Machine learning in financial forecasting

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Financial forecasting

- Start with a sales forecast
- Ends with a forecast of how much money you will spend (net) of inflows to get those sales
- Continuous process of directing and allocating financial resources to meet strategic goals and objectives

Financial forecasting

- The output from financial planning takes the form of budgets
- We can also break financial forecasting down into planning for operations and planning for financing
- But we will consider as one single process that encompasses both operations and financing

Window Method

- What is window method?
  - It is an algorithm to make financial forecast

$$x_1, x_2, \ldots, x_n \mapsto x_{n+1}, x_{n+2}, \ldots, x_{n+m}$$

Two Types of Window Methods (1)

- Use the predicted data in forecasting

$$x_1, x_2, \ldots, x_n \longmapsto x_{n+1}$$

$$x_2, x_3, \ldots x_n, x_{n+1} \longmapsto x_{n+2}$$

$$x_3, x_4, \ldots x_{n+1}, x_{n+2} \longmapsto x_{n+3}$$

Two Types of Window Methods

- Don't use the predicted data

$$x_1, x_2, \ldots, x_n \mapsto x_{n+1}$$

$$x_2, x_3, \ldots x_n, x'_{n+1} \mapsto x_{n+2}$$

$$x_3, x_4, \ldots x'_{n+1}, x'_{n+2} \mapsto x_{n+3}$$

where $x'_{n+1}, x'_{n+2}, \ldots$ are the real values

Tools needed for Window Methods

- Data
  - The size of the window
  - Initial data
    - Number of these data >= size of window
- Machine learning Algorithms
  - MLP (Multi Layer Perception)
  - GP (Gaussian Process)

Initial data

- Training data
- Santa Fe data set
  - exchange rates from Swiss francs to US dollars
  - recorded from August 7, 1990 to April 18, 1991
  - contains 30.000 data points

Machine learning-past and future

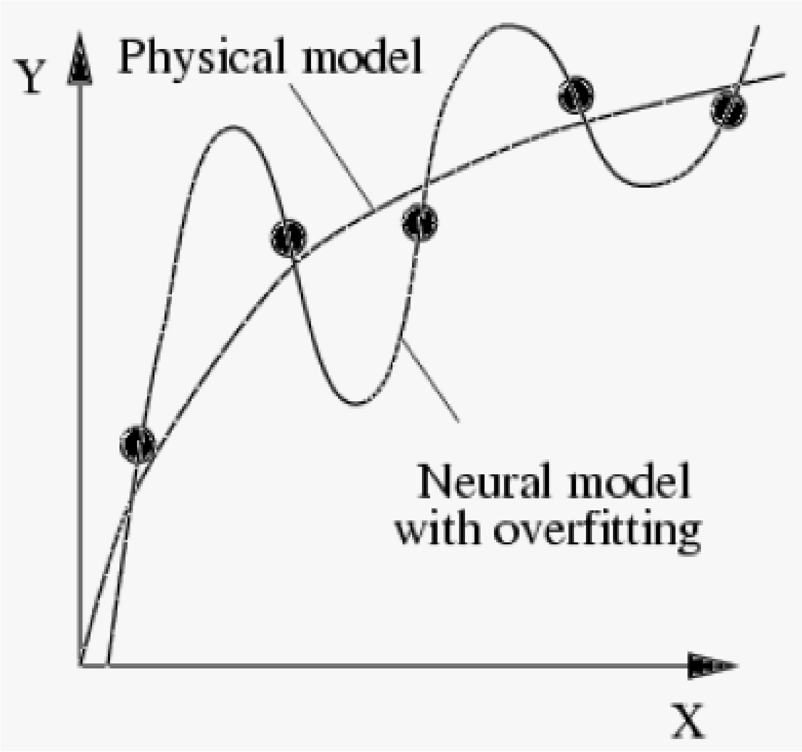
- Neural networks generated much interest
- Neural networks solved some useful problems
- Other learning methods can be even better

What do neural networks do?

- Approximate arbitrary functions from training data

What is wrong with neural networks?

