UNIVERSITEIT GENT

FACULTY OF ECONOMICS
AND BUSINESS ADMINISTRATION

A forecasting study to predict EAC(t)

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Mario Vanhoucke

EVM Europe, Valencia, 2011

Outline

- Existing forecasting methods
- New forecasting method
- Illustration
- Preliminary results
- Conclusions

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Existing forecasting methods

- 1 generic formula
- EAC(t) = AD + PDWR

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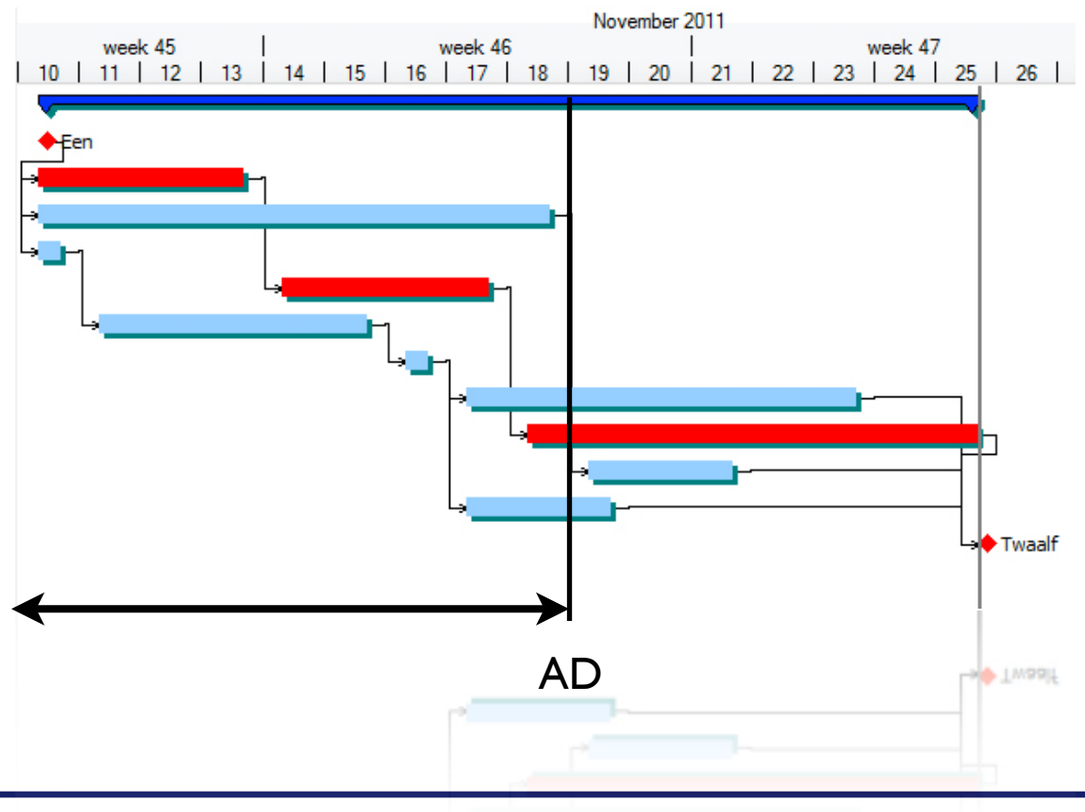

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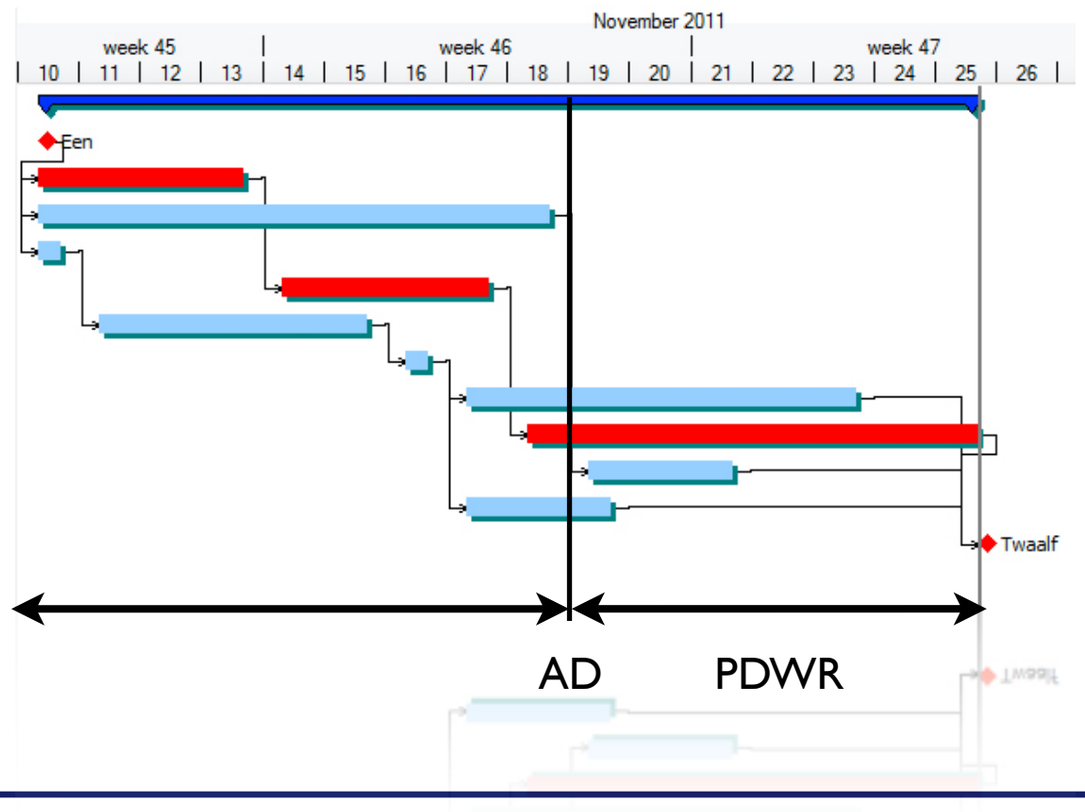

Existing forecasting methods

- Planned Value
  - relies on Planned Value rate...
  - ...by translating SV into time units
- Earned Duration
  - = the product of AD and the SPI
- Earned Schedule
  - time instance at which the EV should be earned according to plan

Existing forecasting methods

$$\boxed{\mathbf{EAC(t) = AD + PDWR}}$$

Existing forecasting methods

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Planned Value

$$EAC(t)_{PV1} = PD - TV$$

$$EAC(t)_{PV2} = \frac{PD}{SPI}$$

$$EAC(t)_{PV3} = \frac{PD}{SCI}$$

Existing forecasting methods

$$\boxed{\mathbf{EAC(t) = AD + PDWR}}$$

Planned Value	Earned Duration
$EAC(t)_{PV1} = PD - TV$	$EAC(t)_{ED1} = PD + AD * (1 - SPI)$
$EAC(t)_{PV2} = \frac{PD}{SPI}$	$EAC(t)_{ED2} = \frac{PD}{SPI}$
$EAC(t)_{PV3} = \frac{PD}{SCI}$	$EAC(t)_{ED3} = \frac{PD}{SCI} + AD * (1 - \frac{1}{CPI})$

Existing forecasting methods

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Planned Value	Earned Duration	Earned Schedule
$EAC(t)_{PV1} = PD - TV$	$EAC(t)_{ED1} = PD + AD * (1 - SPI)$	$EAC(t)_{ES1} = AD + (PD - ES)$
$EAC(t)_{PV2} = \frac{PD}{SPI}$	$EAC(t)_{ED2} = \frac{PD}{SPI}$	$EAC(t)_{ES2} = AD + \frac{PD - ES}{SPI(t)}$
$EAC(t)_{PV3} = \frac{PD}{SCI}$	$EAC(t)_{ED3} = \frac{PD}{SCI} + AD * (1 - \frac{1}{CPI})$	$EAC(t)_{ES3} = AD + \frac{PD - ES}{SCI(t)}$

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New forecasting method

- Difference?
  - ✦ No Performance Factors
  - ✦ Use SV(t) as a signal to predict EAC(t)
  - ✦ SV(t) = ES - AD

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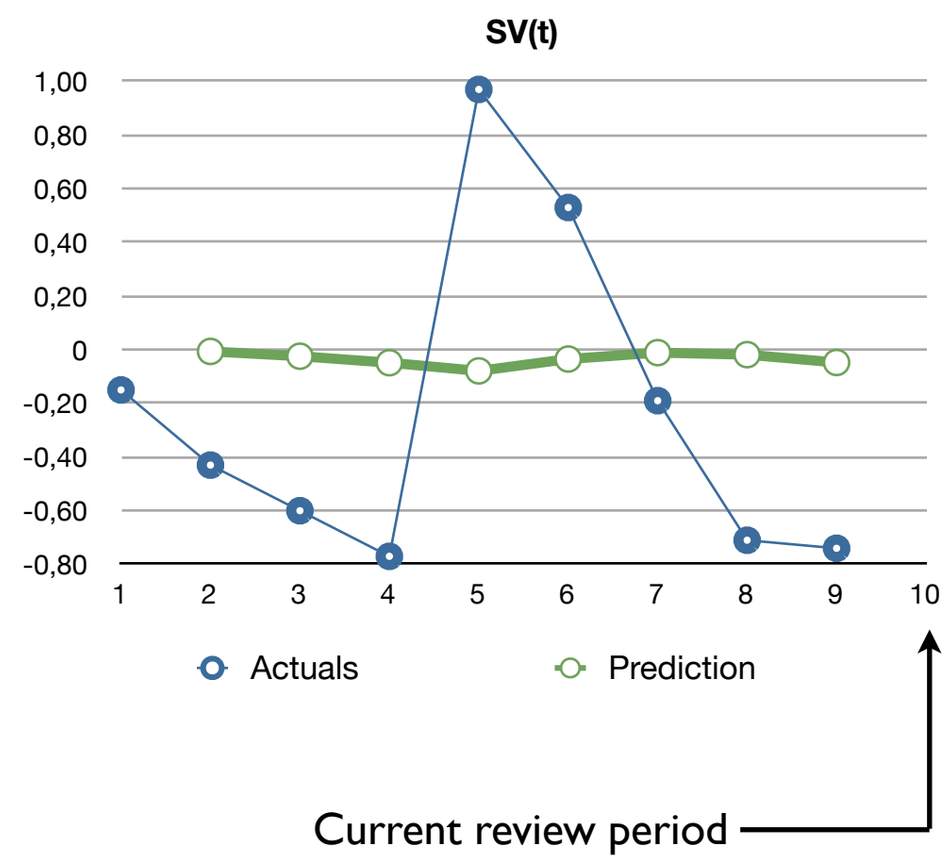

New forecasting method

- Apply exponential smoothing to make a prediction

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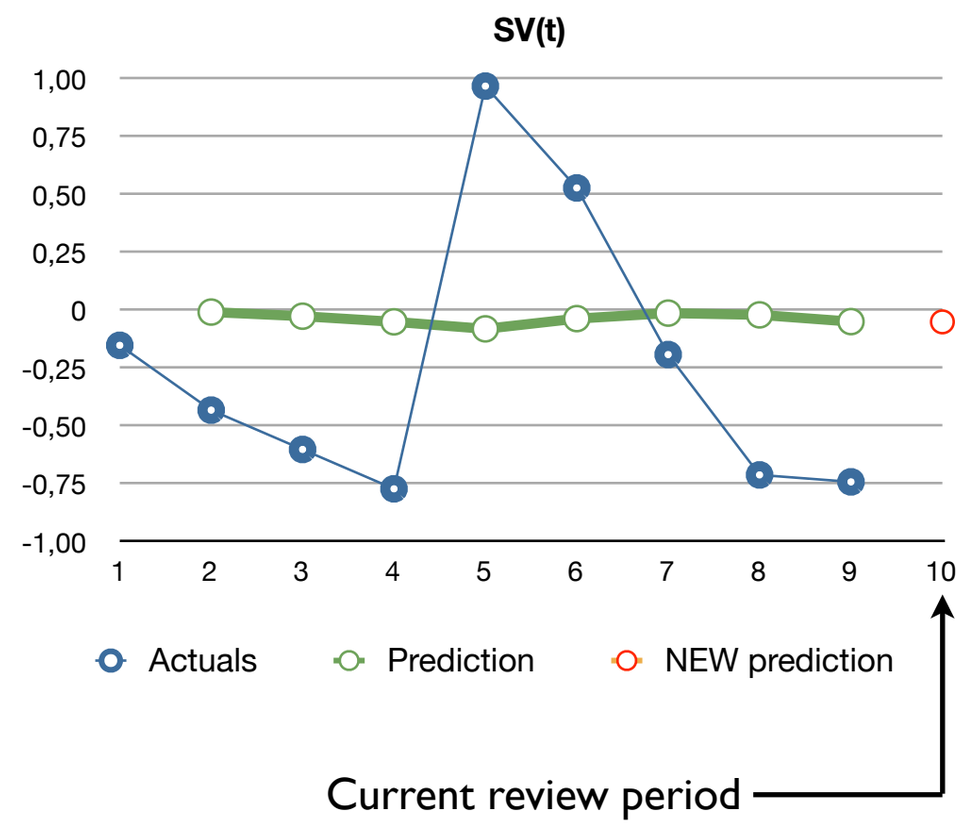

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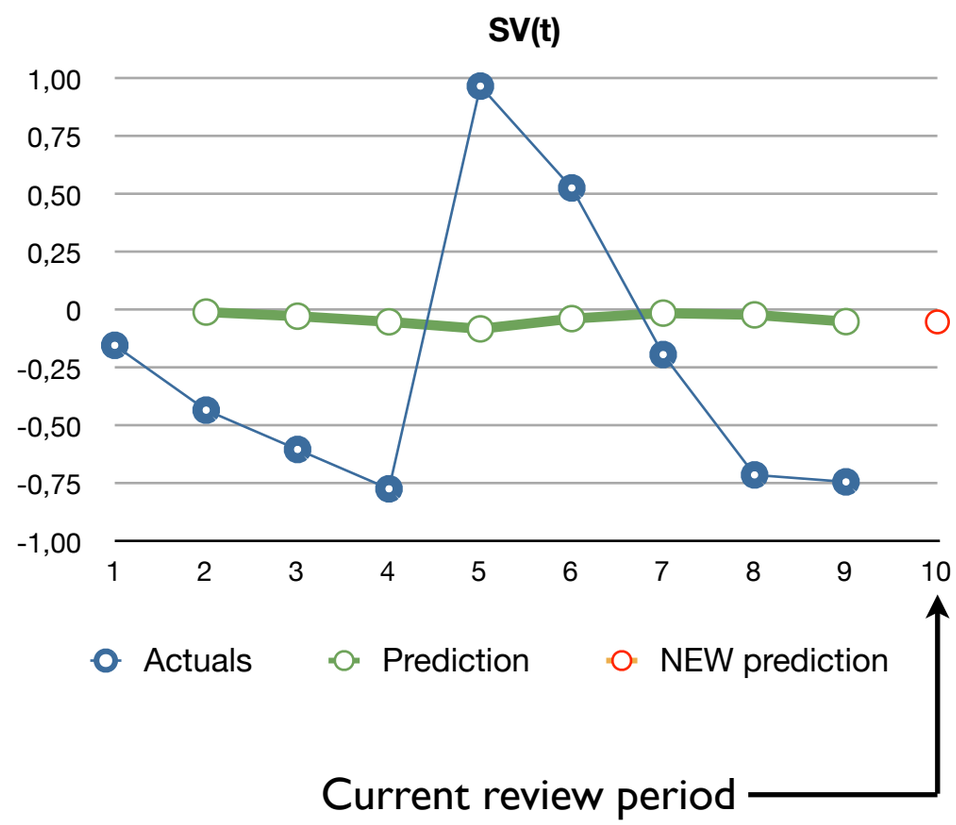
How to determine α?



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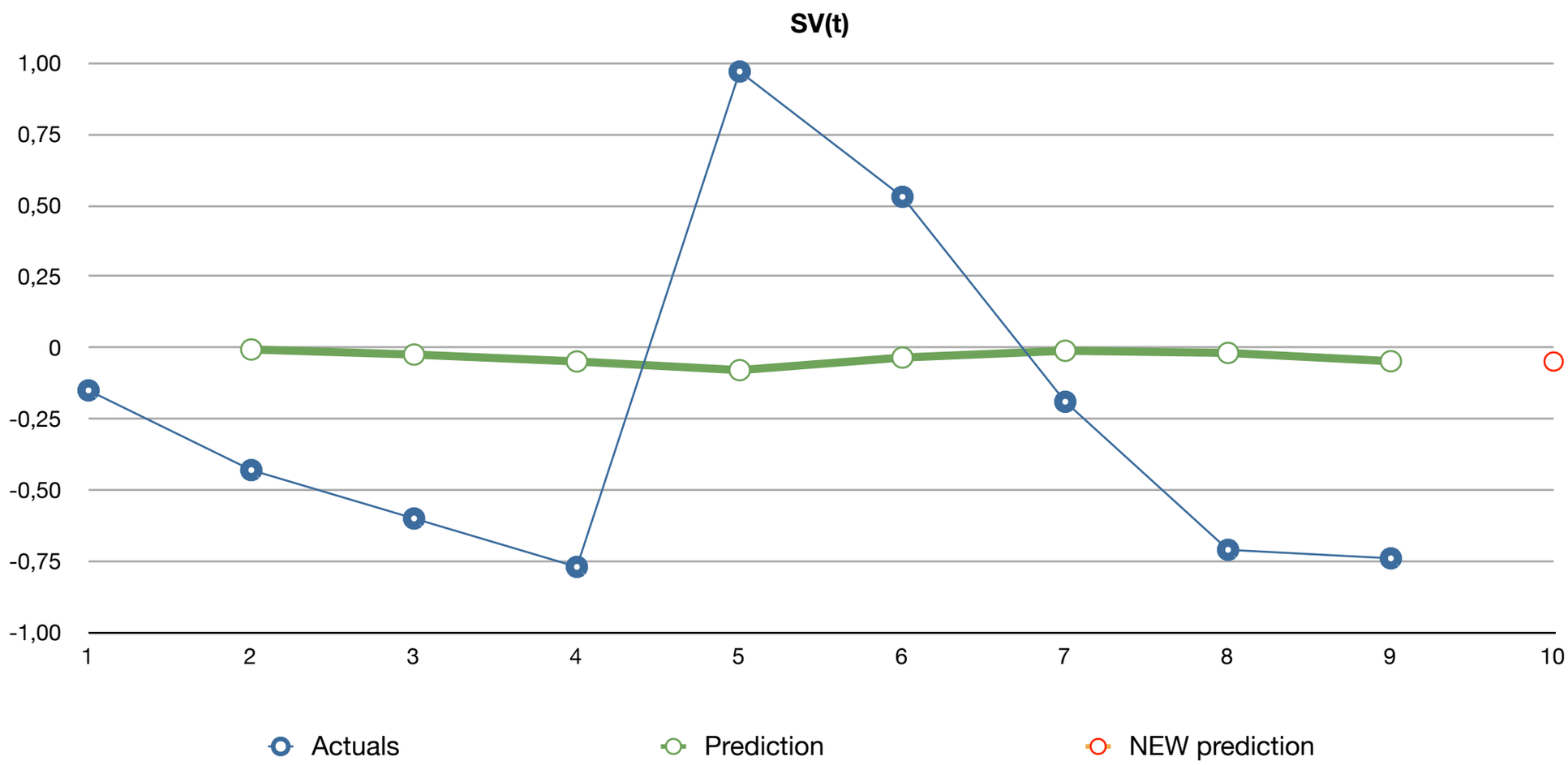

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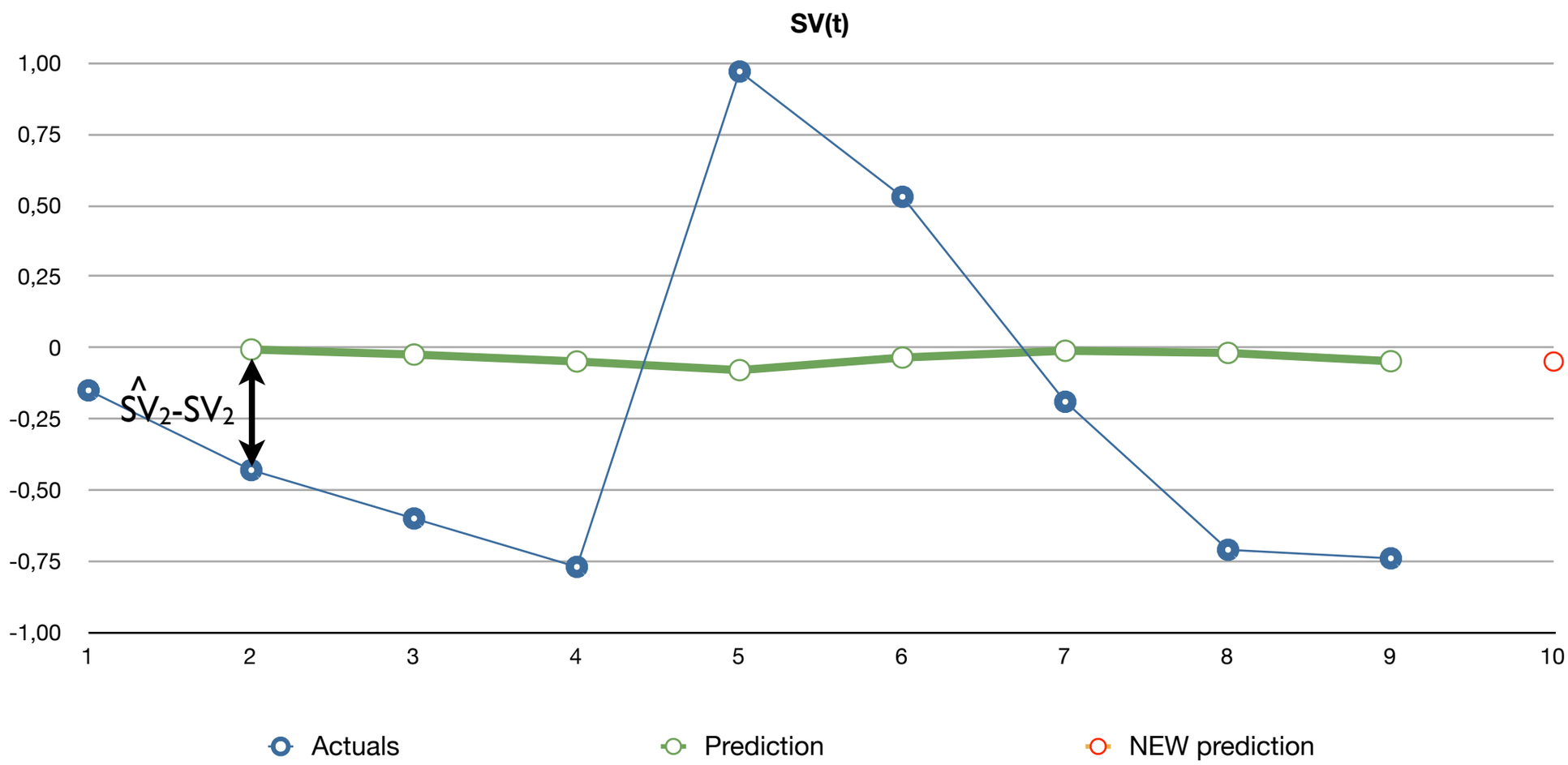

