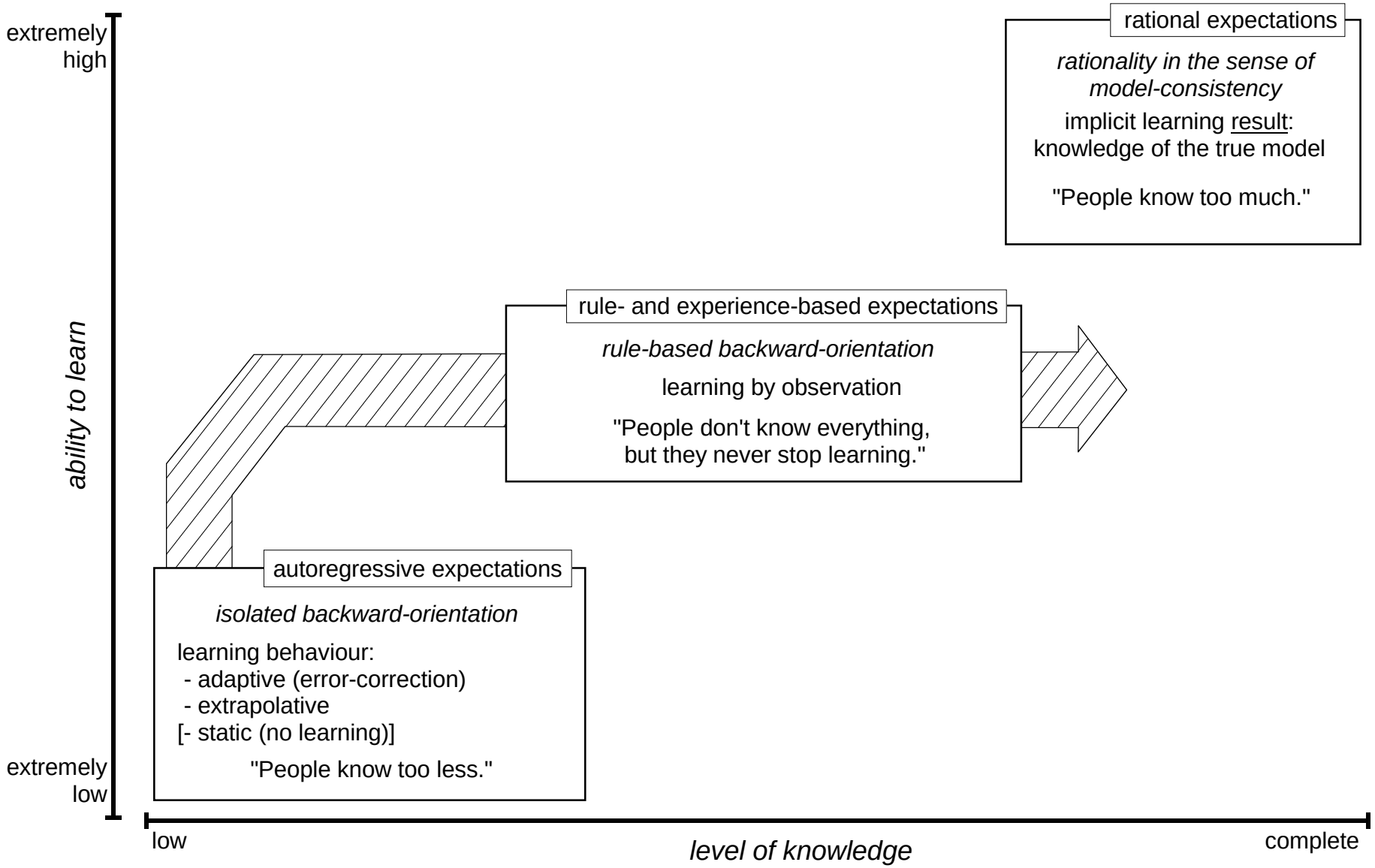
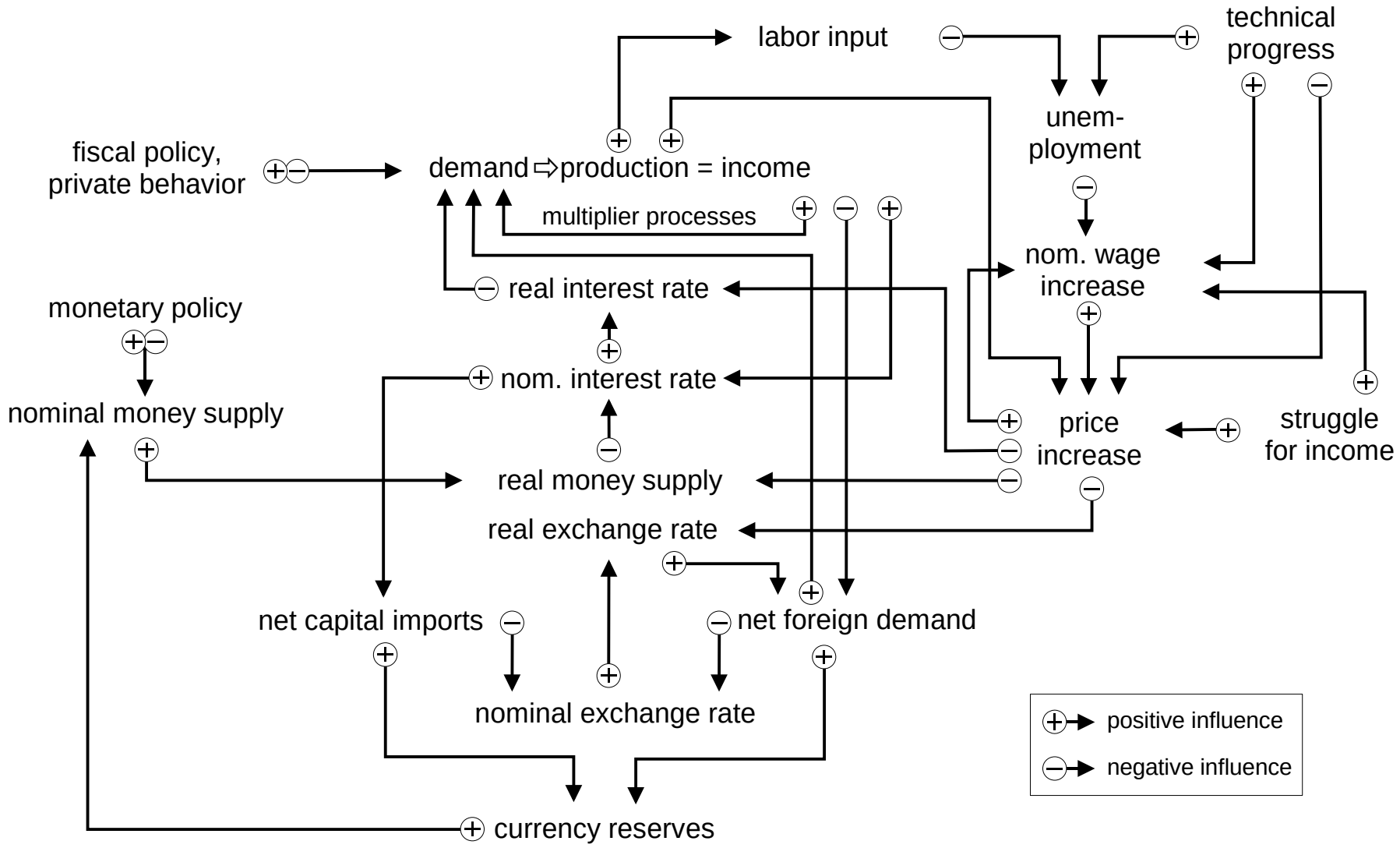
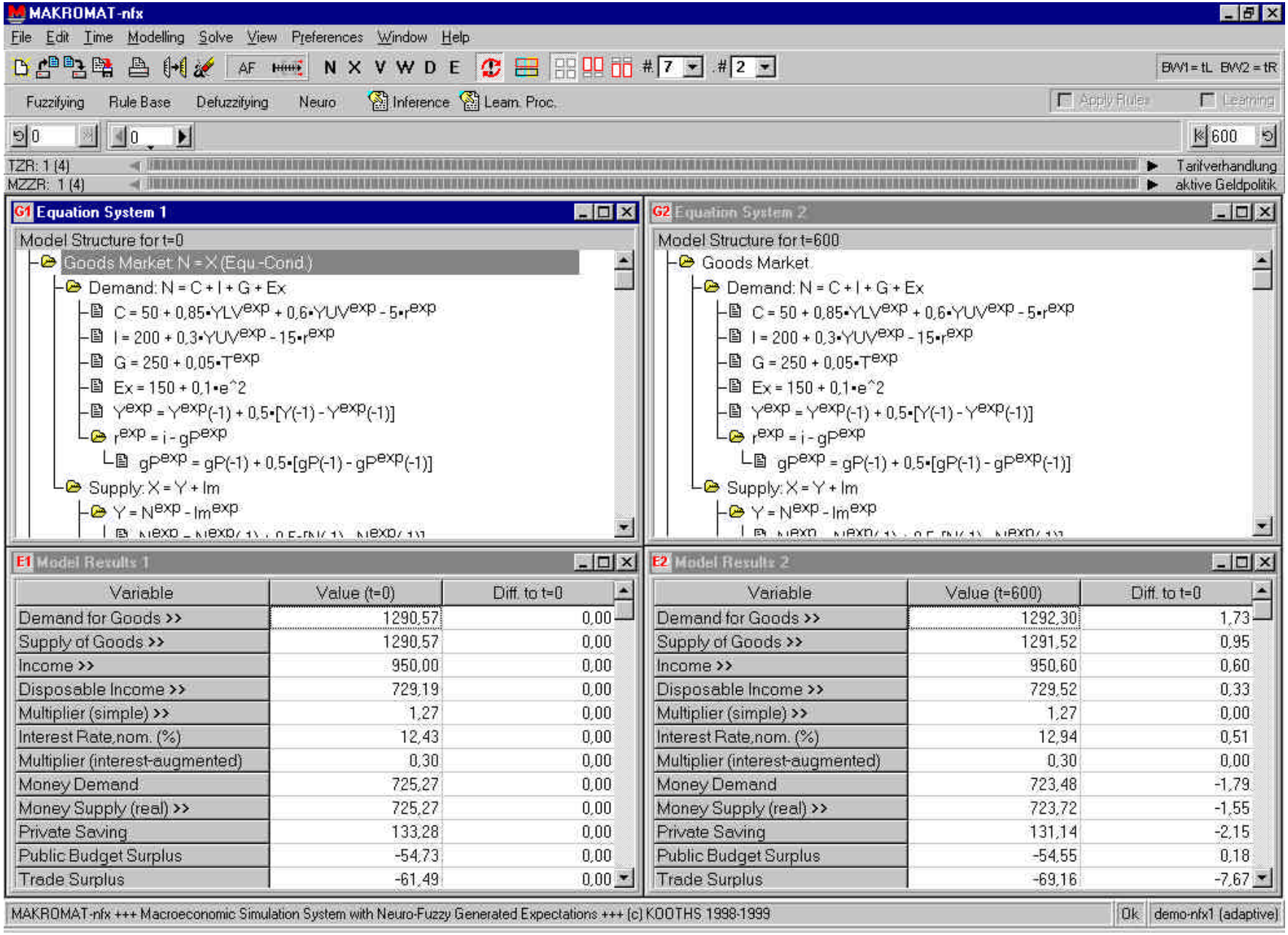
Modelling Rule- and Experience-based Expectations Using Neuro-Fuzzy Systems