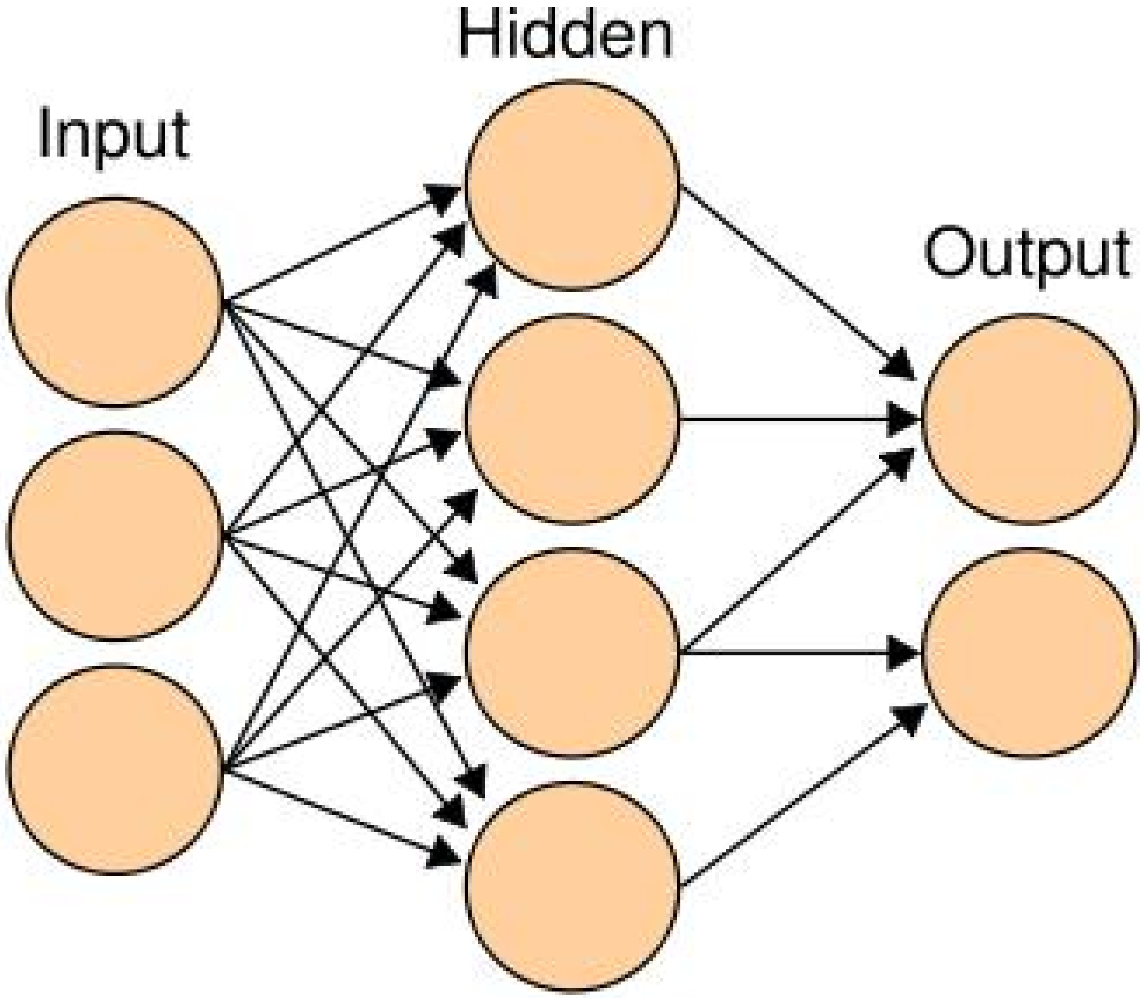
- The 'overfitting' problem
- Domain knowledge is hard to utilize
- We have no bounds on generalization performance



MLP (Multi-layer perceptron)

- Feed-forward neural networks
- Are the first and arguably simplest type of artificial neural networks devised
- In this network, the information moves in only one direction, forward, from the input nodes, through the hidden nodes (if any) and to the output nodes.
- There are no cycles or loops in the network.

Feedforward neural networks



MLP (Multi-layer perceptron)

- This class of networks consists of multiple layers of computational units
- These are interconnected in a feed-forward way
- Each neuron in one layer has directed connections to the neurons of the subsequent layer

In our example

- We use the Santa Fe data set
- We use three function
  - eq_data
  - equal_steps
  - mlp_main

Eq_data

- Load the data
- the time format is:
  - 1.column:day
  - 2.column:(hour).(minute)(second)
- convert the time into second

<<< Why needed >>>
!Explain!

- Needed to ....

Equal_steps

- Time the inputs uniformly
- Input: time-series with the ticks
- Output: time-series that contains the values on an equally-spaced time-steps

<<< Why needed >>>
!Explain!