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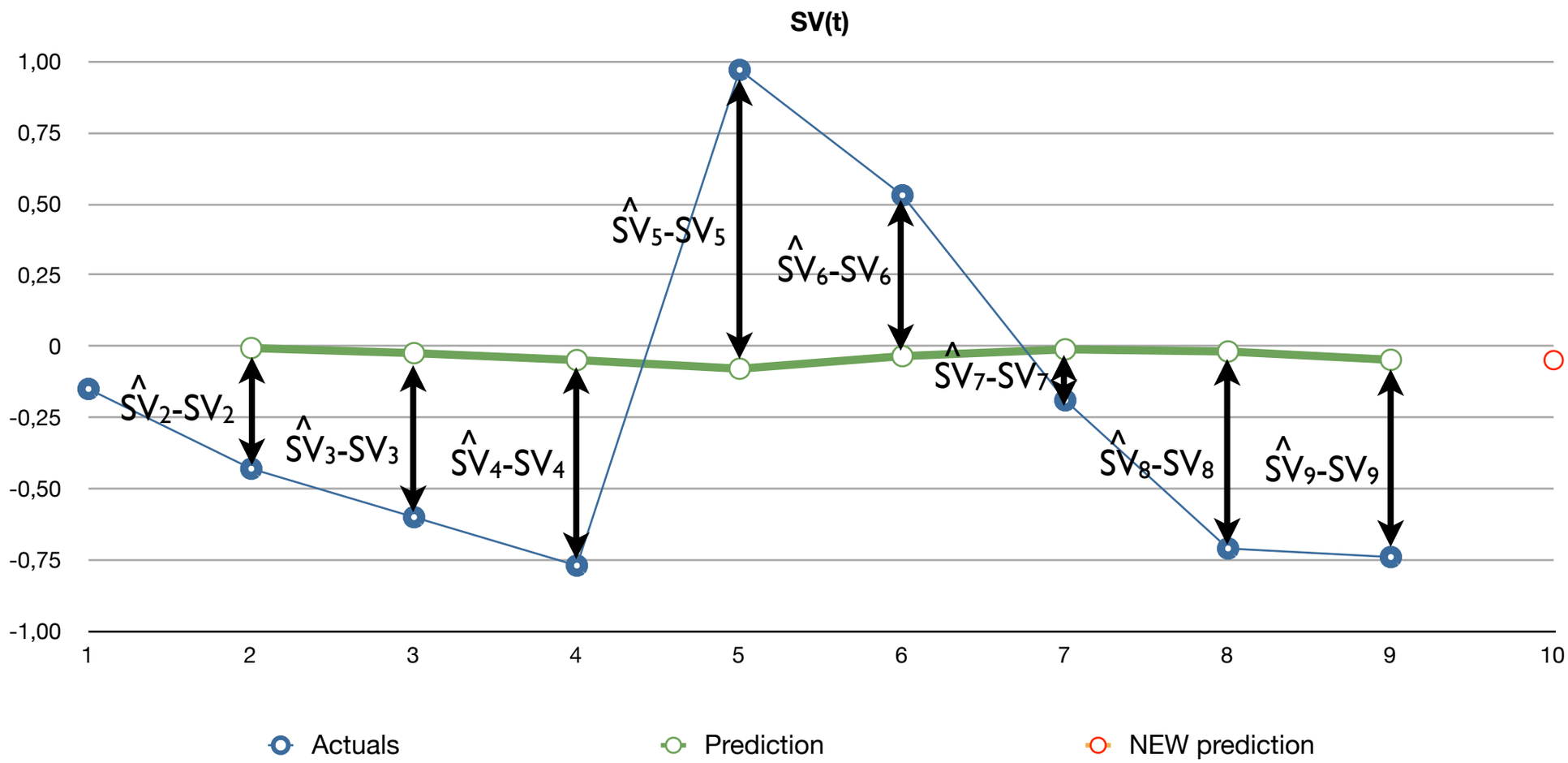

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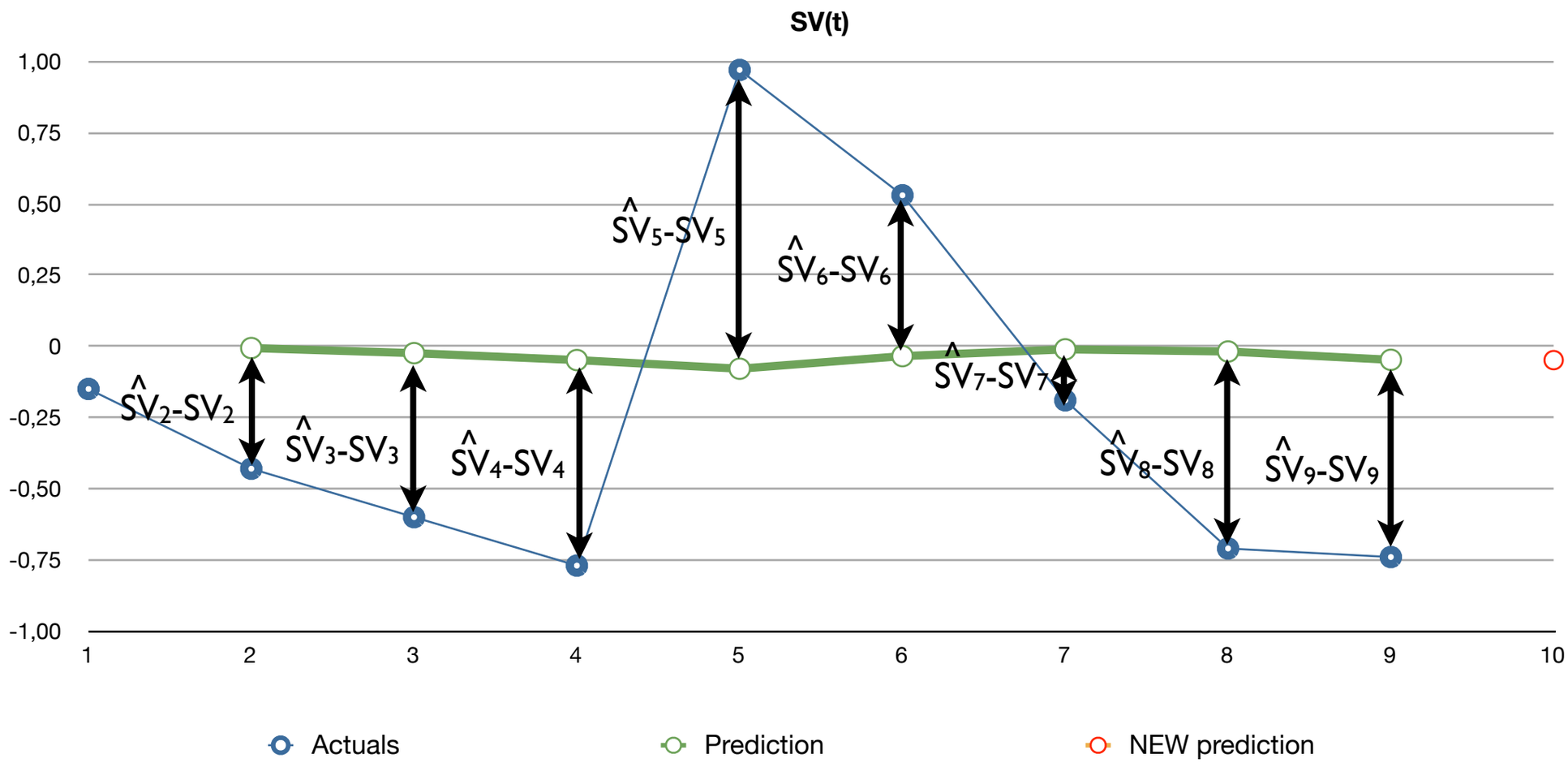

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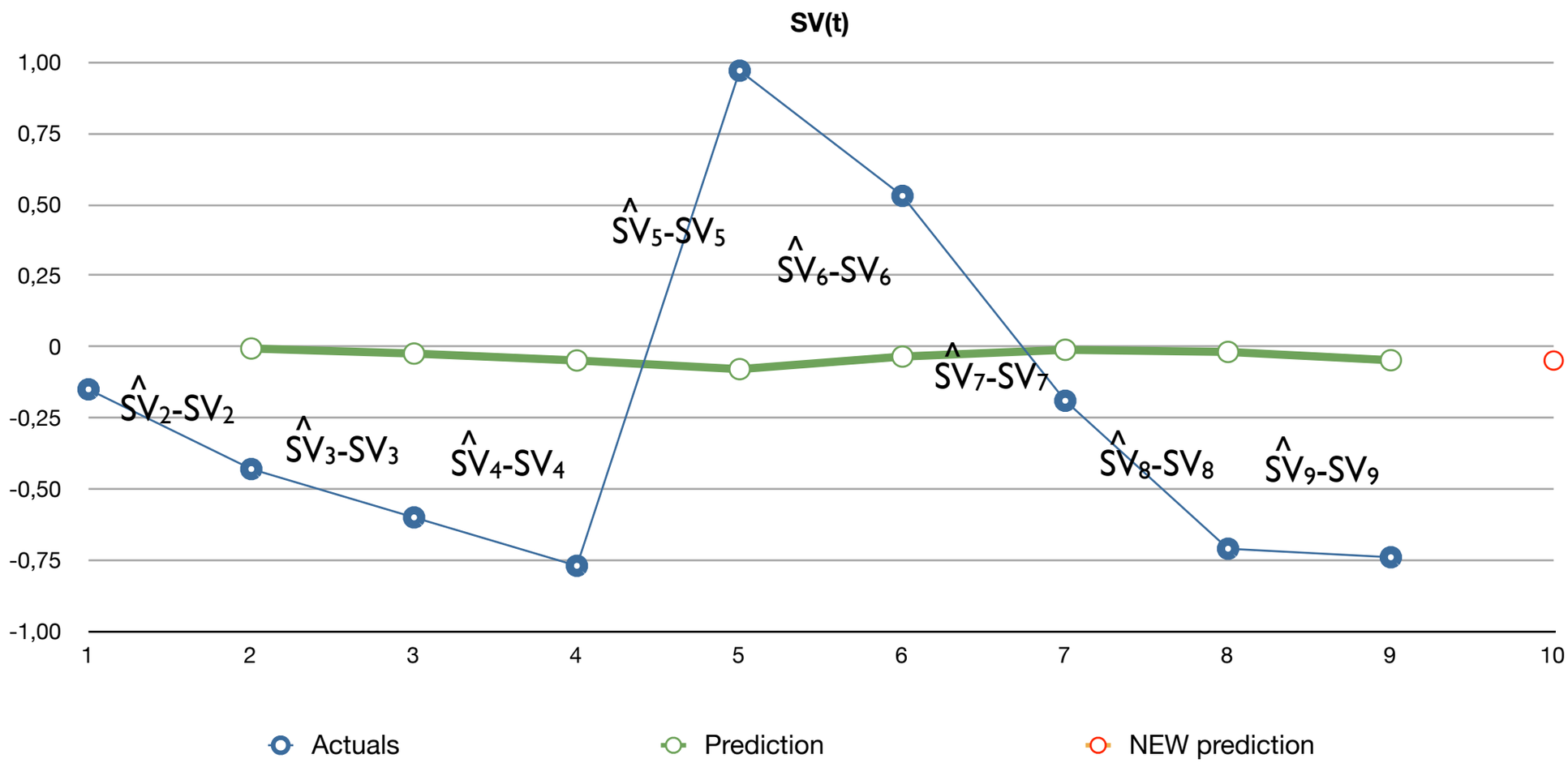

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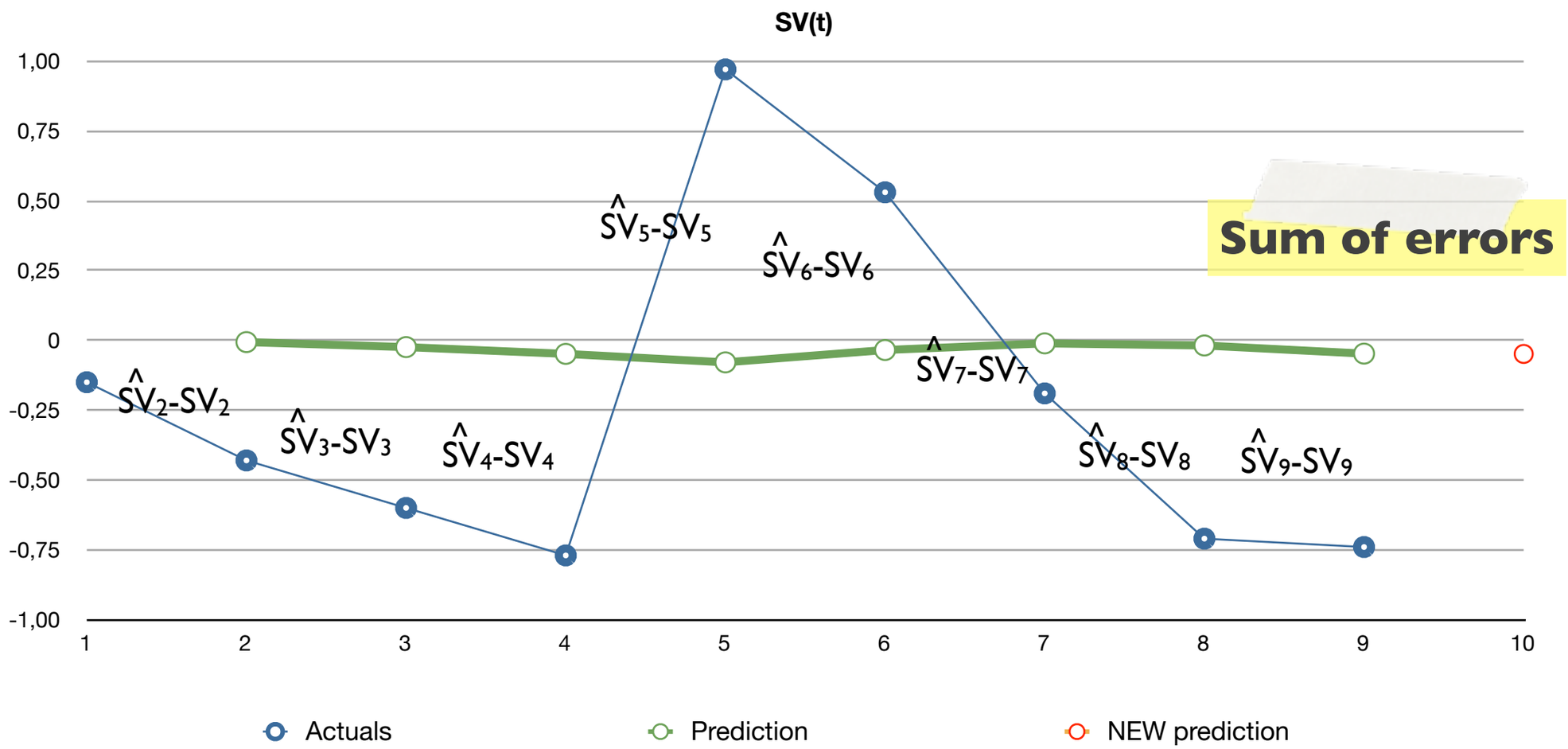

New forecasting method

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$$\hat{SV}_i = \alpha * SV_{i-1} + (1-\alpha) * \hat{SV}_{i-1}$$

  - Small optimization problem:

$$Min. \sum_{i=2}^{r-1} (\hat{SV}_i - SV_i)^2$$

$$s.t.\ 0 \leq \alpha \leq 1$$

  - r denotes the current review period

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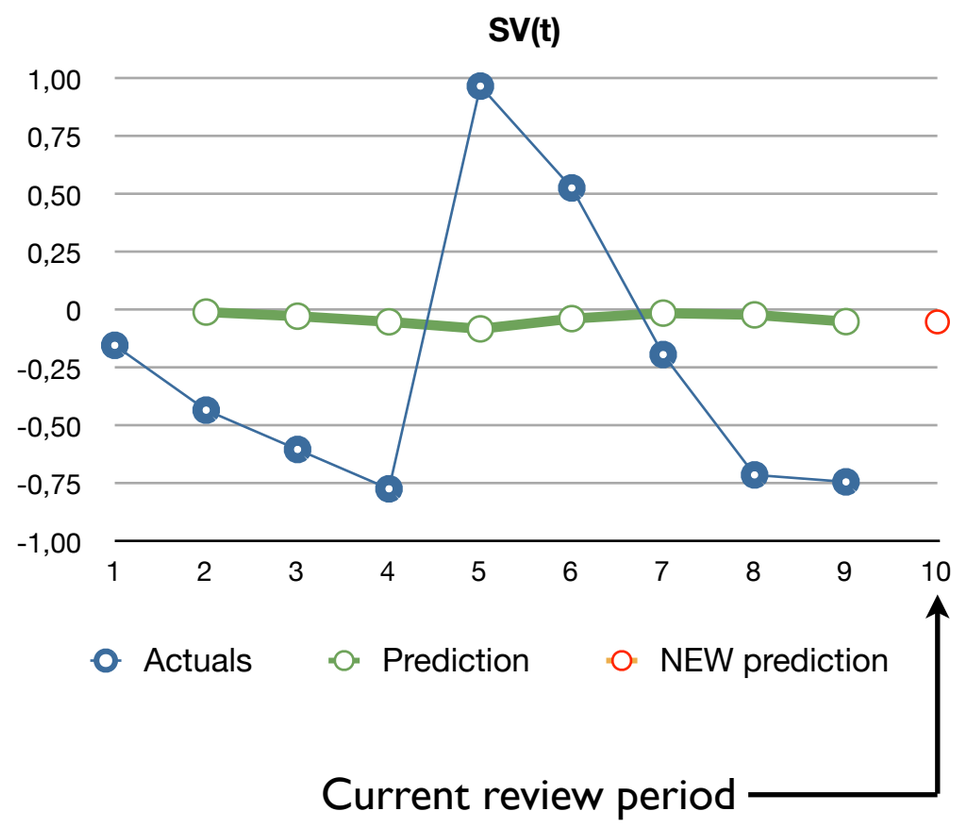

New forecasting method

- Prediction of SV(t)
- How do we derive EAC(t)?
  - SV(t) = ES - AD <=> SV(t) + AD = ES
  - EV = PV(ES) (use linear interpolation to calculate PV(ES))
  - Is EV = BAC?
    - YES: stop
    - NO: continue forecasting procedure