Dr. Stefan Kooths
Institute for Industrial Economics
University of Muenster/Germany
kooths@uni-muenster.de

http://makromat.uni-muenster.de?cef99

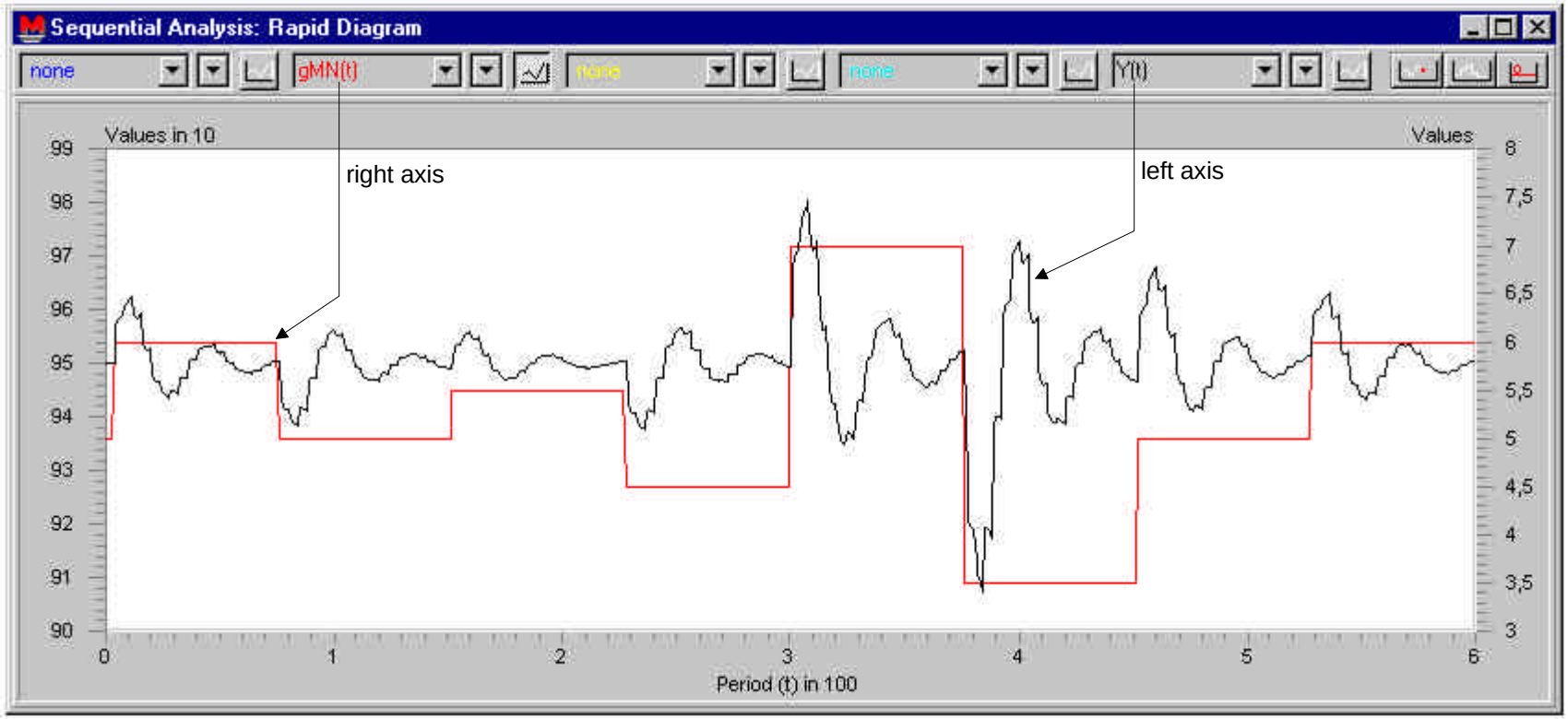

extremely high
ability to learn
extremely low
rational expectations
rationality in the sense of model-consistency
implicit learning result: knowledge of the true model
"People know too much."
rule- and experience-based expectations
rule-based backward-orientation
learning by observation
"People don't know everything, but they never stop learning."
autoregressive expectations
isolated backward-orientation
learning behaviour:
- adaptive (error-correction)
- extrapolative
[- static (no learning)]
"People know too less."
low
level of knowledge
complete


labor input
technical progress
unem-ployment
fiscal policy, private behavior
demand ⇨ production = income
multiplier processes
nom. wage increase
real interest rate
monetary policy
nom. interest rate
nominal money supply
price increase
struggle for income
real money supply
real exchange rate
net capital imports
net foreign demand
nominal exchange rate
currency reserves
positive influence
negative influence

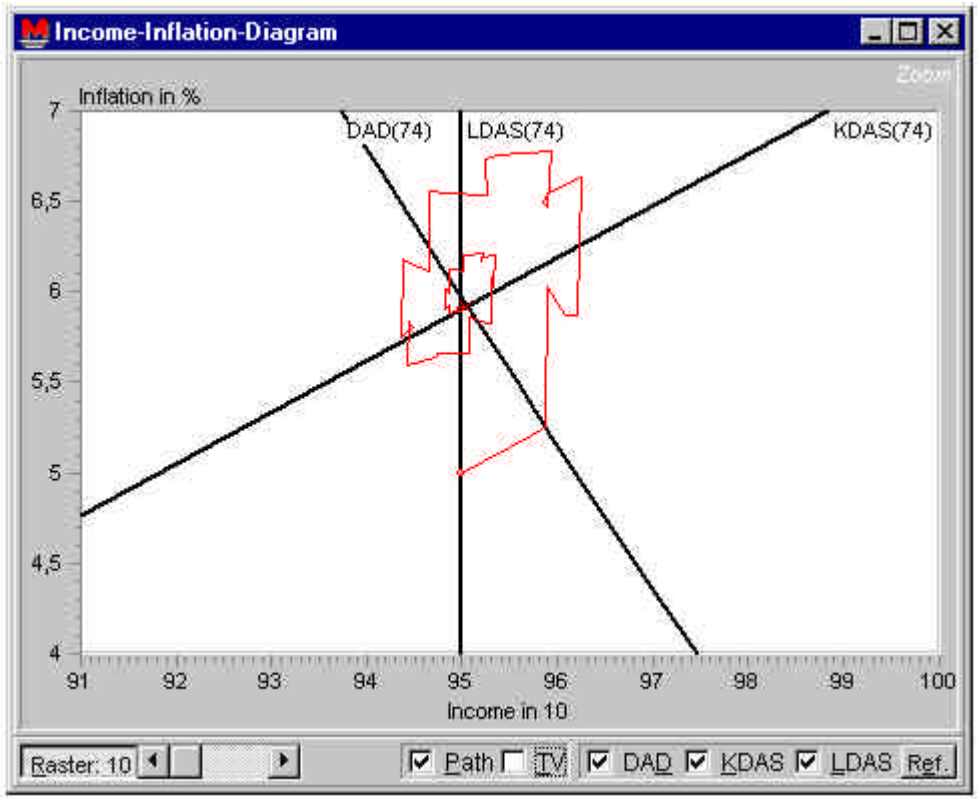


Variable	Value (t=0)	Diff. to t=0
Demand for Goods >>	1290,57	0,00
Supply of Goods >>	1290,57	0,00
Income >>	950,00	0,00
Disposable Income >>	729,19	0,00
Multiplier (simple) >>	1,27	0,00
Interest Rate,nom. (%)	12,43	0,00
Multiplier (interest-augmented)	0,30	0,00
Money Demand	725,27	0,00
Money Supply (real) >>	725,27	0,00
Private Saving	133,28	0,00
Public Budget Surplus	-54,73	0,00
Trade Surplus	-61,49	0,00