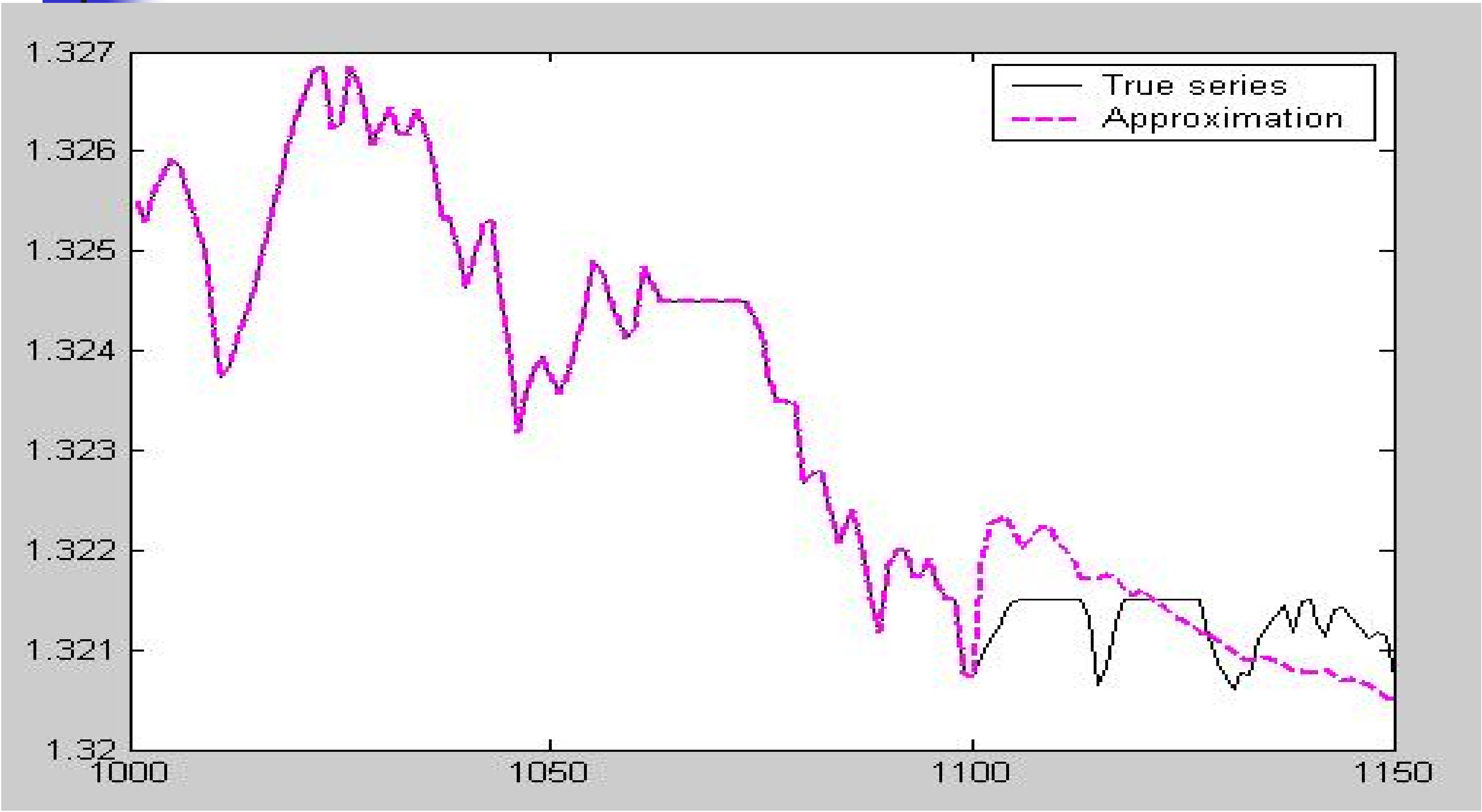
Mlp_main

- Call the eq_data and equal_steps on the Santa Fe data set
- the input window length = 100
- the output window length = 20
- prediction length = 50
- length of the training set = 2700