New forecasting method

- Overview

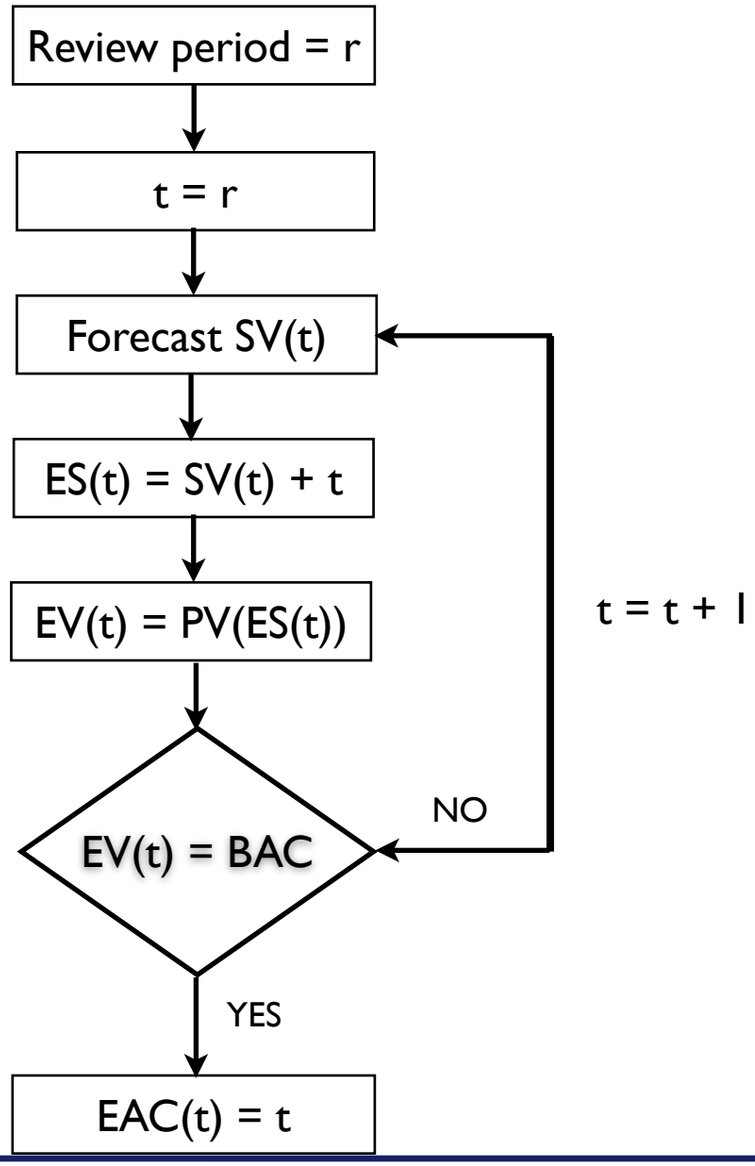

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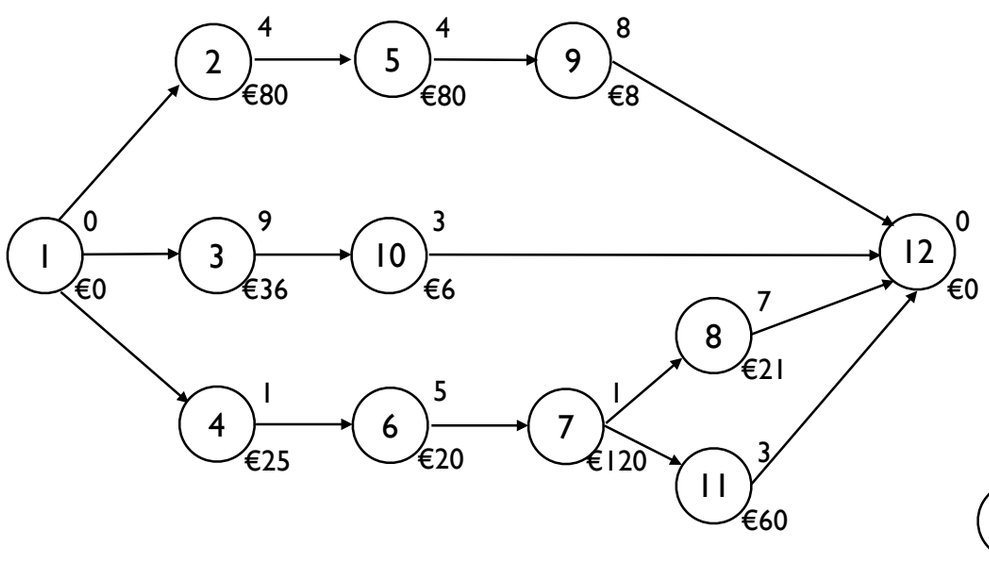
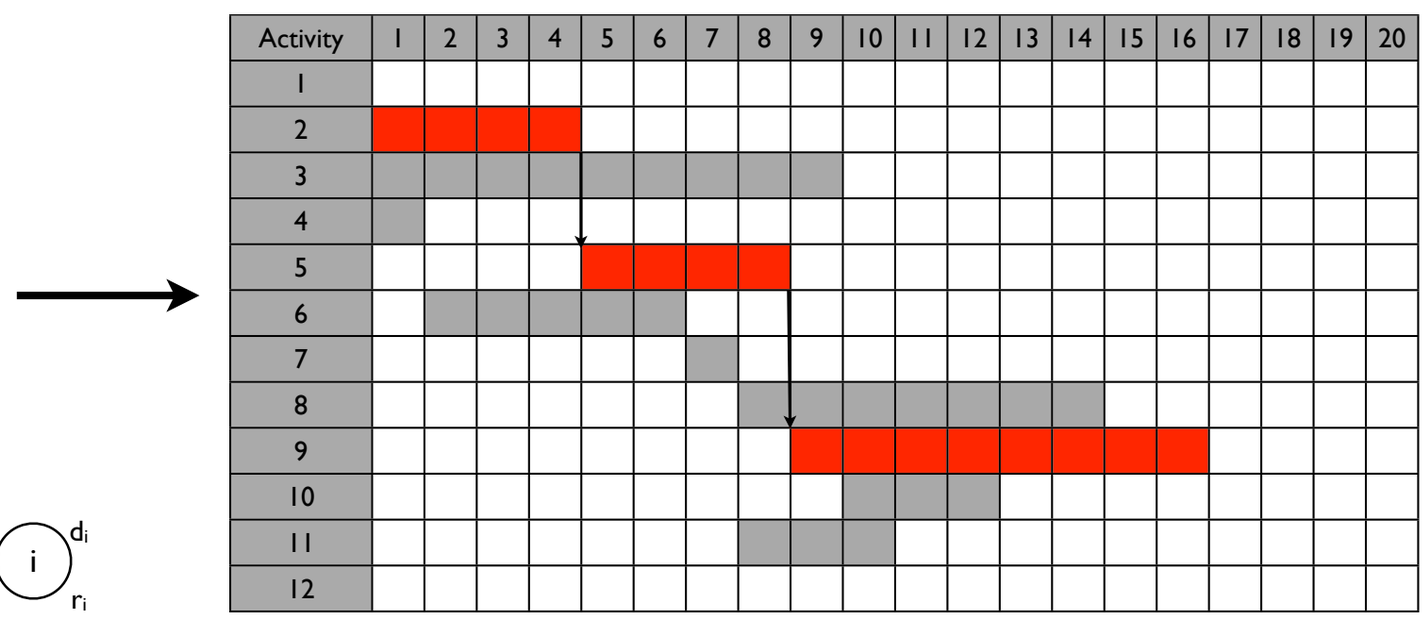
Illustration

- Example from 

  - ✦ BAC = 456
  - ✦ PD = 16





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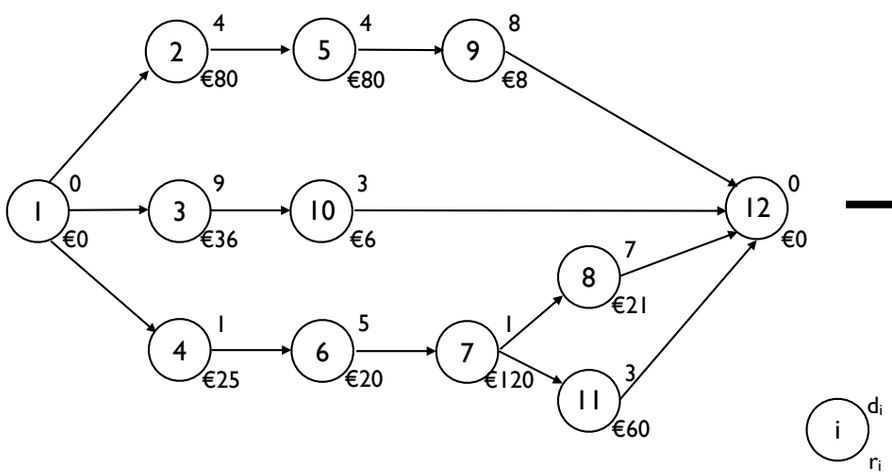

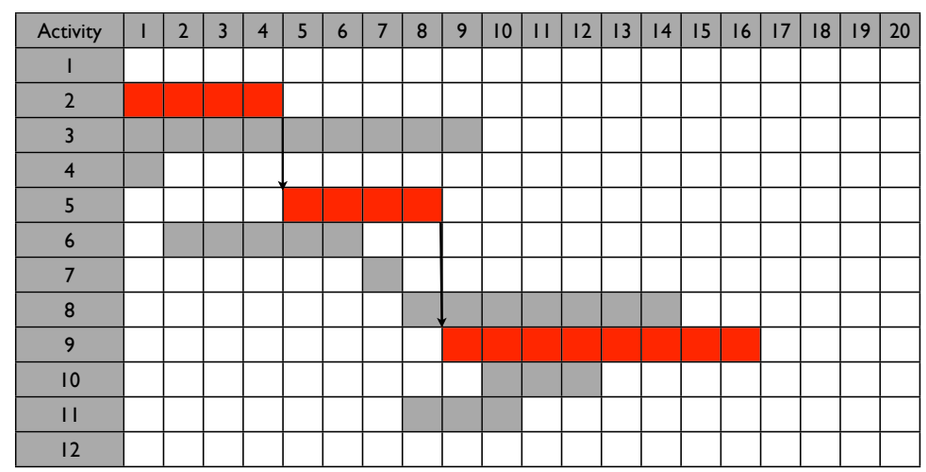

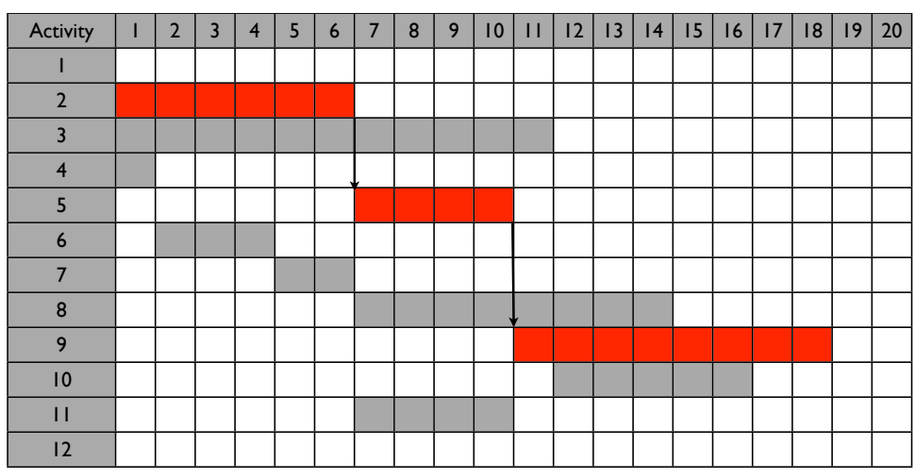

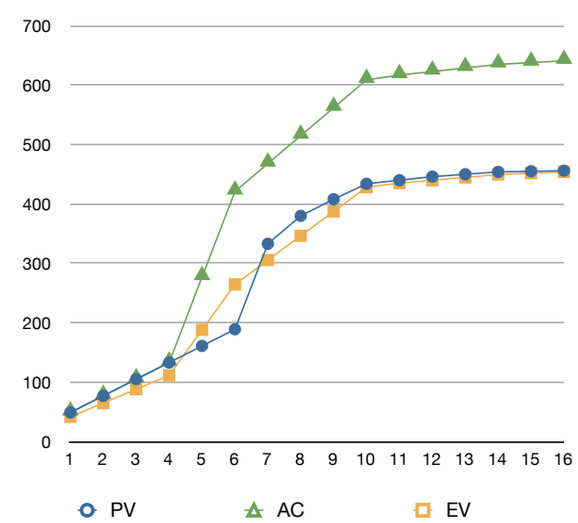

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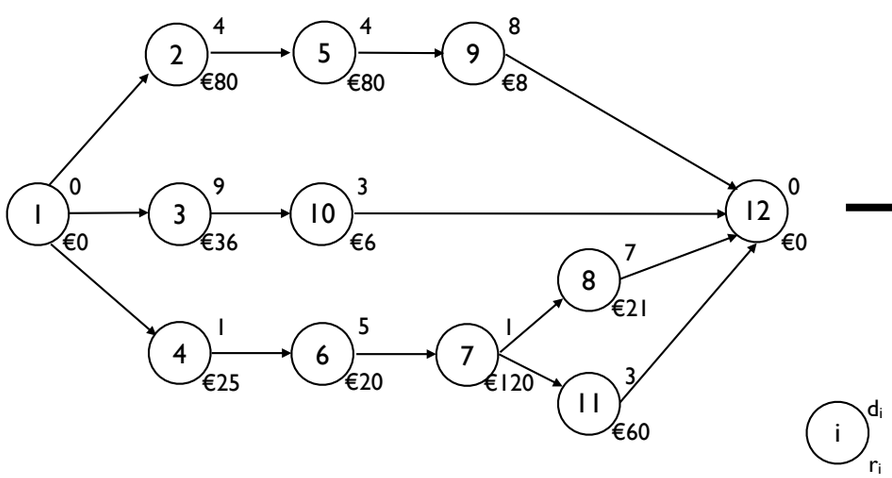
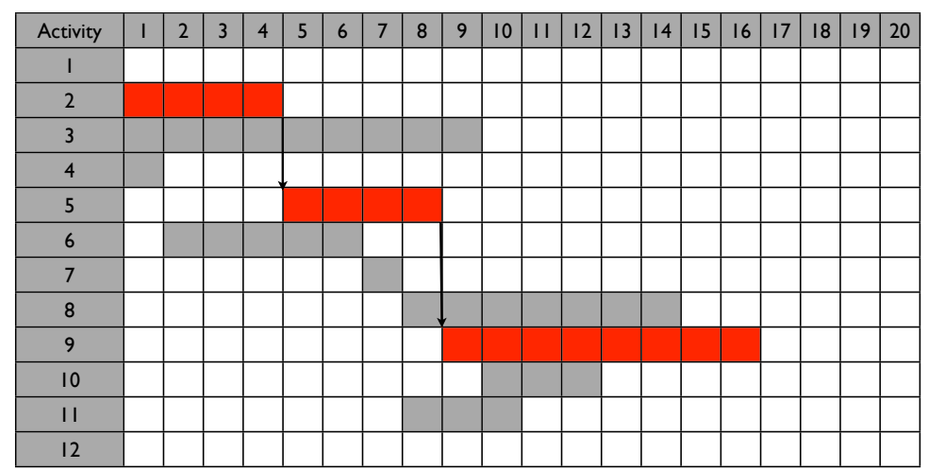
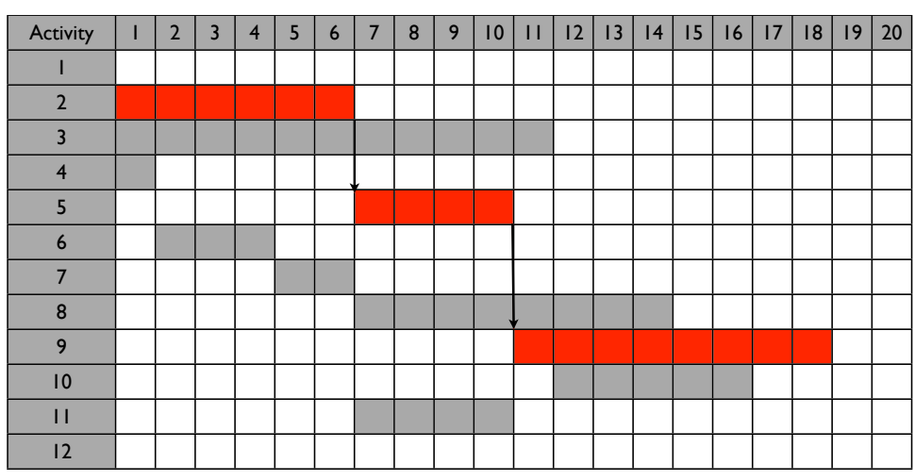
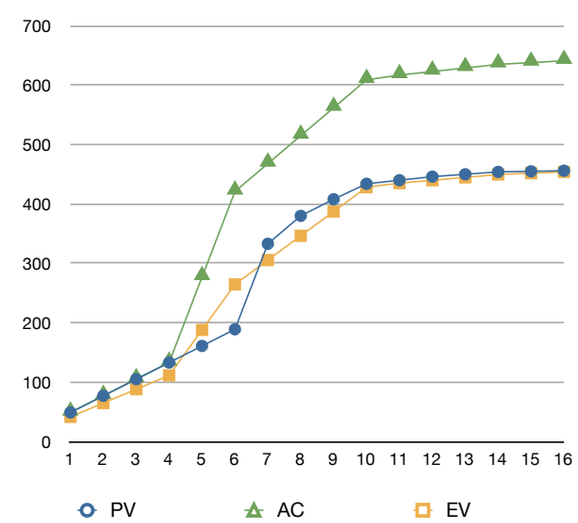




Plan





Execution

Illustration

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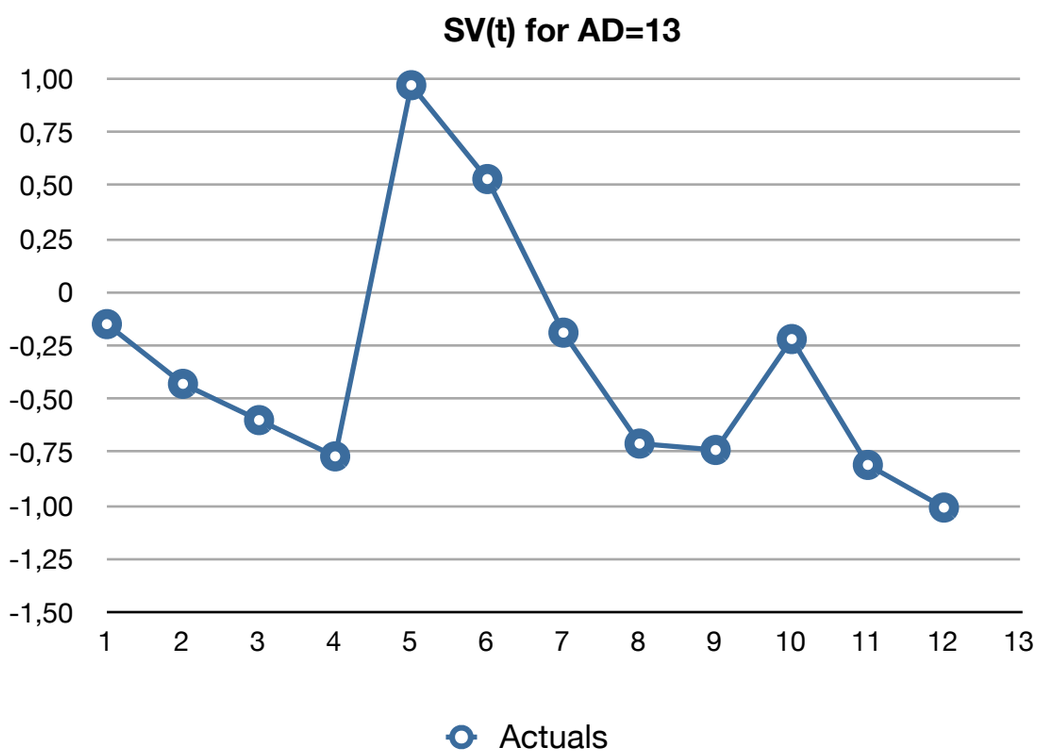

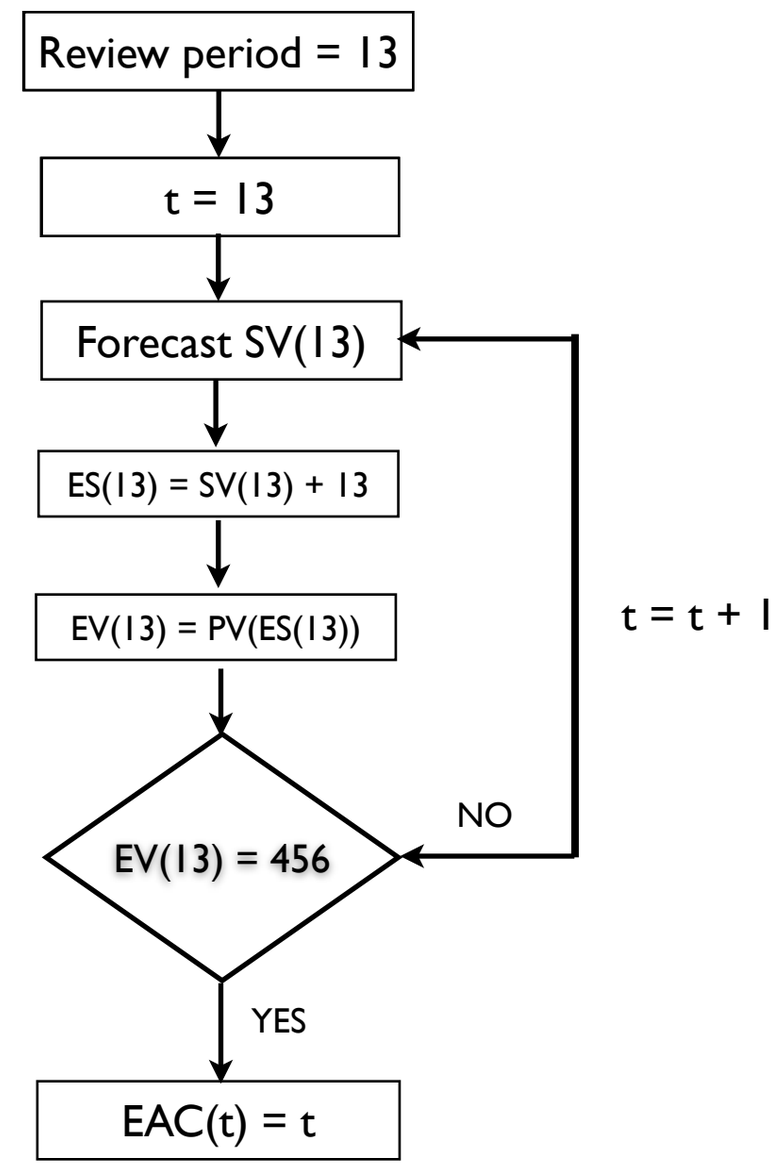

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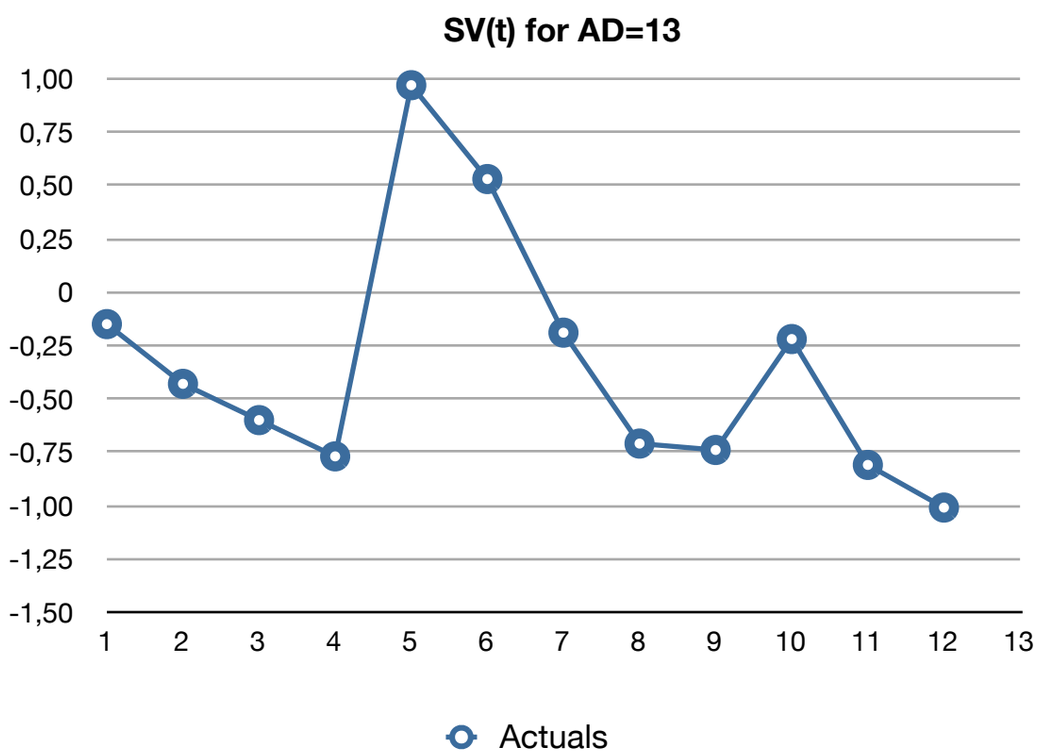