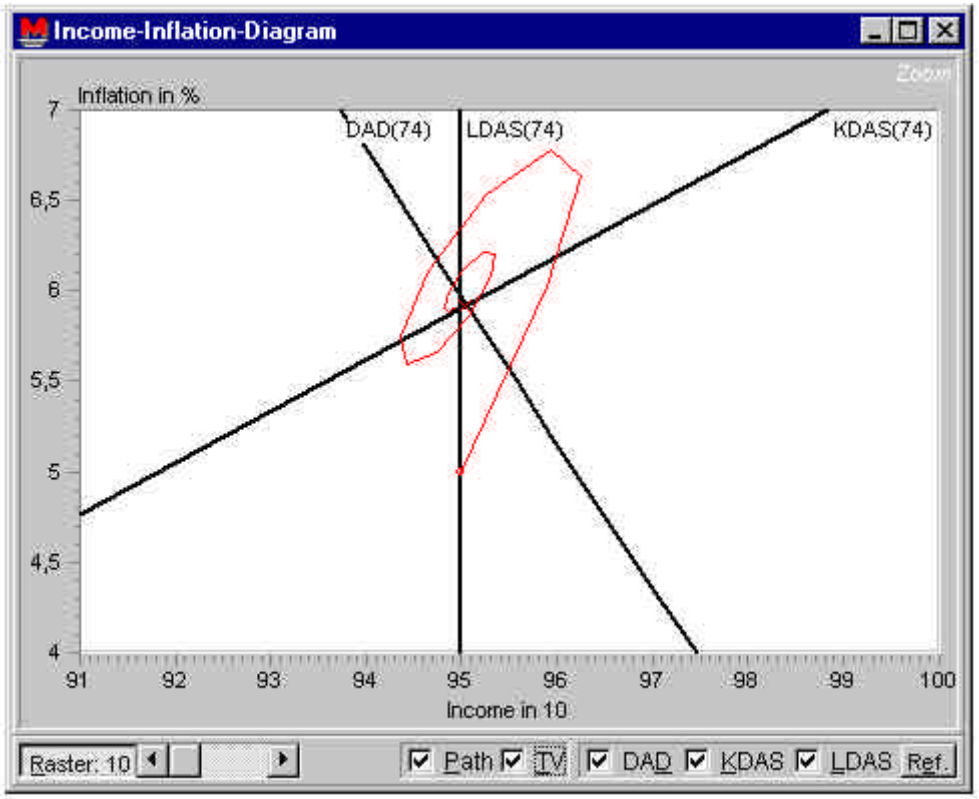
Variable	Value (t=600)	Diff. to t=0
Demand for Goods >>	1292,30	1,73
Supply of Goods >>	1291,52	0,95
Income >>	950,60	0,60
Disposable Income >>	729,52	0,33
Multiplier (simple) >>	1,27	0,00
Interest Rate,nom. (%)	12,94	0,51
Multiplier (interest-augmented)	0,30	0,00
Money Demand	723,48	-1,79
Money Supply (real) >>	723,72	-1,55
Private Saving	131,14	-2,15
Public Budget Surplus	-54,55	0,18
Trade Surplus	-69,16	-7,67

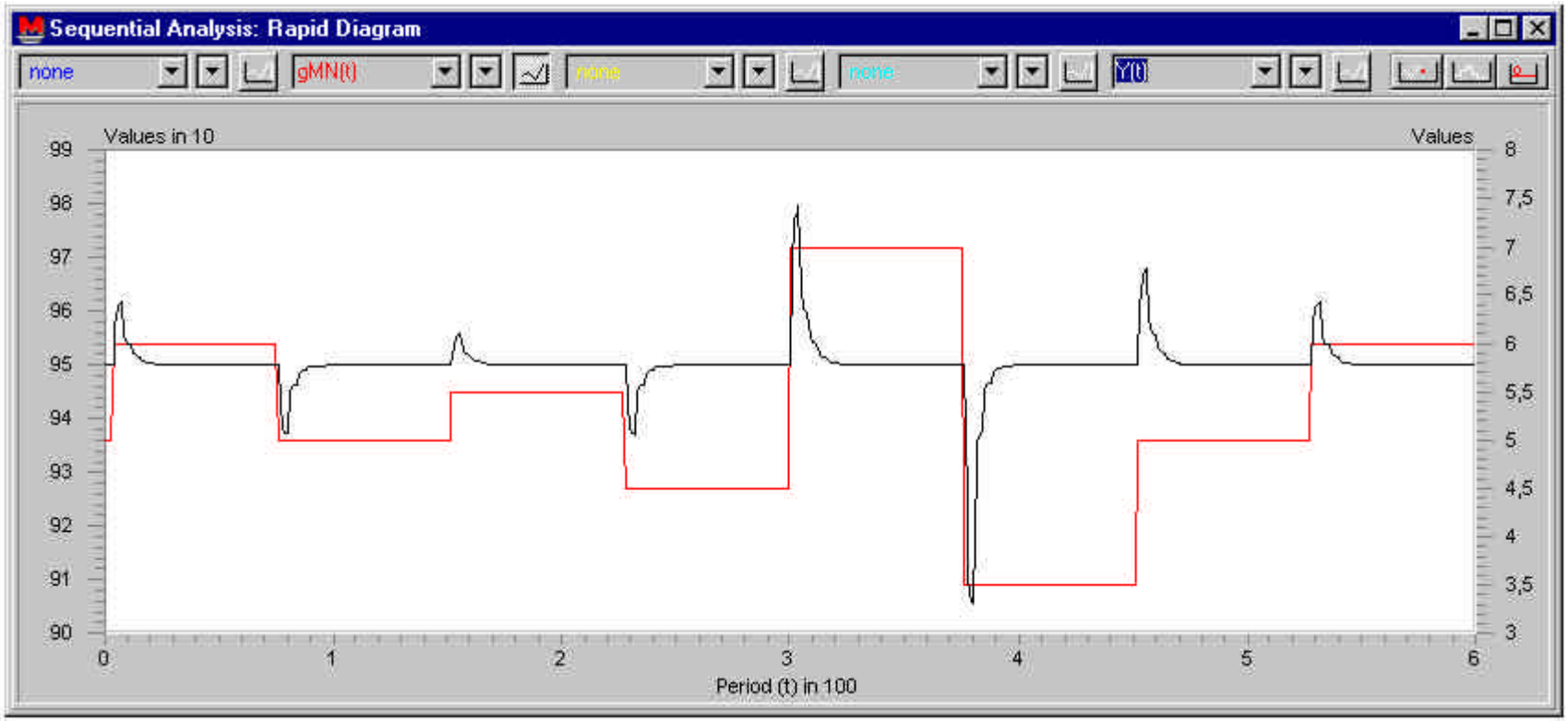

Sequential Analysis: Rapid Diagram
none
gMN(t)
none
none
Y(t)
Values in 10
Values
right axis
left axis
99
98
97
96
95
94
93
92
91
90
8
7,5
7
6,5
6
5,5
5
4,5
4
3,5
3
0
1
2
3
4
5
6
Period (t) in 100

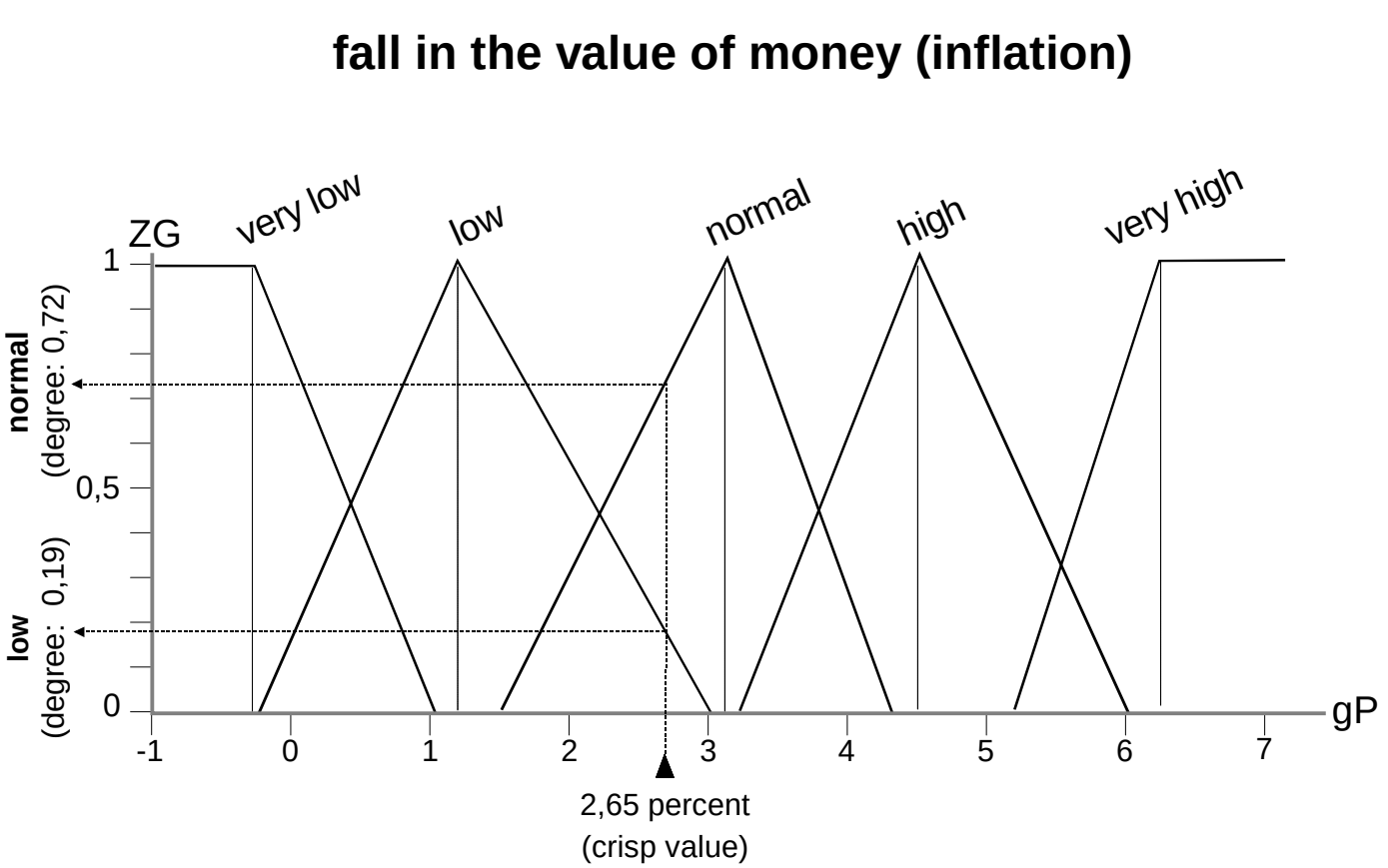
all periods

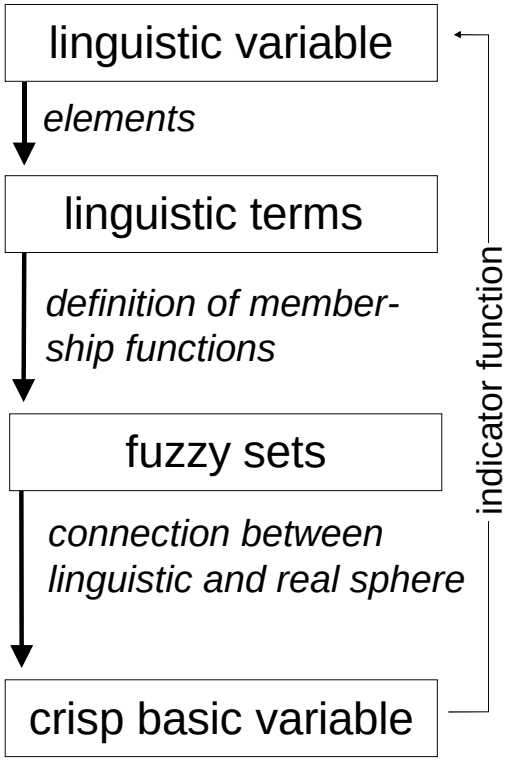


periods with wage bargaining




Sequential Analysis: Rapid Diagram
none
gMN(t)
none
none
Y(t)
Values in 10
Values
99
98
97
96
95
94
93
92
91
90
8
7,5
7
6,5
6
5,5
5
4,5
4
3,5
3
0
1
2
3
4
5
6
Period (t) in 100


fall in the value of money (inflation)
ZG
very low
low
normal
high
very high
1
0,5
0
normal
(degree: 0,72)
low
(degree: 0,19)
-1
0
1
2
3
4
5
6
7
gP
2,65 percent
(crisp value)


linguistic variable
elements
linguistic terms
definition of member-ship functions
fuzzy sets
connection between linguistic and real sphere
crisp basic variable
indicator function

