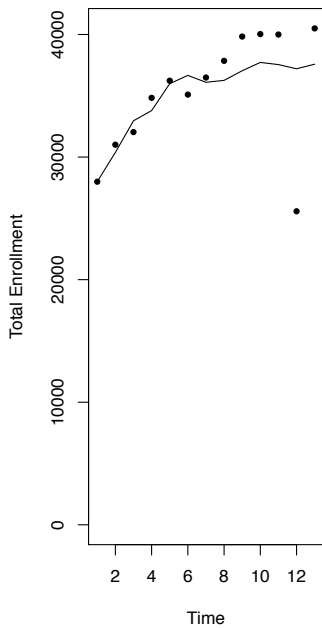
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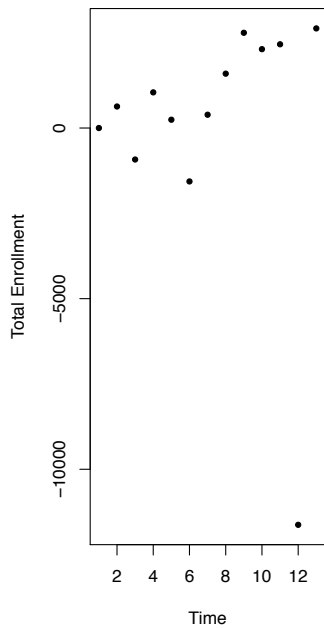
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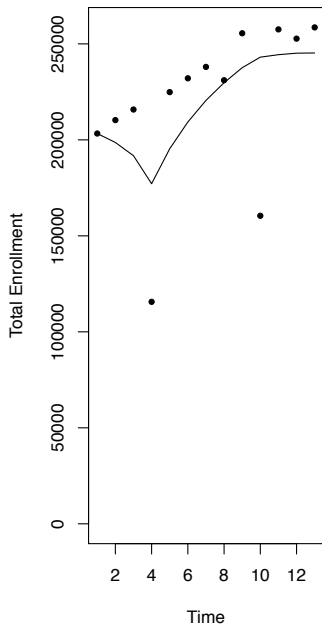
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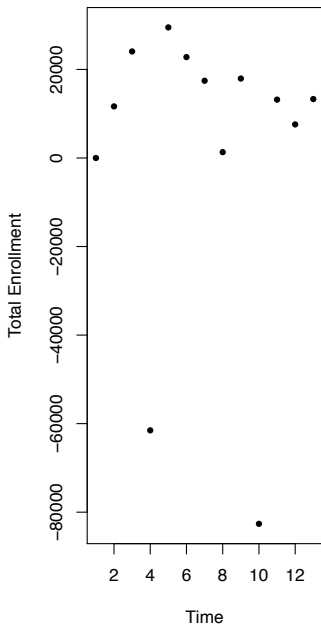
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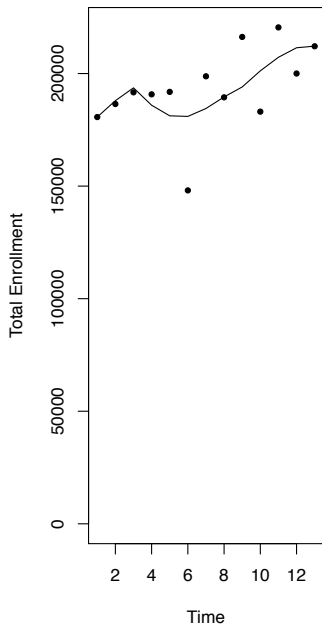
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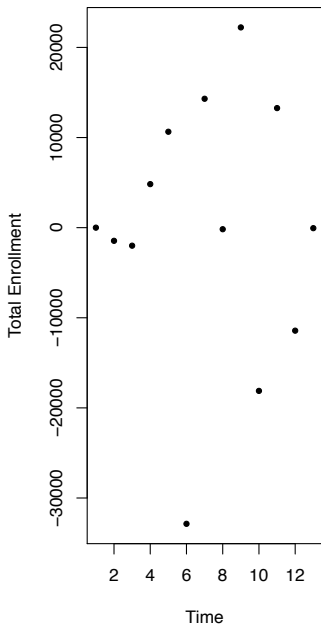
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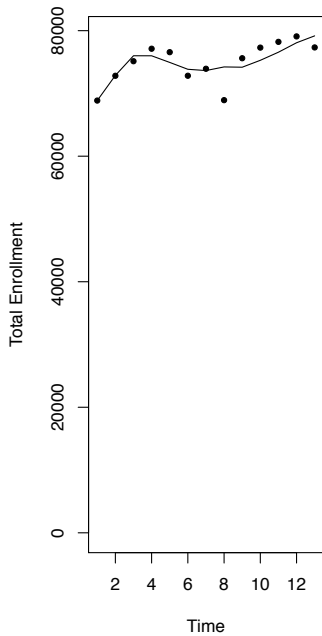
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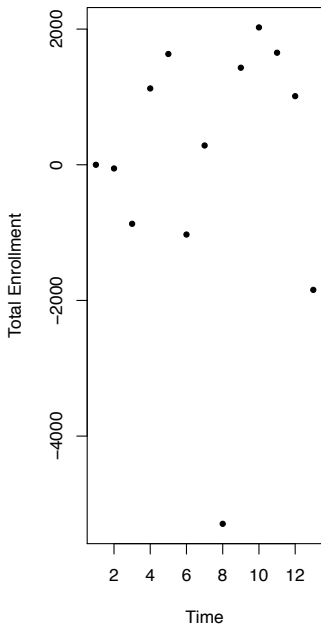
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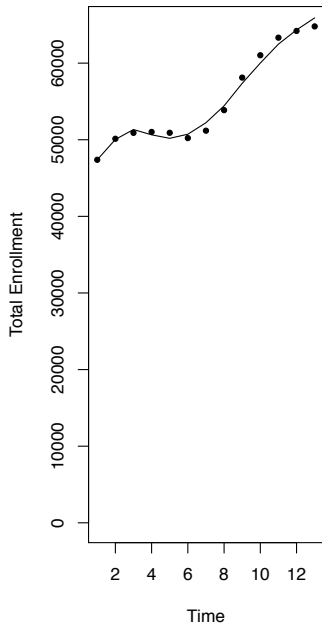
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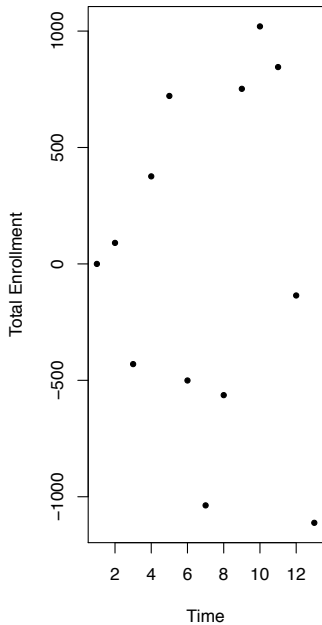
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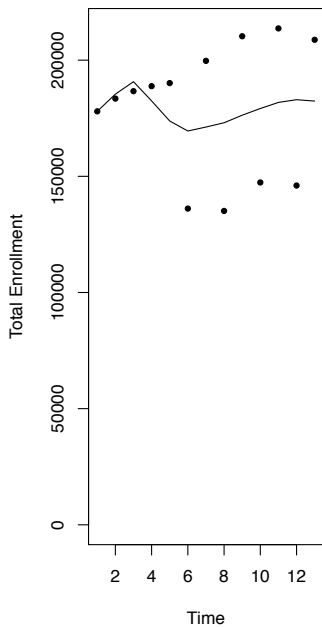
OR