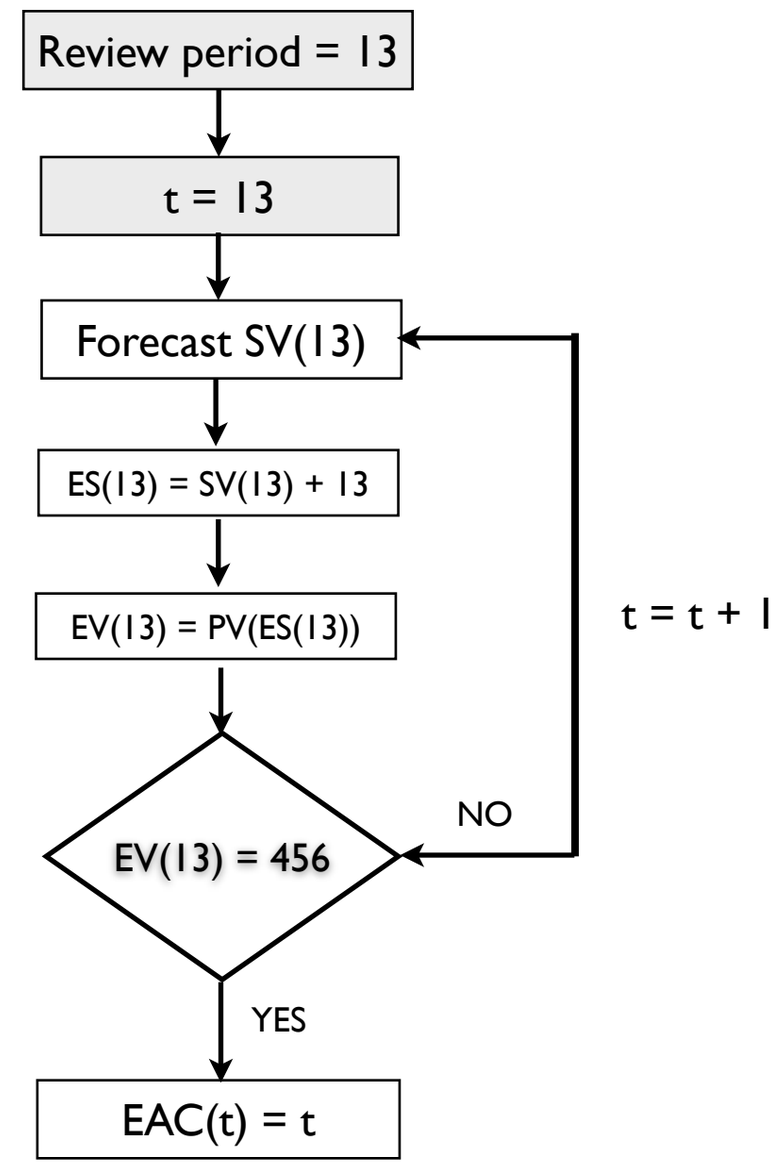

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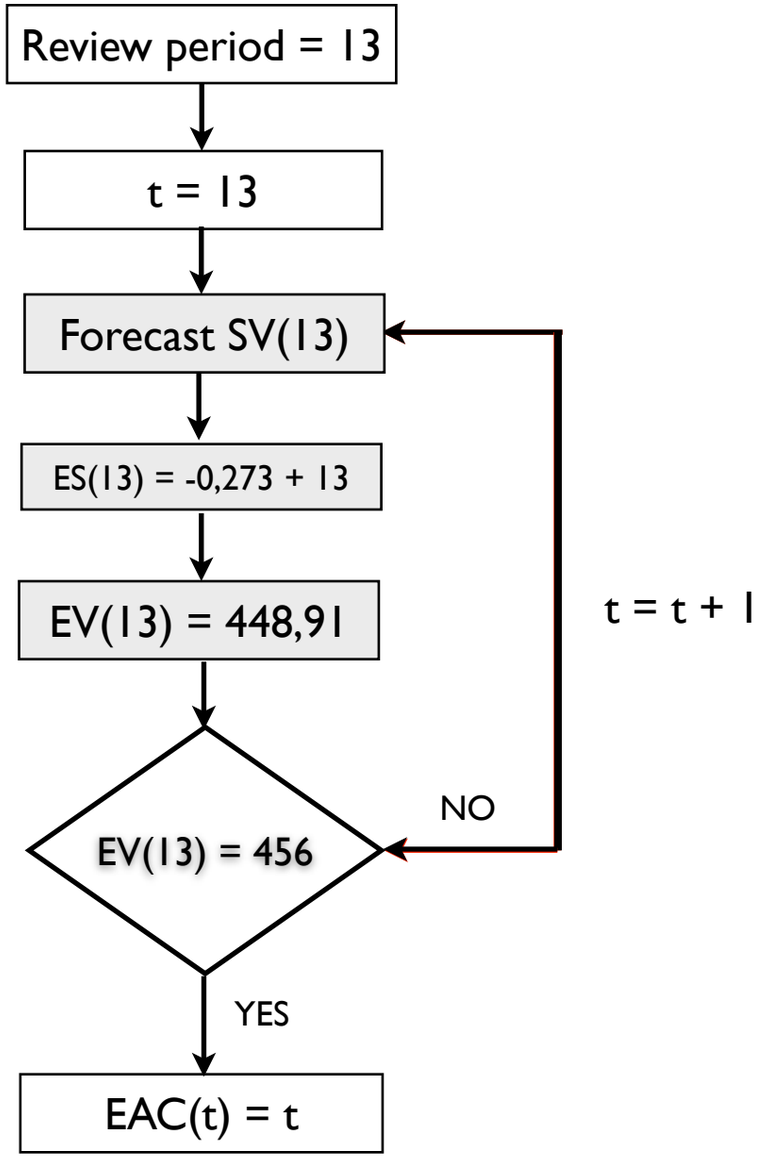
  - Forecast SV(13)
    - α = 0,0589
    - SV(13) = -0,273



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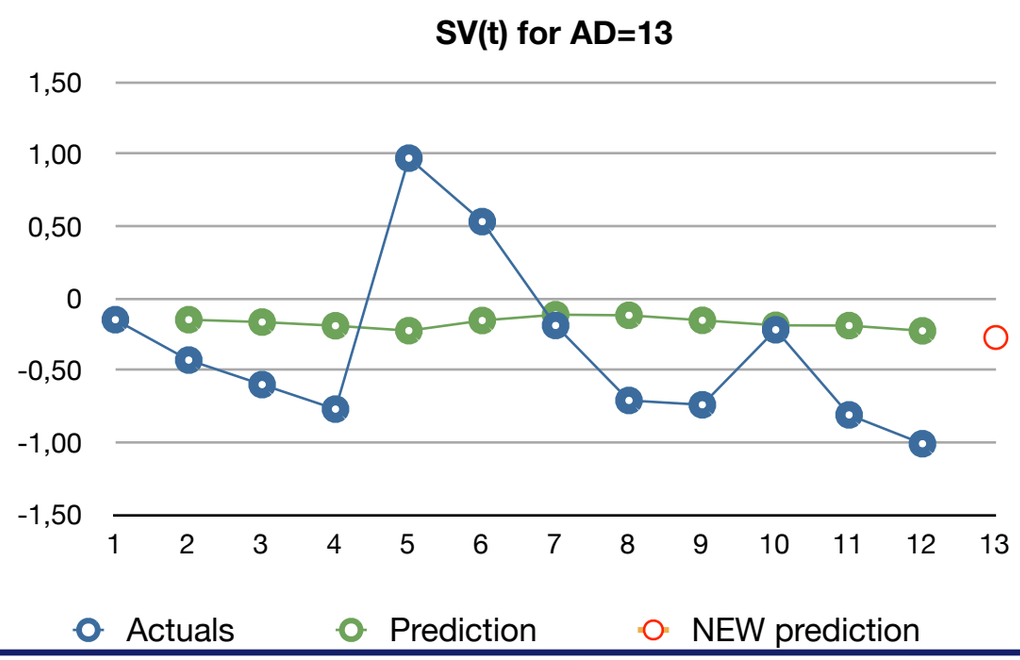

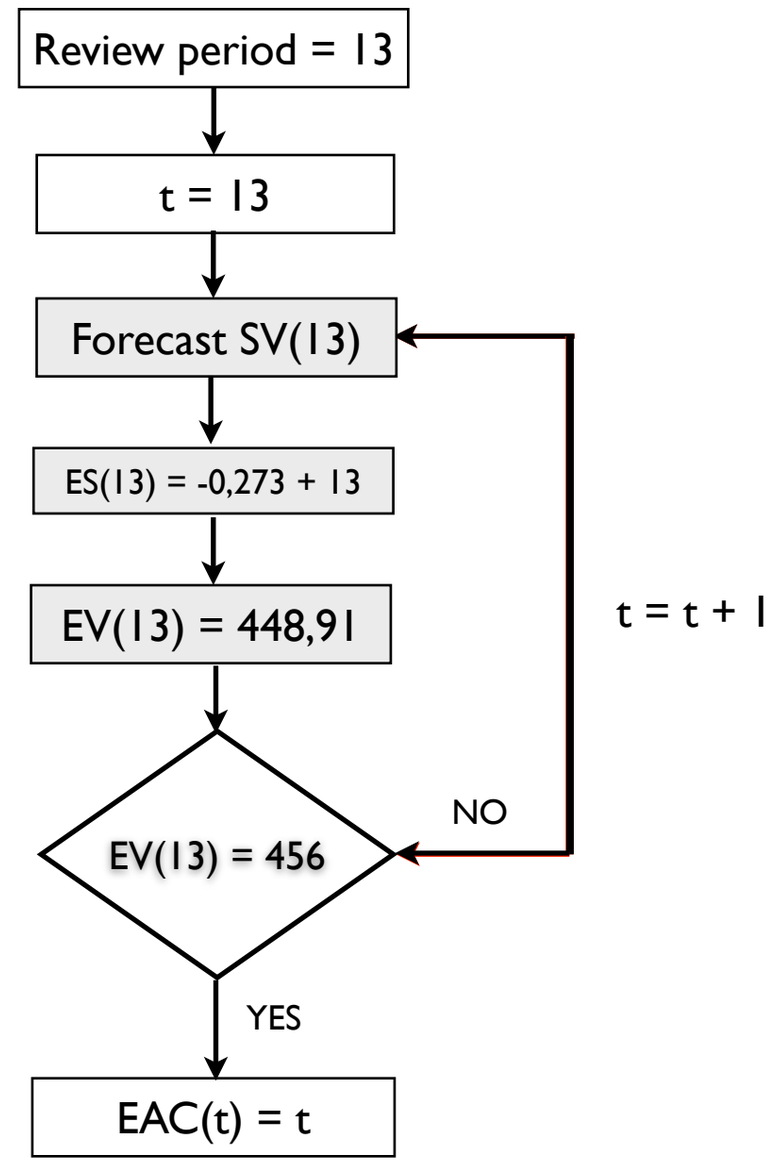

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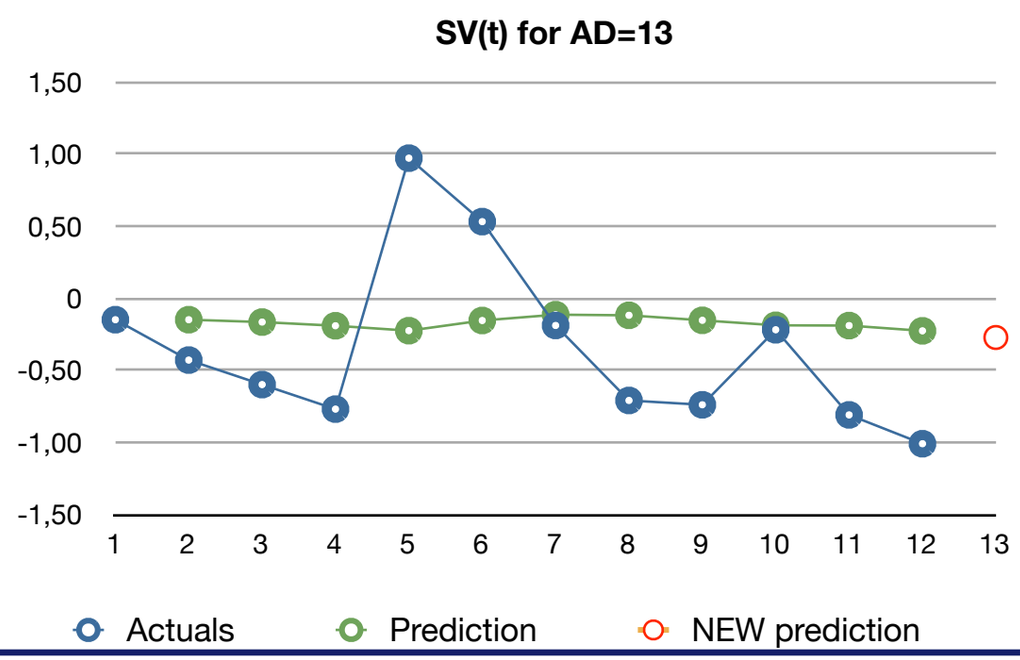

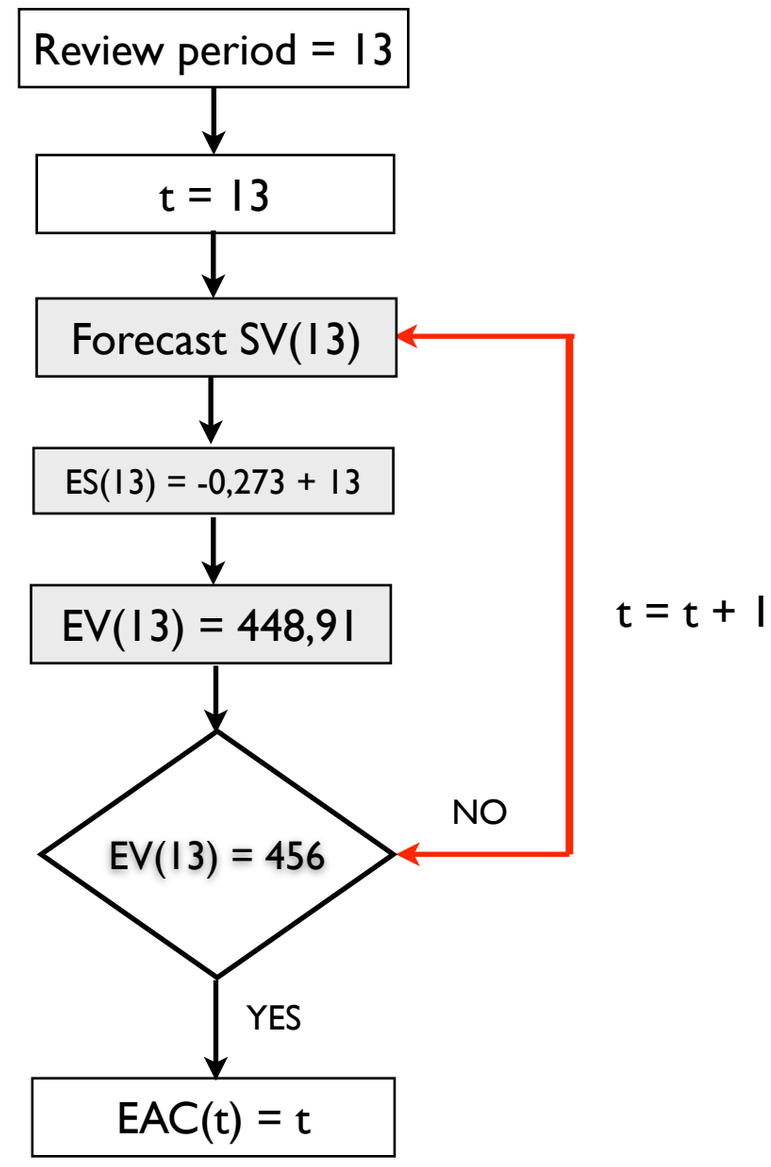

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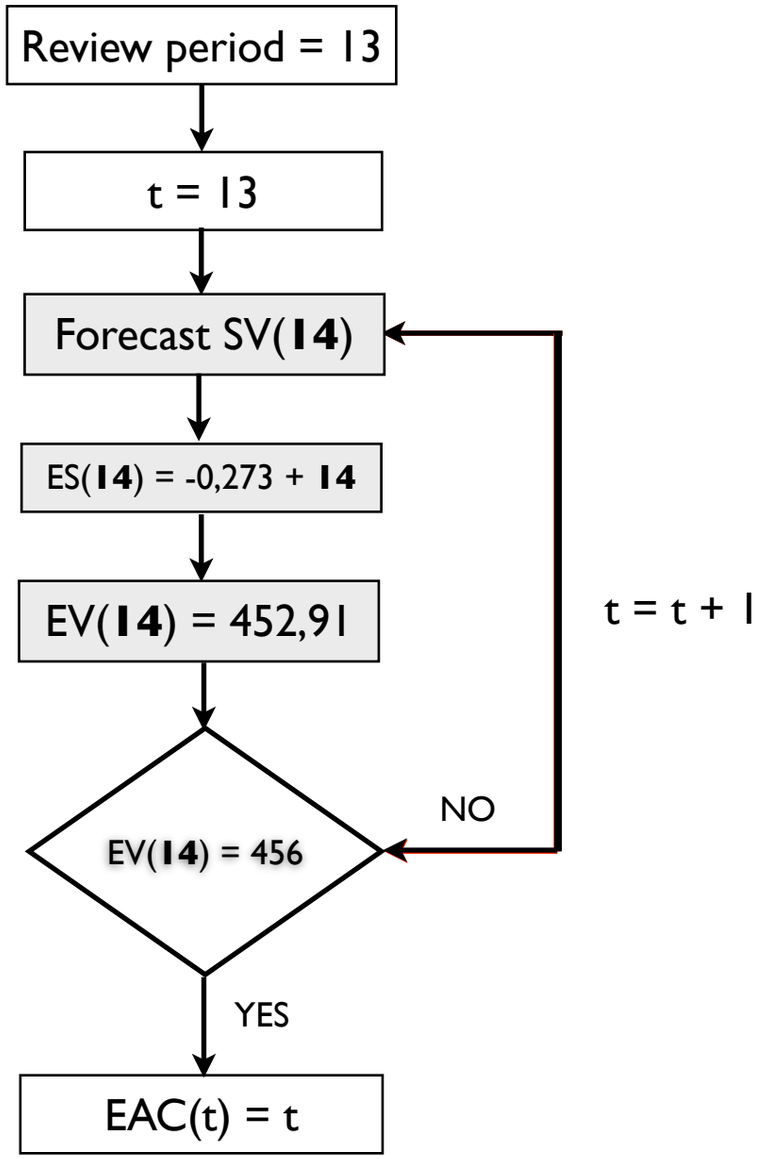

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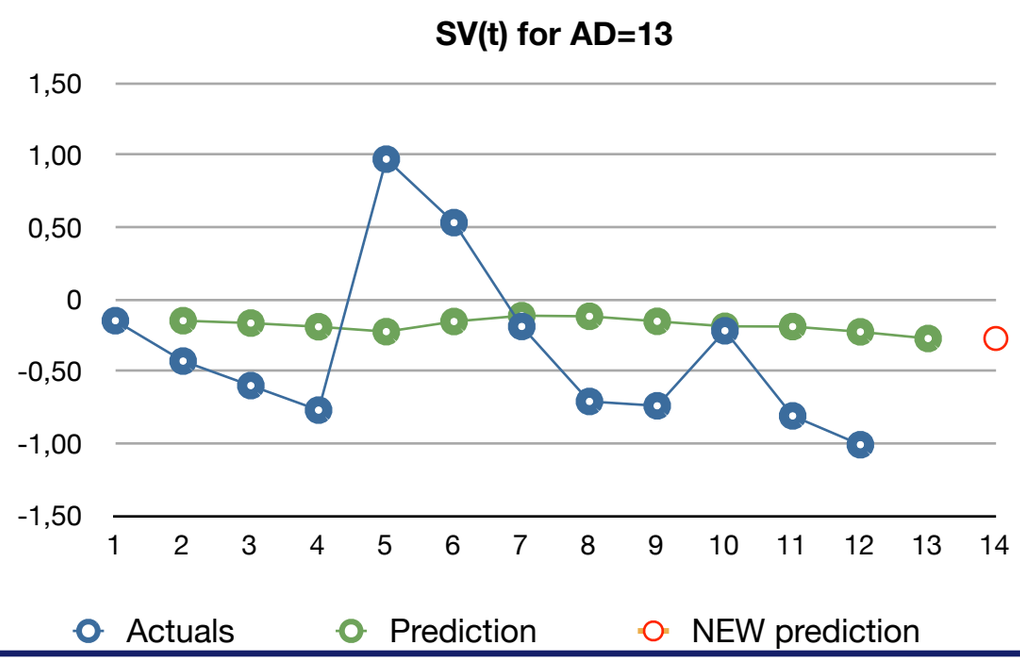