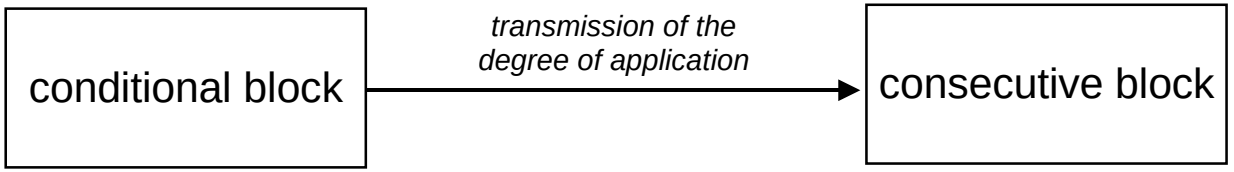
a) stylized form of a fuzzy rule

fuzzy rule

IF condition(s) **THEN** reaction to condition(s)

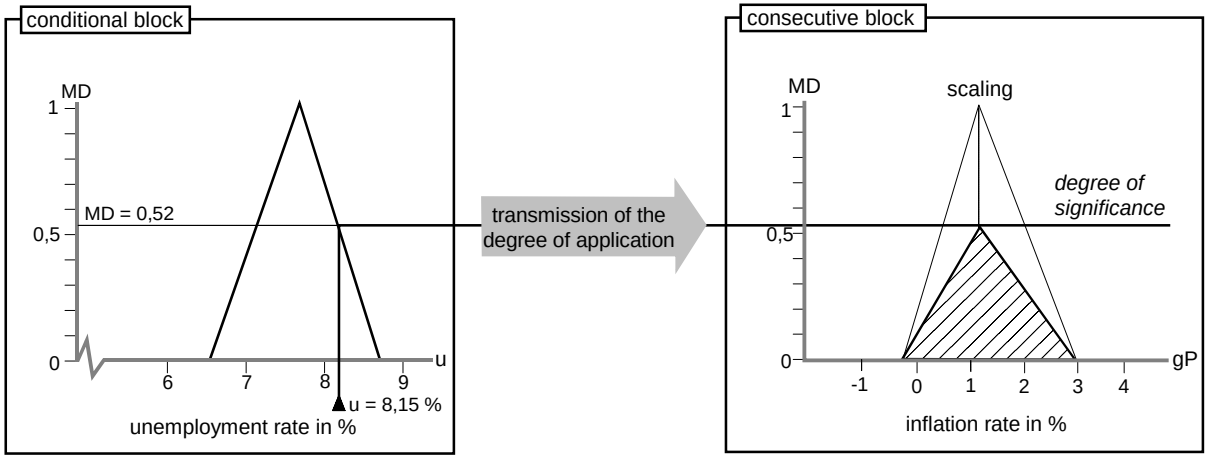
conditional block *consecutive block*

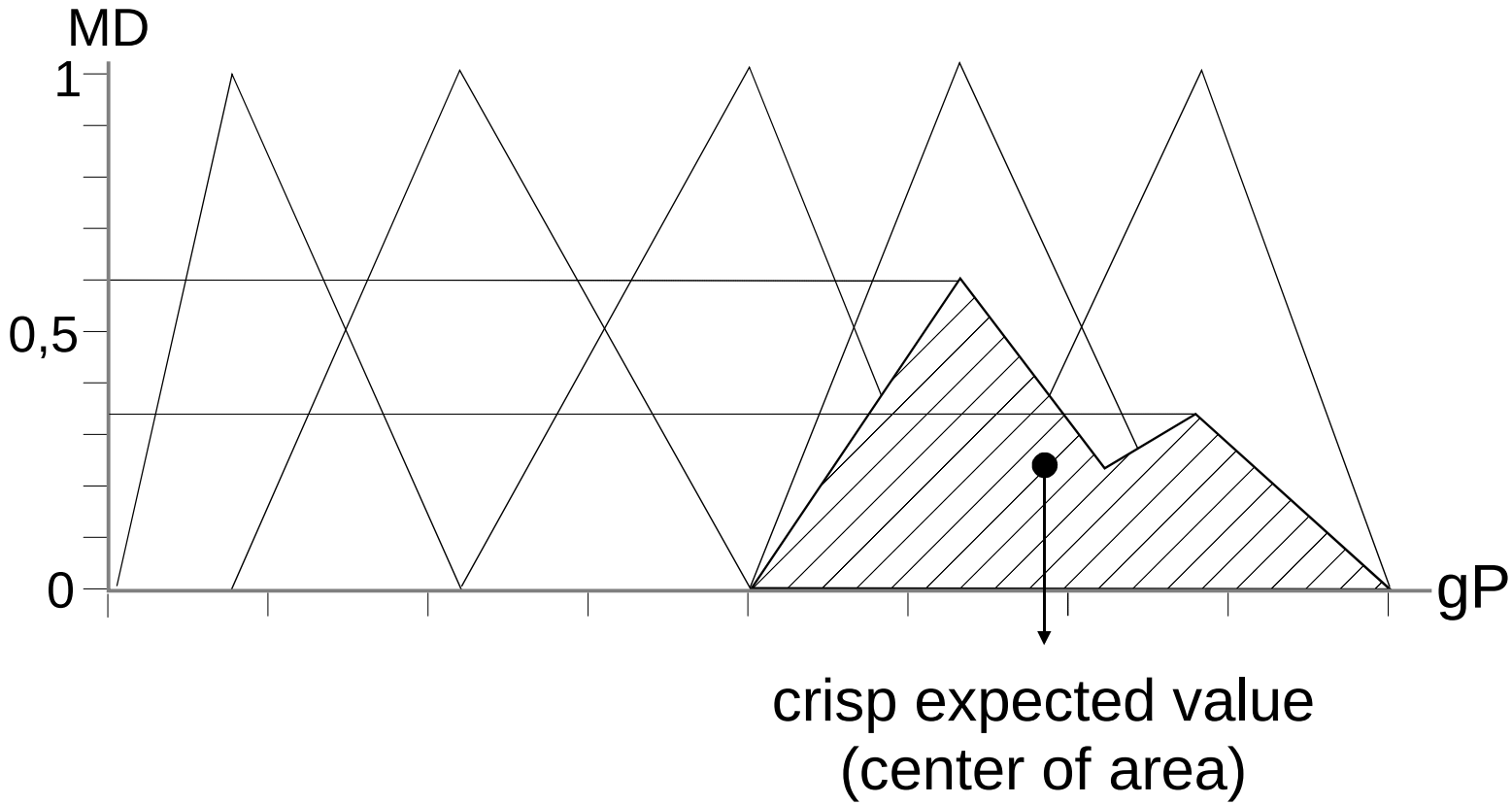
