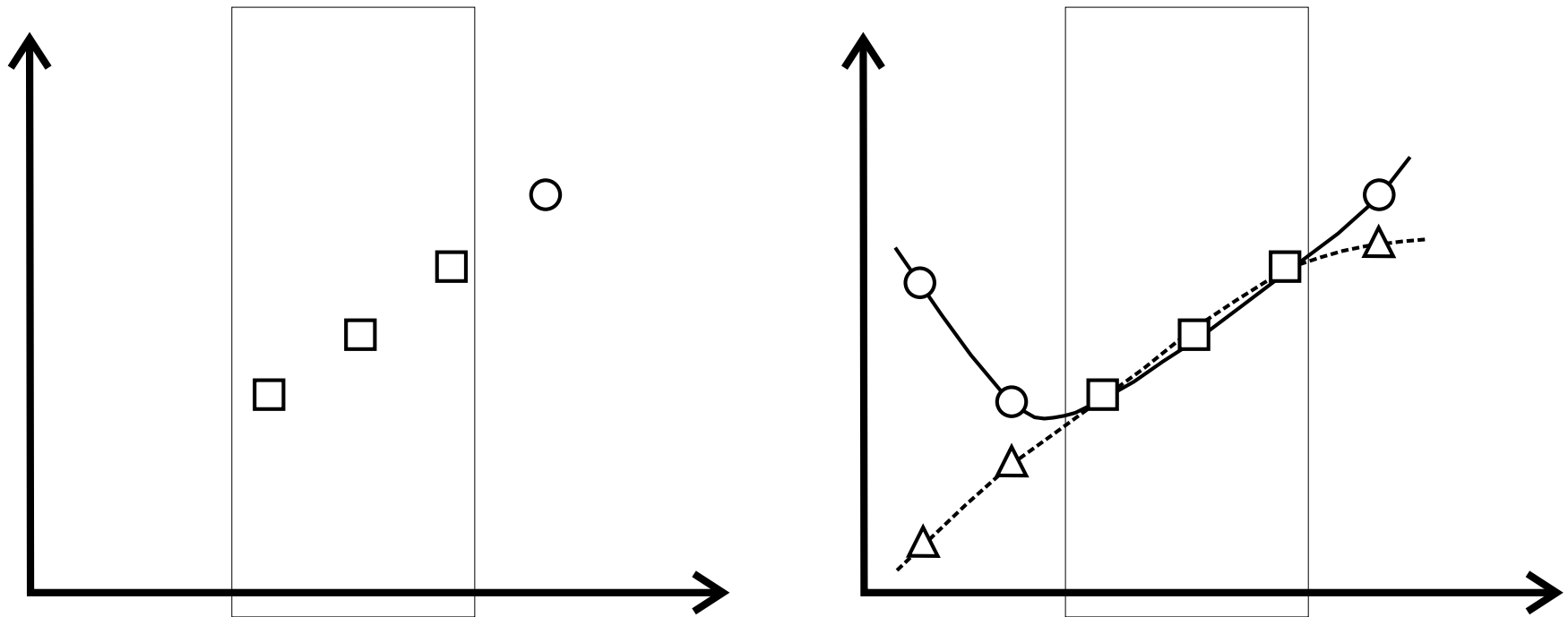


Example: Time series prediction

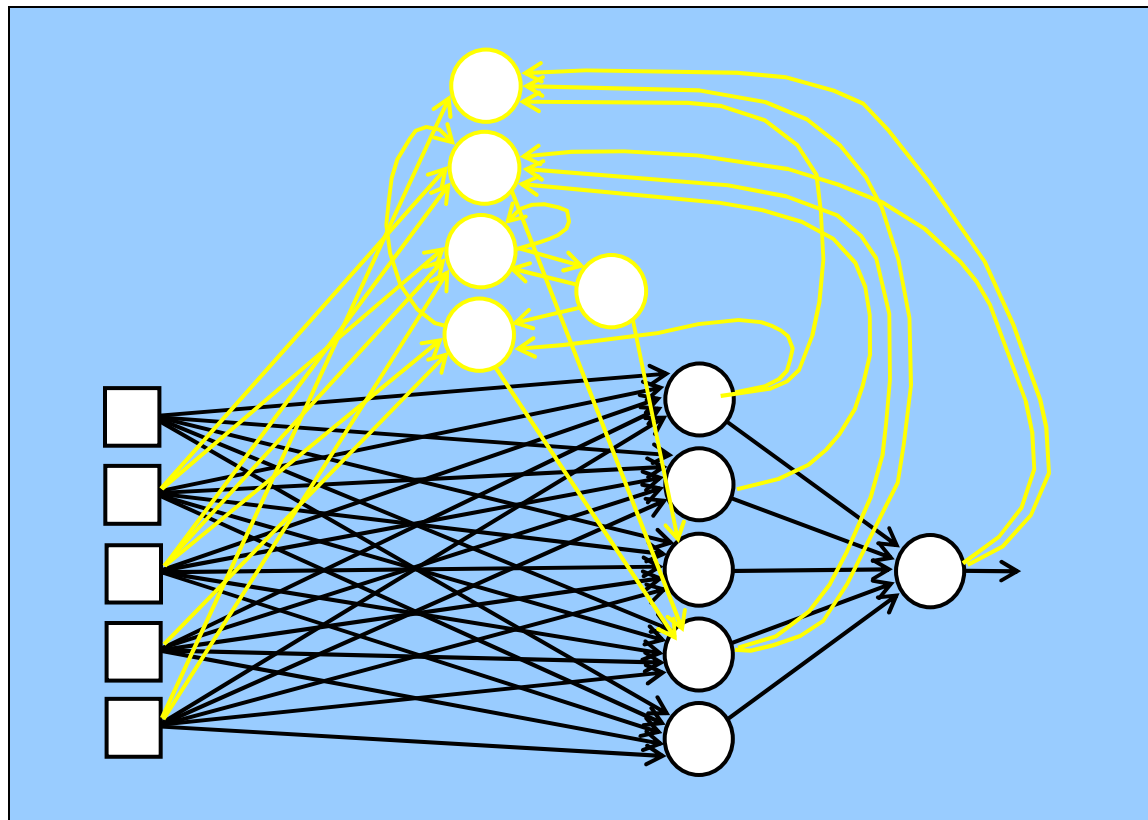
Problem with FFNNs for time series prediction



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Evolve