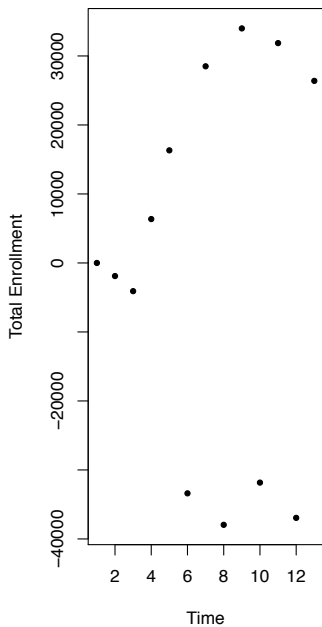
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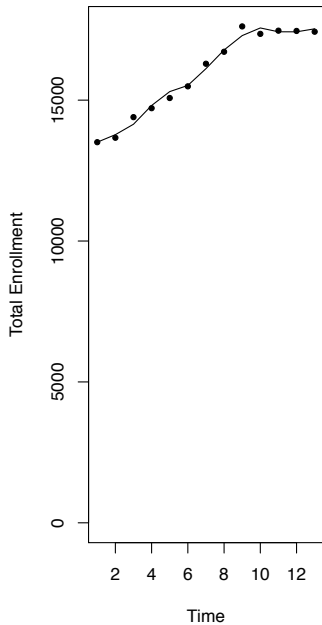
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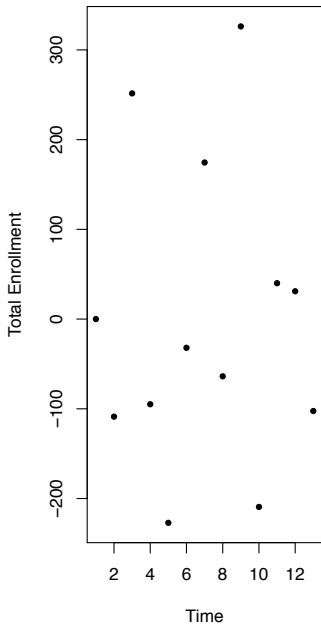
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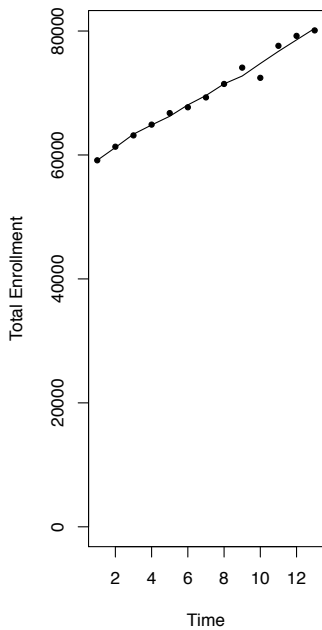
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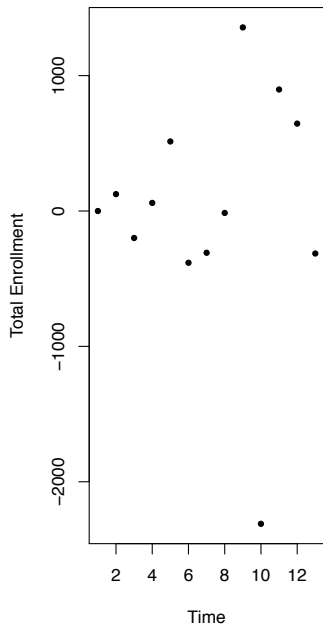
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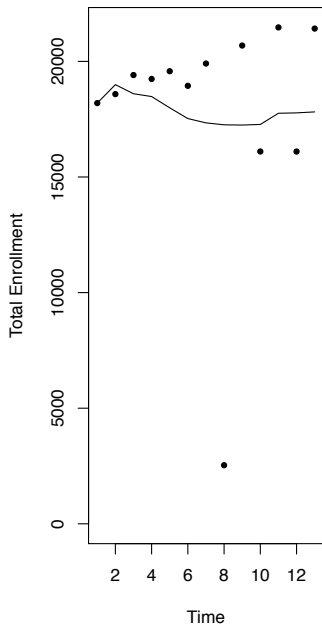
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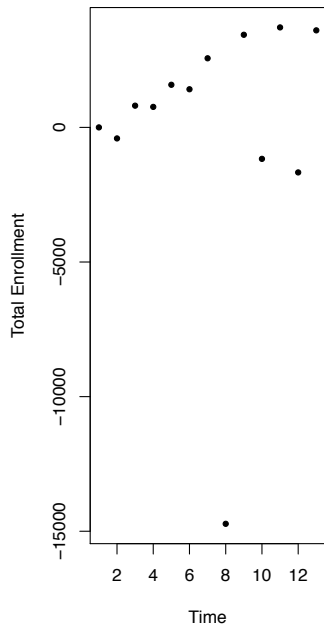
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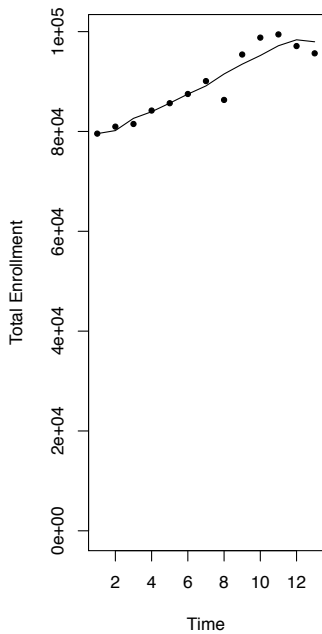
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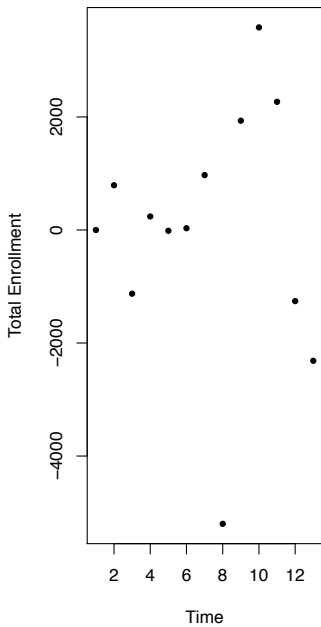
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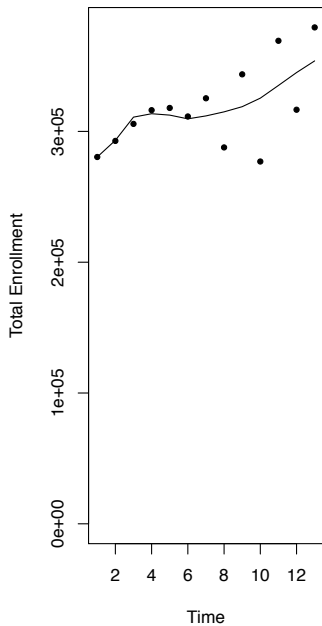
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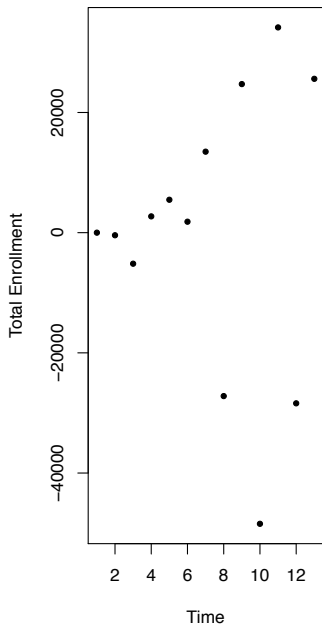
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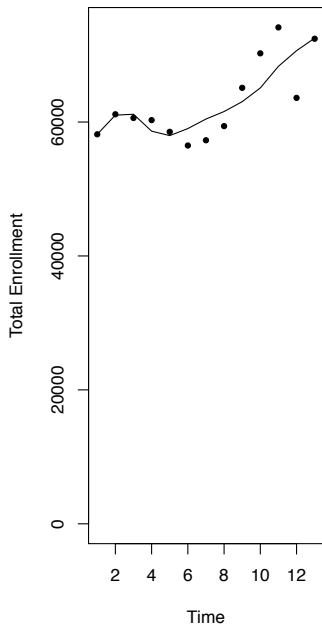
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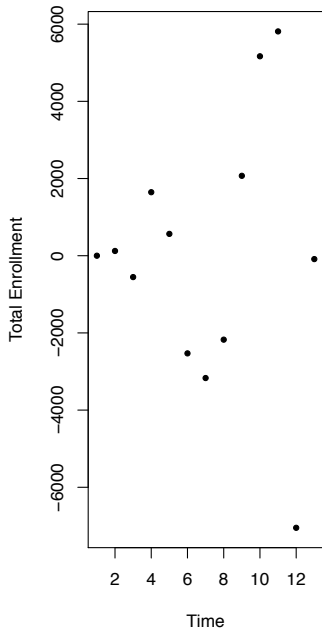
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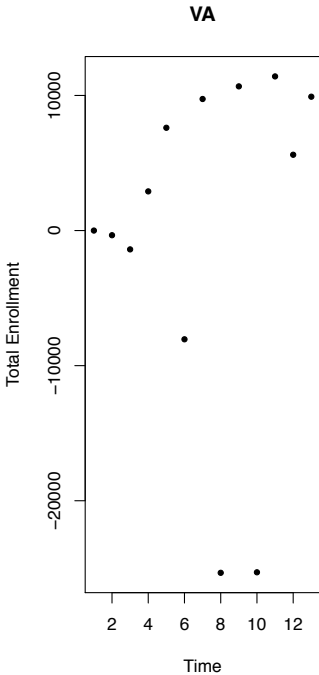
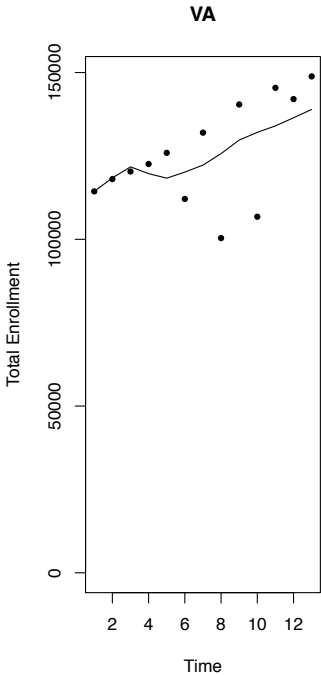


UT

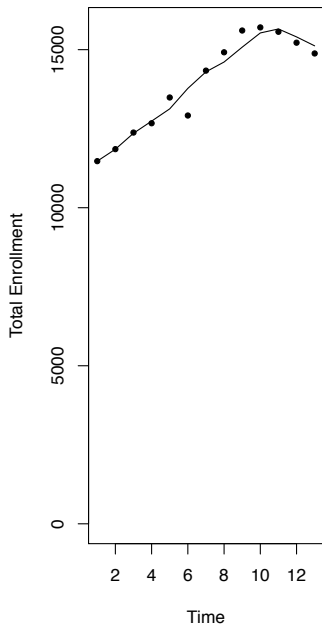


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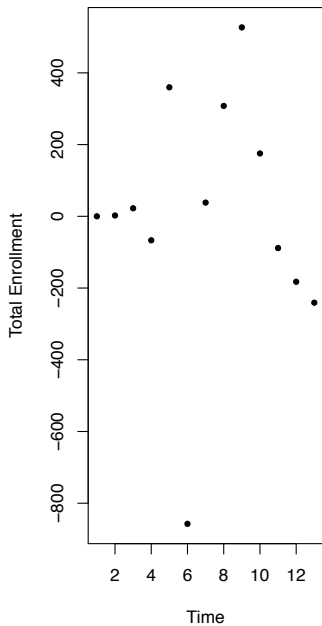




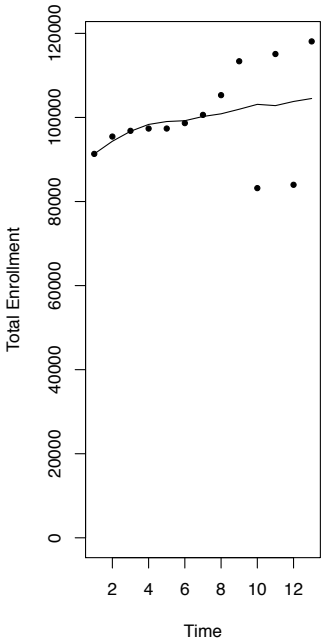
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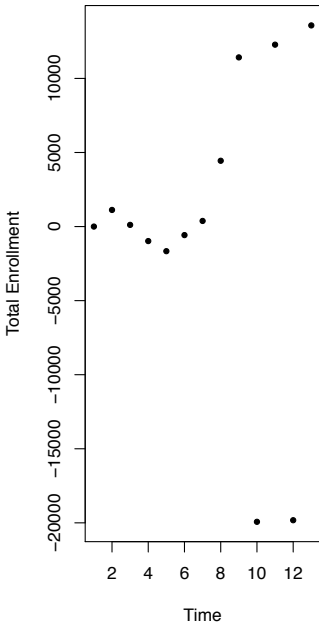
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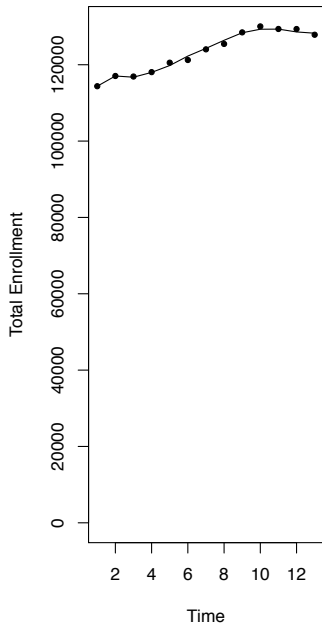
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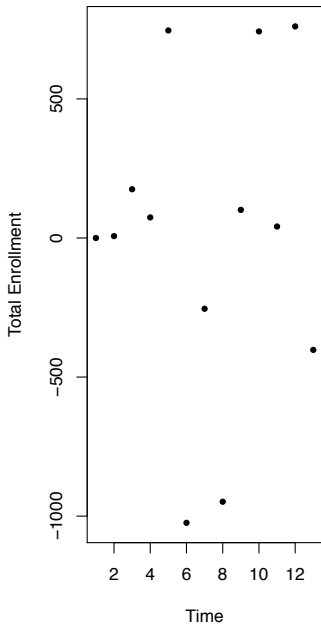
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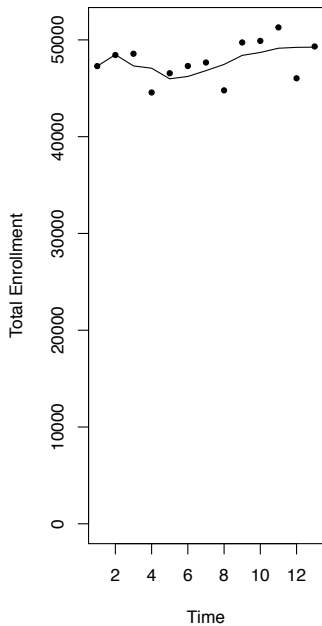
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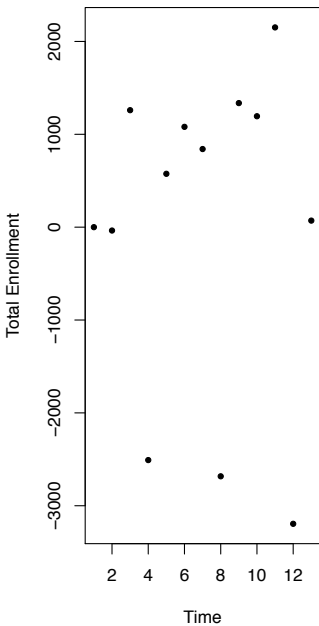
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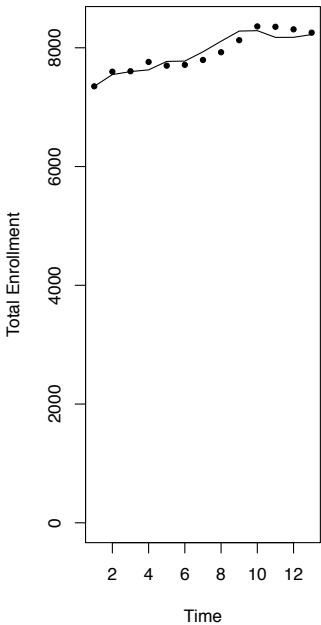
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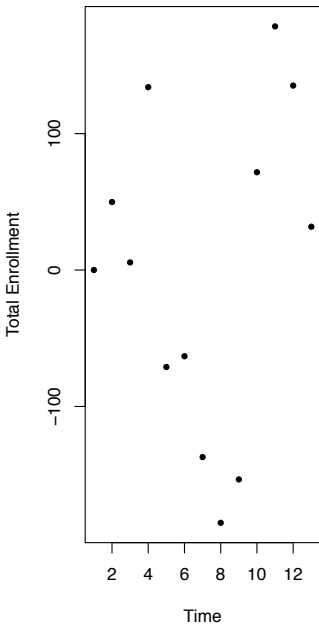
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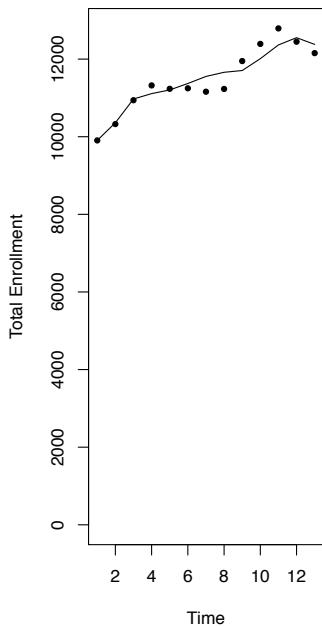
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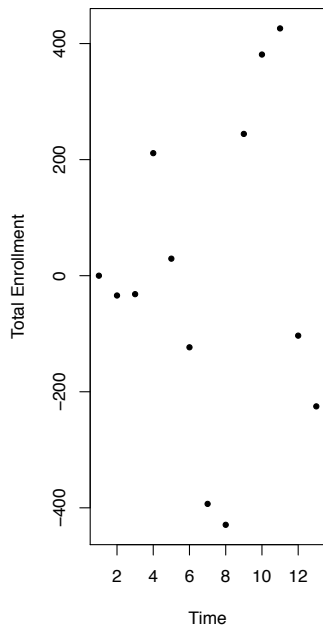
WY