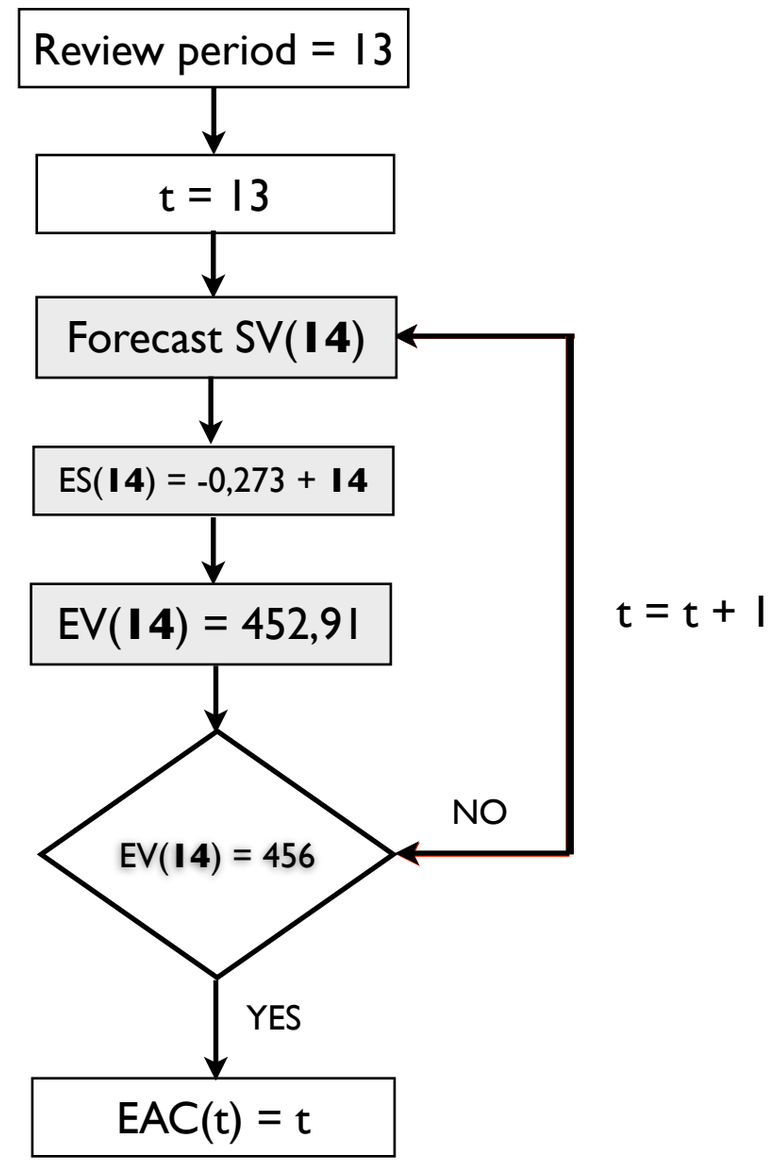

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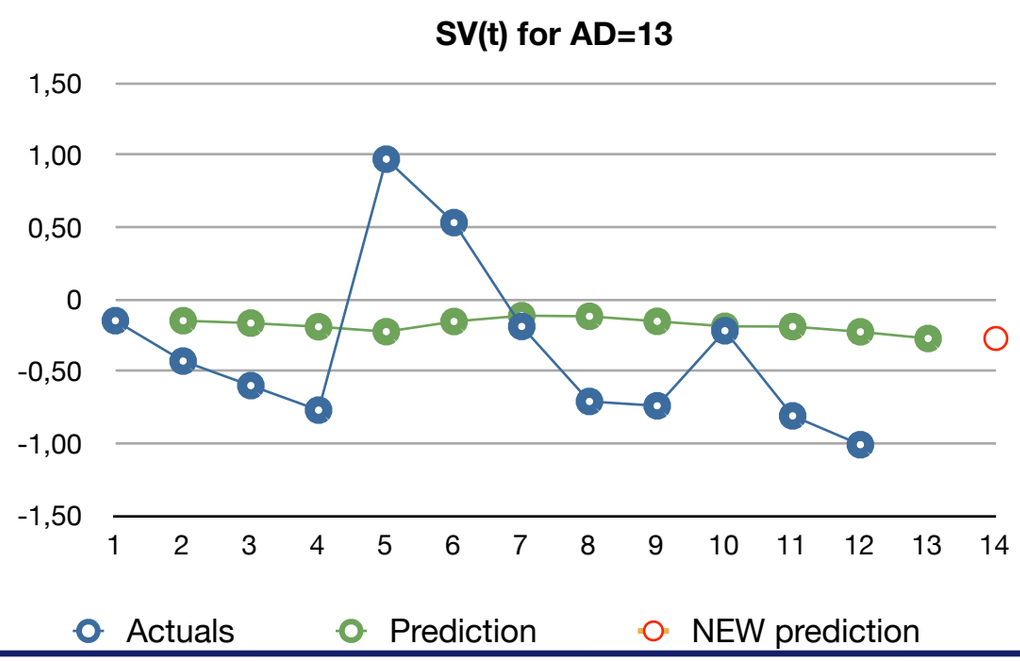

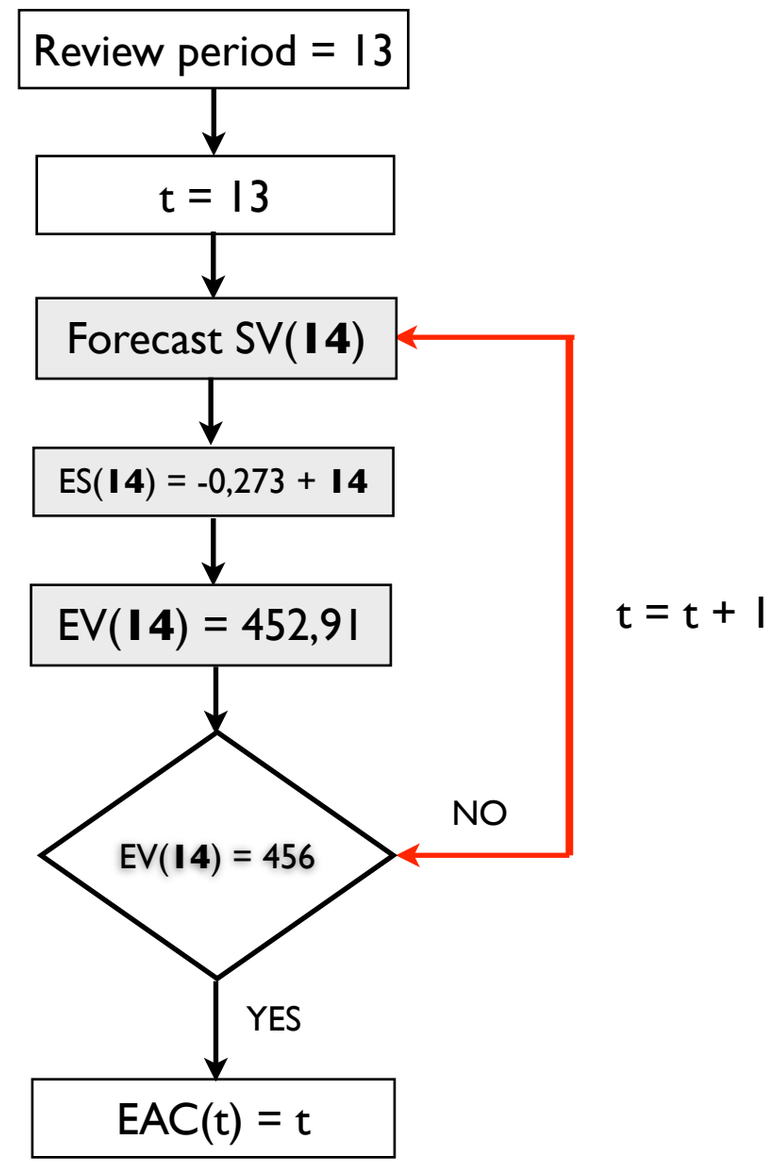

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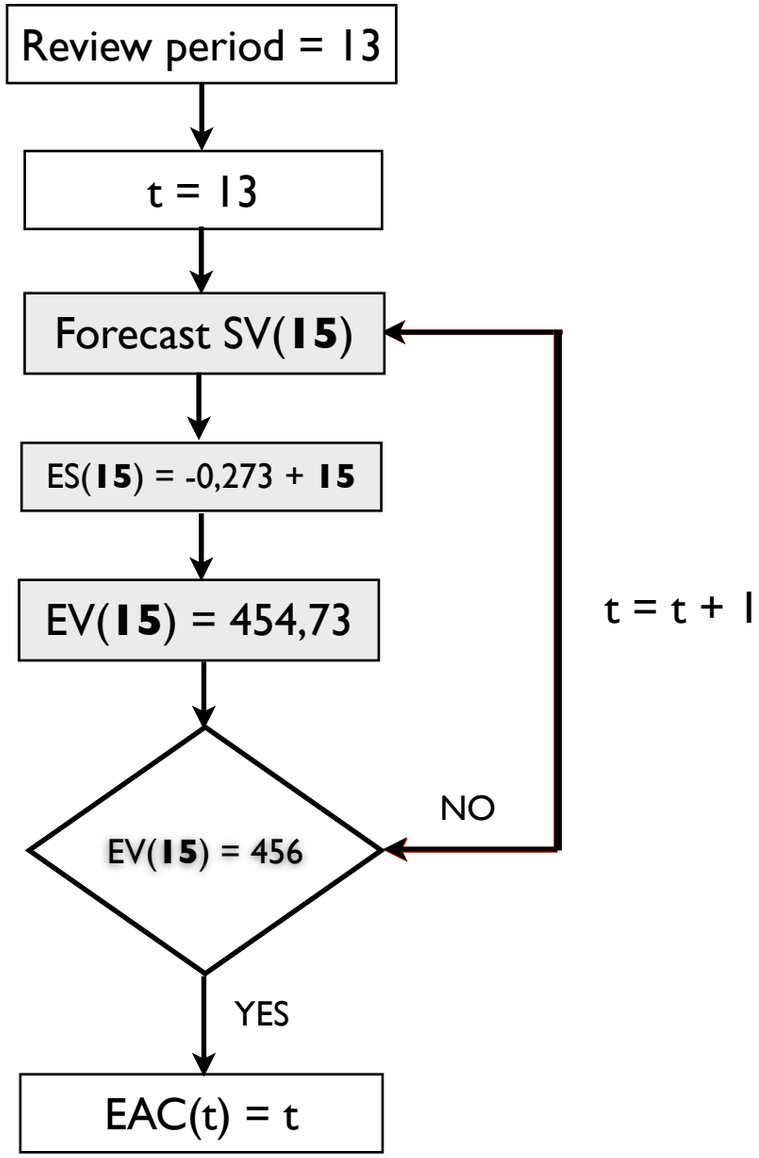

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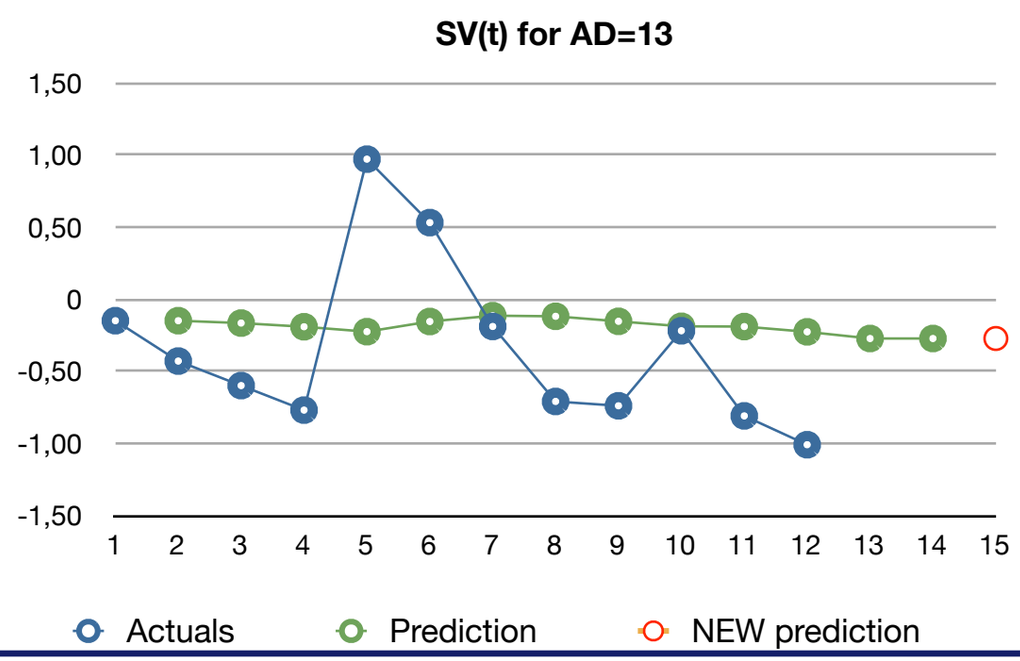

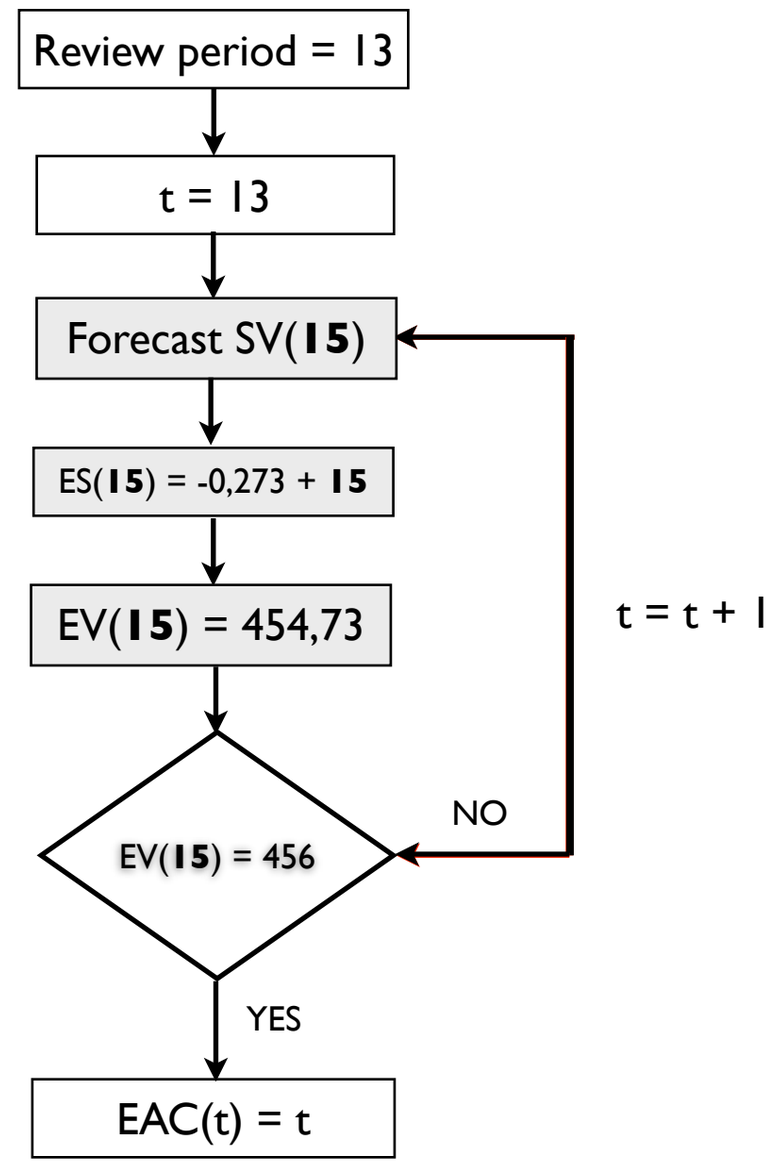

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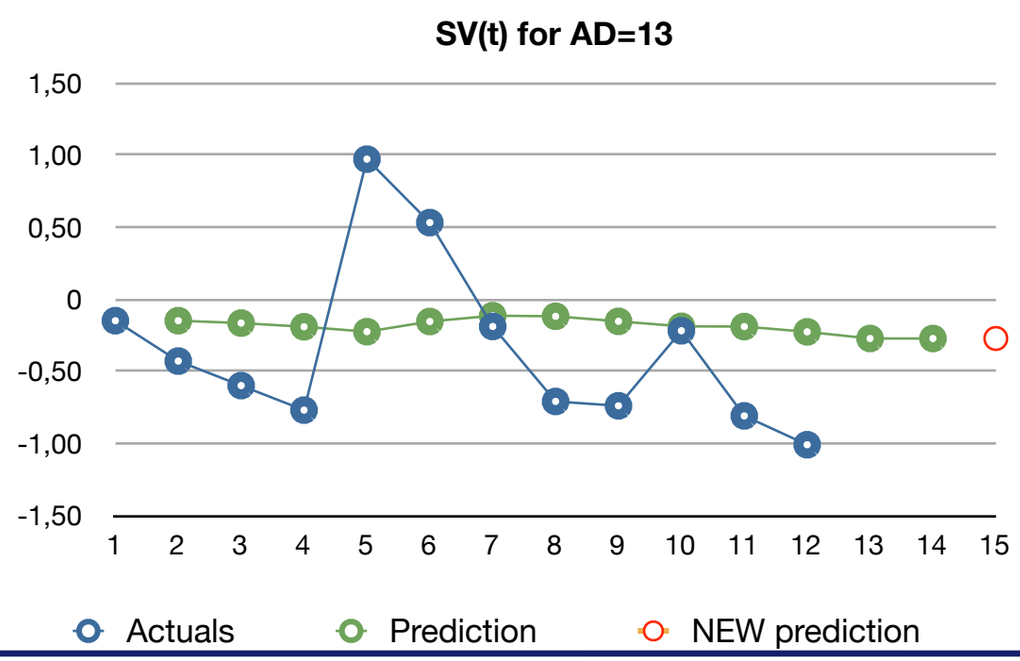

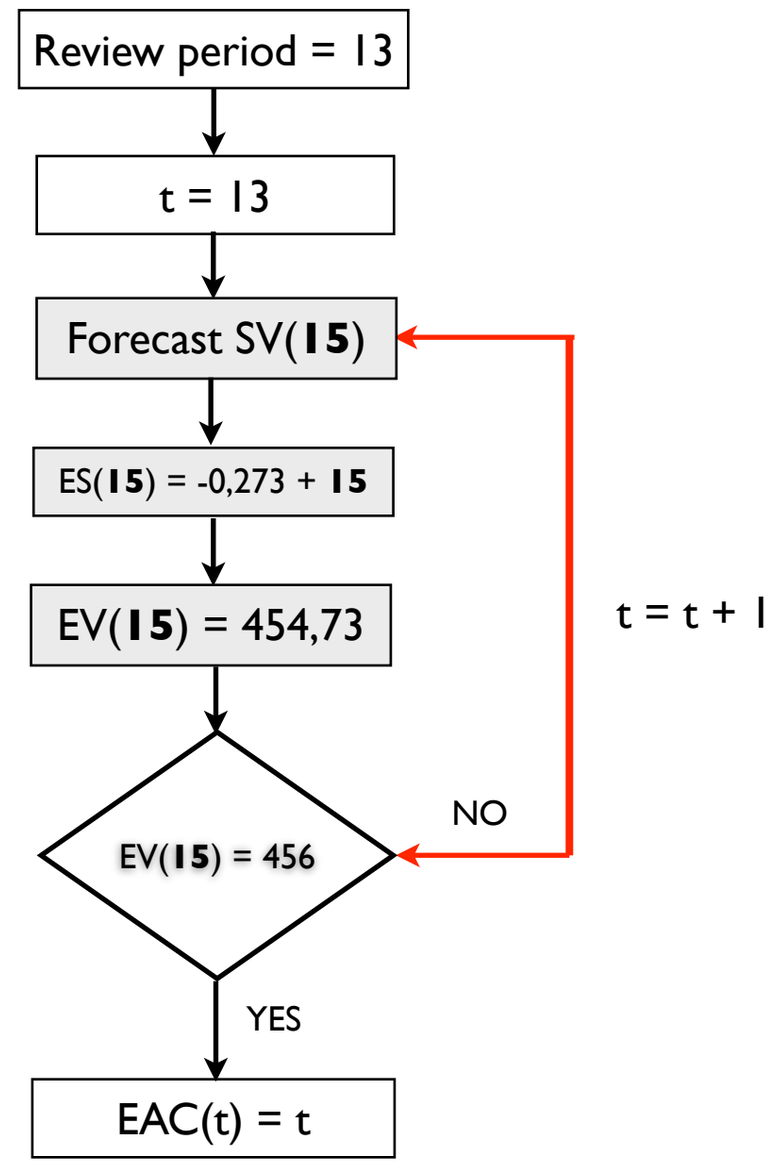

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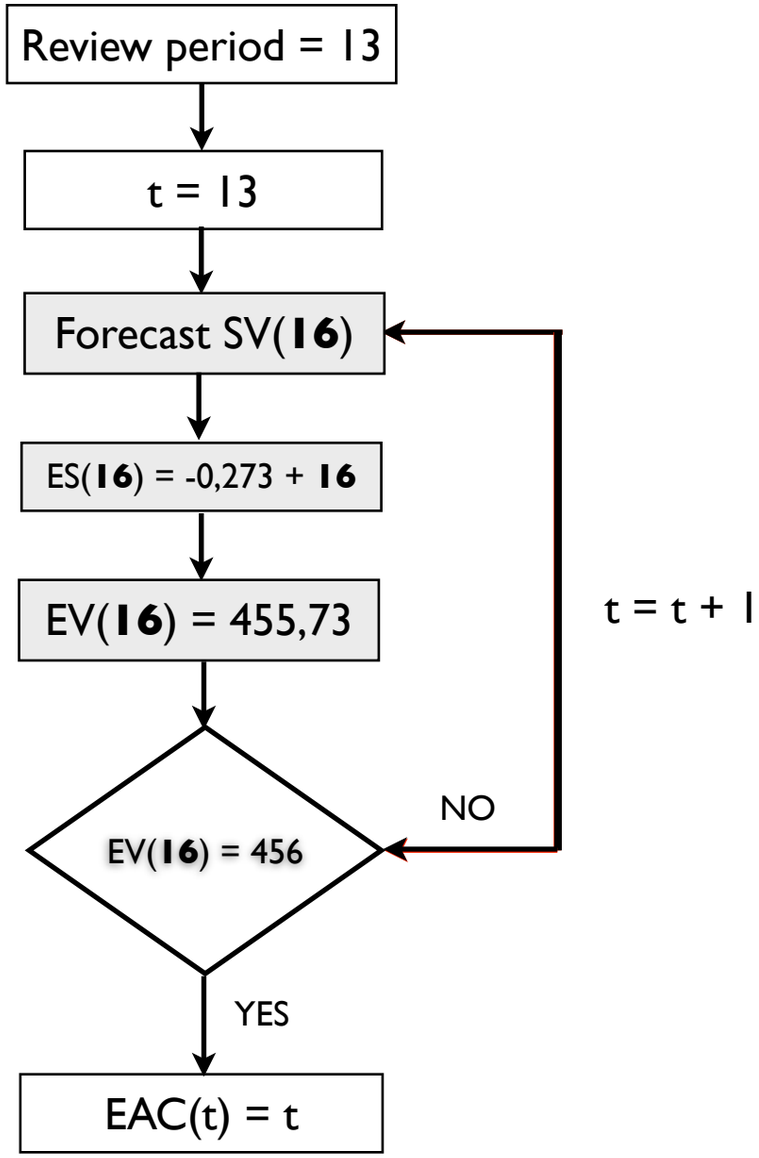

