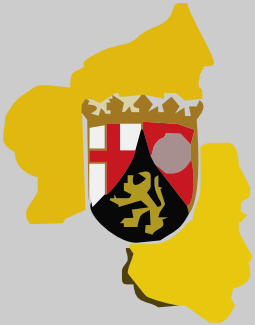
Comparison of Neural Networks and Configuration Frequency Analysis for Pattern Analysis in Criminology "Relapse" of juvenile offenders



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Overview

A) Introduction

1. Aim & Possibilties
2. Survey
3. Population in juvenile prison

B) “Relapse”

1. Definitions
2. Overview about "relapse"
3. Comparing prisons

C) Evaluation

1. School education
2. Training qualification

D) Explaining of "relapse"

1. Method: Approach by types of juvenile offender
2. Further description of time

E) Quantitive method

1. CFA
2. P-CFA
3. Neural networks

Result

Forecast

Aim and possibilities

- **First aim: Exploration of "relapse"**

- **Possibilities**
  - **Evaluation of methods and institutions**
  - **Decision for methods and institution in one case**
  - **Financial reasons**

Methods

1. Qualitative Types
(developed by apperception of police officers)

2. Quantitative Tests to select significant types

3. Quantitative evaluation according feature characteristics and types

Survey

First step:

• Personal data at beginning of prison sentence

Second step:

• data collected at the first conference of education

Third step:

• data collected at the last conference of education

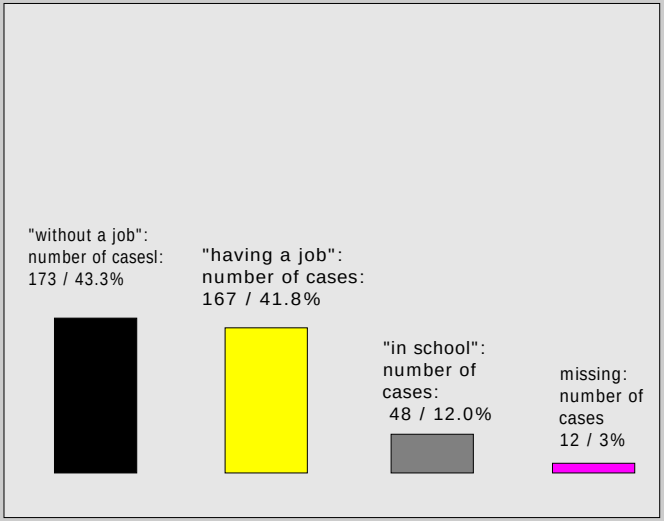
Fourth step:

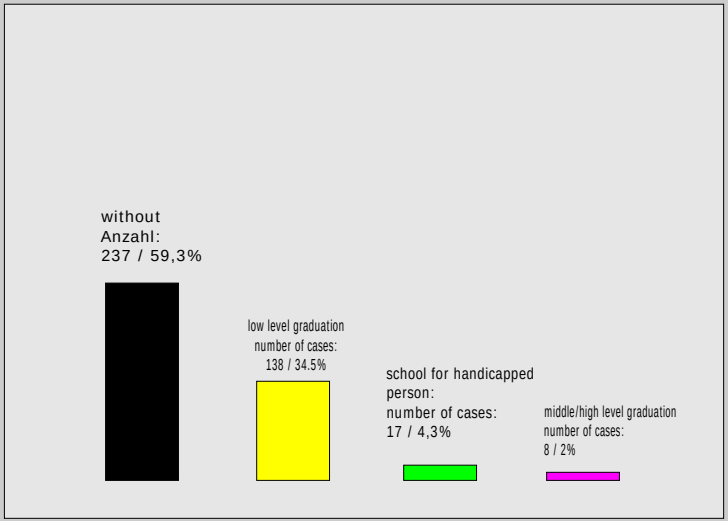
• delinquency in a time period of four years after discharge (official registration)

- **change in another federal state (max. 2 juvenile offender per prison and year)**
- **missing information in official registration**
- **percentage of juvenile offenders with foreign nationality (language, laws for foreigners, removals)**

Population in juvenile prison III

(school/job activities before prison)





High rate of unemployment
(43.3%)

High rate "without graduation"
(59.3%)
comparing 9.7% in RLP

115 juvenile offender (28.8%)
"without graduation"/"unemployment" (combined)

Population in juvenile prison IV (delinquency)

Robbery, extortion, theft
- 60.3% (241)