AK



AK



Akaike Information Criterion

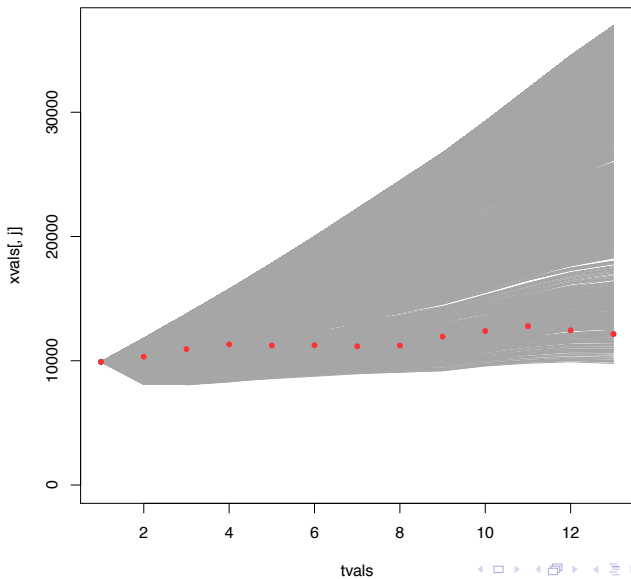
$$AIC_c = n \log \left(\frac{RSS}{n} \right) + 2k + \frac{2k(k+1)}{n-k-1}$$

- We selected the "best" model by computing an AIC score for all four models
 - This analysis was done with all 51 datasets
- **Model 3** consistently had the lowest AIC score for the 51 datasets

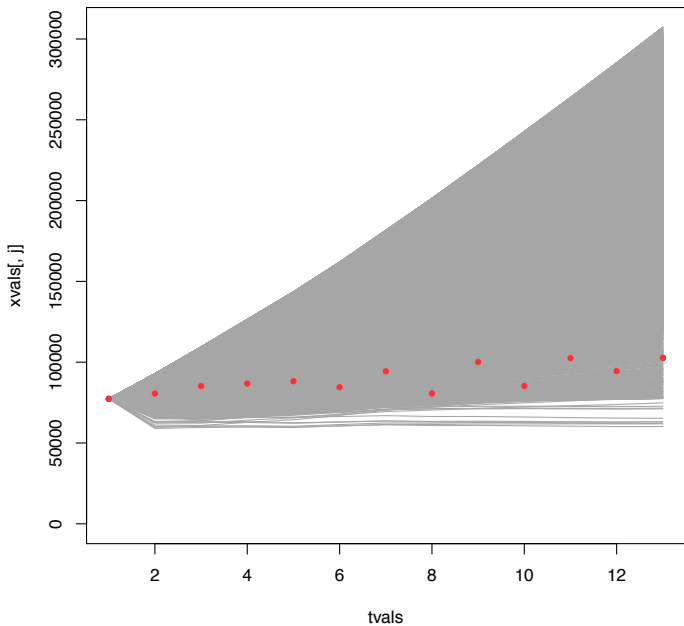
Bootstrap Analysis: Model 3

- Performed bootstrapping on Model 3 parameter estimates
- A total of 10,000 estimates for the true parameters were obtained
- By evaluating the model at each of these estimates we are able to produce cloud plots
- The bootstrapping estimate, $\hat{\theta}_{BOOT}$ will allow us to compute life tables