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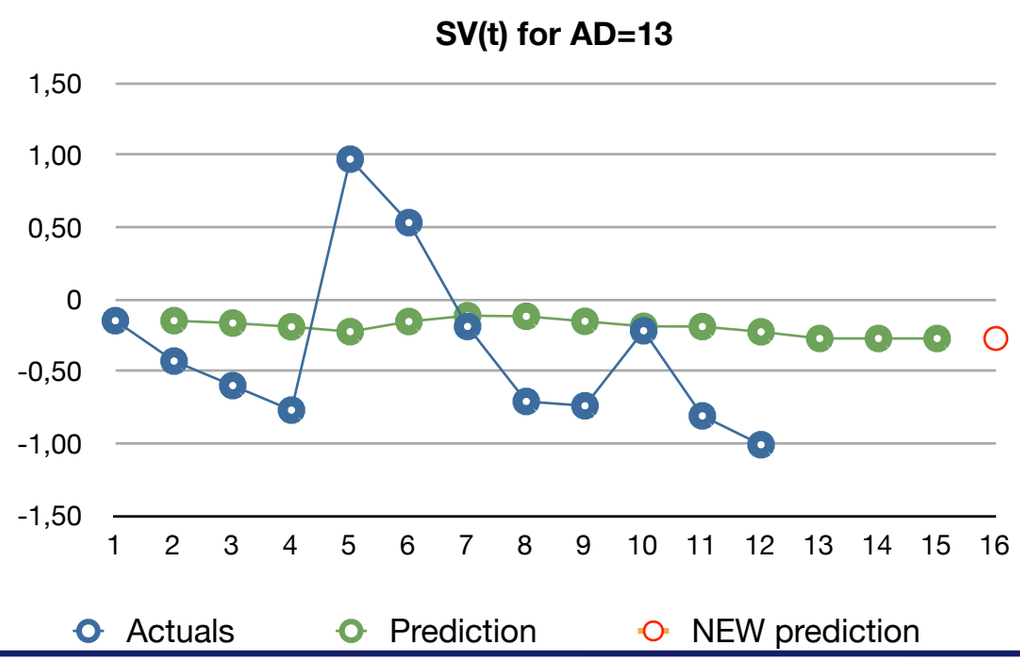

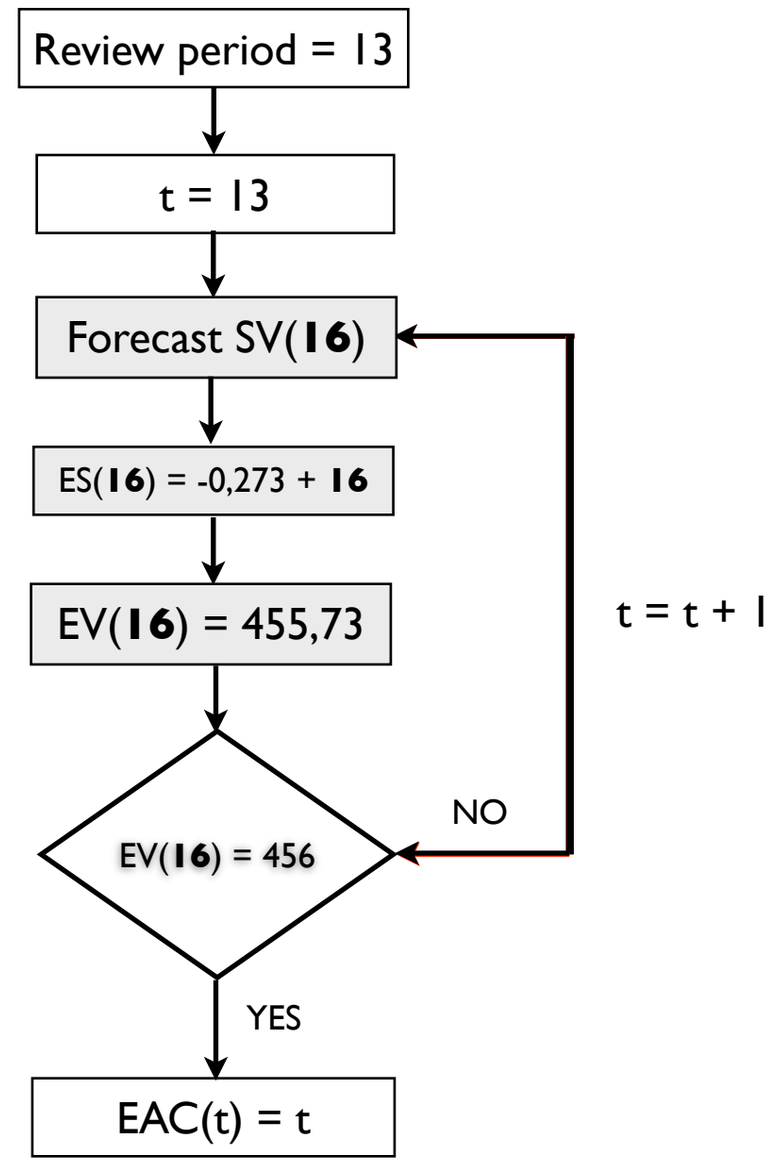

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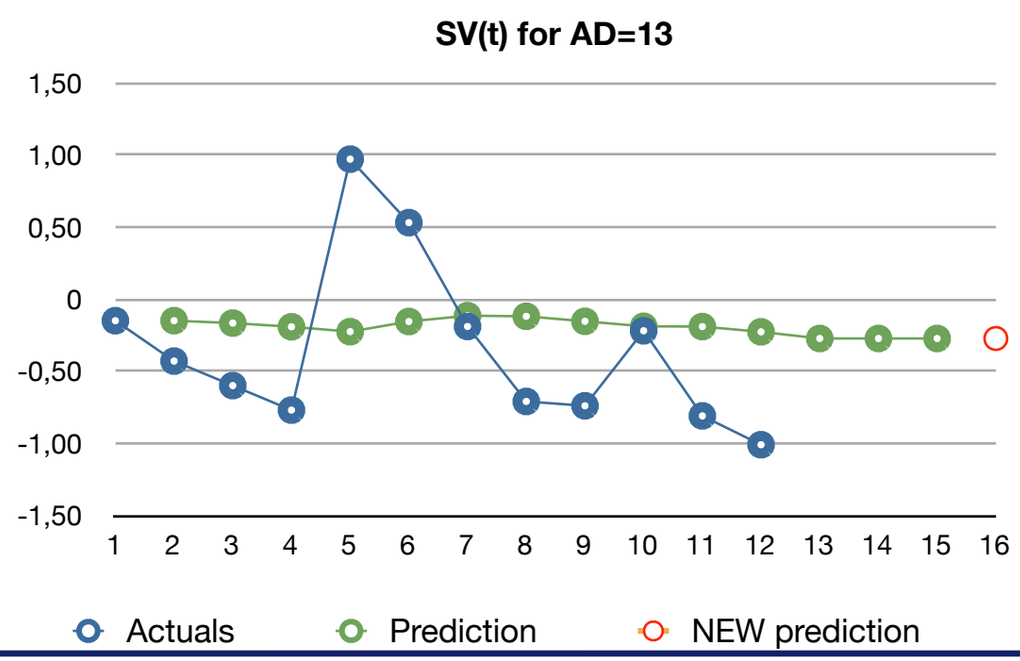

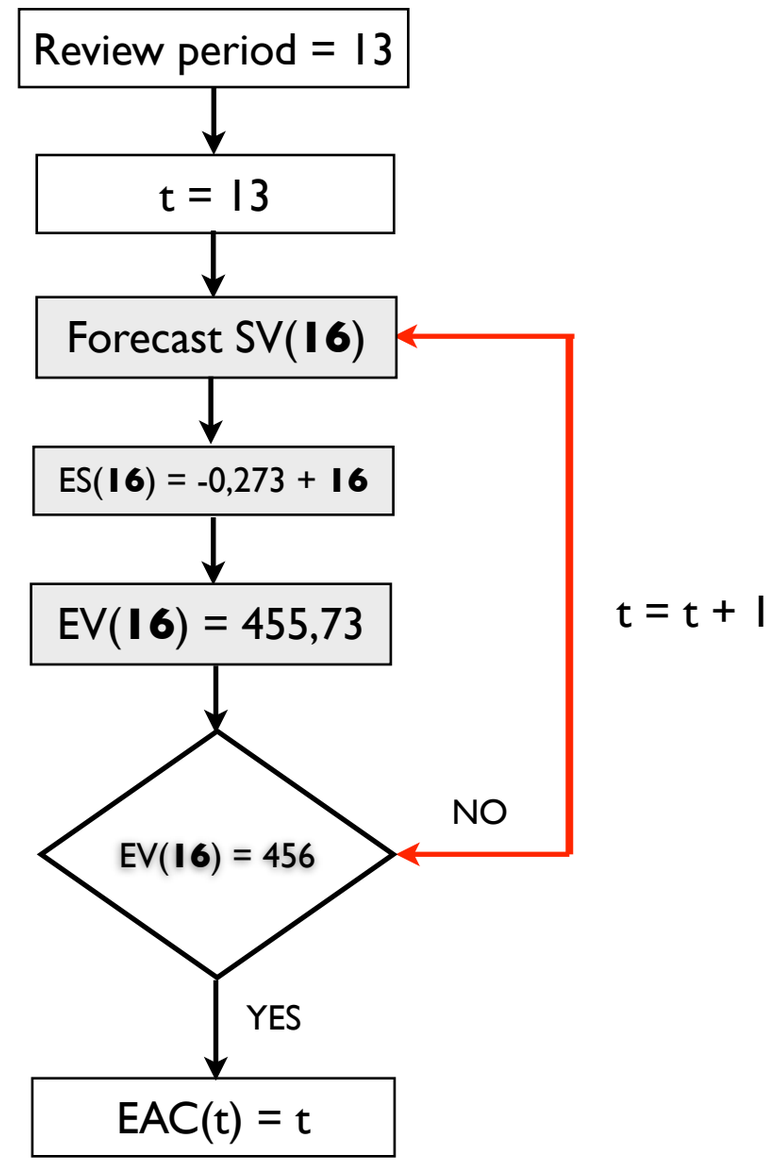

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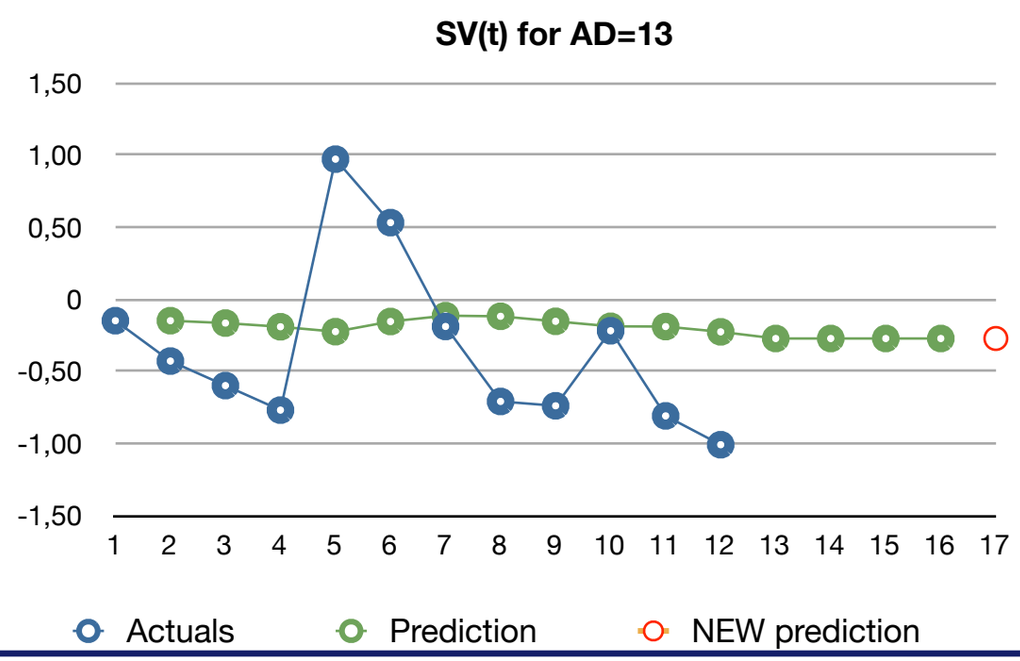
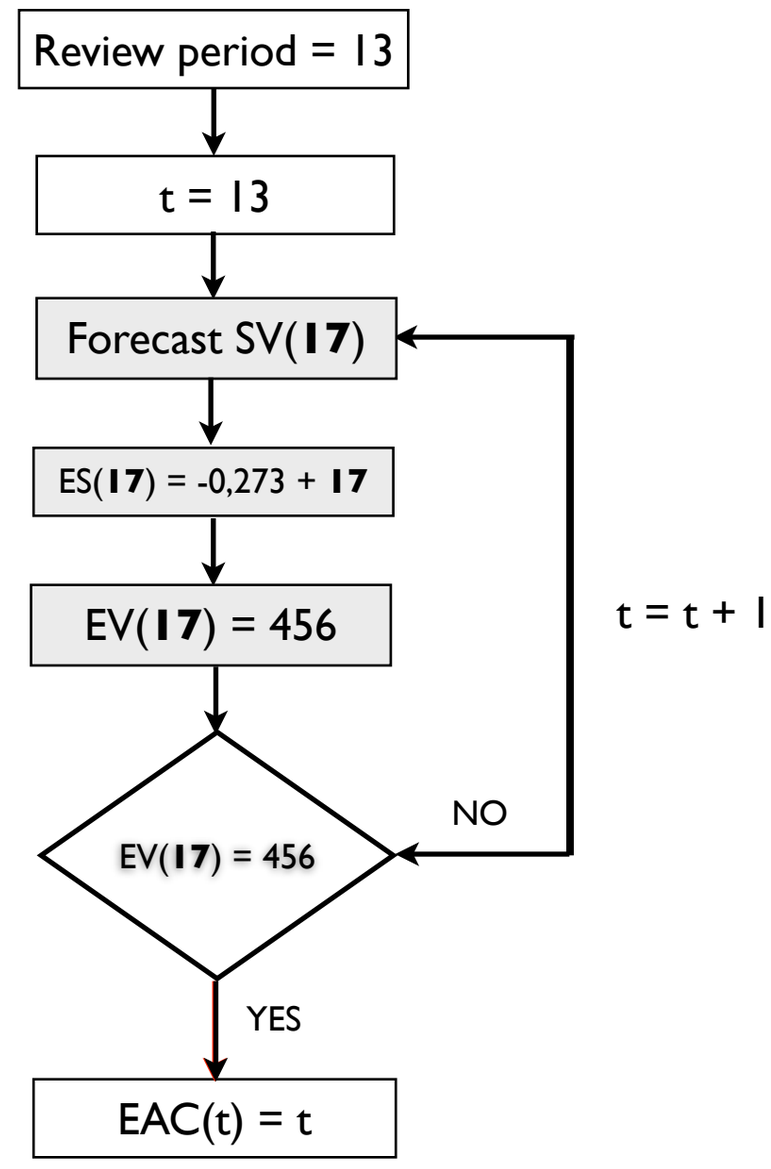
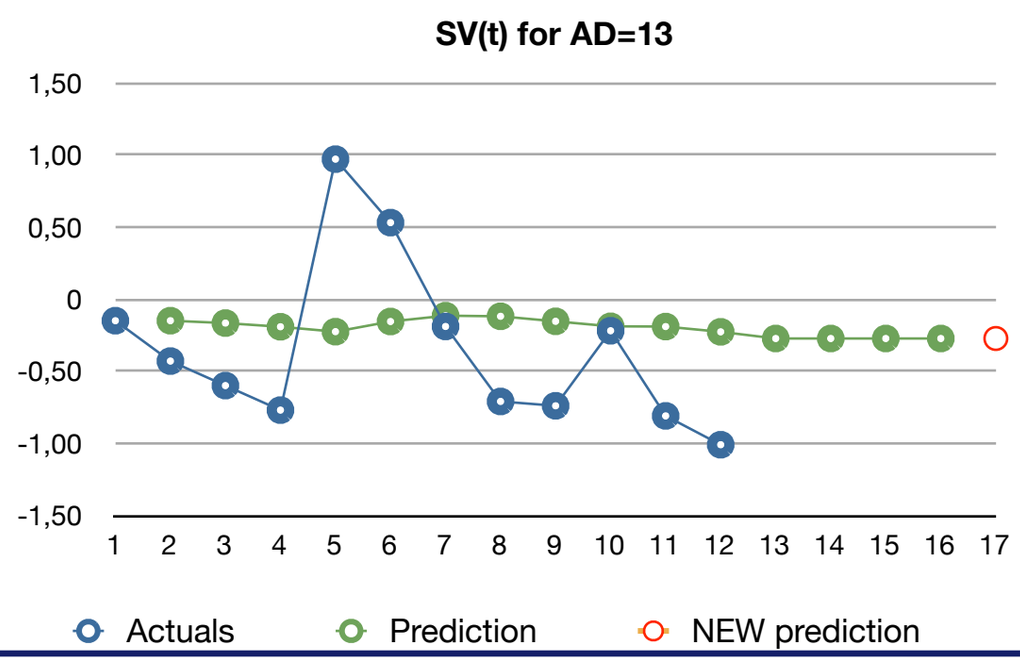
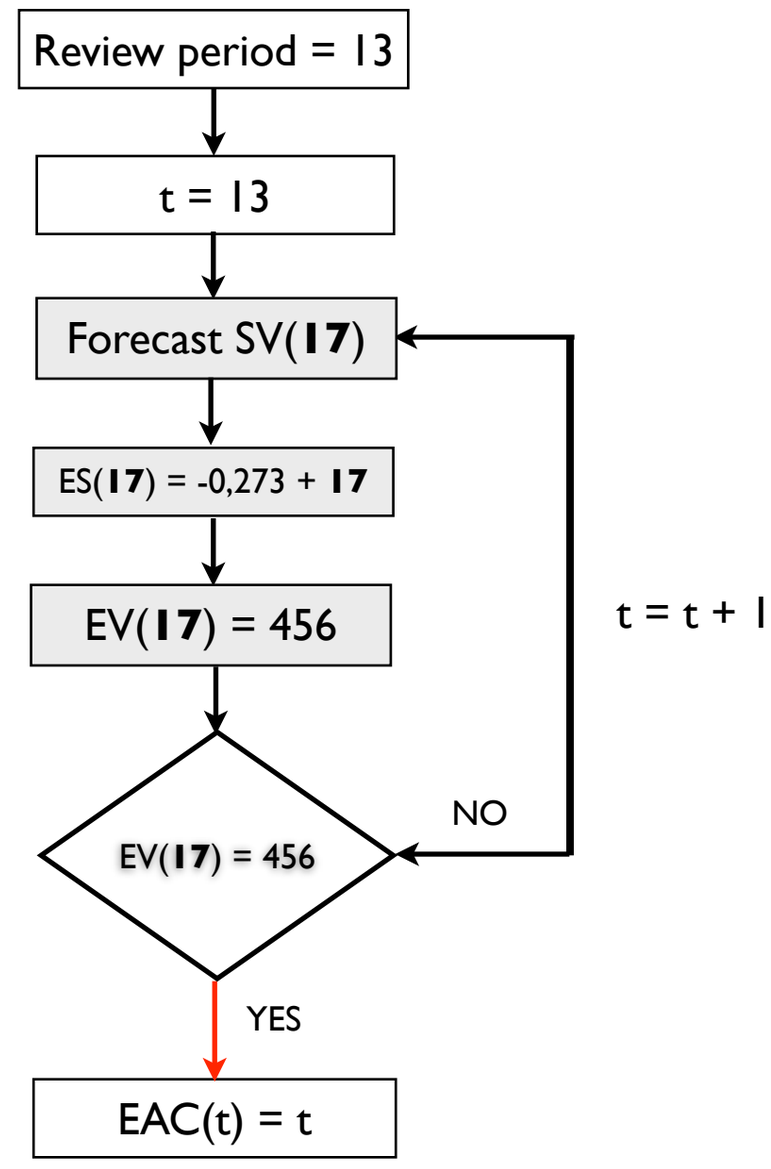




Illustration

- Period 13
  - Forecast SV(17)
    - SV(17) = -0,273





Illustration

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  - Forecast SV(17)
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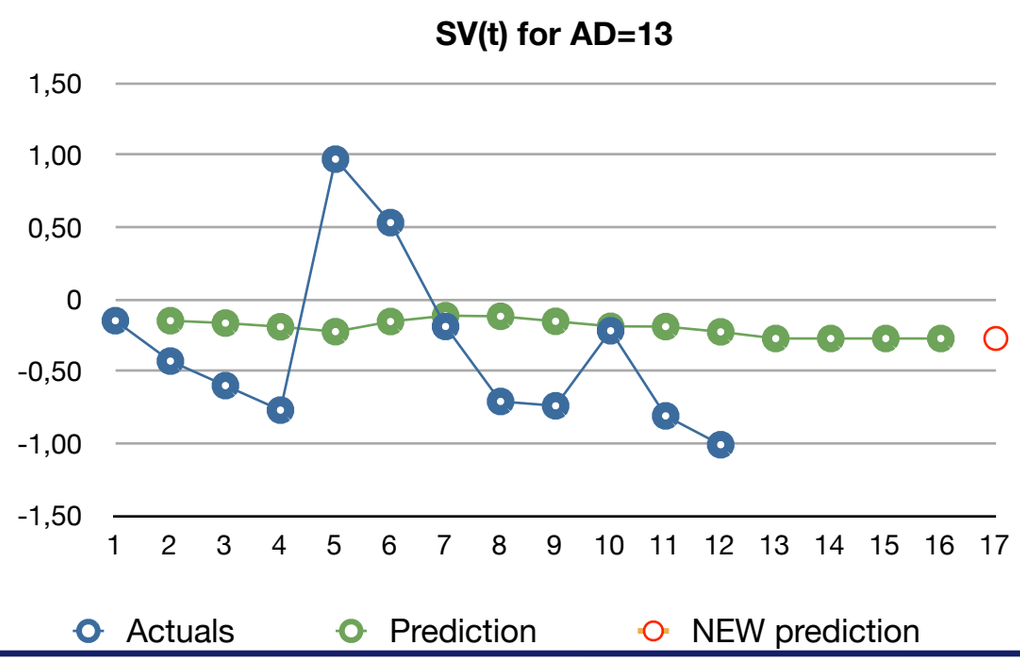