Drug abuse
- 22% (88)

Violent crime: bodily harm, murder, homicide
- 18.3% (73)

Sexual offence seperated
- 2.5% (10) (5 have ‘’no relapse’’)

"Committing crime not alone":
- 34.3% (173)

In prison:
- median $\tilde{x}$ = 20 months

Definitions of "relapse"

To research “relapse of juvenile offenders” two different definitions for “relapse” are used:

1.“Relapse I” in form of a further entry in official registration of delinquency

2.“Relapse II” in form of a further prison sentence with/without probation and manhunt

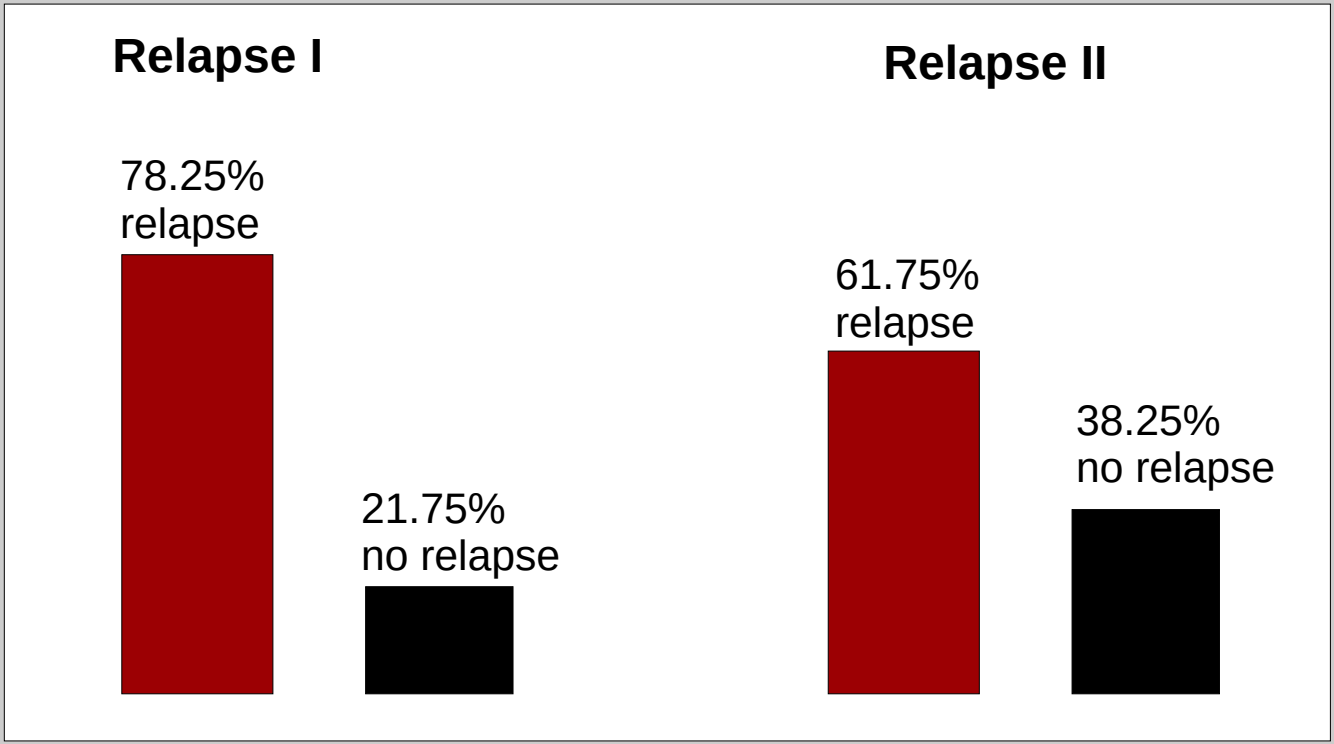
“Relapse I” defined as every kind of official delinquency of juvenile offenders

“Relapse II” defined as high cost delinquency

The definition of “relapse” has to be adapted to the focus of interest.