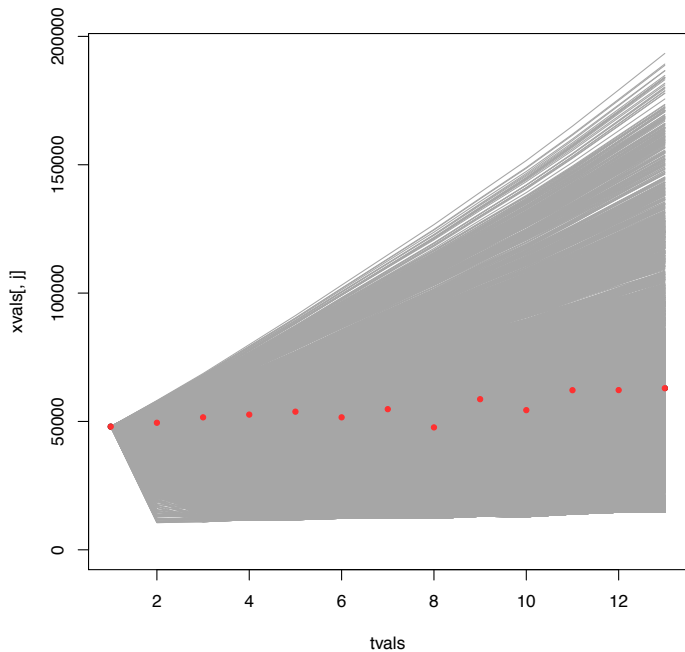
Cloud Plot for AK



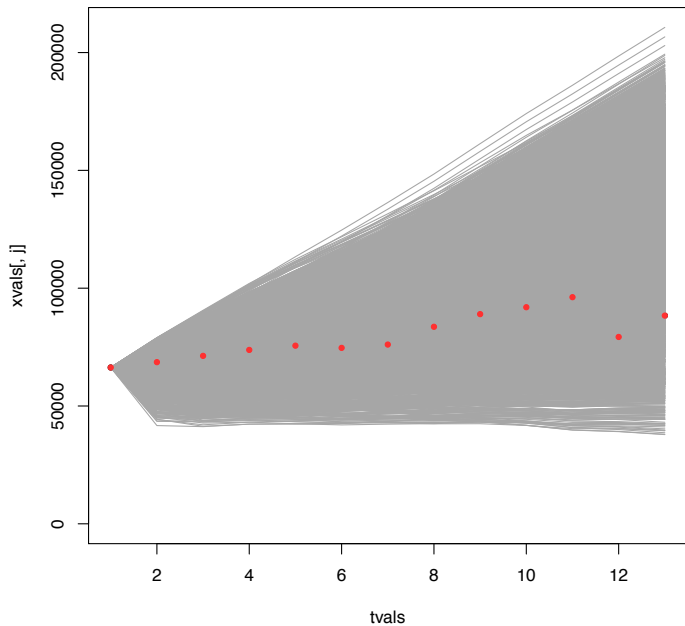
Cloud Plot for AL



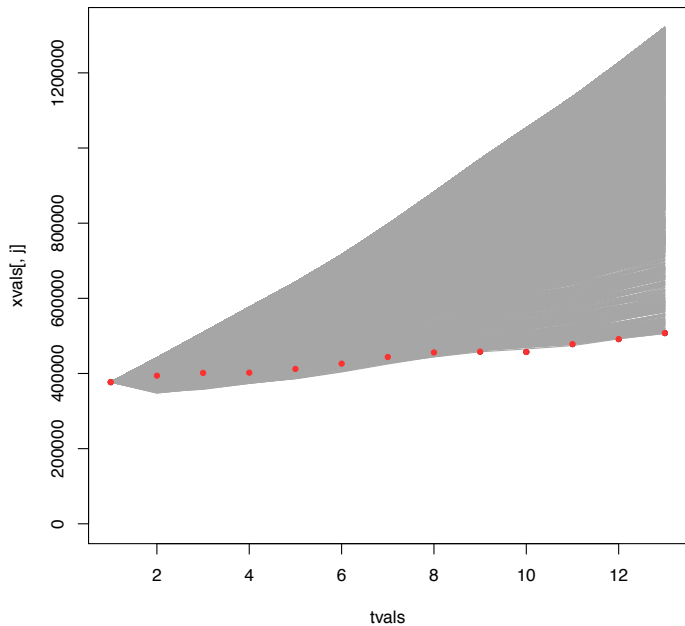
Cloud Plot for AR



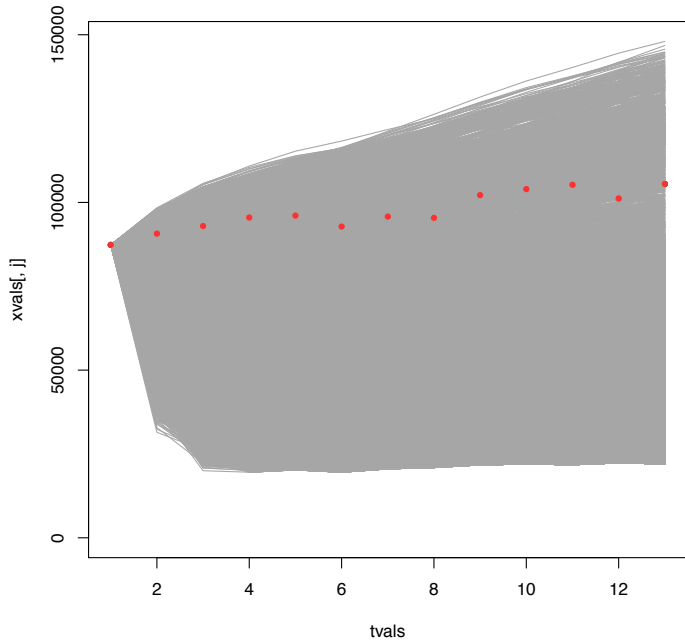
Cloud Plot for AZ



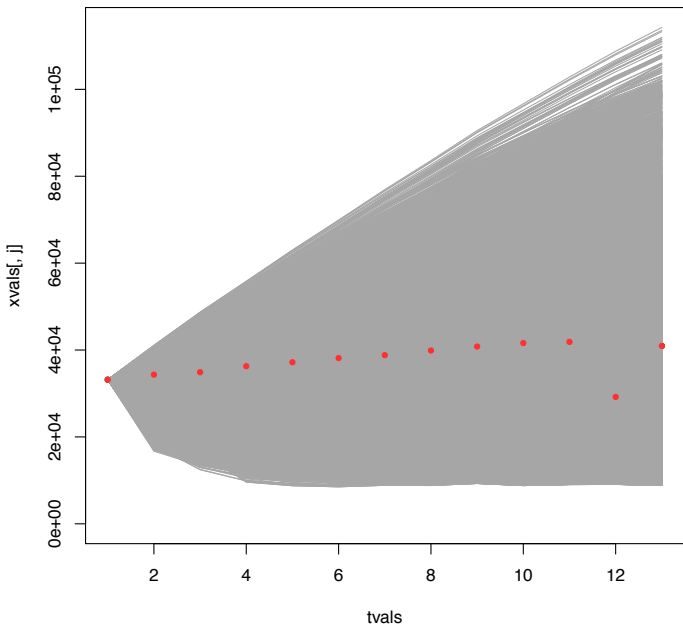
Cloud Plot for CA



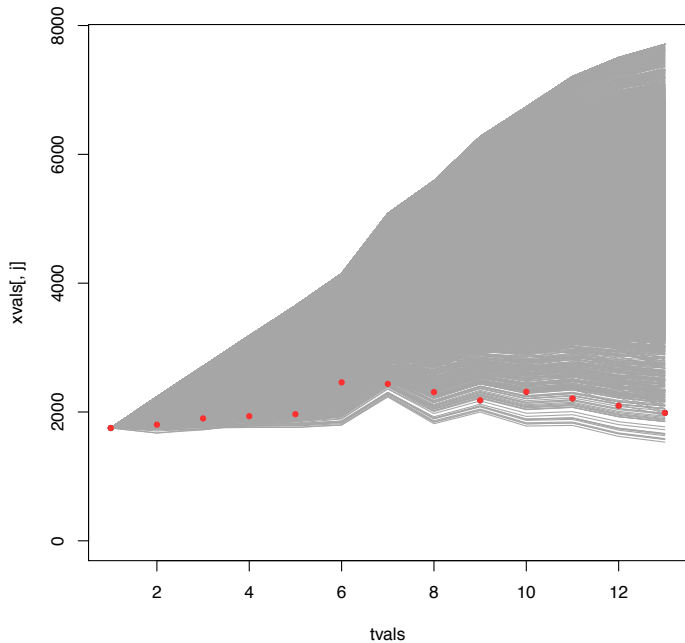
Cloud Plot for CO



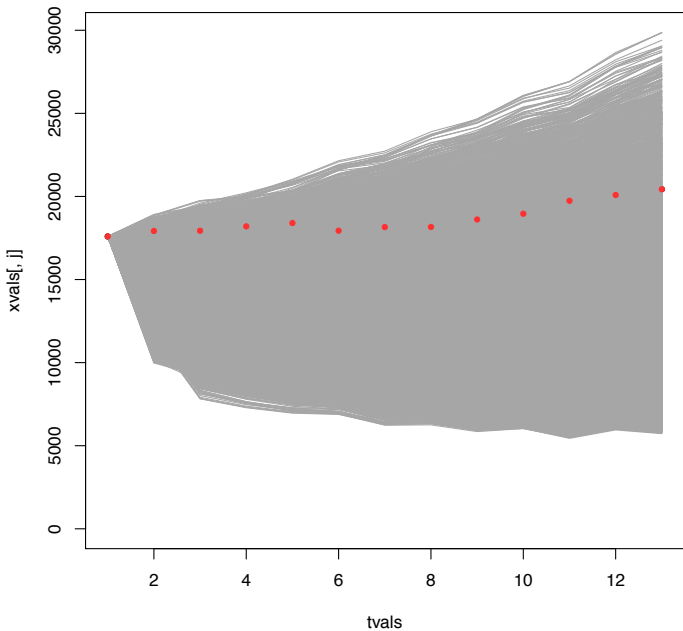
Cloud Plot for CT



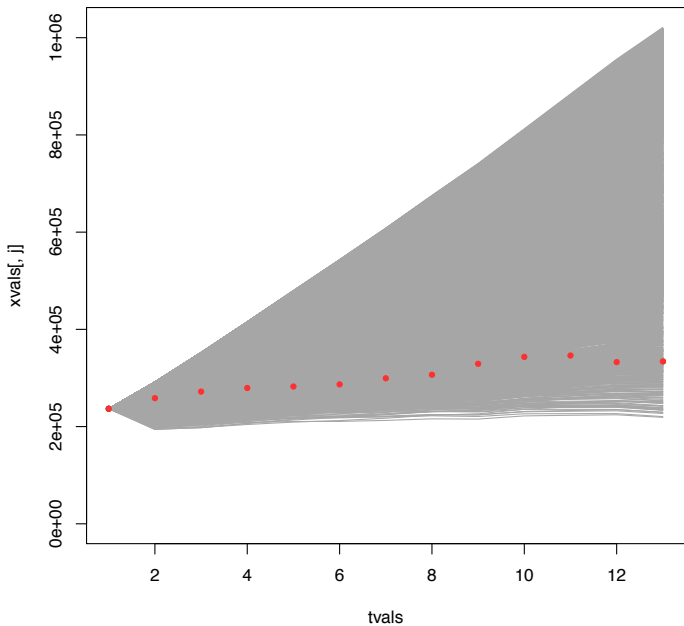
Cloud Plot for DC



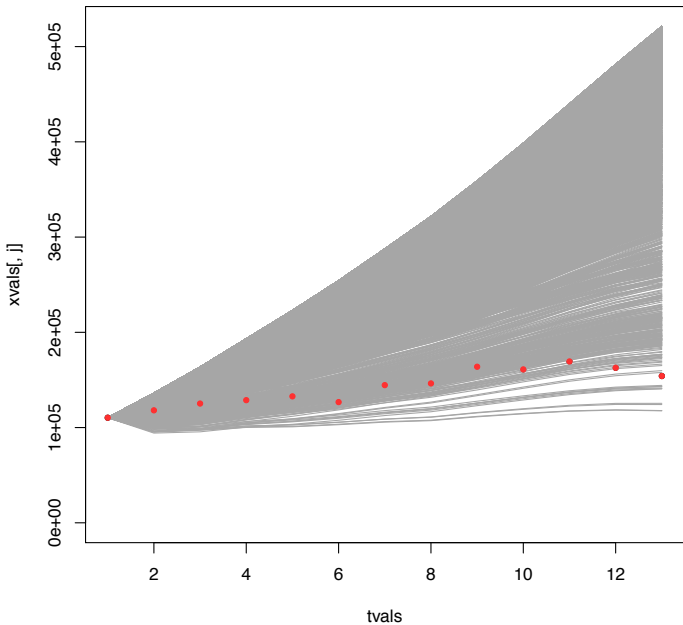
Cloud Plot for DE



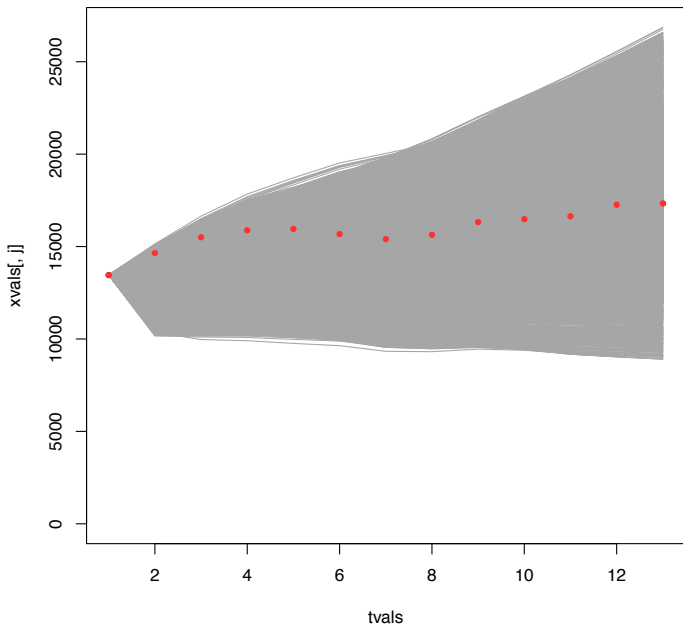