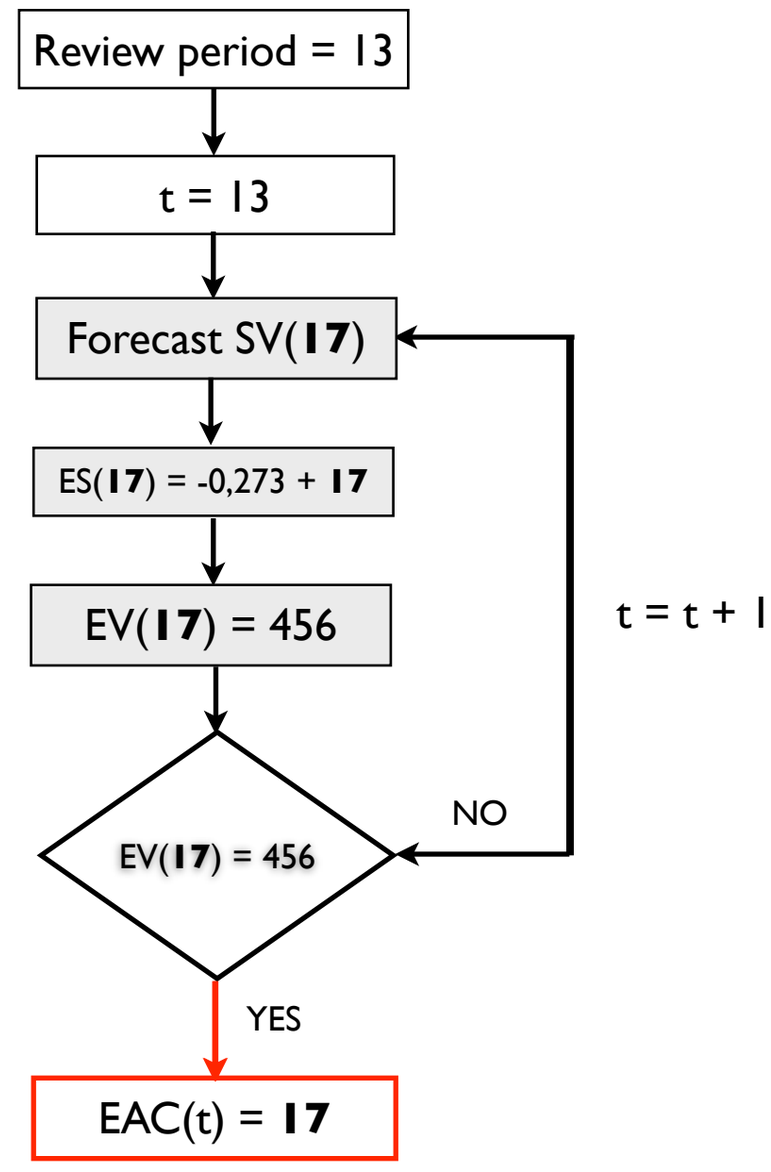

Illustration

- Period 13
  - Forecast SV(17)
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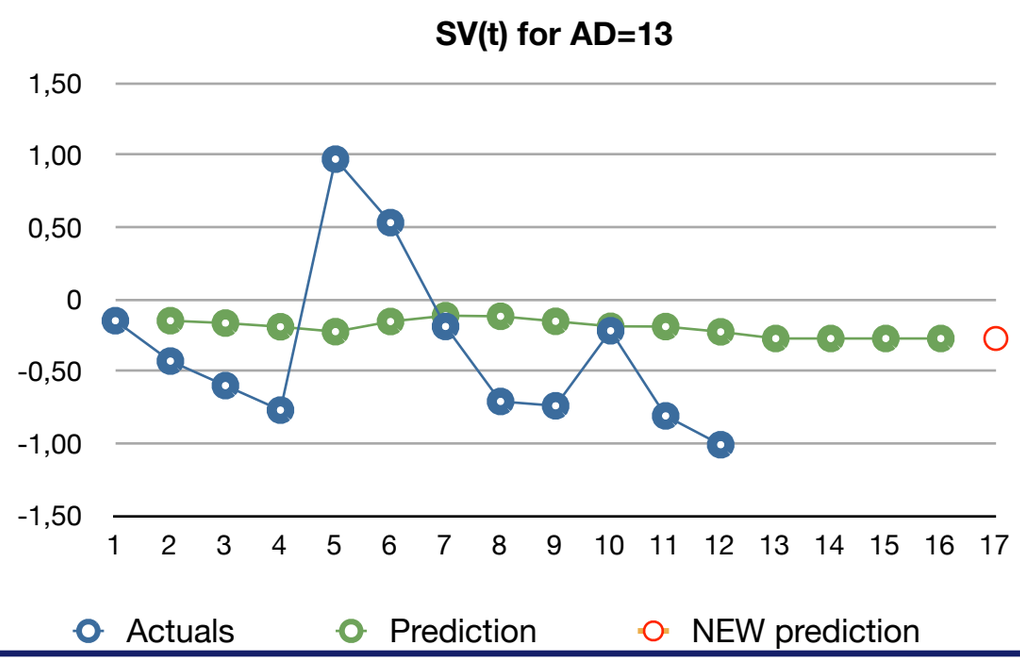

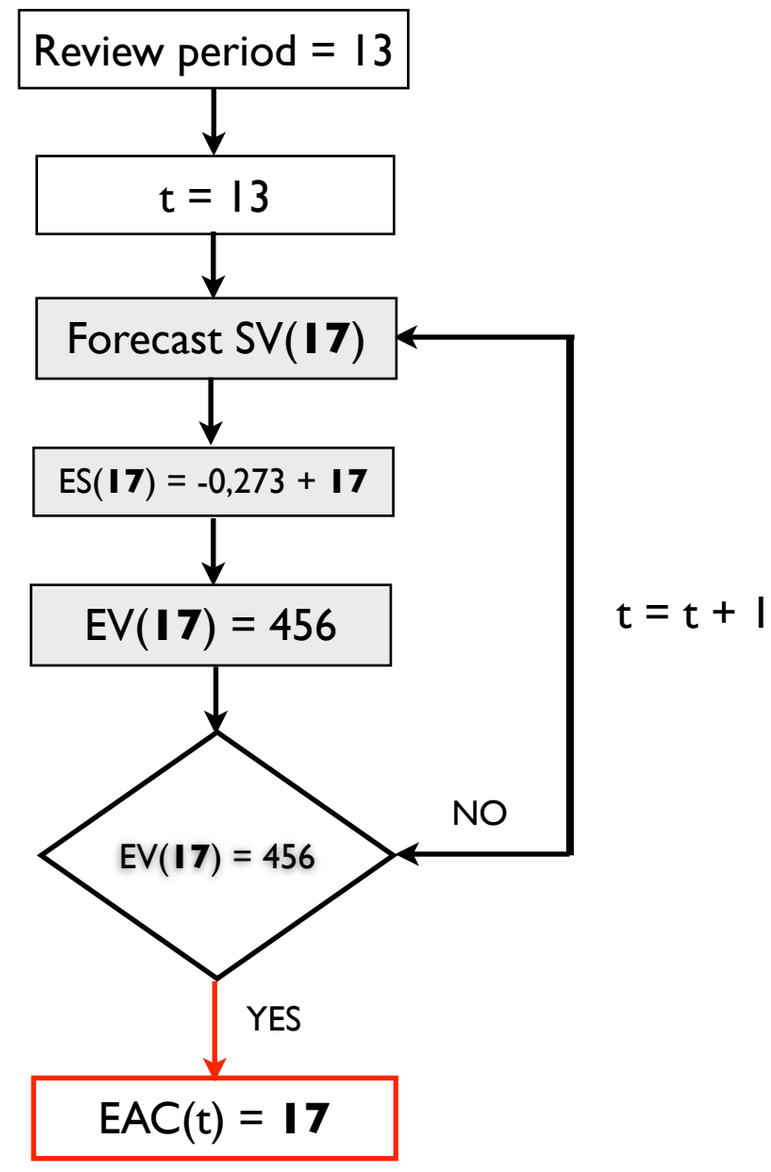

Outline

- Existing forecasting methods
- New forecasting method
- Illustration
- Preliminary results
- Conclusions

Preliminary results

- Simulation settings
  - Network complexity
    - SP-indicator 0.1-0.2-0.3-0.4-0.5

Preliminary results

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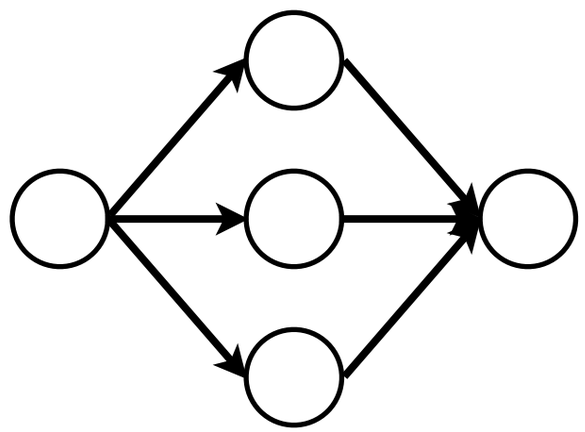
  - Network complexity
    - SP-indicator 0.1-0.2-0.3-0.4-0.5

SP=0



Preliminary results

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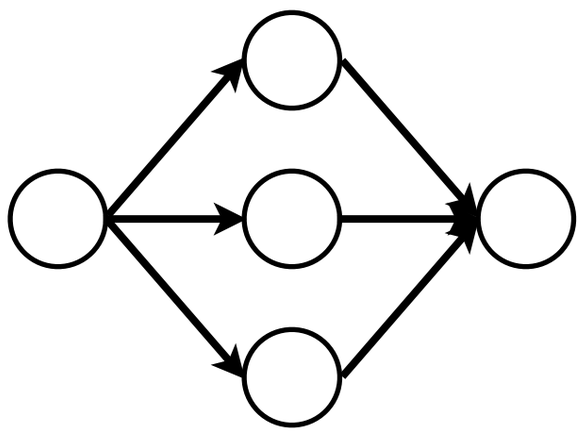
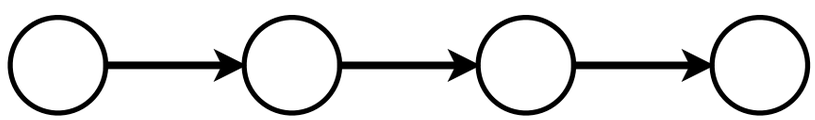
    - SP-indicator 0.1-0.2-0.3-0.4-0.5

SP=0



SP=1



Preliminary results

- Simulation settings
  - Network complexity
    - SP-indicator 0.1-0.2-0.3-0.4-0.5
  - # projects
    - 100/SP-level
  - # runs
    - 100 runs/project
    - For each run: max. 50% deviation from baseline

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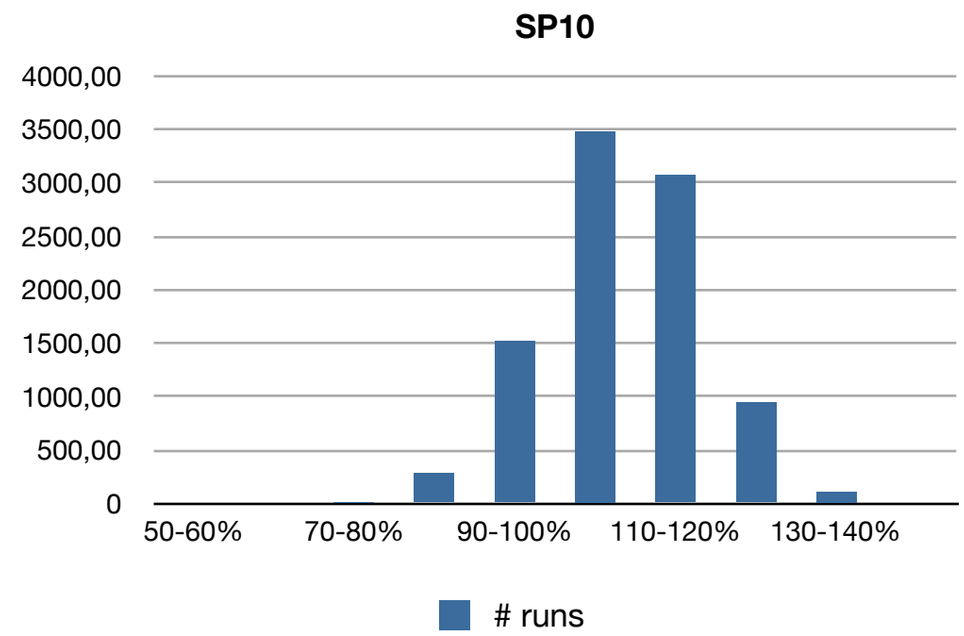

Preliminary results

- Simulation settings
  - ✦ Network complexity
    - SP-indicator 0.1-0.2-0.3-0.4-0.5
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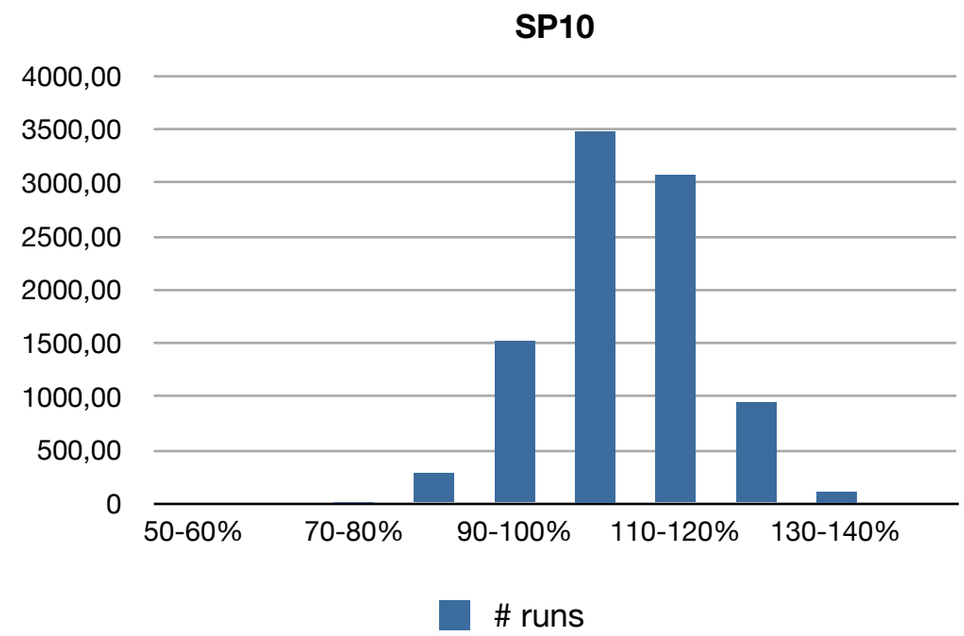

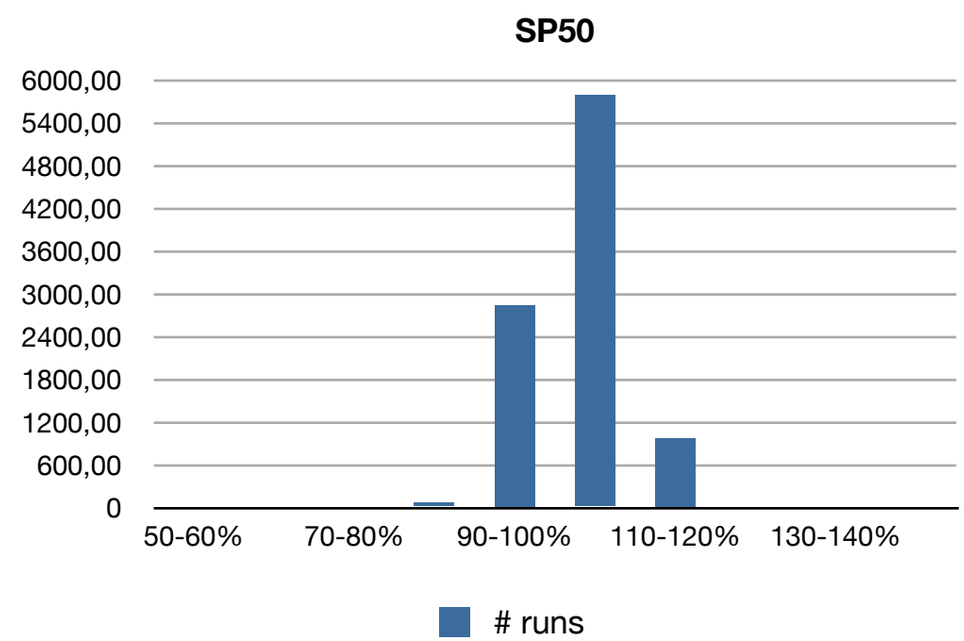

Preliminary results

- Simulation settings
  - ✦ Network complexity
    - SP-indicator 0.1-0.2-0.3-0.4-0.5
  - ✦ # projects
    - 100/SP-level
  - ✦ # runs
    - 100 runs/project
    - For each run: max. 50% deviation from baseline
  - ✦ Forecast EAC(t) at every review period
    - Early - Middle - Late periods

Preliminary results

- Simulation settings
  - ✦ Network complexity
    - SP-indicator 0.1-0.2-0.3-0.4-0.5
  - ✦ # projects
    - 100/SP-level
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    - 100 runs/project
    - For each run: max. 50% deviation from baseline
  - ✦ Forecast EAC(t) at every review period
    - Early - Middle - Late periods

Stage	% of RD
Early	[0-30]
Middle	]30-70]
Late	]70-100]

Preliminary results

- Measures of accuracy
  - MAPE versus sMAPE
    - Example: Ft = 50, RD = 100
    - MAPE:

$$\frac{|RD - f_t|}{RD} = \frac{|100 - 50|}{100} = \frac{1}{2}$$

    - sMAPE:

$$\frac{|RD - f_t|}{\frac{RD+F_t}{2}} = \frac{|100 - 50|}{\frac{100+50}{2}} = \frac{2}{3}$$

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    - Example: Ft = **100**, RD = **50**
    - MAPE:

$$\frac{|RD - f_t|}{RD} = \frac{|50 - 100|}{50} = 1$$

    - sMAPE:

Preliminary results

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  - MAPE versus sMAPE
    - Example: Ft = 50, RD = 100
    - MAPE:

$$\frac{|RD - f_t|}{RD} = \frac{|100 - 50|}{100} = \frac{1}{2}$$

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$$\frac{|RD - f_t|}{\frac{RD+F_t}{2}} = \frac{|100 - 50|}{\frac{100+50}{2}} = \frac{2}{3}$$

    - Example: Ft = **100**, RD = **50**
    - MAPE:

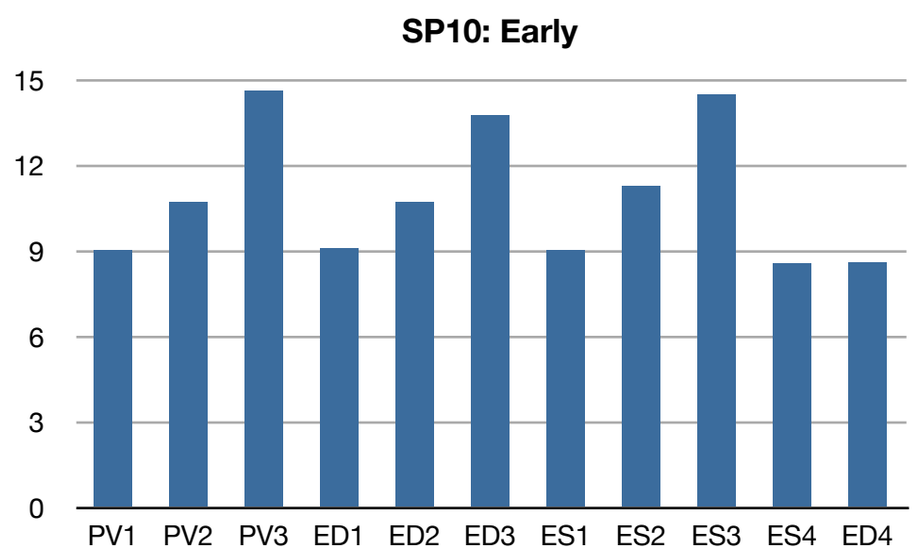
$$\frac{|RD - f_t|}{RD} = \frac{|50 - 100|}{50} = 1$$

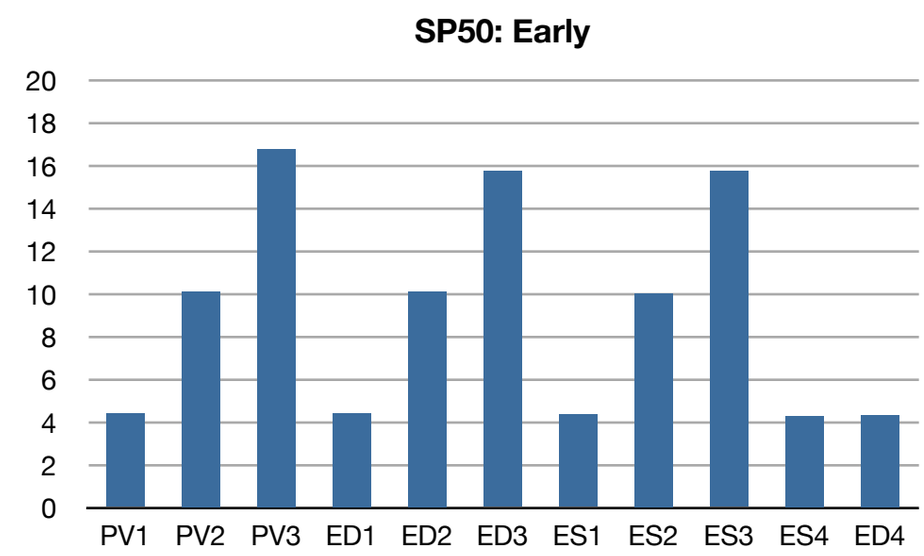
    - sMAPE:

$$\frac{|RD - f_t|}{\frac{RD+F_t}{2}} = \frac{|50 - 100|}{\frac{50+100}{2}} = \frac{2}{3}$$