As an example for “relapse” after hospital treatment order because of delinquency caused by drug- and alcohol addiction (§64 StGB) the delinquency caused by addiction is in the focus of interest
(Giebel 2008, Evaluation of hospital treatment order in Hadamar)

“Relapse”



Compare: 78% “Relapse after youth custody" - Heinz, Jehle u. Sutterer 2003

“Relapse“

Evaluation of treatment

Difficulties:

1. Population in prisons
(delinquency, education, natonality etc.)

2. Situation after dismissal
(unemployment, crime rate, family, relations, etc.)

Evaluation

Before evaluating the effects of juvenile prisons and methods in reducing relapse following has to be considered:

1.) *In which group of juvenile offenders are effects of juvenile prisons and treatment expectable?*
2.) *With which criteria can the groups (or "types") for treatment be described?*

The description of socioscientific and psychologic interesting groups by combining criteria is leading to the "type" of juvenile offenders (Wenninger, Lexikon der Psychologie, 2001, p.352).

Next:

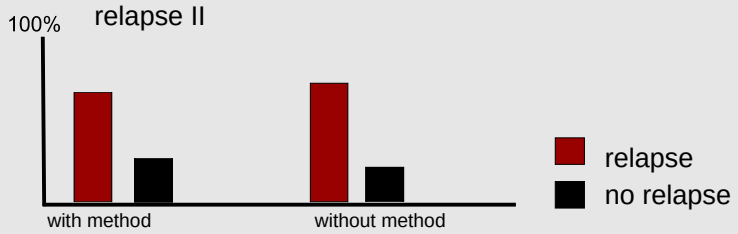
1. The subgroup without graduation
2. The subgroup without qualification: "types" of juvenile offenders

Evaluation

School education:

1. select a subgroup (without graduation)
2. compare relapse “with” / “without method”

Relapse II in subgroup without graduation		
	relapse	no relapse
with method	**61.9% (52)**	**38.4% (32)**
without method	**68.6%(105)**	**31.3% (48)**



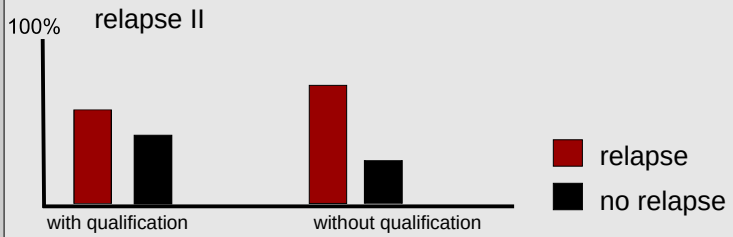
without method 6.7% more juvenile offenders

Evaluation

Training qualification:

1. select a subgroup (without qualification)
2. compare relapse “with” / “without method”

Relapsed II in subgroup without qualification		
	relapse	no relapse
with qualification	**56.5% (65)**	**43.5% (50)**
without qualification	**66.5%(167)**	**34.5% (88)**



without method 10 % more juvenile offenders

Evaluation

Treatments in prisons

Difficulties

- no group for controlling
- finding suitable subgroup

Advantage of research:

- Assessment of effects on relapse
- Evaluation of the adjournment-processes in the execution

Evaluation

The combination of feature characteristic “without graduation” and “without training qualification” leads to groups adapted for the methods.

For evaluating the youth custody more feature characteristics have to be combined:

- *In both examined examples citizenship is not considered. The effect can only be a result of removals*

- *In both examined example all juvenile prisons with young men are pooled. Differences in the methods of juvenile prisons are ignored*

Evaluation

Problem:

1. For evaluating treatments suitable groups have to be found

2. For developing new treatments for reducing "relapse" relevant groups of juvenile offenders have to be found

Qualitative method

to find relevant subgroups and types

Approach by "types" of juvenile offenders

(compare Kluge, S., "Empirisch begründete Typenbildung", 1999)

Neumann (2008) examined these types also in apperception of police officers (n=50)

Police officers are the first contact with the penal system for juvenile offender

Types of juvenile offenders

- **“Social loser”**

The “Social loser” is defined as

1. **changing homes**
2. **without school graduation**
3. **without training qualification**

The “Social loser” is a special “type” of interest as a result of the political discussion of “a new underclass” in Germany (Friedrich Ebert- Stiftung, Gesellschaft im Reformprozess, December 2006)

- **“Young rebel”**

The “Young rebel” is defined:

1. parents belong to “middle class”
2. school graduation

The rebellion of a “young rebel” is mainly a result of adolescence and not of a conflict with norms and having ideals.

- **“Mentally disordered”**

The “Mentally disordered” juvenile offender is the result of:

1. at the start of prison sentence the juvenile offender is described as “mentally disordered”

To recieve this type a lot of different diagnoses have to be pooled: Mental deficiency, Borderline, depression, suicidal tendency etc..
The “mentally disordered” juvenile offender is of interest because the juvenile prison is not suitable to help him.