Cloud Plot for FL



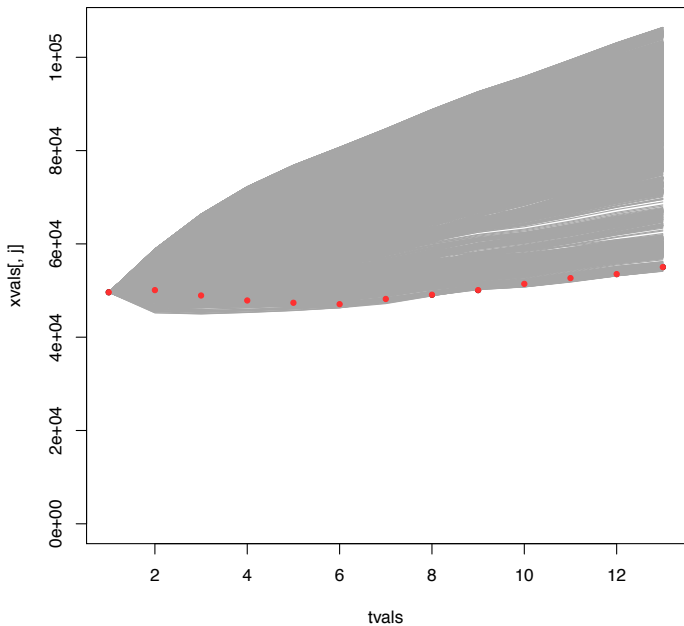
Cloud Plot for GA



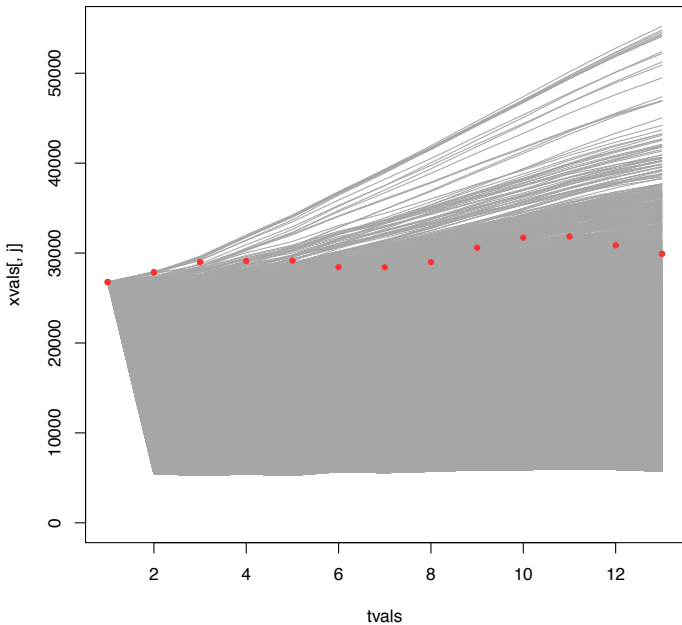
Cloud Plot for HI



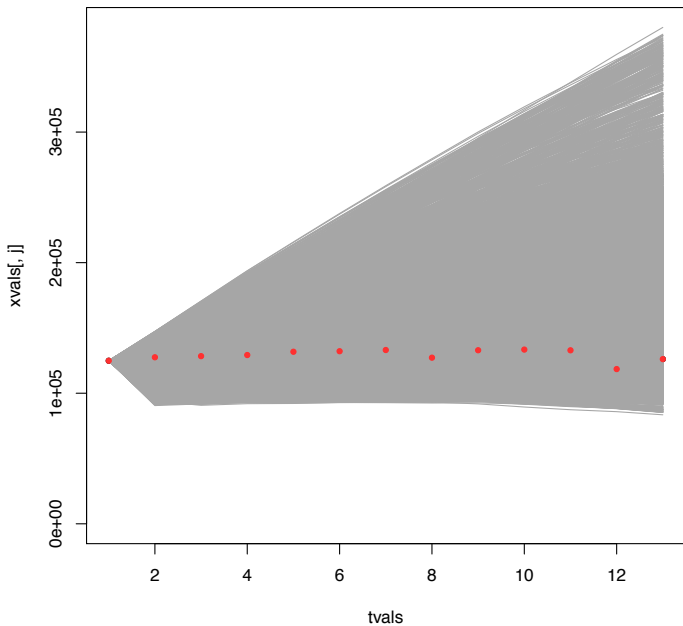
Cloud Plot for IA



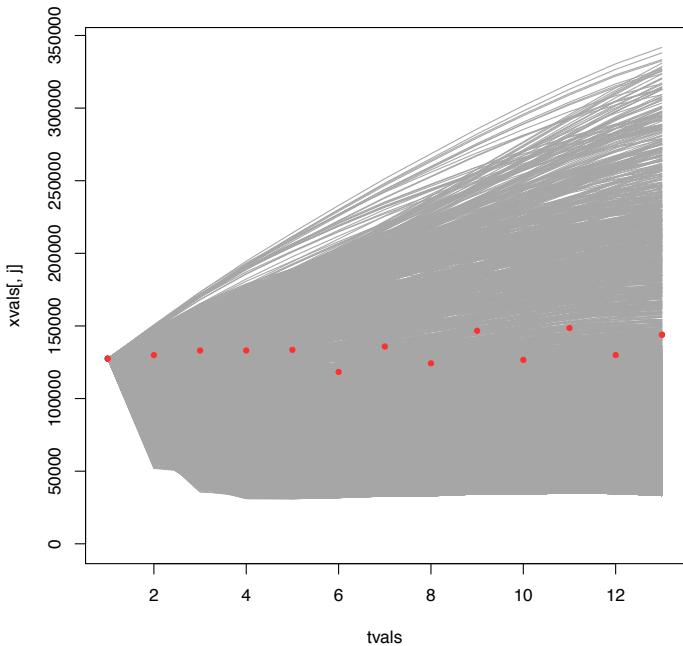
Cloud Plot for ID



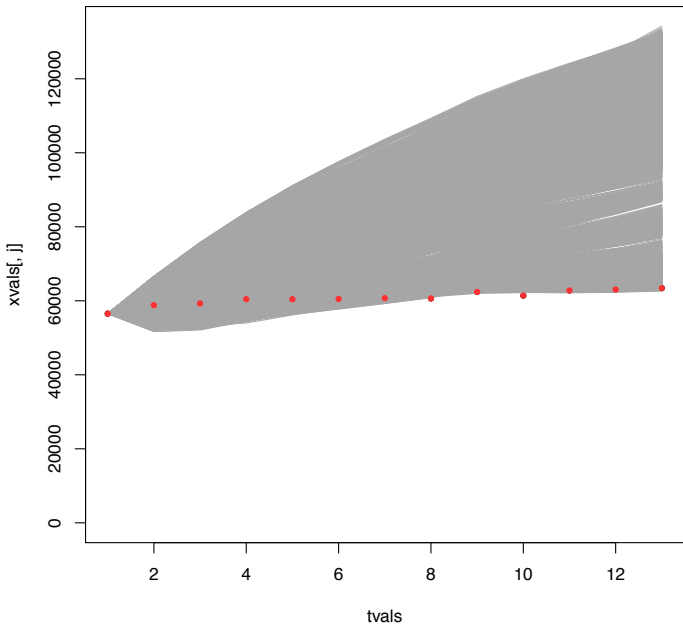
Cloud Plot for IL



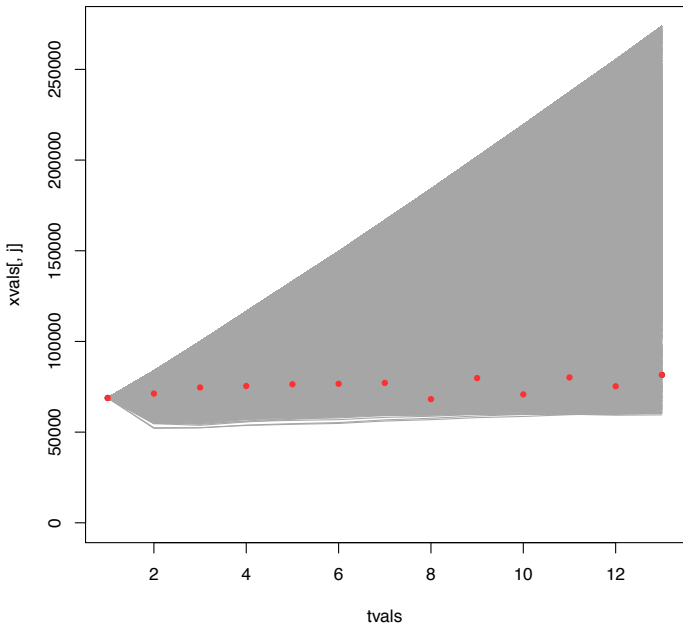
Cloud Plot for IN



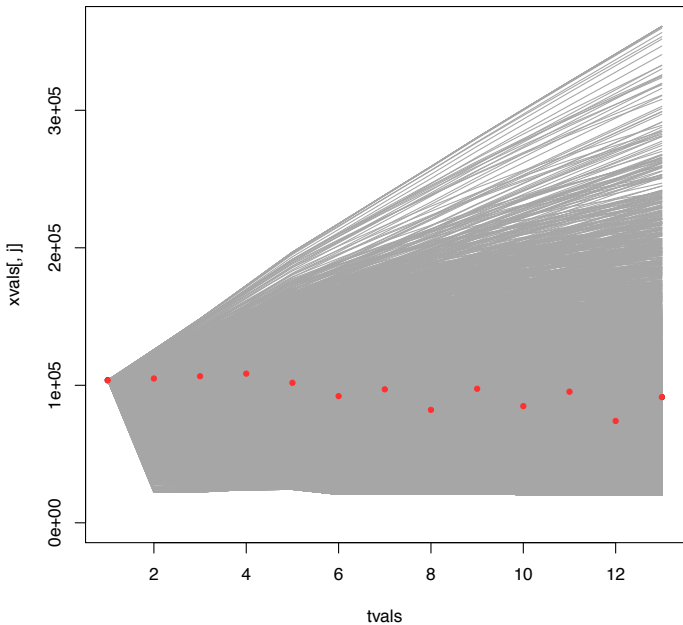
Cloud Plot for KS



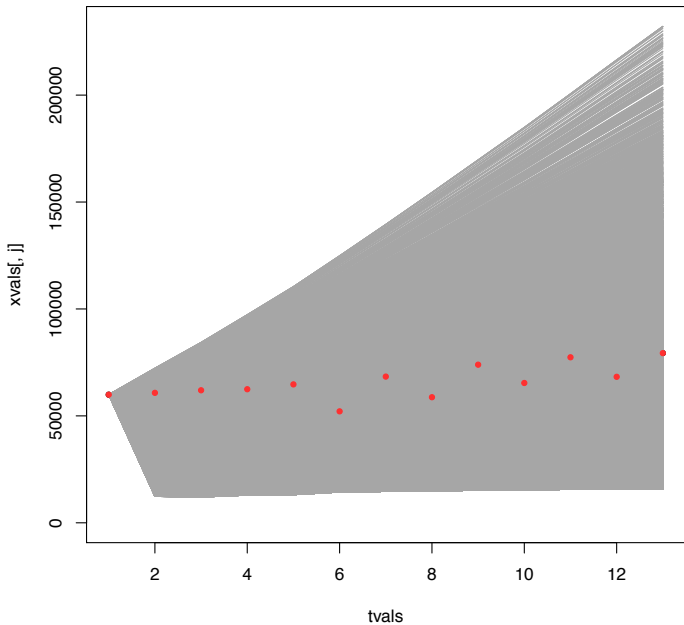
Cloud Plot for KY



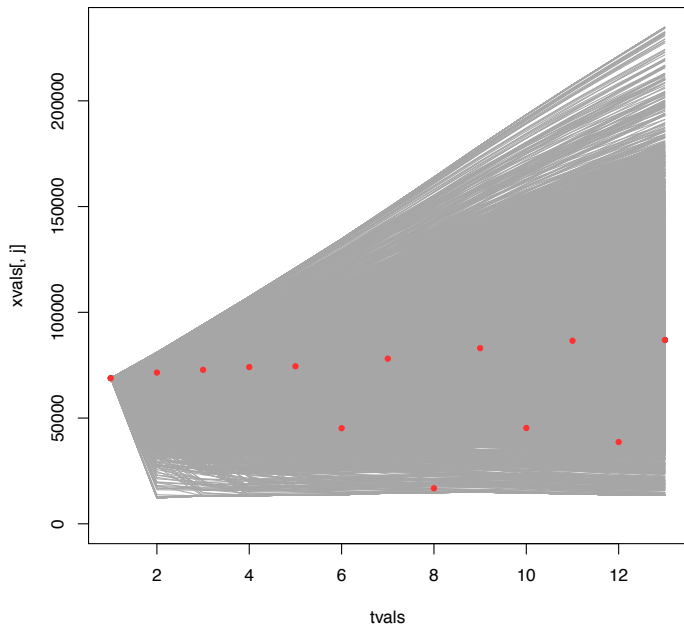
Cloud Plot for LA



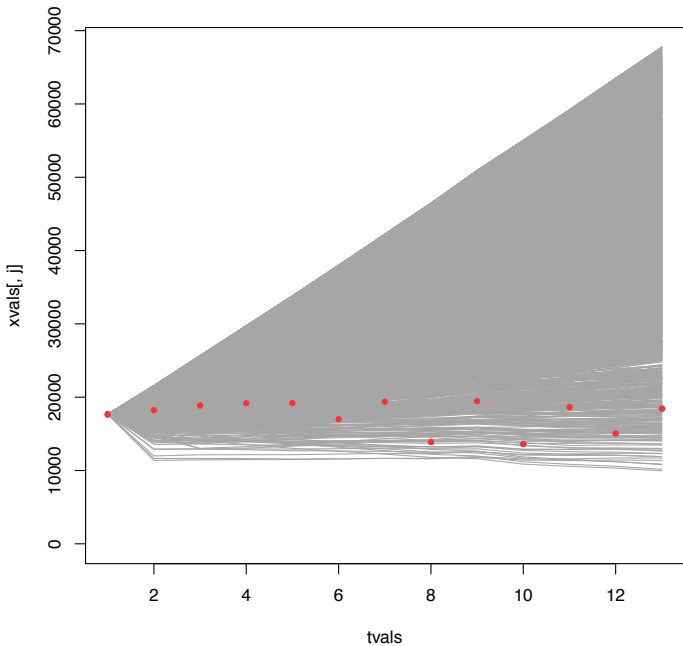