b) inference principle

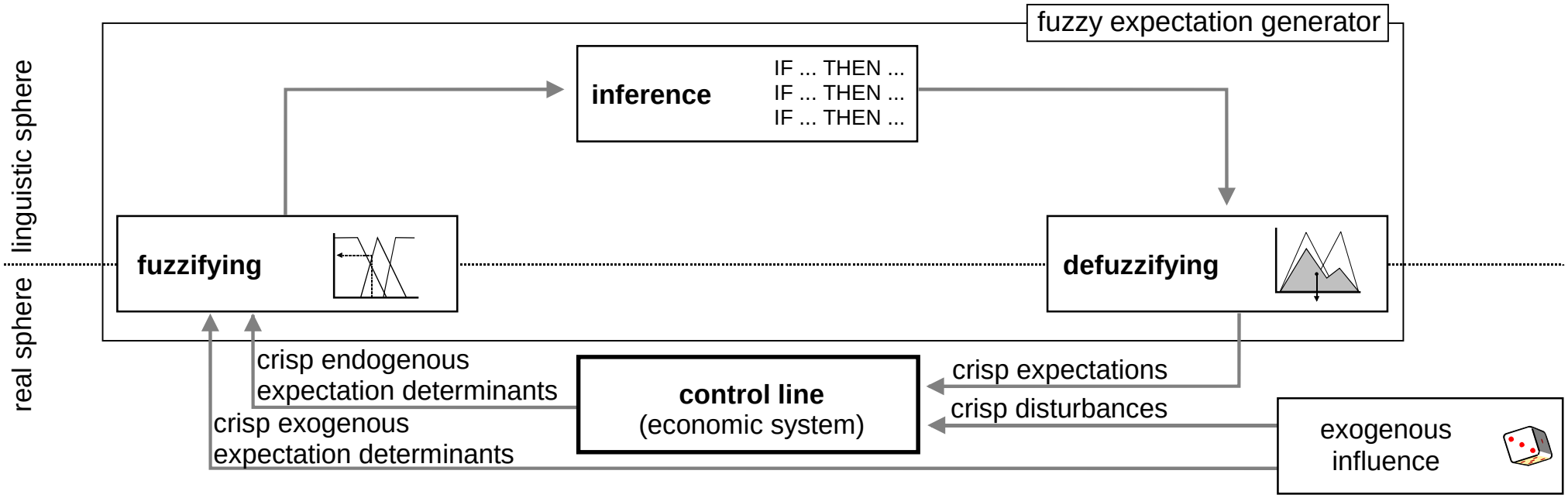


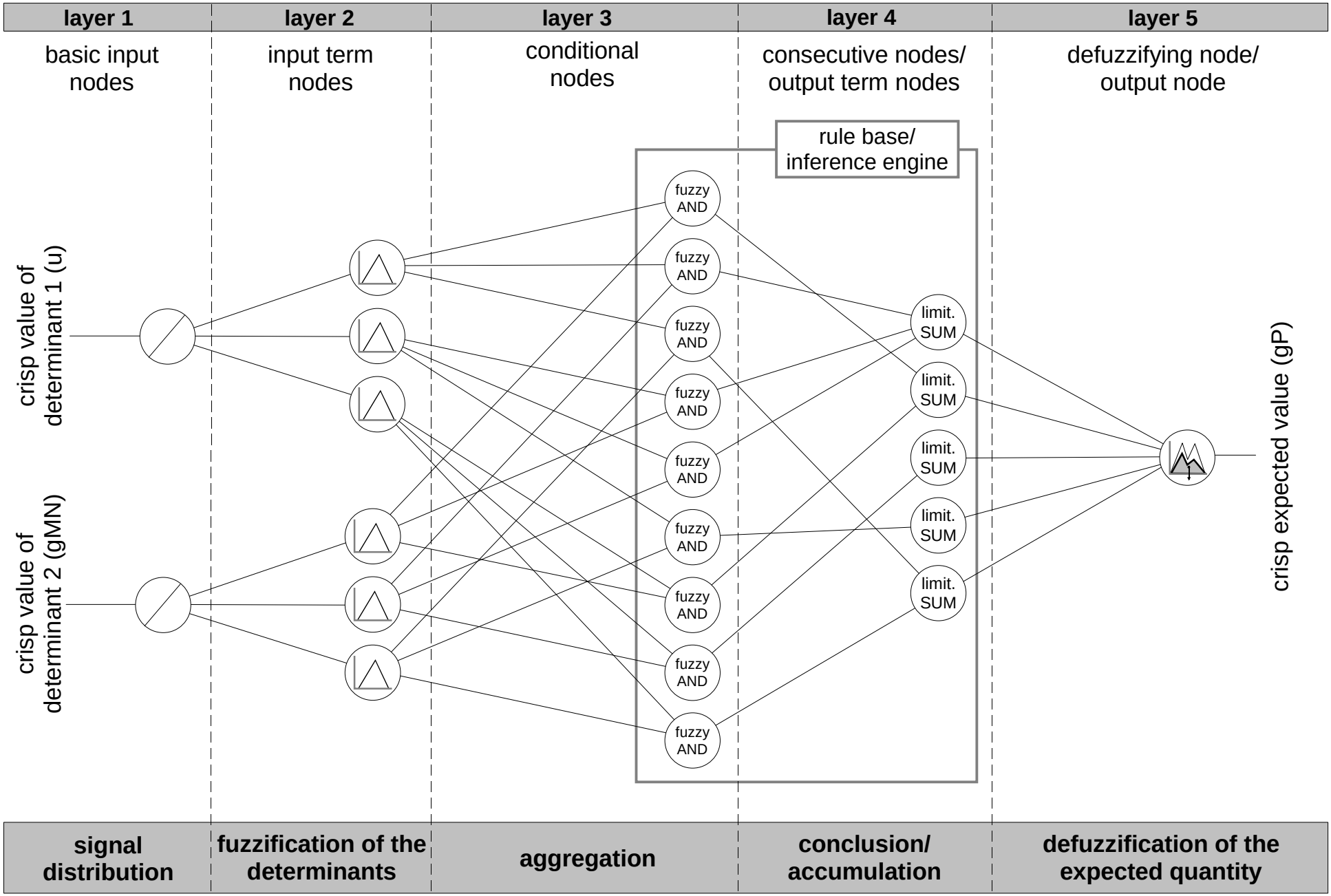
c) example (rule estimation by means of the scaling procedure)

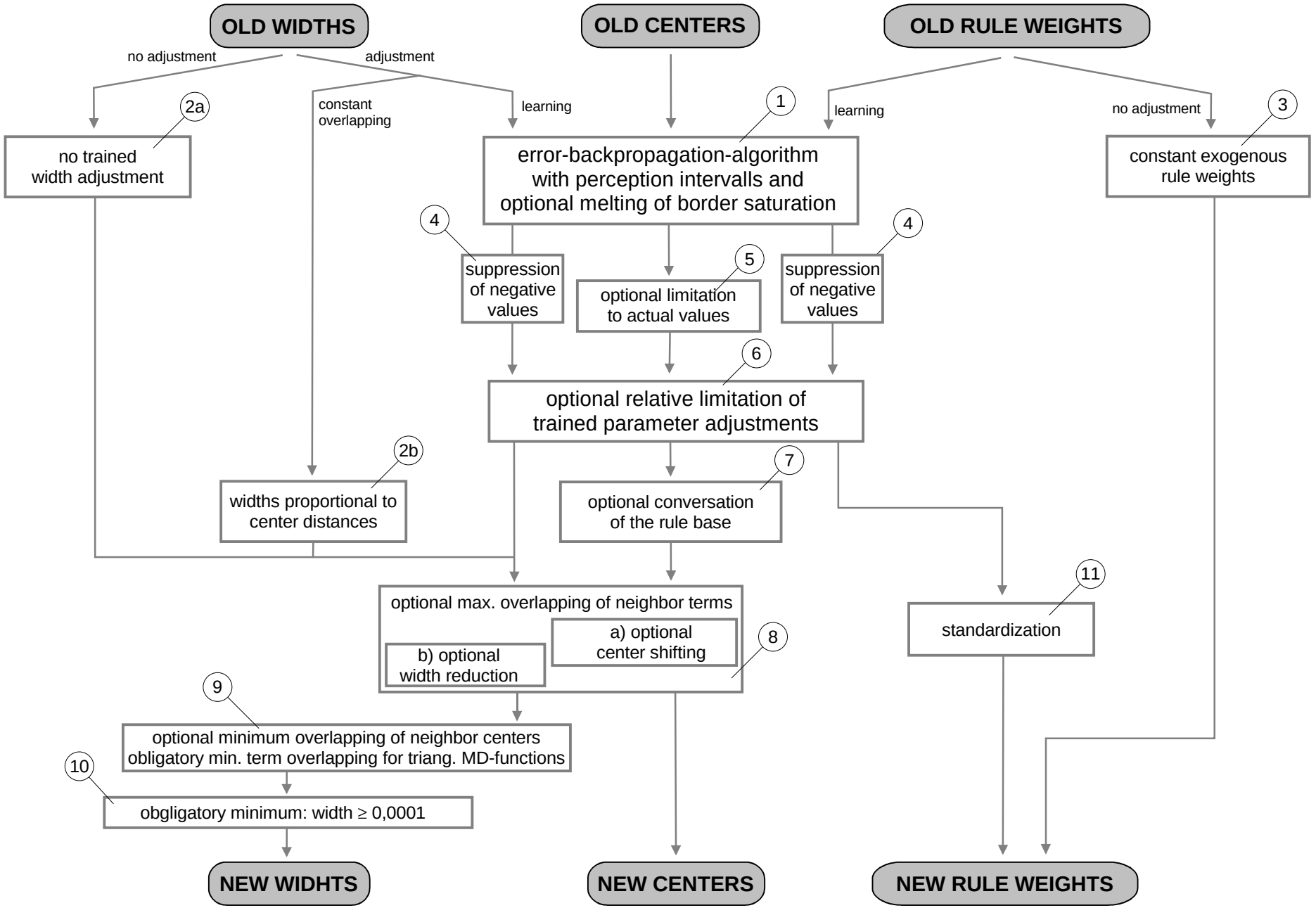
IF (unemployment = "high") **THEN** (inflation = "low")