Exact diagnoses are missing.

Overview

Types of juvenile offenders

- **“Violent criminals”**

The “Violent criminal” is defined as:

1. **Committing bodily harm and/or**
2. **Committing sexual offences and/or**
3. **Committing homicide**

Regarding “sexual offence” child maltreatment is reviewed as violent crime. There are also cases of juvenile offenders older than 14 having sexual intercourse with a person not much younger than 14.

To reduce “relapse” of “violent criminal” is always for public benefit. Public believe that a “violent criminal” will commit a violent offence, if he has a relapse. (comparable with “intensive offender”)

- **“Female offender”**

Because of the low number of cases only the gender defined the type.
As a result of a different survey female and male juvenile offenders are not pooled (!!!).
All former types are male juvenile offender

(It is necessary to accomplish more studies about female juvenile offenders. Comparing the time period 1996-2000 to 2007 a quadruplication is found in prison of Rhineland-Palatinate: 6 to 24 (compare PKS, official statistics of crime 2007)

Types of juvenile offenders

--**“German with non-German origin”**

This type is defined:

1. **German citizenship**
2. **Non-German origin**

Most of them are Russian Germans / Volga Germans.

And different types of young foreign nationals:

Result of combining “origin” and “citizenship”

- “Turk born in Turkey”
- “Turk born in Germany”
- “Yugoslav born in former Yugoslawia”
- “Yugoslav born in Germany”
- “East-European born in East-Europe”
- “Arabic-Persians born in Arabic-Persian region”
- “Arabic-Persians born in Germany”

Overview

Further description of times

“Social loser”

feature characteristics:
n=45 11.25%of male juvenile offenders
n=33 73.3% property offences
n=30 66.7% "parents divorced"
n=44 97.8% German
n=23 51.1% school education
n=15 33.3% training qualification
n=35 77.8% contact person: mother

Relapse I: 93.3%
Relapse II: 84.4%

“Mentally disordered”

feature characteristics:
n=30 7.5% of male juvenile offenders
n=7 23.3% violent crime
n=16 53.3% many have traumata ("violence")
n=26 86.7% German
n=7 23.3% national assistance
n=14 46.7% home change
n=23 76.7% contact person: mother

Relapse I: 80%
Relapse II: 60%

“Young rebel”

feature characteristics:
n=18 4.5%of male juvenile offenders
n=6 33.3% violent crime
n=15 83.3% "good relations to parents"
n=15 83.3% German
n=9 50% drug abuse, no heroin
no "mentally disordered"
n=16 88.8% contact person: mother

Relapse I: 72.2%
Relapse II: 61.1%

“Violent criminals”

feature characteristics:
n=73 18.25%of male juvenile offenders
n=33 45.2% traumata
n=14 19.2% home change
n=50 68.5% German
n=66 90.4% born in Germnany
n=27 37% alcohol consumption n=11 whisky
n=61 83.6% contact person: mother

Relapse I: 77.9%
(one psychiatrie / four removals)
Relapse II: 60.3%

Overview

Further description of times

“Female offender”
feature characteristics:
n=5 and 1 without "official registration"
n=3 violent crime
n=3 origin family with 4 children
n=4 "parents divorced"
n=5 drug abuse
n=2 alcohol consumption
all German
Relapse I: 80%
Relapse II: 20%

“Turk born in Turkey”
n=9 2.25%of male juvenile offenders

family structure is dominated by tradition

Minimum: 4 years in Germany
Relapse I: 42.8%
Relapse II: 42.8%

without two removals

“German with non-German origin”
feature characteristics:
n=36 9%of male juvenile offenders
n=9 25% "parents divorced"
n=22 61.1% Russians
n=35 97.2% can speak German
n=20 55.6% drug abuse n=14 heroin
n=13 36.1 alcohol consumption n=11 whisky
n=33 91.7% contact person: mother
Relapse I: 80.6%
Relapse II: 58.3%

“Turk born in Germany”
feature characteristics:
n=34 8.5%of male juvenile offenders
family structure dominated by cultural change
n=4 11.8% "parents divorced"
n=4 11.8% home change
n=7 20.6% alcohol consumption
n=14 41.2% drug abuse
Relapse I: 70%
Relapse II: 43.3%
without three removals / one psychiatry