RNNs to generate short-term dynamic memory



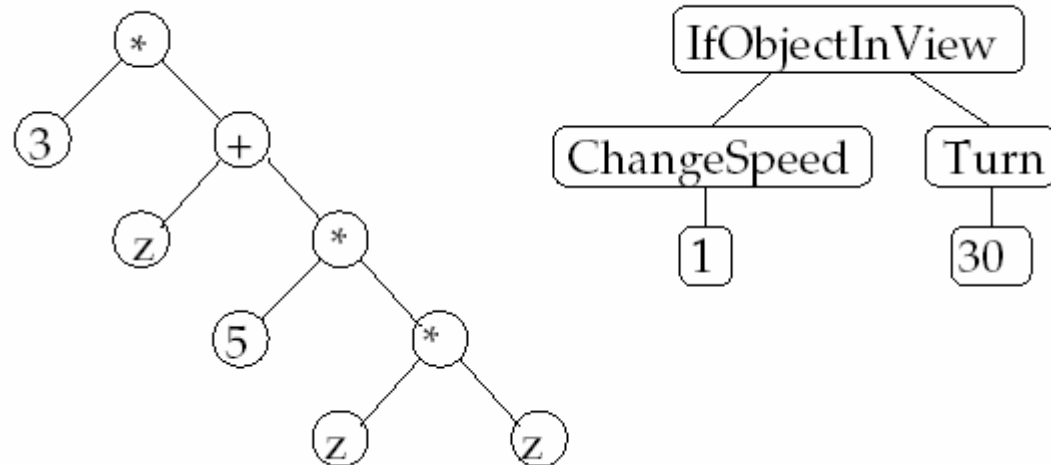
Mattias Wahde, Department of Machine and Vehicle Systems, Chalmers University of Technology, 412 96 Göteborg, Sweden.