Cloud Plot for MA



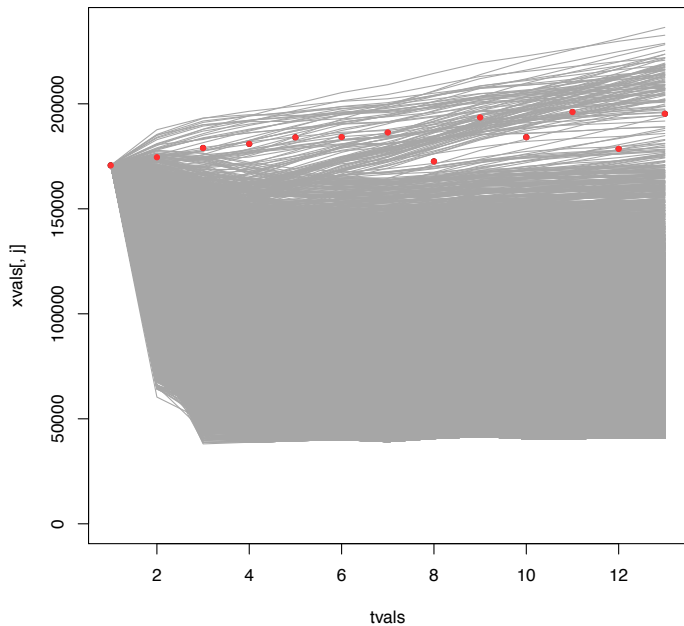
Cloud Plot for MD



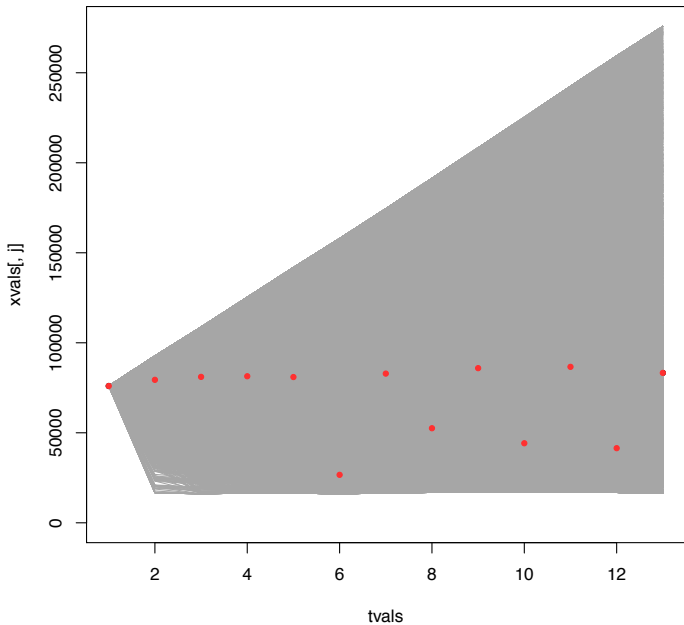
Cloud Plot for ME



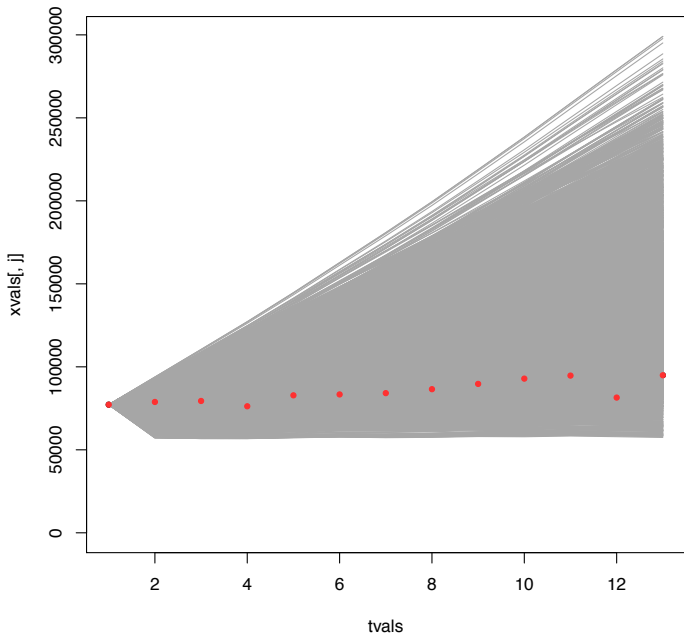
Cloud Plot for MI



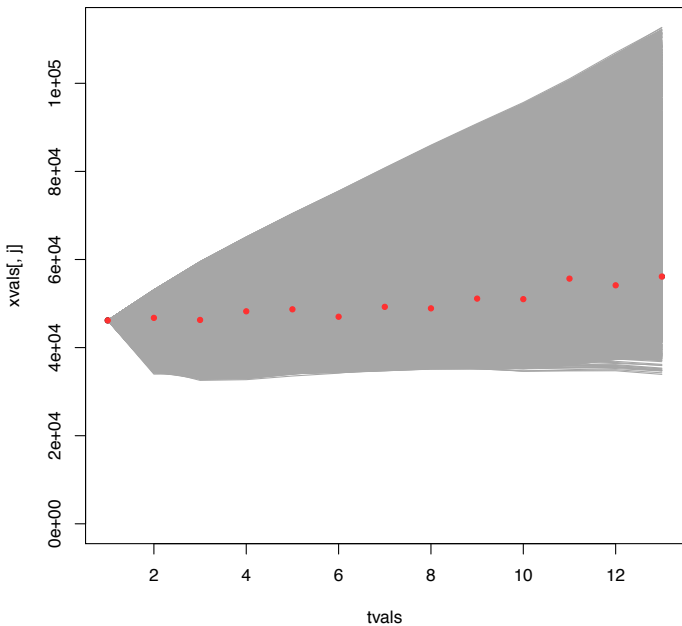
Cloud Plot for MN



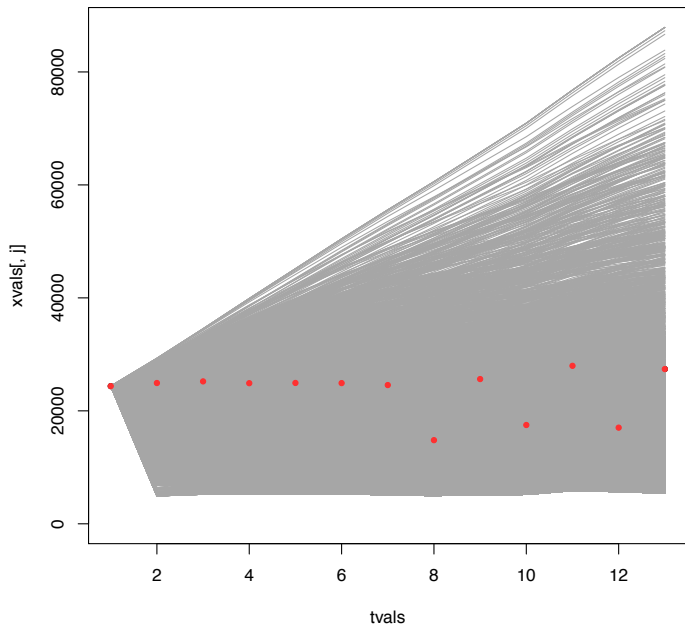
Cloud Plot for MO



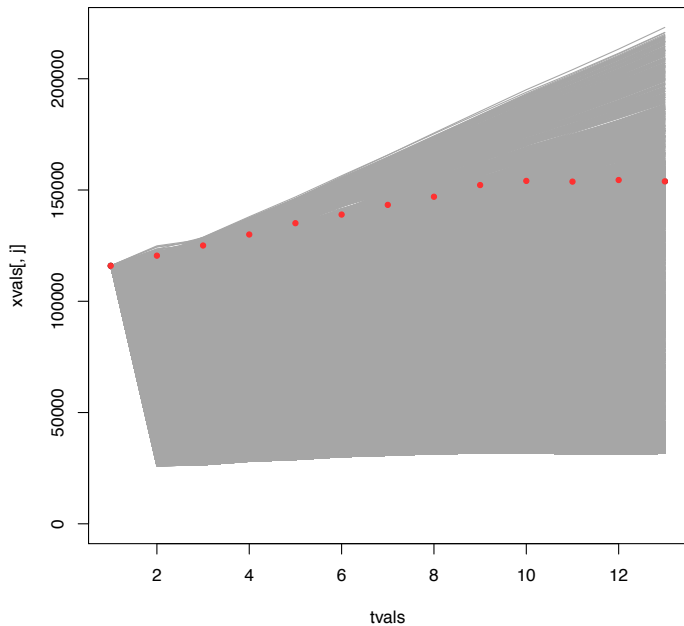
Cloud Plot for MS



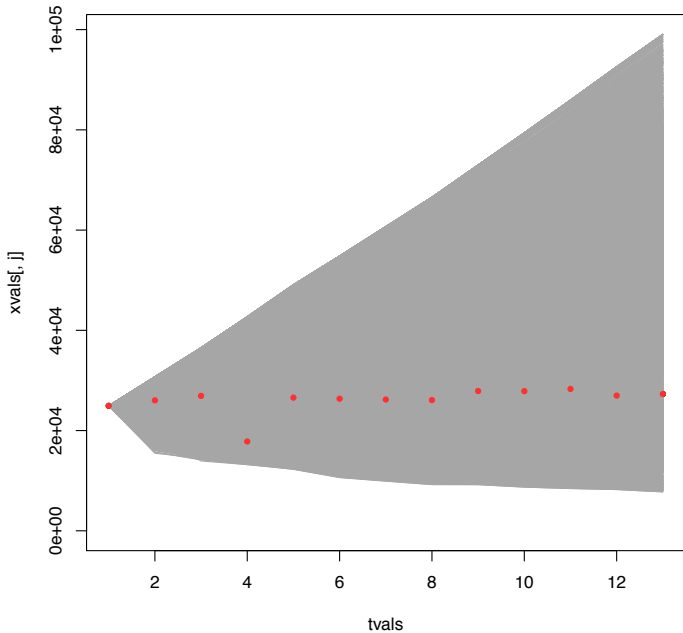
Cloud Plot for MT



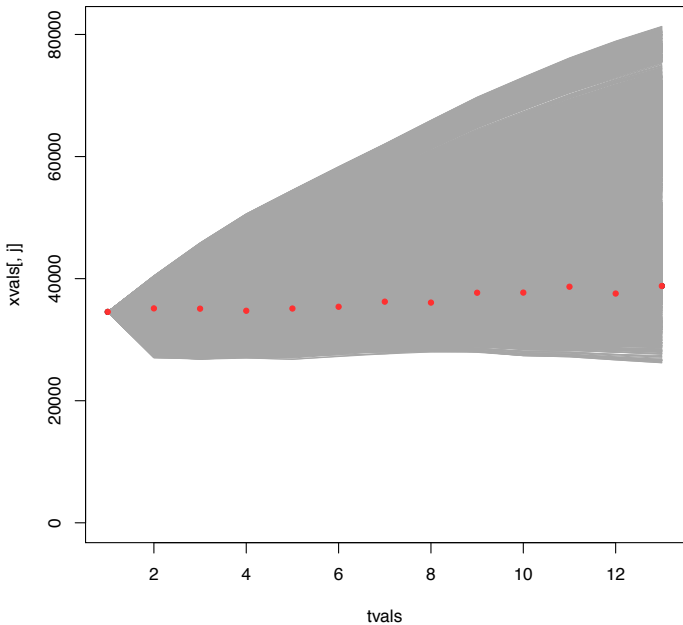
Cloud Plot for NC



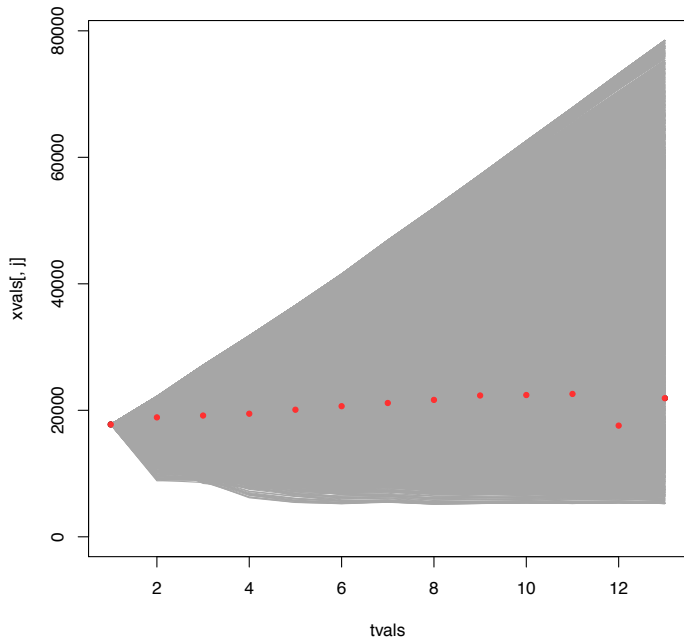
Cloud Plot for ND



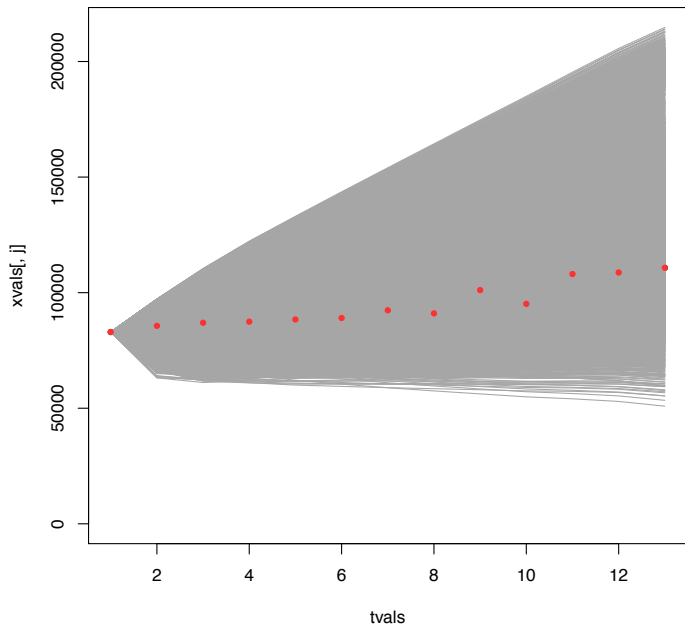