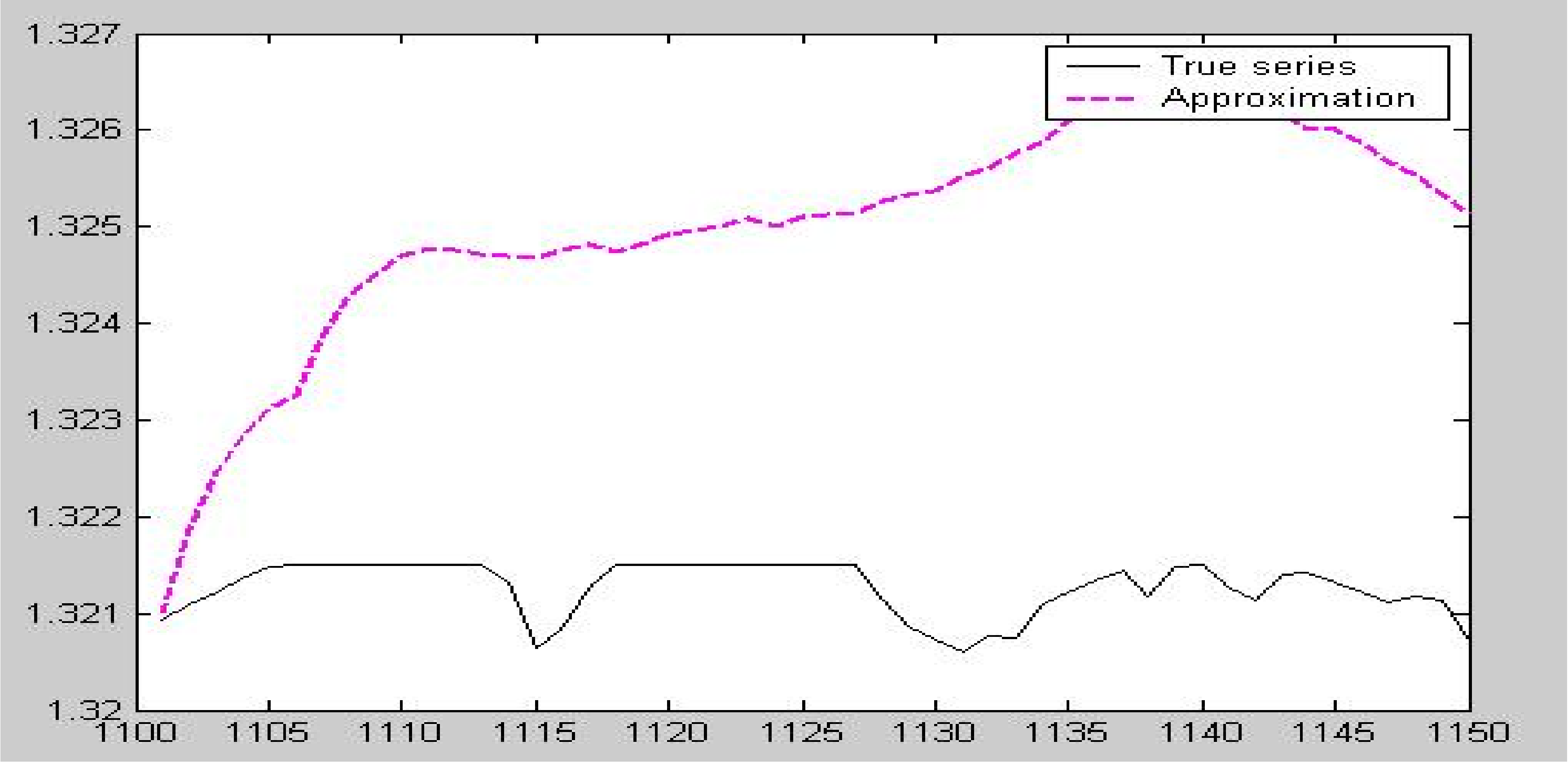
Mlp_main

- Create the MLP network
- training the network
- testing the network
- give the prediction
- plot the prediction

MLP with test data



MLP with test data (detail)



Conclusion

- Theoretically the second method is the best, because it predict only one data
- After that it use, the real data to make the next prediction

One idea of machine learning

- The implicit Bayesian prior is then a class of Gaussian Process
- Gaussian processes are probability distribution on a space of function
- Are well-understood

GP-Mathematical interpretation

- A Gaussian process is a stochastic process which generates samples over time X_t such that no matter which finite linear combination of the X_t ones takes (or, more generally, any linear functional of the sample function X_t), that linear combination will be normally distributed

Important Gaussian processes

- The Wiener process is perhaps the most widely studied Gaussian process. It is not stationary, but it has stationary increments
- The Ornstein-Uhlenbeck process is a stationary Gaussian process. The Brownian bridge is a Gaussian process whose increments are not independent