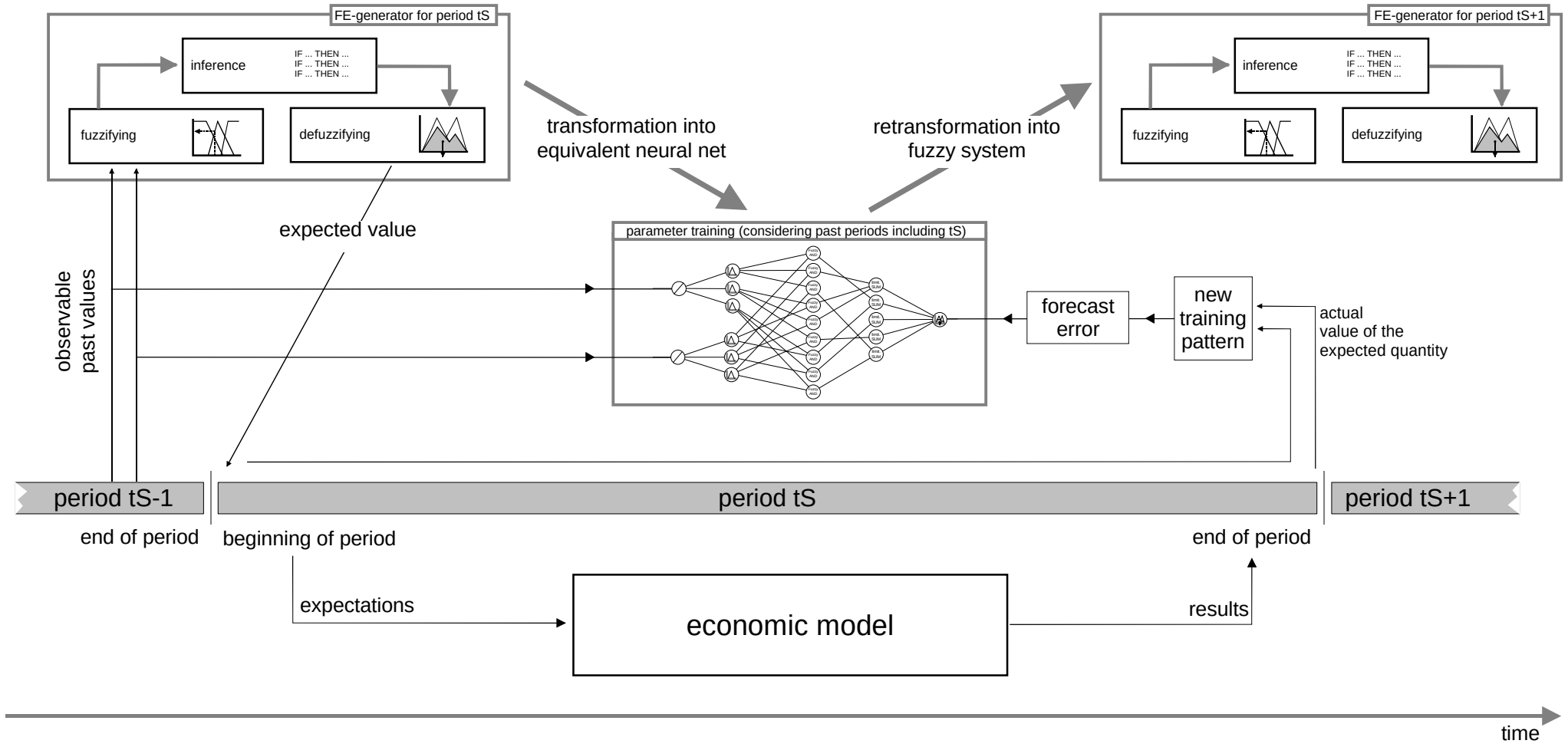


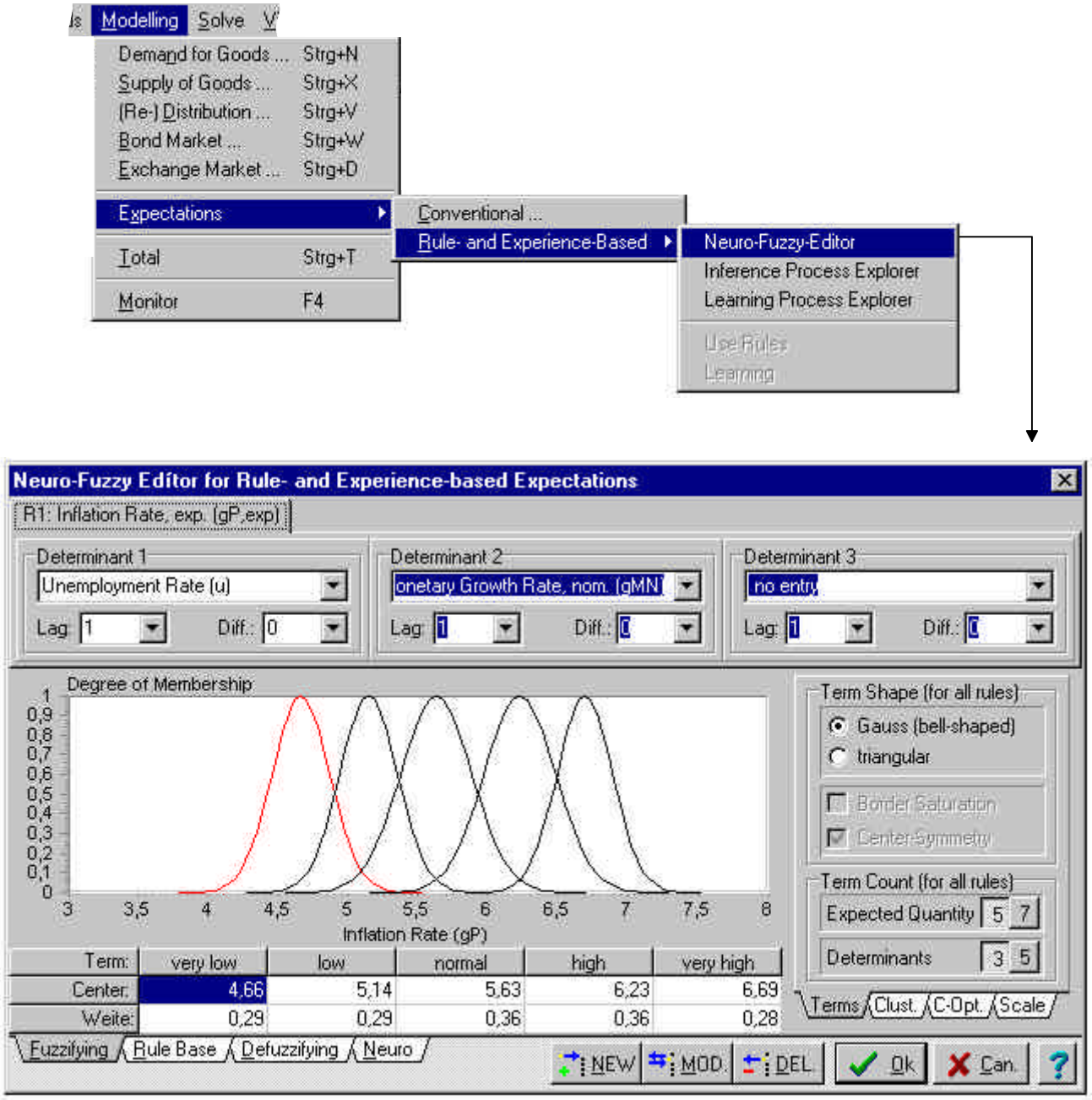

MD
1
0,5
0
gP
crisp expected value
(center of area)


fuzzy expectation generator
linguistic sphere
real sphere
inference
IF ... THEN ...
IF ... THEN ...
IF ... THEN ...
fuzzifying
defuzzifying
crisp endogenous
expectation determinants
crisp exogenous
expectation determinants
control line
(economic system)
crisp expectations
crisp disturbances
exogenous
influence

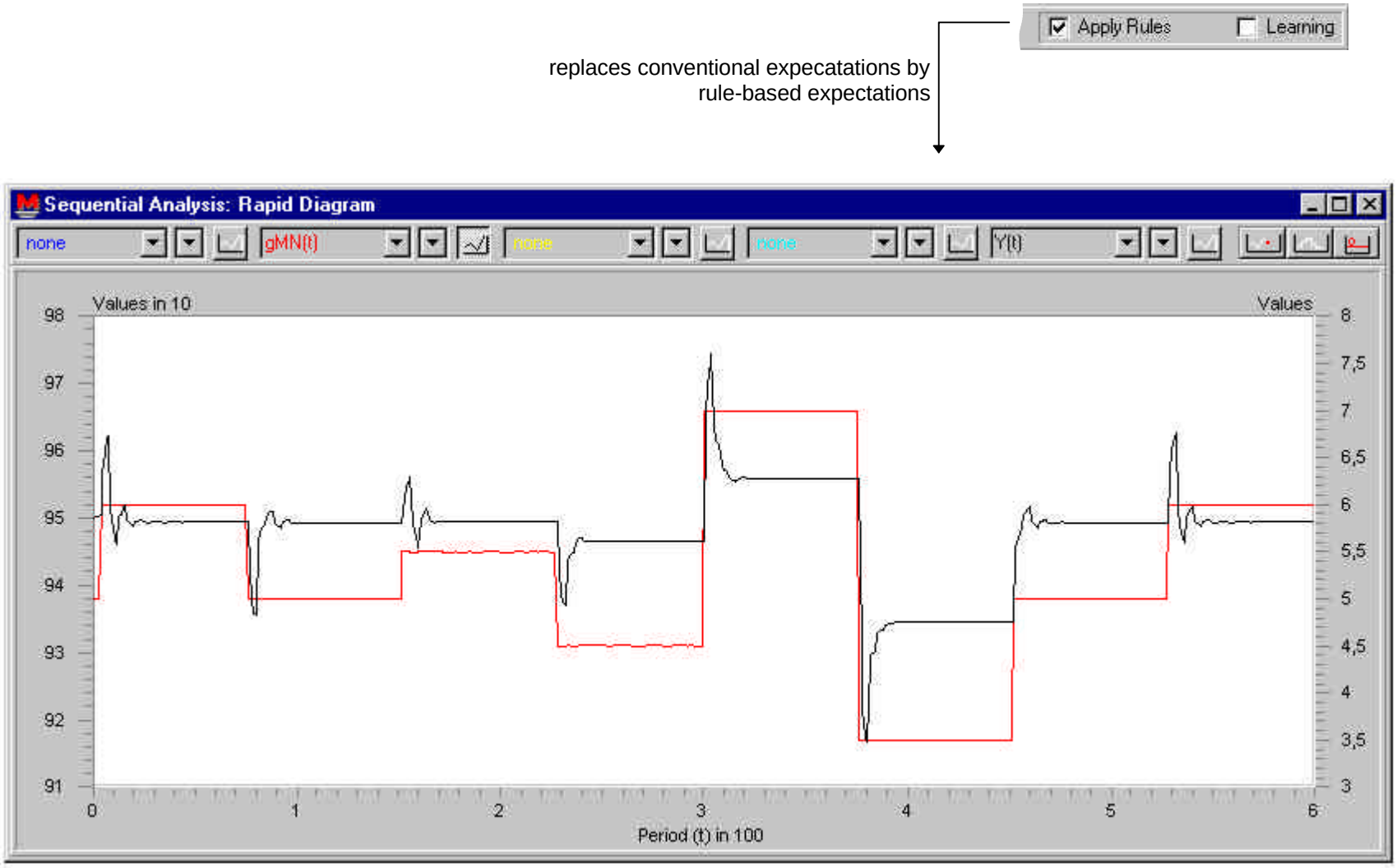

layer 1
layer 2
layer 3
layer 4
layer 5
basic input nodes
input term nodes
conditional nodes
consecutive nodes/ output term nodes
defuzzifying node/ output node
rule base/ inference engine
crisp value of determinant 1 (u)
crisp value of determinant 2 (gMN)
fuzzy AND
limit. SUM
crisp expected value (gP)
signal distribution
fuzzification of the determinants
aggregation
conclusion/ accumulation
defuzzification of the expected quantity