Cloud Plot for NE



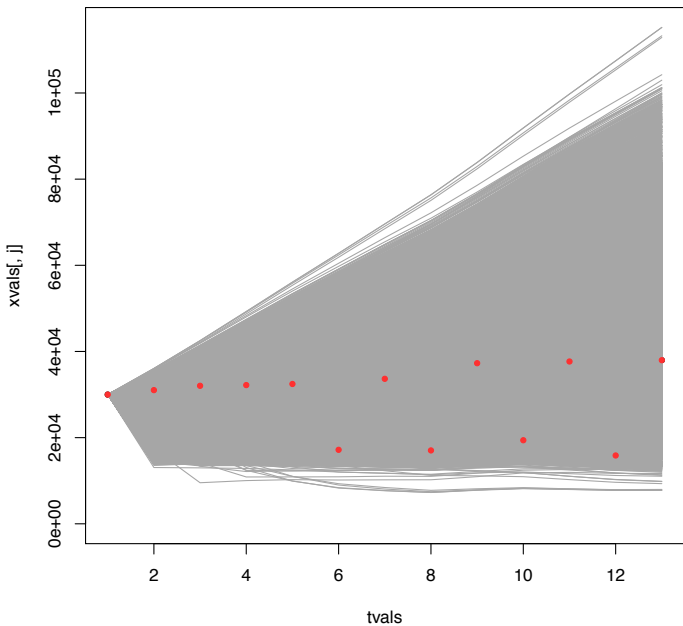
Cloud Plot for NH



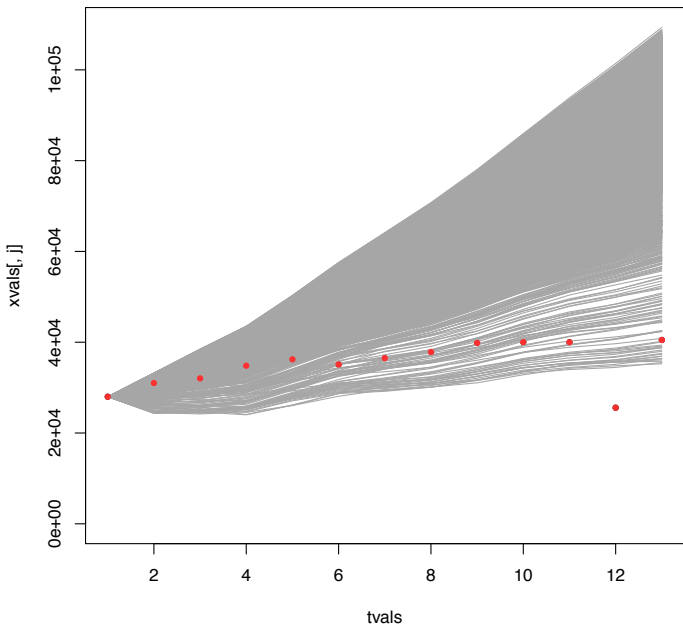
Cloud Plot for NJ



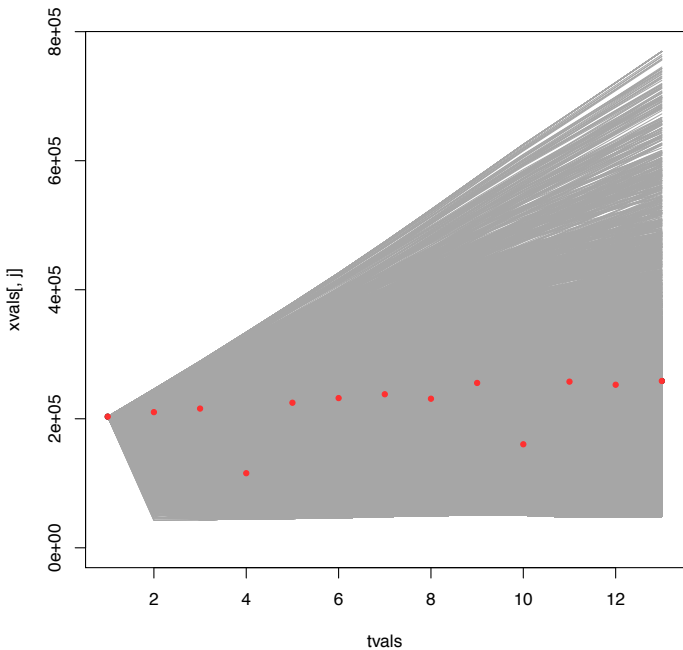
Cloud Plot for NM



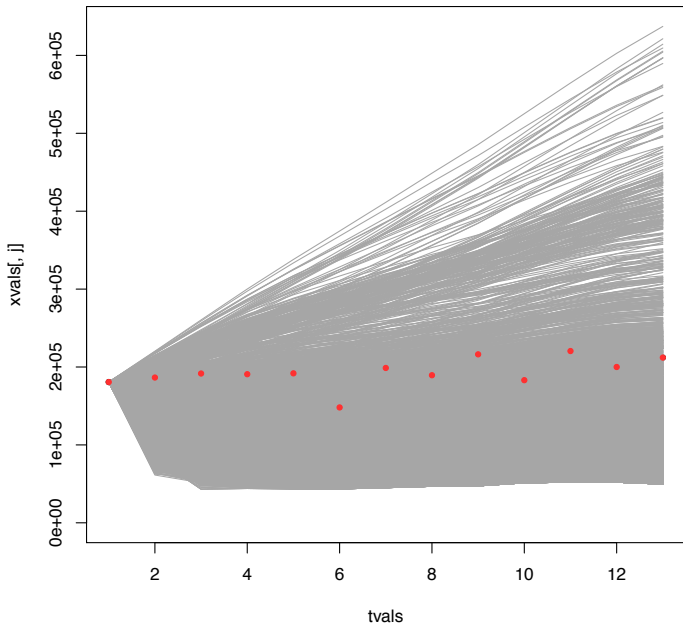
Cloud Plot for NV



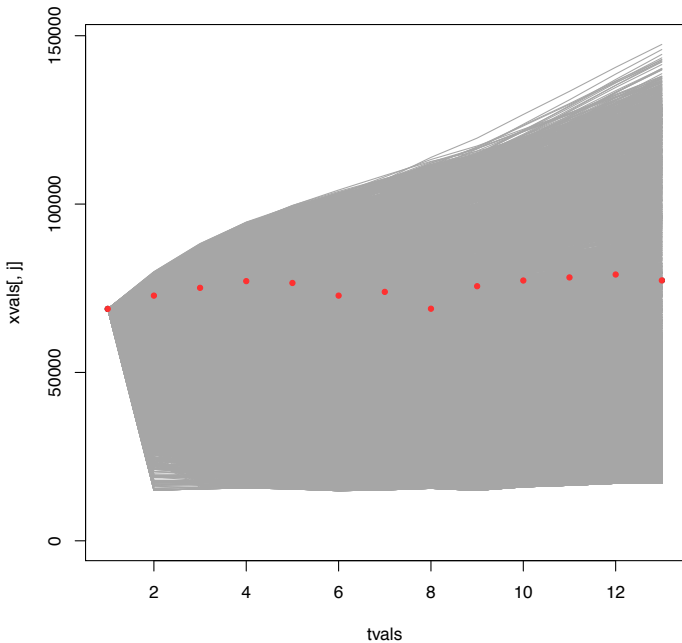
Cloud Plot for NY



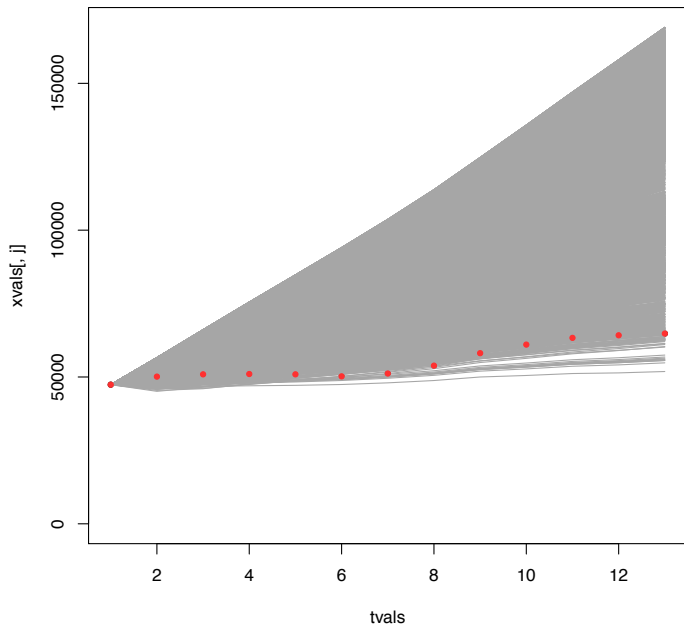
Cloud Plot for OH



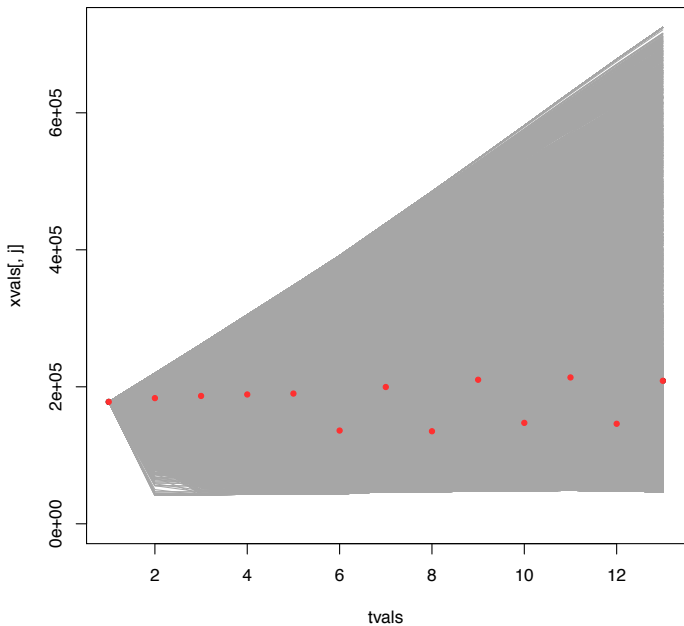
Cloud Plot for OK



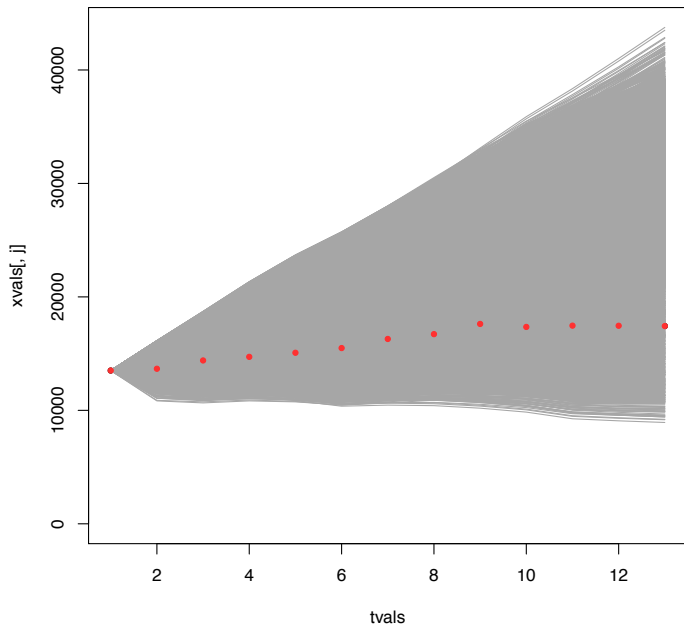
Cloud Plot for OR



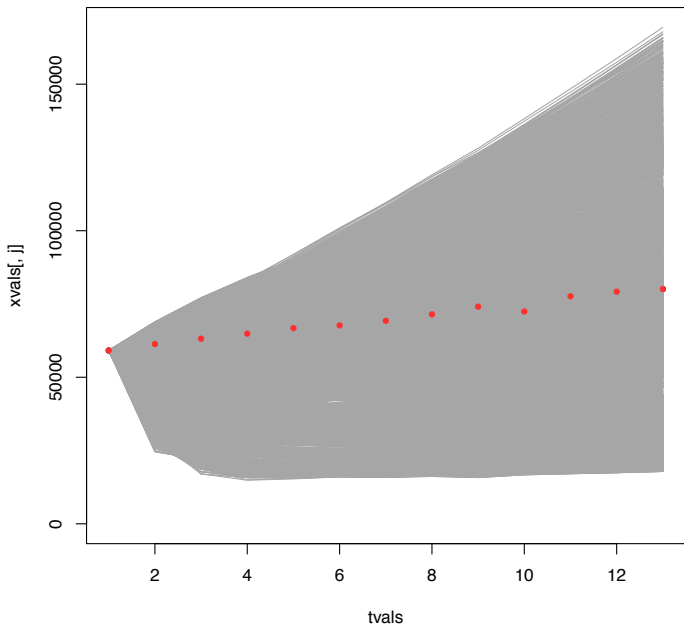
Cloud Plot for PA