Quantitative Method

Configuration frequency analysis

The **CFA** is able to find “statistically relevant types” in the group of all "possible" types

More different characteristics lead to more interesting statements about the juvenile offenders

The **Prediction-CFA** is able to find types can be assigned to categories “relapse”/”no relapse"

Krauth, J., "Einführung in die Konfigurationsfrequenzanalyse, 1993

Quantitative Method

Configuration frequency analysis (CFA)

Example: „Social looser“

changing home x school education x training qualification

possibilities: 2 x 2 x 2 = 8

frequency of a combination: f_{j1j2j3} =45 (“100")

Krauth, J., "Einführung in die Konfigurationsfrequenzanalyse, 1993

Quantitative Method

Configuration frequency analysis (CFA)

a) We have a type, if $p_{j_1 \ldots j_t} > p^0_{j_1 \ldots j_t}$

probability of frequency is higher than random

b) We have an antitype, if $p_{j_1 \ldots j_t} < p^0_{j_1 \ldots j_t}$

probability of frequency is smaller than random

$$p^0_{j_1 \ldots j_t} = p_{j_1 \ldots} * p_{.j_2} * p_{..j_3.} * \ldots * p_{\ldots j_t}$$

Assumption: statistical independence

Krauth, J., "Einführung in die Konfigurationsfrequenzanalyse, 1993

Quantitative Method

Configuration frequency analysis (CFA)

Estimating the probabilities from the sample:

$$\hat{p}_{j_1 \cdots j_t} = f_{j_1,\ldots,j_t} / n$$

$$p^{0c}_{j_1 \cdots j_t} = \frac{f_{j_1 \cdots}}{n} * \frac{f_{\cdot j_2 \cdot \cdot}}{n} * \ldots * \frac{f_{\cdots j_1}}{n} = \frac{\prod_{i=1}^{t} f_{j_i}}{n^t}$$

Krauth, J., "Einführung in die Konfigurationsfrequenzanalyse, 1993

Quantitative Method

Configuration frequency analysis (CFA)

Exact hypergeometric test:

1. step: We neglect the hypothesis: „probability of frequency is random“ if $p \leq 0.05$

2. step: We determine all tables of contingency
(t=number of variables, K: contingency)

3. step: Compute the probability: $P(X \geq f_{j_1,\ldots,j_t}) = \sum_{Kt} P_{Kt}(X \geq f_{j_1,\ldots,j_t})$

possible: Approximation with normal distribution

Krauth, J., "Einführung in die Konfigurationsfrequenzanalyse, 1993

Quantitative Method

Configuration frequency analysis (P-CFA)

Example: „ Social looser“ and „relapse“

changing home x school education x training qualification x relapse

possibilities: 2 x 2 x 2 x 2 = 16

We have only to test on „relapse“. P-CFA distinguishs between criteria and predictors.

Expected values for criteria according to predictor higher than random

Krauth, J., "Einführung in die Konfigurationsfrequenzanalyse, 1993

First question CFA:

profile: home change / school graduation / qualification

profile	z-value	p-value
000	1.866	0.031
001	-1.675	0.953
010	-4.856	0.999
011	3.793	0.000
100	0.790	0.215
101	-1.575	0.942
110	-1.327	0.907
111	2.324	0.010

Bonferoni adjustment p=0.00625 alpha=0.05

The “social looser” “100” is not oftener than it is in consequence of random process expected!!!

More than expected "011": no home change/school/ graduation

Second question P-CFA

profile: home change / school graduation / qualification x **relapse II**

profile	p-value	
000x0	0.546	
000x1	0.536	
001x0	1	
001x1	1	
010x0	0.059	-
010x1	0.963-	
011x0	0.012	
010x1	0.997	
100x0	0.999	
100x1	**0.0004**	
101x0	1	
101x1	0.617	
110x0	0.845	
110x1	0.287	
111x0	0.633	
111x1	0.713	

"Social loser" x relapse II is significant

compare: Giebel, S..,Sexual offenders, DGP / Giebel, S. Geruchsprofile, VDI Bad Kissingen 2007

One type "social loser" x relapse

Fisher-Exact Test

Relapse

		Relapse I	
		no	yes
"Social loser"	yes	3	42
	no	84	271

p=0.003

		Relapse II	
		no	yes
"Social loser"	yes	7	38
	no	146	209

p=0.000

Considered only the type "Social loser":