OLD WIDTHS
OLD CENTERS
OLD RULE WEIGHTS
no adjustment
adjustment
constant overlapping
learning
learning
no adjustment
2a
no trained width adjustment
1
error-backpropagation-algorithm with perception intervalls and optional melting of border saturation
3
constant exogenous rule weights
4
suppression of negative values
5
optional limitation to actual values
4
suppression of negative values
6
optional relative limitation of trained parameter adjustments
2b
widths proportional to center distances
7
optional conversation of the rule base
11
standardization
optional max. overlapping of neighbor terms
a) optional center shifting
b) optional width reduction
8
9
optional minimum overlapping of neighbor centers obligatory min. term overlapping for triang. MD-functions
10
obgligatory minimum: width ≥ 0,0001
NEW WIDHTS
NEW CENTERS
NEW RULE WEIGHTS


FE-generator for period tS
inference
IF ... THEN ...
IF ... THEN ...
IF ... THEN ...
fuzzifying
defuzzifying
transformation into
equivalent neural net
retransformation into
fuzzy system
FE-generator for period tS+1
inference
IF ... THEN ...
IF ... THEN ...
IF ... THEN ...
fuzzifying
defuzzifying
expected value
parameter training (considering past periods including tS)
observable
past values
forecast
error
new
training
pattern
actual
value of the
expected quantity
period tS-1
period tS
period tS+1
end of period
beginning of period
end of period
expectations
economic model
results
time


Modelling
Solve
Demand for Goods ... Strg+N
Supply of Goods ... Strg+X
(Re-) Distribution ... Strg+V
Bond Market ... Strg+W
Exchange Market ... Strg+D
Expectations
Total Strg+T
Monitor F4
Conventional ...
Rule- and Experience-Based
Neuro-Fuzzy-Editor
Inference Process Explorer
Learning Process Explorer
Use Rules
Learning
Neuro-Fuzzy Editor for Rule- and Experience-based Expectations
R1: Inflation Rate, exp. (gP,exp)
Determinant 1
Unemployment Rate (u)
Lag: 1
Diff.: 0
Determinant 2
onetary Growth Rate, nom. (gMN
Determinant 3
no entry
Degree of Membership
Inflation Rate (gP)
Term Shape (for all rules)
Gauss (bell-shaped)
triangular
Border Saturation
Center-Symmetry
Term Count (for all rules)
Expected Quantity 5 7
Determinants 3 5
Term: very low low normal high very high
Center: 4,66 5,14 5,63 6,23 6,69
Weite: 0,29 0,29 0,36 0,36 0,28
Terms Clust. C-Opt. Scale
Fuzzifying Rule Base Defuzzifying Neuro
NEW MOD. DEL Ok Can.

replaces conventional expecatations by
rule-based expectations



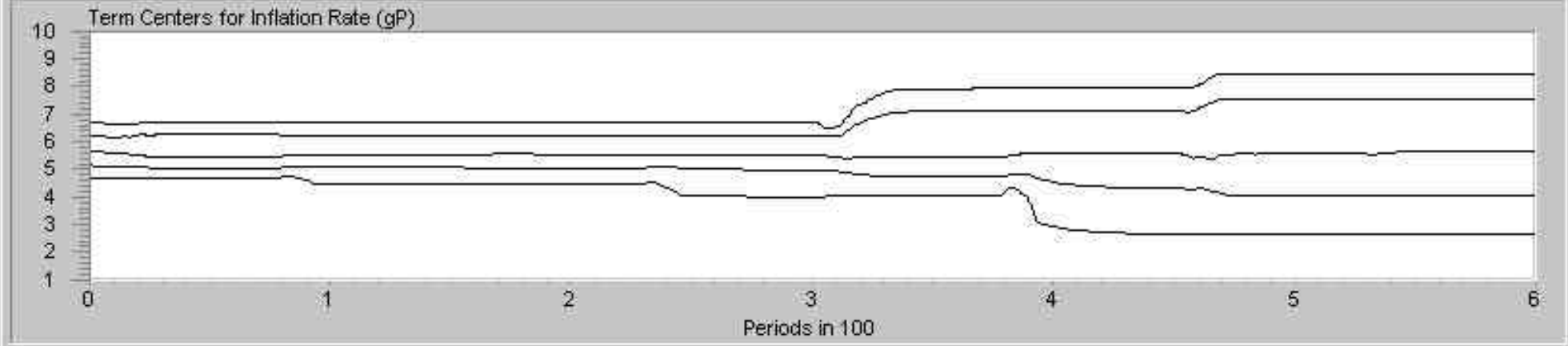

Solve
View
Prefe
All Unsolved Periods F9
Recalc Interval Strg+F9
Recalc All Periods Umsch+F9
1st recal-culation
training rules after each simulated period
Apply Rules
Learning
Sequential Analysis: Rapid Diagram
none
gMN(t)
none
none
Y(t)
Values in 10
Values
98
97
96
95
94
93
92
91
90
8
7,5
7
6,5
6
5,5
5
4,5
4
3,5
3
0
1
2
3
4
5
6
Period (t) in 100

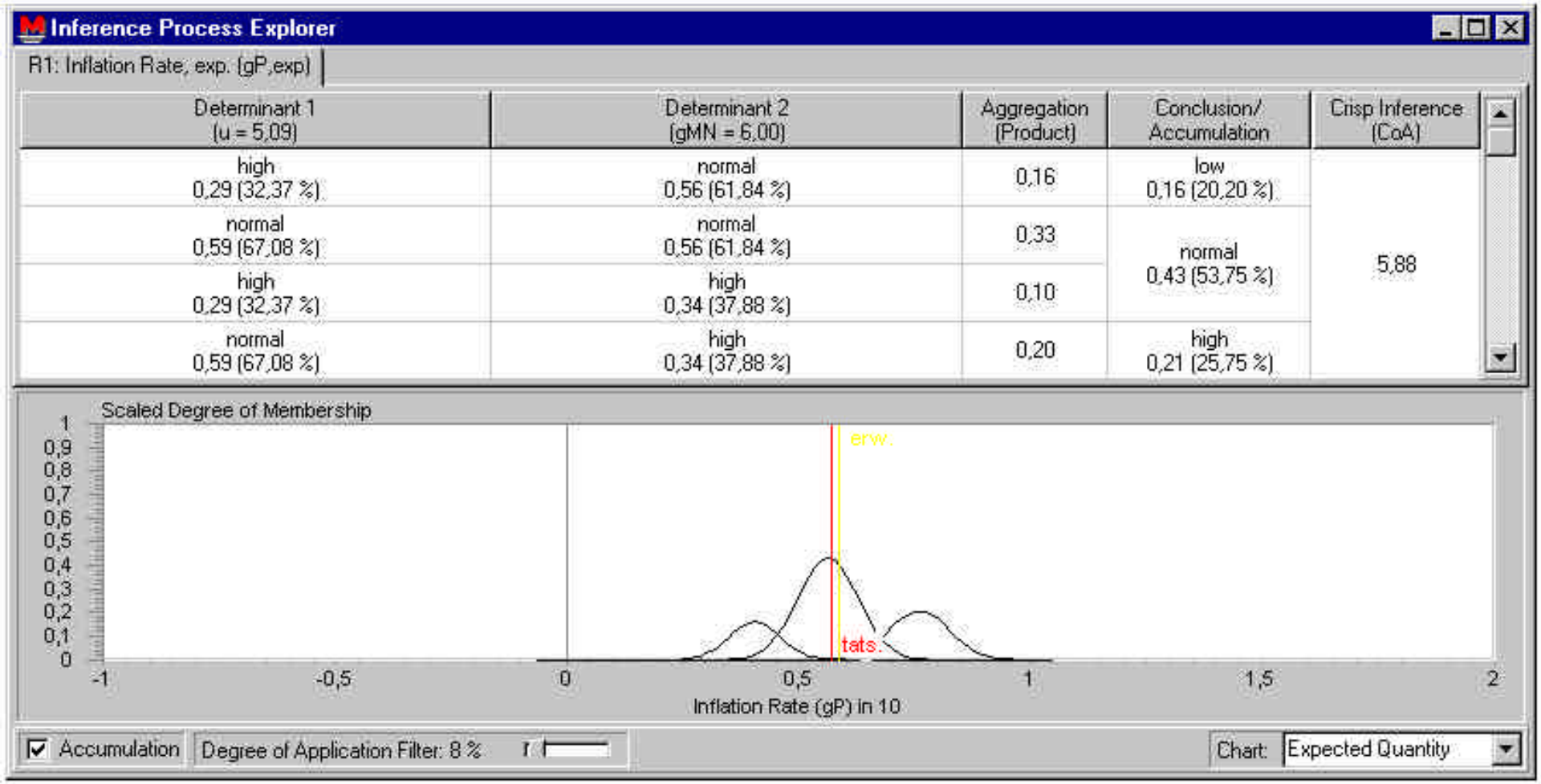

Solve
View
Prefe
All Unsolved Periods F9
Recalc Interval Strg+F9
Recalc All Periods Umsch+F9
2nd recal-culation
training rules after each simulated period
Apply Rules
Learning
Sequential Analysis: Rapid Diagram
none
gMN(t)
none
none
Y(t)
Values in 10
Values
99
98
97
96
95
94
93
92
91
90
8
7,5
7
6,5
6
5,5
5
4,5
4
3,5
3
0
1
2
3
4
5
6
Period (t) in 100