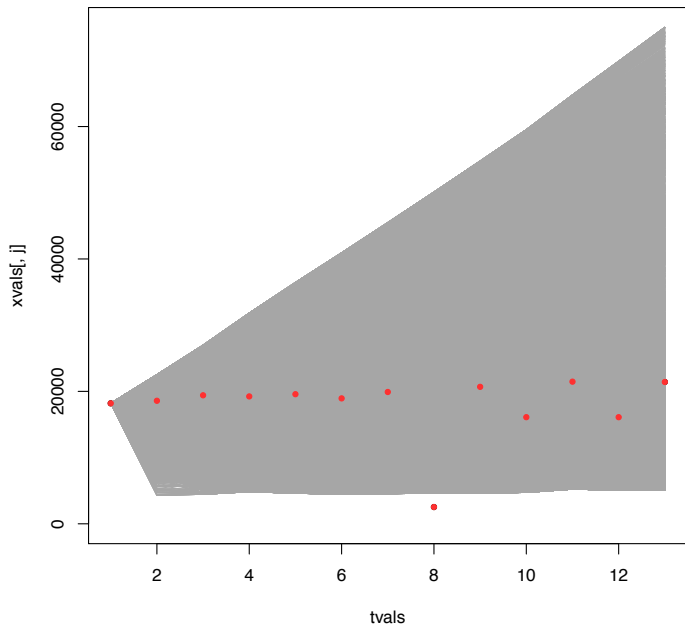
Cloud Plot for RI



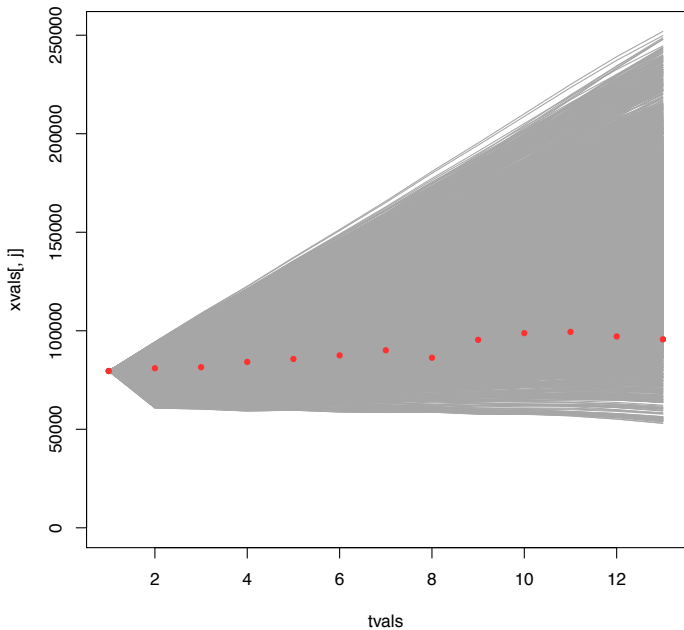
Cloud Plot for SC



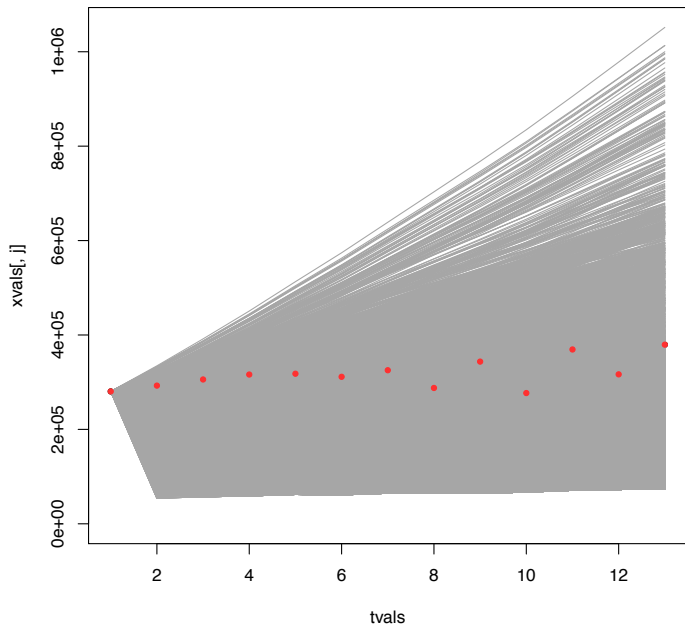
Cloud Plot for SD



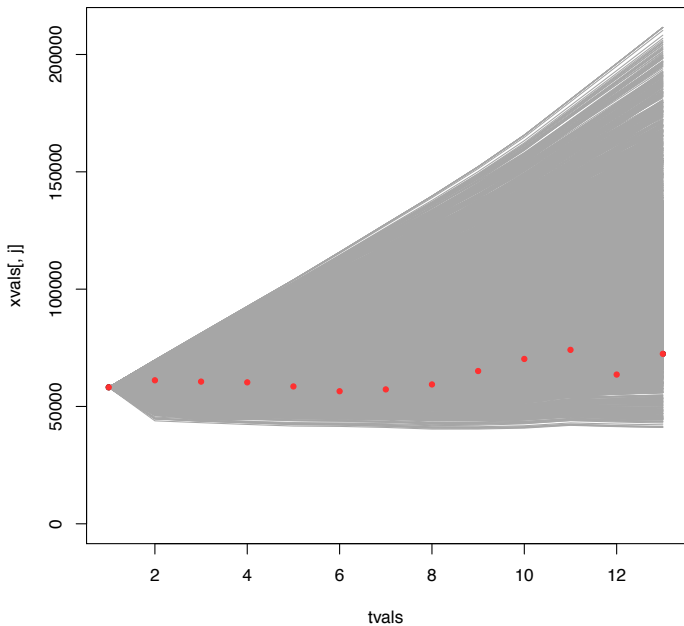
Cloud Plot for TN



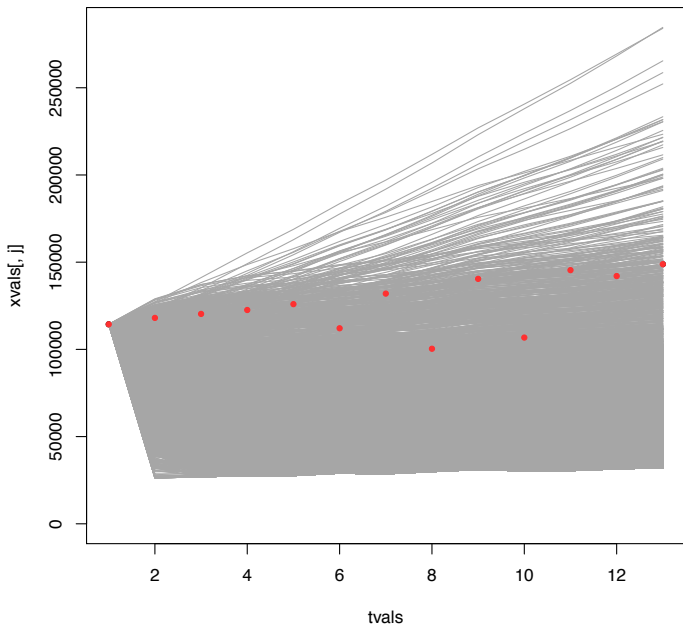
Cloud Plot for TX



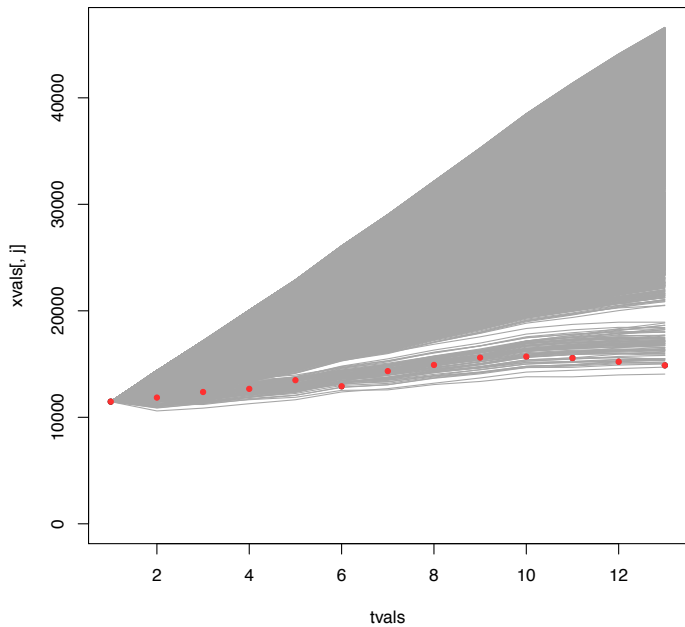
Cloud Plot for UT



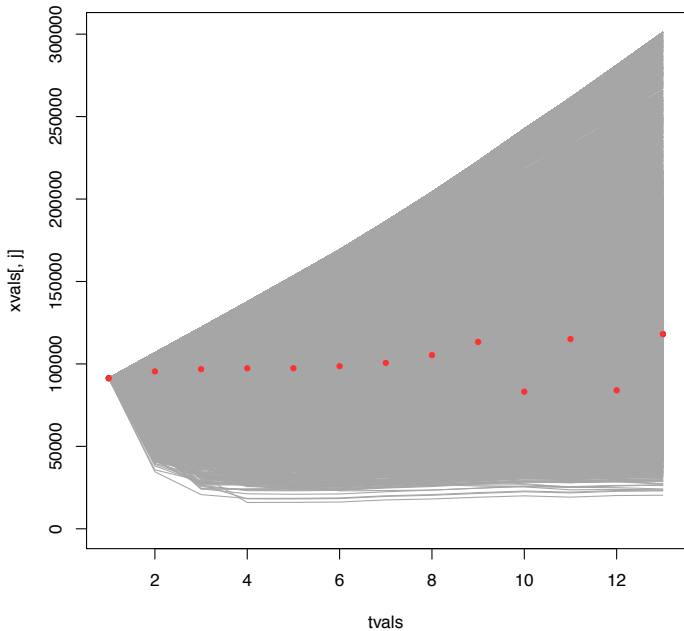
Cloud Plot for VA



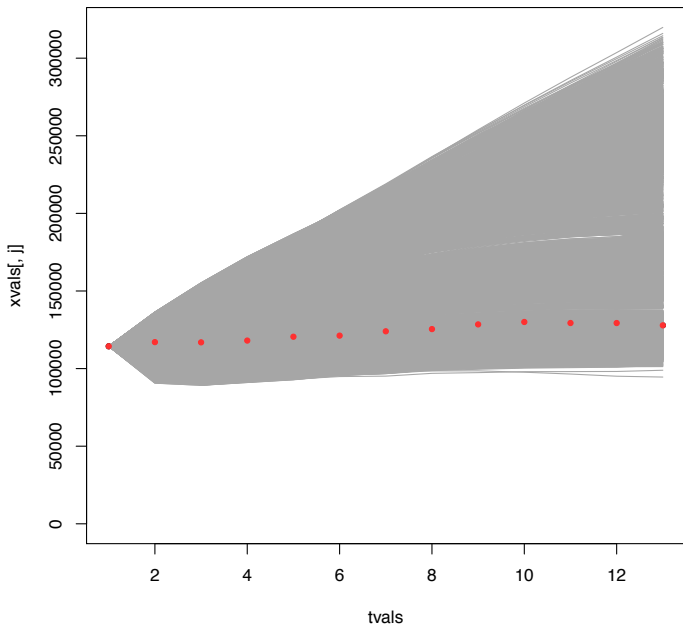
Cloud Plot for VT



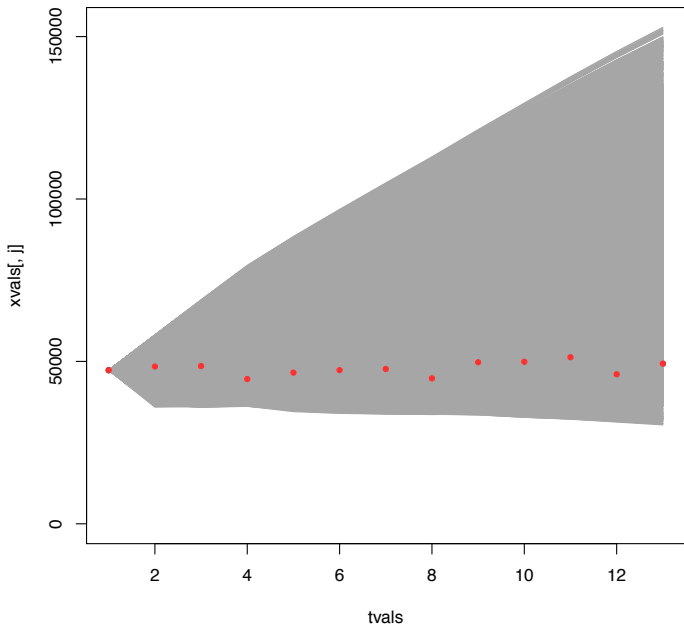
Cloud Plot for WA



Cloud Plot for WI



Cloud Plot for WV



Cloud Plot for WY