Juvenile offenders with the type have more oftener a "relapse" than all other juvenile offenders

Social loser has a higher rate of relapse

Evaluation of methods

for reducing "relapse" of "social loser"

Relapse I

additional school education p = 0.374
social training p = 0.048
training qualification p = 0.715

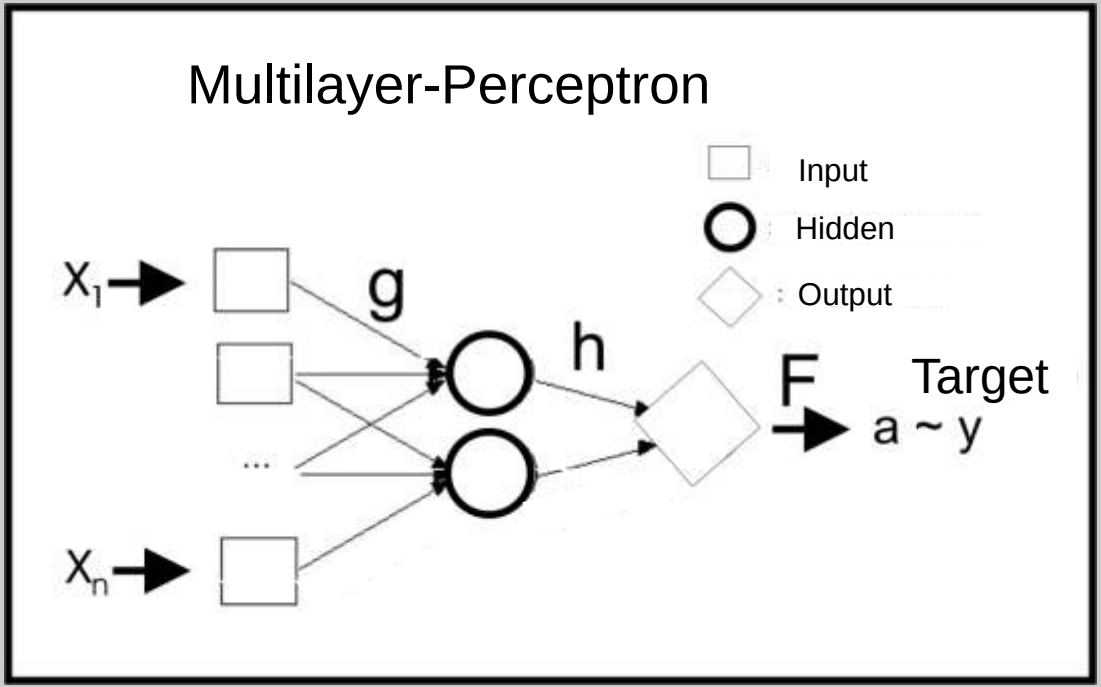
Relapse II

additional school education p = 0.285
social training p = 0.172
training qualification p = 0.516

Only "social training" is significant in reducing relapse I of "social loser"

Prediction:
Neural networks

Supervised neuronal networks



Often used only for fuzzy-problems
Example: „1": „up“ and „0": „down/equal“

Neural networks algorithm

Step 1. $E = \sum_{k=1}^{N} (\tilde{y}_k - y_k)^2$

Differences between estimation and reality

Aim: Minimum of error E

Step 2. $z_j = g(\sum_{i=1}^{n} w_i \cdot x_i)$

Hidden layer (Sigmoid-function)

Step 3. $a = h(\sum_{j=1}^{m} u_j \cdot z_j)$

Output layer (Sigmoid-function)

Step 4. $\tilde{y} = F(a)$

Function for output (Interpretation)