GP (Gaussian process) method

- Provide promising non-parametric tools for modelling real-word statistical problems
- An important advantage of GP-s over other non-Bayesian models is the explicit probabilistic formulation of the model
- Unfortunately this model has a relevant drawback

GP (Gaussian process) method

- This drawback of GP models lies, in the huge increase of the computational cost with the number of training data
- This seems to preclude applications of GPs to large datasets

GP (Gaussian process) method

- Create a Gaussian process
- Initialize Gaussian Process model with training data
- Forward propagation through Gaussian Process

In our example

- We use the Santa Fe data set
- windows size=120
- the forecasting data size=300

GP with Exponential and Quadratic covariance using new data

<<< REMAKE THE PLOTS >>>
!Ez NINCS IGY. Nem jo!

At kell venni az adatokat az equal...-bol.

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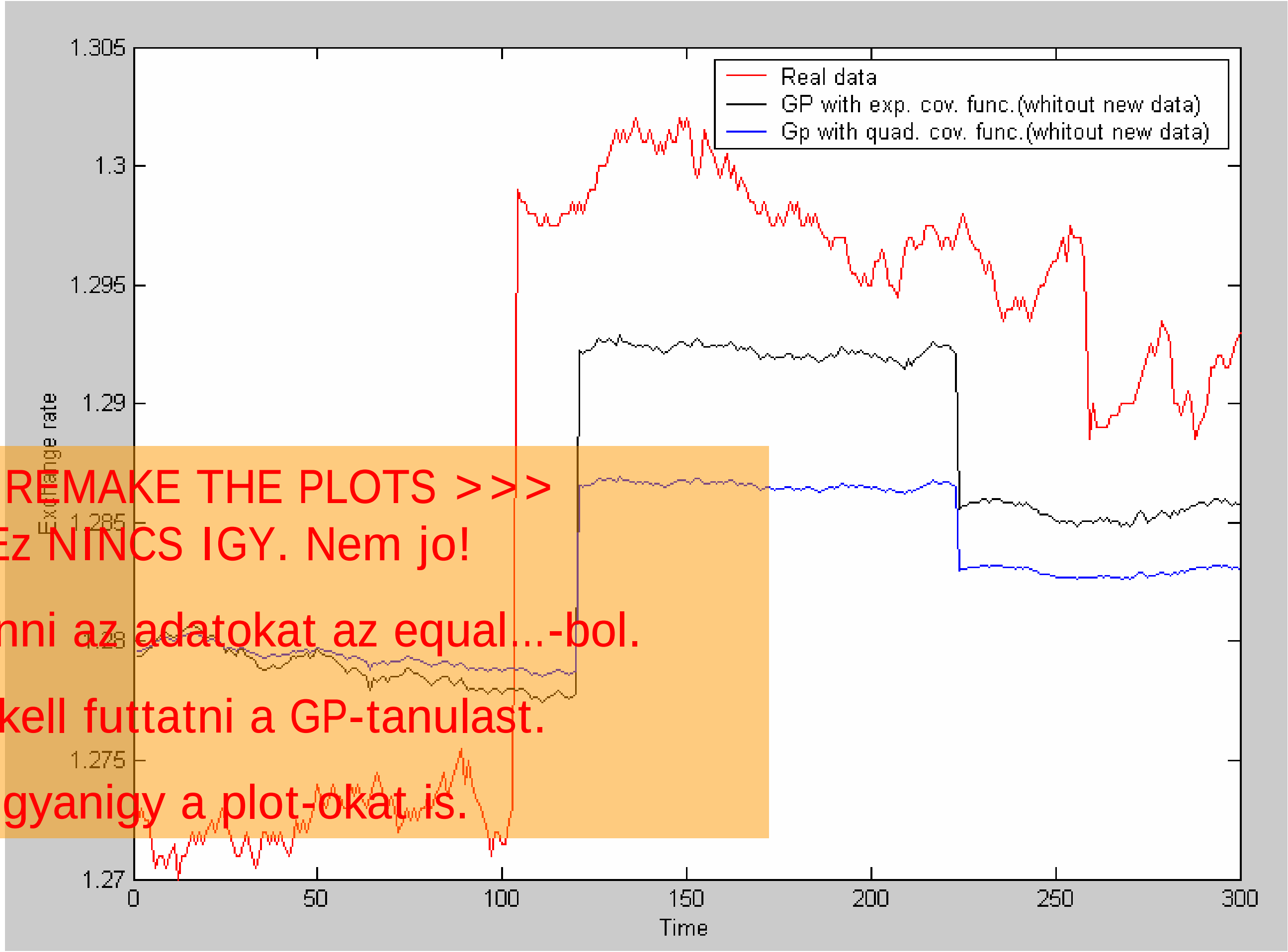
GP with Exponential and Quadratic covariance without using new data