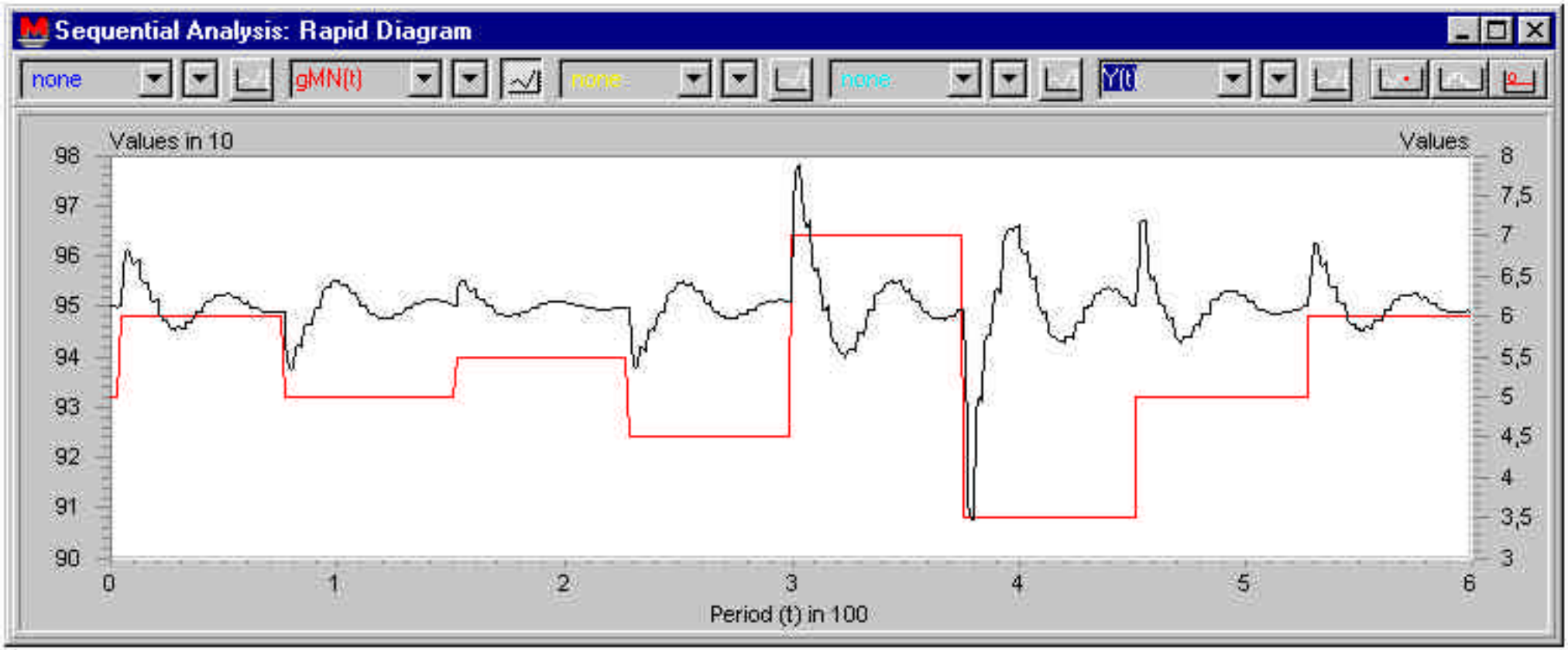
Learning Process Explorer

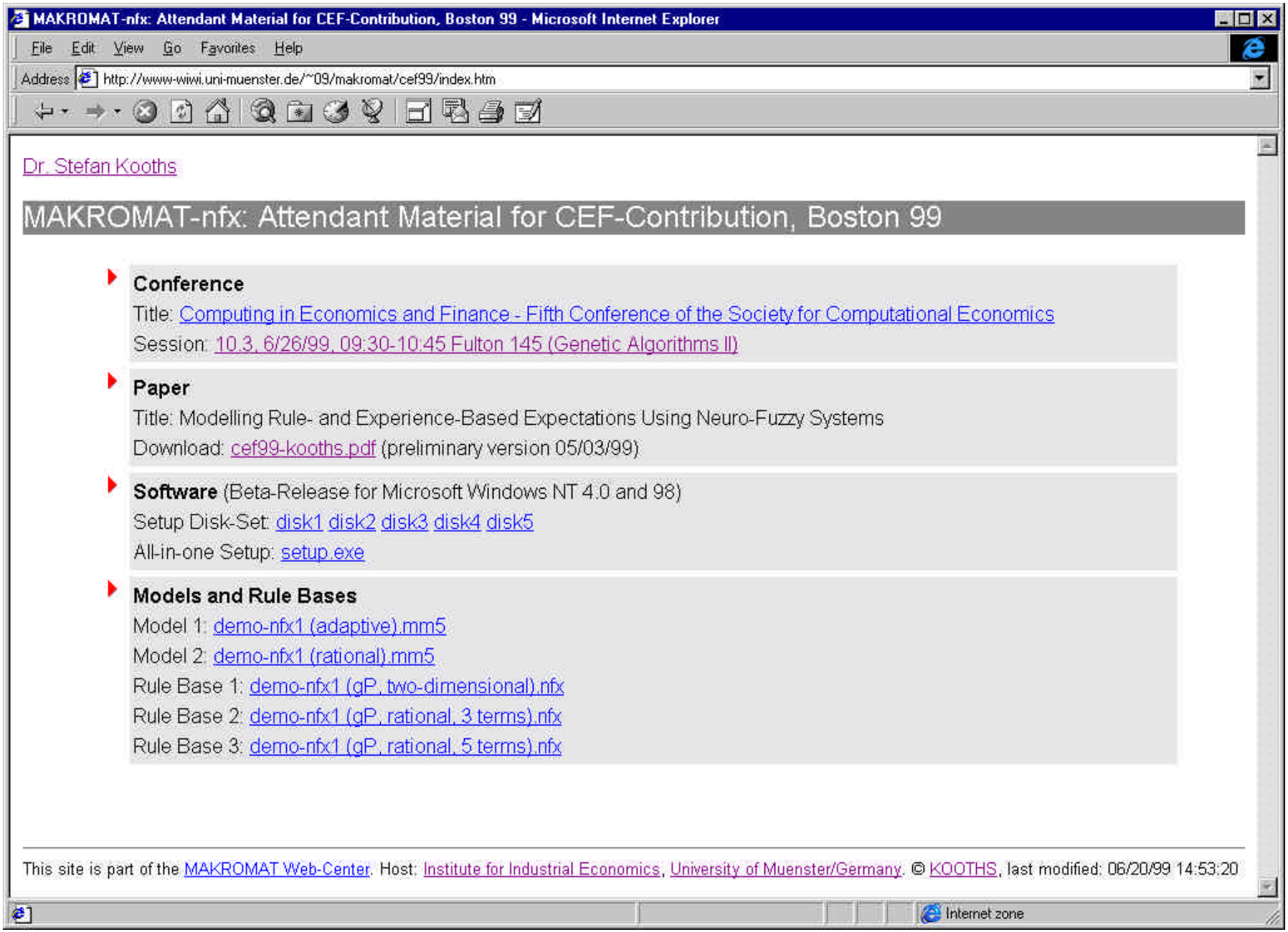
R1: Inflation Rate, exp. (gP,exp)

t	D1-Z1	D1-Wl1	D1-Wr1	D1-Z2	D1-Wl2	D1-Wr2	D1-Z3	D1-Wl3	D1-Wr3	D2-Z1	D2-Wl1	D2-W
1	4,22	0,38	0,38	4,86	0,38	0,40	5,52	0,40	0,40	5,00	0,30	0
2	4,22	0,38	0,37	4,85	0,38	0,40	5,50	0,41	0,40	5,00	0,30	0
3	4,22	0,38	0,37	4,85	0,38	0,39	5,50	0,42	0,40	5,00	0,30	0
4	4,22	0,38	0,37	4,85	0,38	0,39	5,49	0,43	0,40	5,00	0,30	0
5	4,22	0,38	0,37	4,85	0,38	0,39	5,49	0,43	0,40	5,00	0,30	0
6	4,22	0,38	0,37	4,85	0,38	0,39	5,48	0,44	0,40	5,00	0,30	0
7	4,21	0,38	0,36	4,83	0,40	0,39	5,47	0,45	0,40	5,00	0,30	0




Inference Process Explorer
R1: Inflation Rate, exp. (gP,exp)
Determinant 1 (u = 5,09)
Determinant 2 (gMN = 6,00)
Aggregation (Product)
Conclusion/ Accumulation
Crisp Inference (CoA)
high 0,29 (32,37 %)
normal 0,56 (61,84 %)
0,16
low 0,16 (20,20 %)
normal 0,59 (67,08 %)
normal 0,56 (61,84 %)
0,33
normal 0,43 (53,75 %)
5,88
high 0,29 (32,37 %)
high 0,34 (37,88 %)
0,10
normal 0,59 (67,08 %)
high 0,34 (37,88 %)
0,20
high 0,21 (25,75 %)
Scaled Degree of Membership
1
0,9
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
erw.
tats.
-1
-0,5
0
0,5
1
1,5
2
Inflation Rate (gP) in 10
Accumulation
Degree of Application Filter: 8 %
Chart:
Expected Quantity


Sequential Analysis: Rapid Diagram
none
gMN(t)
none
none
Y(t)
Values in 10
Values
98
97
96
95
94
93
92
91
90
8
7,5
7
6,5
6
5,5
5
4,5
4
3,5
3
0
1
2
3
4
5
6
Period (t) in 100


MAKROMAT-nfx: Attendant Material for CEF-Contribution, Boston 99 - Microsoft Internet Explorer
File Edit View Go Favorites Help
Address http://www-wiwi.uni-muenster.de/~09/makromat/cef99/index.htm
Dr. Stefan Kooths
MAKROMAT-nfx: Attendant Material for CEF-Contribution, Boston 99
Conference
Title: Computing in Economics and Finance - Fifth Conference of the Society for Computational Economics
Session: 10.3, 6/26/99, 09:30-10:45 Fulton 145 (Genetic Algorithms II)
Paper
Title: Modelling Rule- and Experience-Based Expectations Using Neuro-Fuzzy Systems
Download: cef99-kooths.pdf (preliminary version 05/03/99)
Software (Beta-Release for Microsoft Windows NT 4.0 and 98)
Setup Disk-Set: disk1 disk2 disk3 disk4 disk5
All-in-one Setup: setup.exe
Models and Rule Bases
Model 1: demo-nfx1 (adaptive).mm5
Model 2: demo-nfx1 (rational).mm5
Rule Base 1: demo-nfx1 (gP, two-dimensional).nfx
Rule Base 2: demo-nfx1 (gP, rational, 3 terms).nfx
Rule Base 3: demo-nfx1 (gP, rational, 5 terms).nfx
This site is part of the MAKROMAT Web-Center. Host: Institute for Industrial Economics, University of Muenster/Germany. © KOOTHS, last modified: 06/20/99 14:53:20
Internet zone