Step 5. $w_i^{new} = w_i^{old} + \alpha \cdot \Delta w_i$

Initialisation of raise in hidden layer

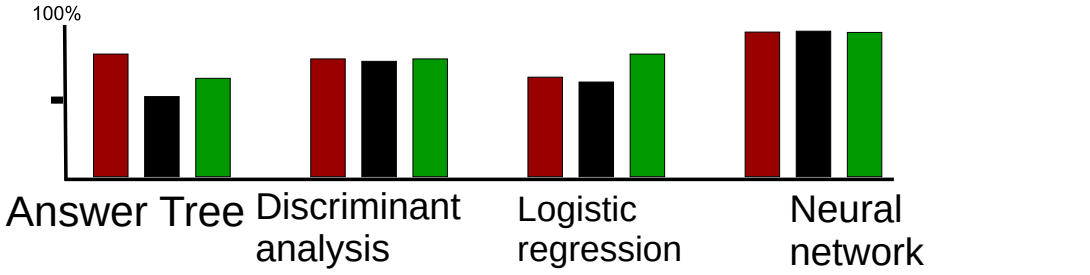
At start: random weights

back propagation

Step 6. $u_j^{new} = u_j^{old} + \alpha \cdot \Delta u_j$

Initialisation of raise in output layer

Explanation of „relapse“ - using different mathematical procedure



Overview

Prediction of relapse- using different mathematical procedures

Relapse 200 juveniles (Explanation)			
	Relapse	No relapse	Total
Answer Tree	100% (131)	0% (0)	65,5 %(131)
Discriminance Analysis	68,7% (90)	62,3% (43)	66,5 (133)
Logistic Regression	91,6% (120)	39,1% (27)	73,5% (147)
MLP	86,2 %(113)	65,2% (45)	79,0% (158)

Relapse 200 juveniles (Prediction)			
	Relapse	No relapse	Total
Answer Tree	100% (116)	0% (0)	58,0 %(116)
Discriminance Analysis	62,1 % (72)	63,1% (53)	62,5 (125)
Logistic Regression	86,2% (100)	39,1% (27)	63,5 (127)
MLP	74,1 %(86)	57,1% (48)	67,0%(134)

Known sample MLP 79%

⇩

Explanation

Unknown sample MLP 67%

⇩

Prediction

Conclusion

- treatments can be evaluated only in suitable subgroups, not in general
- new treatments adapted to the types can be developed
- improving situation after discharge acording to "types" of juvenile offenders

Conclusion

- Neural networks are suitable for prediction of „relapse“, for explanation they are quite better than other procedures
- CFA and PCFA are much more easy to handle for non-statisticians and test their results in contrast to neural networks
- for prediction split of the sample should be used

Limitations of results

The limitations of results are:

1. Number of reported delinquencies
2. Living circumstances
3. Number of foreign nationals and the possibility of removals
4. Time period of research
5. Regional distinctions

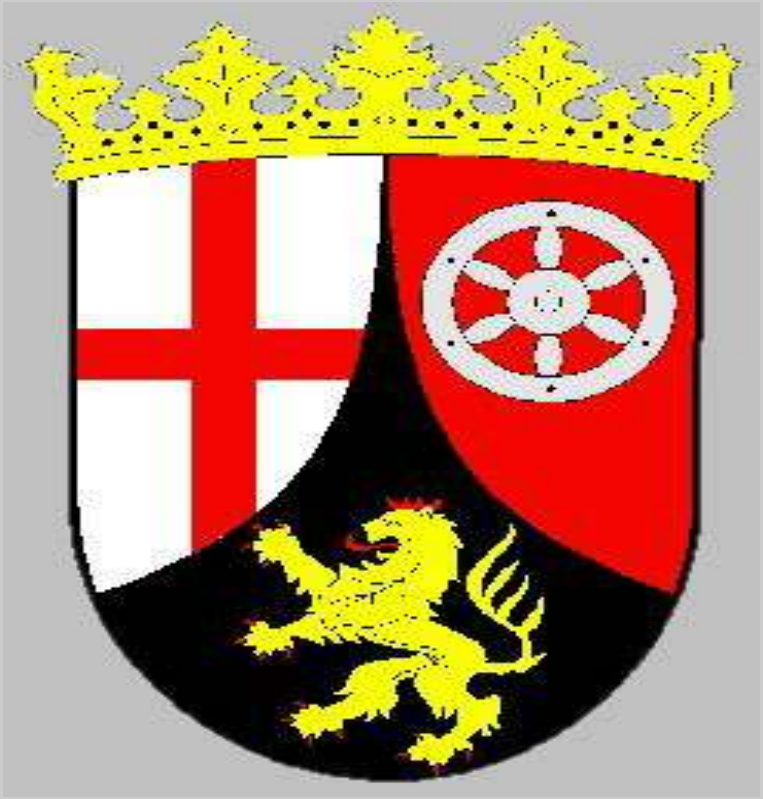
Forecast

- the juvenile offenders in the time period after 2000 have to be examined

(interesting period because of increasing unemployment after 2001)

- comparing the population in different time periods

- influences of time on “relapse” of juvenile offenders (unemployment, crime rate etc.)



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