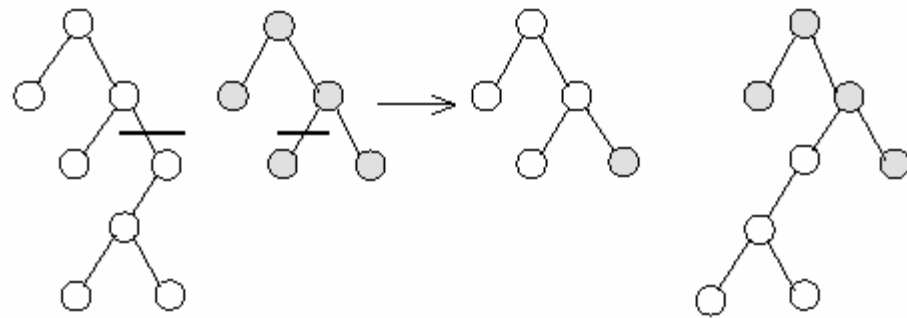
e-mail: mattias.wahde@me.chalmers.se, www: www.me.chalmers.se/~mwahde

Results (best predictors)

Series	FFNN	RNN (from random)	RNN (from FFNN)
USD-JPY	2.20%	1.93%	3.12%
USD-JPY (d)	2.42%	4.39%	4.01%
US unempl.	1.19%	5.50%	4.68%
US unempl. (d.)	2.04%	4.09%	4.12%
DJIA (r.d.)	5.08%	6.01%	6.00%

(All results shown were obtained on the *validation* data. The percentages indicate the improvements relative to a naive predictor, $\hat{x}(t+1) = x(t)$)





Instruction	Description	Instruction	Description
Addition	$r_i := r_j + r_k$	Sine	$r_i := \sin r_j$
Subtraction	$r_i := r_j - r_k$	Cosine	$r_j := \cos r_j$
Multiplication	$r_i := r_j \times r_k$	Square	$r_i := r_j^2$
Division	$r_i := r_j / r_k$	Square root	$r_i := \sqrt{r_j}$
Exponentiation	$r_i := e^{r_j}$	Conditional branch	if $r_i > r_j$
Logarithm	$r_i := \ln r_j$	Conditional branch	if $r_i \leq r_j$

Table 6.1: Examples of typical LGP operators.

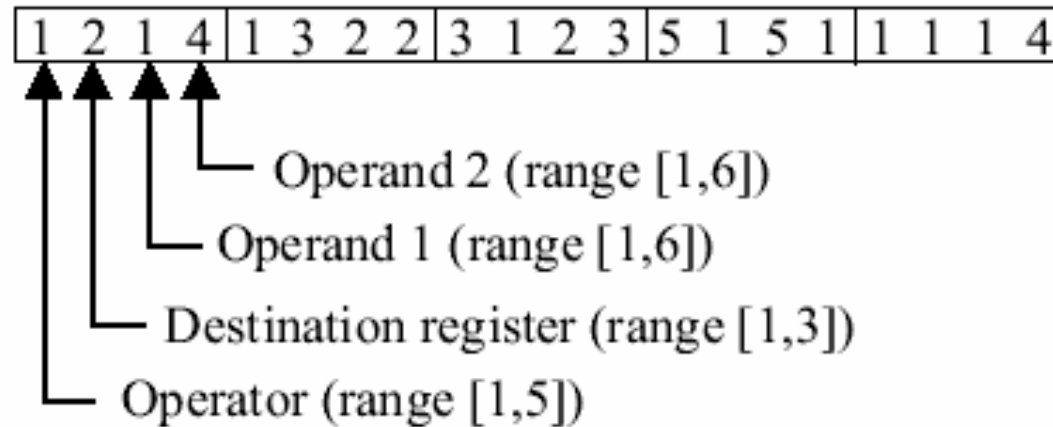


Figure 6.3: An example of an LGP chromosome.

Genes	Instruction	Result
1, 2, 1, 4	$r_1 := r_1 + c_1$	$r_1 = 1, r_2 = 2, r_3 = 0$
1, 3, 2, 2	$r_3 := r_2 + r_2$	$r_1 = 1, r_2 = 2, r_3 = 4$
3, 1, 2, 3	$r_1 := r_2 \times r_3$	$r_1 = 8, r_2 = 2, r_3 = 4$
5, 1, 5, 1	if ($r_1 > c_2$)	$r_1 = 8, r_2 = 2, r_3 = 4$
1, 1, 1, 4	$r_1 := r_1 + c_1$	$r_1 = 9, r_2 = 2, r_3 = 4$