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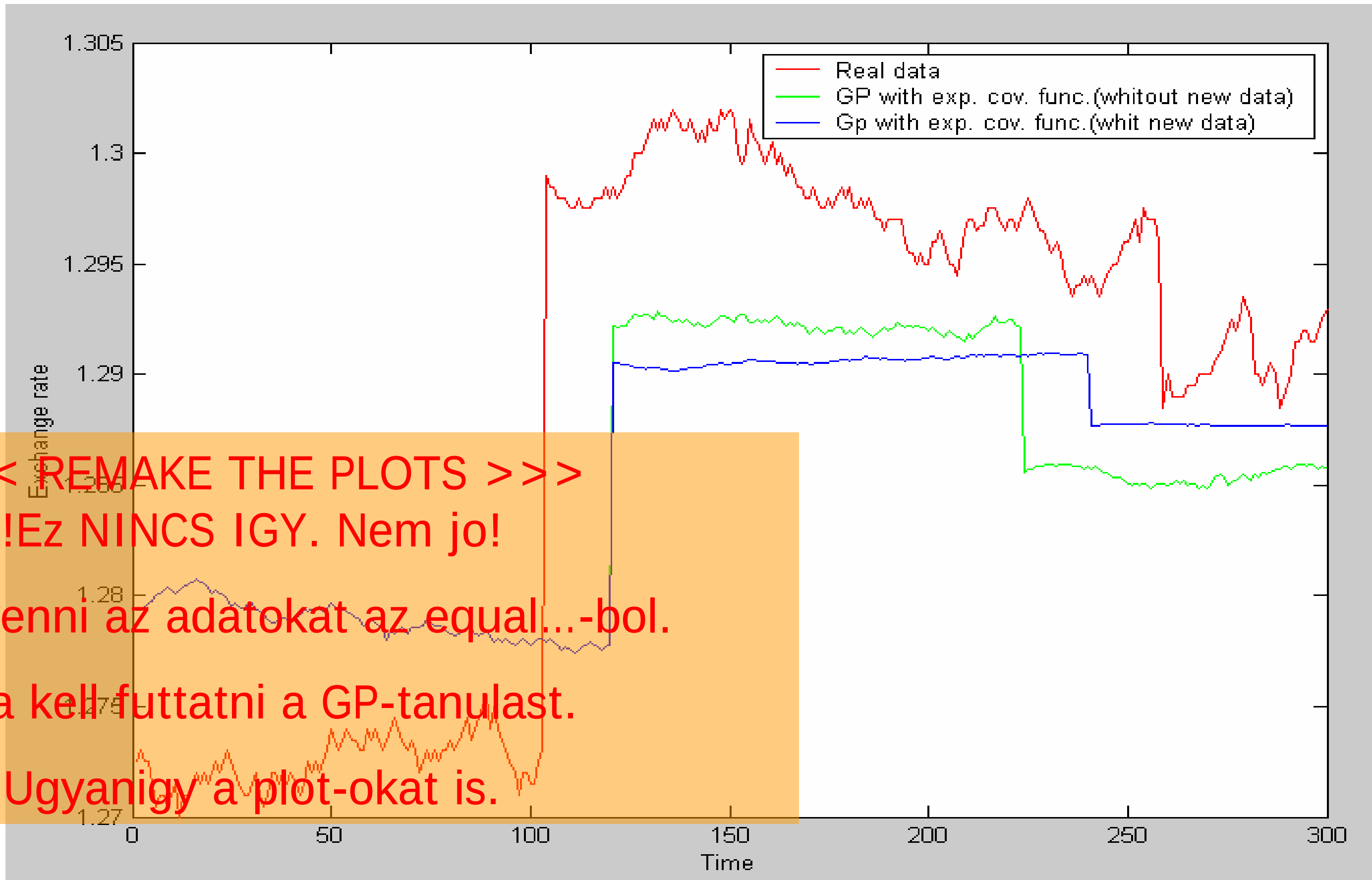
GP with Exponential covariance with and without using new data



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