Preliminary results

- Measures of accuracy
  - ✦ MAPE versus sMAPE

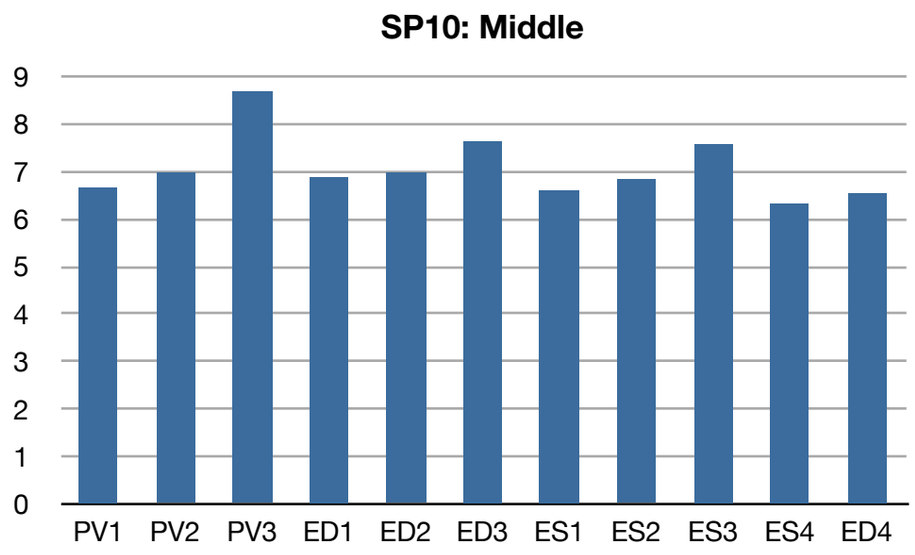


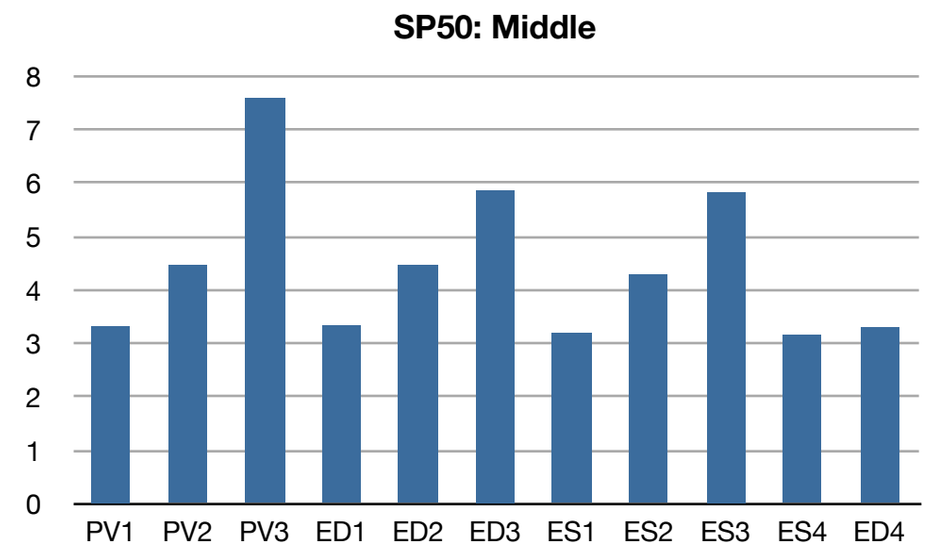


Method	PV1	PV2	PV3	ED1	ED2	ED3	ES1	ES2	ES3	ES4	ED4
SP10	9,02%	10,72%	14,62%	9,08%	10,72%	13,75%	9,04%	11,29%	14,5%	**8,57%**	8,61%
SP50	4,42%	10,12%	16,78%	4,45%	10,12%	15,75%	4,37%	10,04%	15,76%	**4,3%**	4,36%

Preliminary results

- Measures of accuracy
  - ✦ MAPE versus sMAPE

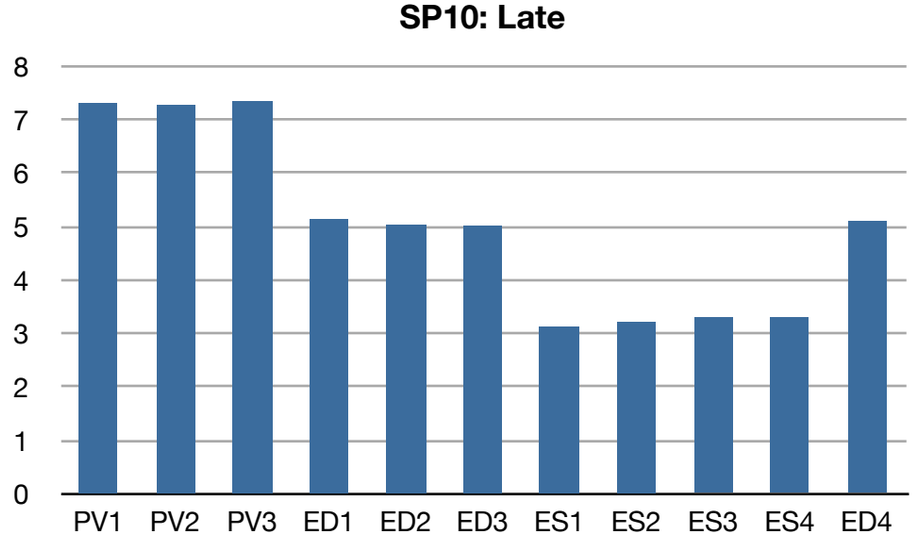


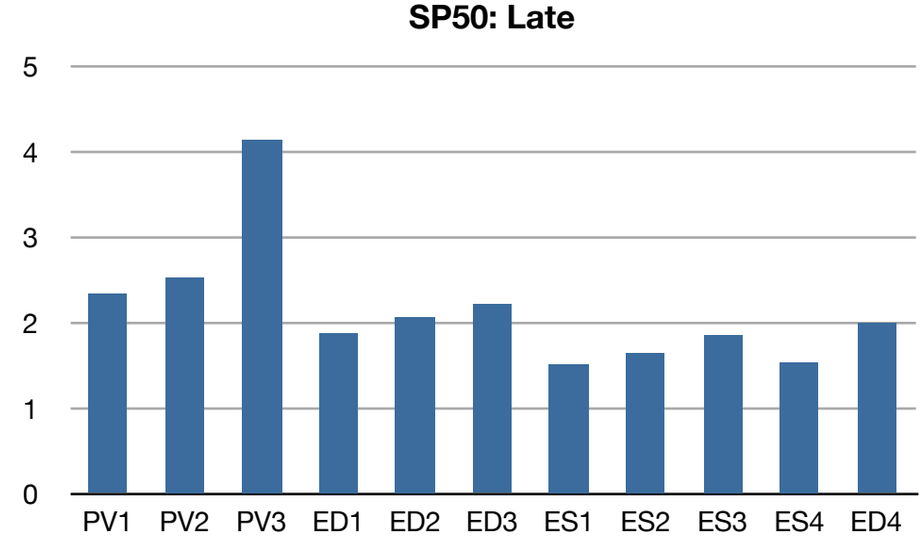


Method	PV1	PV2	PV3	ED1	ED2	ED3	ES1	ES2	ES3	ES4	ED4
SP10	6,67%	6,97%	8,68%	6,88%	6,97%	7,64%	6,6%	6,83%	7,58%	**6,33%**	6,55%
SP50	3,33%	4,47%	7,59%	3,34%	4,47%	5,87%	3,2%	4,29%	5,83%	**3,16%**	3,3%

Preliminary results

- Measures of accuracy
  - ✦ MAPE versus sMAPE

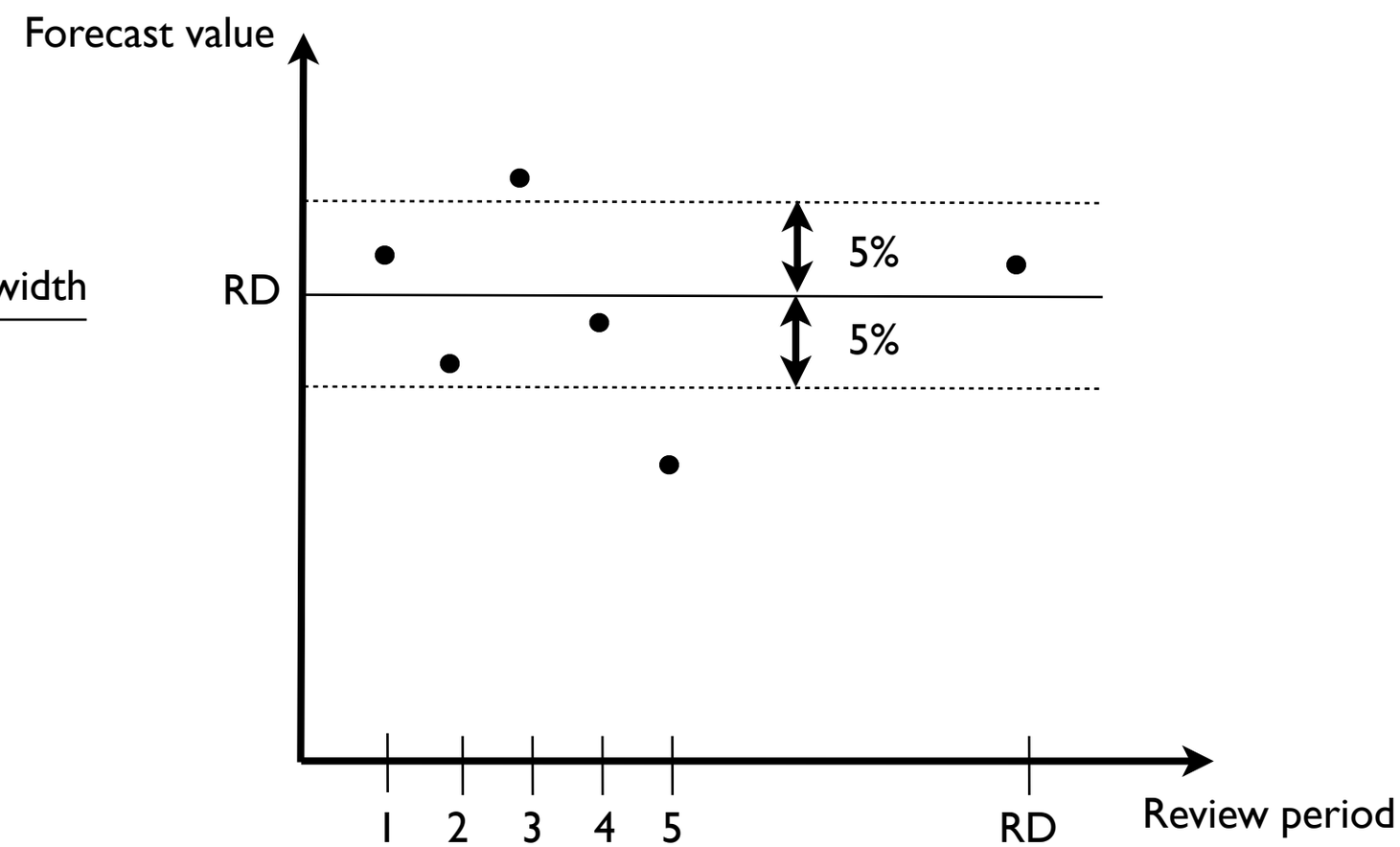




Method	PV1	PV2	PV3	ED1	ED2	ED3	ES1	ES2	ES3	ES4	ED4
SP10	7,32%	7,28%	7,35%	5,15%	5,04%	5,02%	**3,14%**	3,22%	3,3%	3,3%	5,1%
SP50	2,34%	2,53%	4,14%	1,88%	2,07%	2,22%	**1,52%**	1,65%	1,86%	1,54%	2%

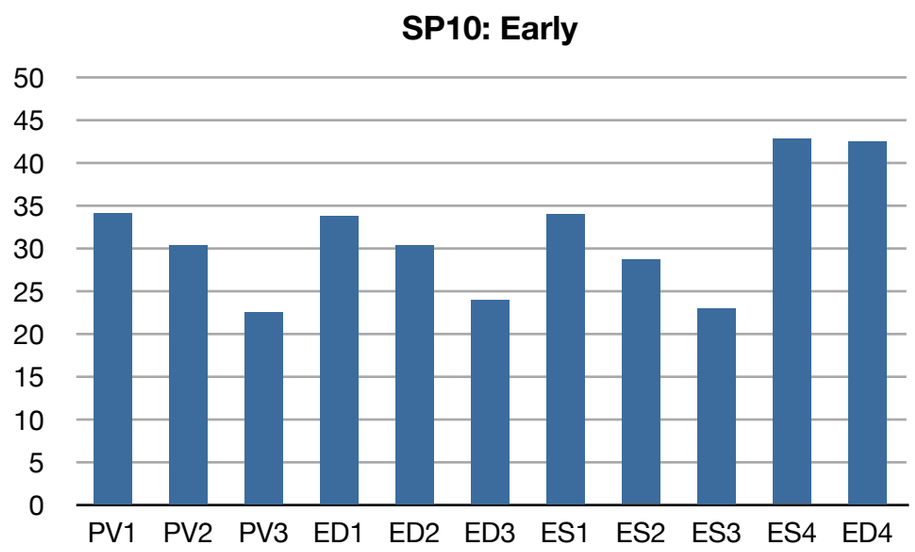
Preliminary results

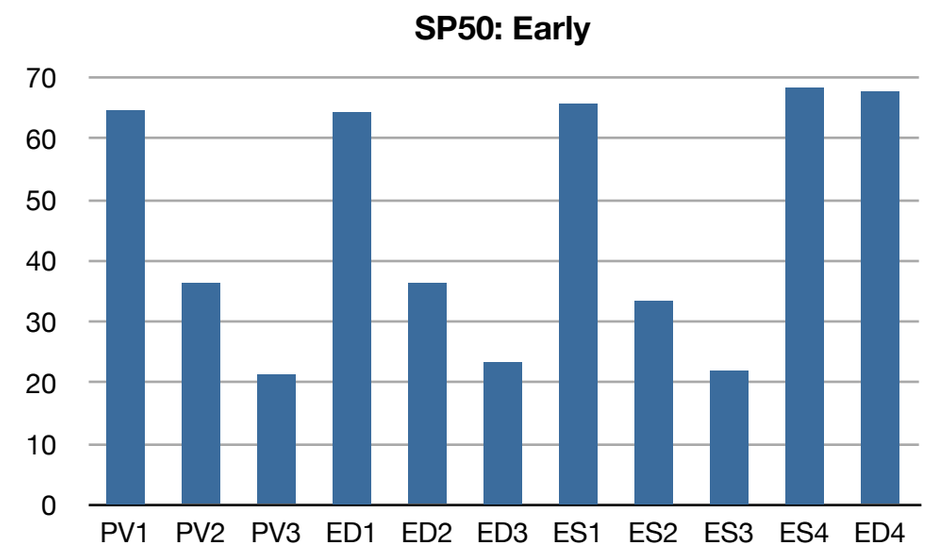
- Measures of accuracy
  - ✦ MAPE versus sMAPE
  - ✦ Frequency of Approximation
    - FOA = $\frac{\text{\#observations within bandwidth}}{\text{total \# observations}}$



Preliminary results

- Measures of accuracy
  - Frequency Of Approximation

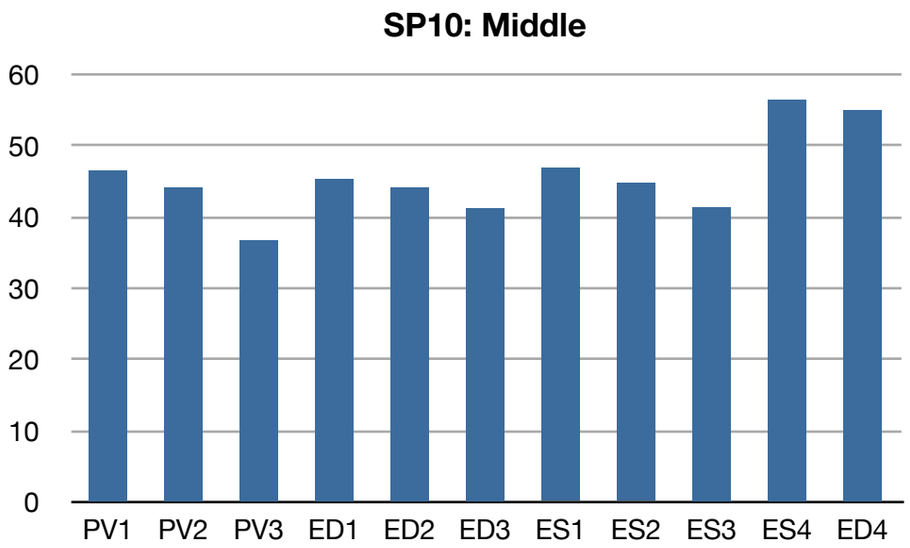


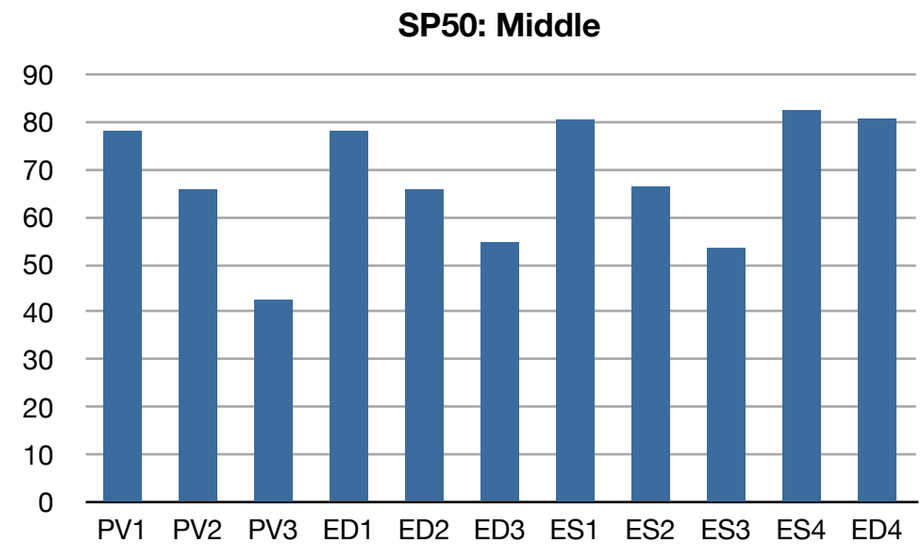


Method	PV1	PV2	PV3	ED1	ED2	ED3	ES1	ES2	ES3	ES4	ED4
SP10	34,14%	30,37%	22,59%	33,86%	30,37%	24,01%	34,06%	28,71%	22,98%	**42,8%**	42,52%
SP50	64,68%	36,32%	21,36%	64,36%	36,32%	23,38%	65,68%	33,47%	22,04%	**68,39%**	67,65%

Preliminary results

- Measures of accuracy
  - Frequency Of Approximation

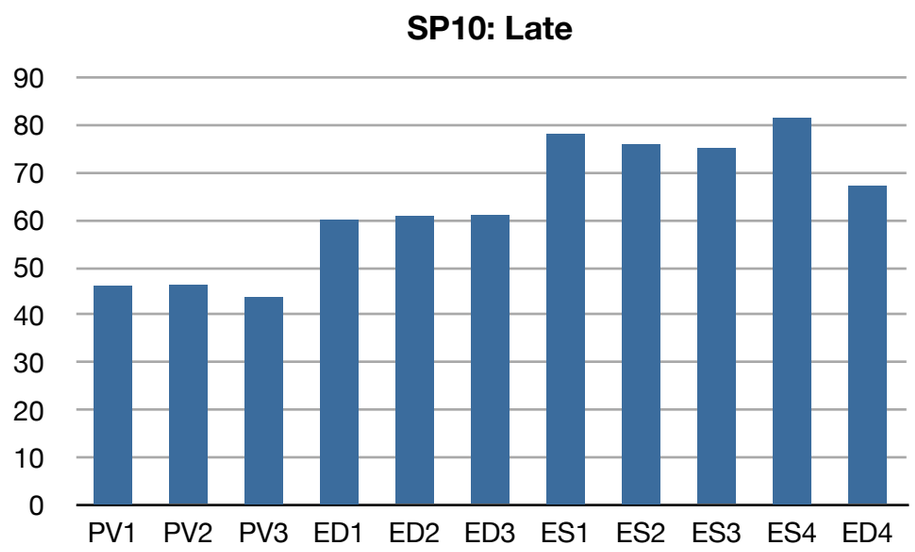


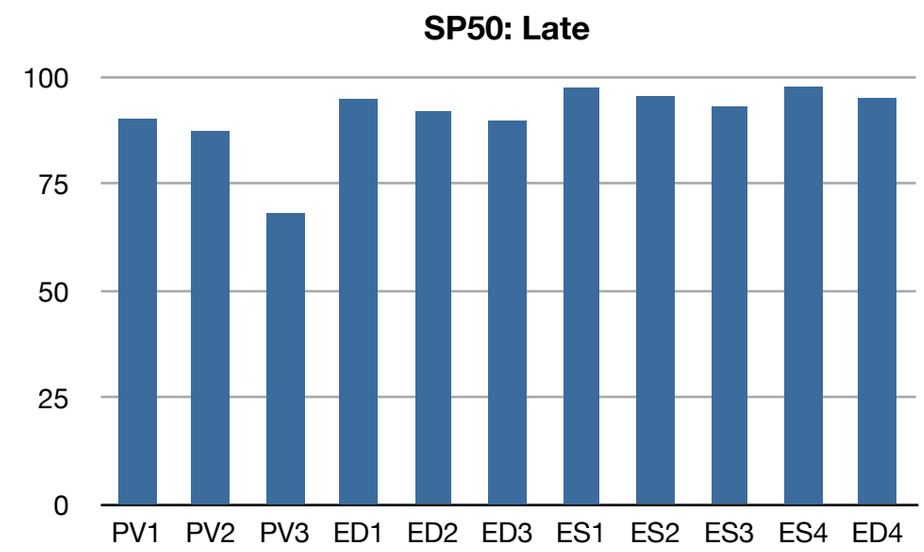


Method	PV1	PV2	PV3	ED1	ED2	ED3	ES1	ES2	ES3	ES4	ED4
SP10	46,55%	44,13%	36,79%	45,32%	44,13%	41,27%	46,86%	44,75%	41,42%	**56,43%**	55,01%
SP50	78,14%	65,73%	42,59%	78,04%	65,73%	54,6%	80,6%	66,35%	53,53%	**82,55%**	80,7%

Preliminary results

- Measures of accuracy
  - Frequency Of Approximation





Method	PV1	PV2	PV3	ED1	ED2	ED3	ES1	ES2	ES3	ES4	ED4
SP10	46,16%	46,26%	43,87%	60,08%	60,75%	60,99%	78,2%	75,94%	75,11%	**81,59%**	67,13%
SP50	90,41%	87,49%	68,34%	95,05%	92,03%	89,98%	97,66%	95,56%	93,11%	**97,81%**	95,12%

Outline

- Existing forecasting methods
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- Conclusions

Conclusions

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- A comparison...

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- A comparison...
  - between the existing methods PV, EV and ES

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  - corroborating earlier research (ES performs best)

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Conclusions

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  - corroborating earlier research (ES performs best)
- A novel method...
  - based on ED and ES
  - showing promising early results
- Future research
  - Identify strengths and weaknesses

Q&A?