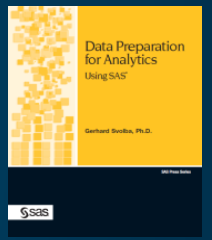
WBS Seminar

Data Science in Action – 10 Dinge, die Advanced Analytics und Data Science für Ihr Unternehmen tun kann

Gerhard Svolba, SAS Austria

Meduni Wien, 22. Februrar 2018



THE POWER TO KNOW.

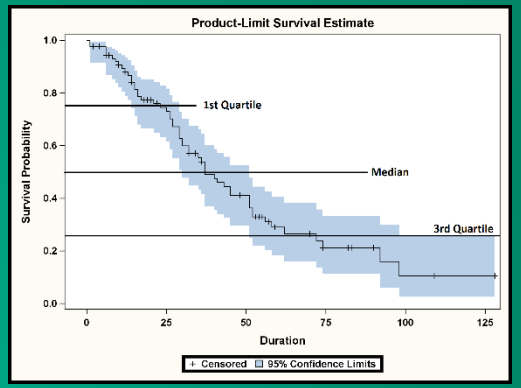
Agenda

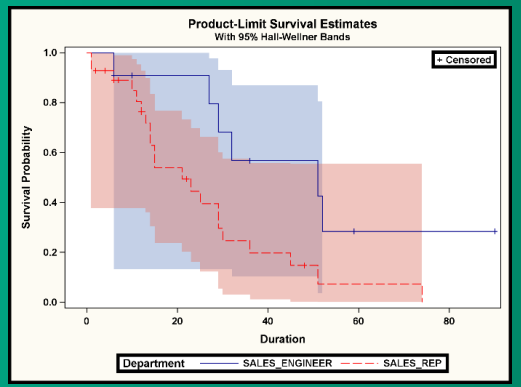
- 10 mal „Data Science in Action“
  - Supervised Machine Learning Methoden
  - Unsupervised Machine Learning Methoden
  - Simulationen

- SAS Viya – Offenheit für unterschiedliche Benutzertypen
  - Gernot Engel, Franz Helmreich, Matthias Svolba, Gerhard Svolba

Data Science in Action: #1

Performing Headcount Survival Analysis for Employee Retention



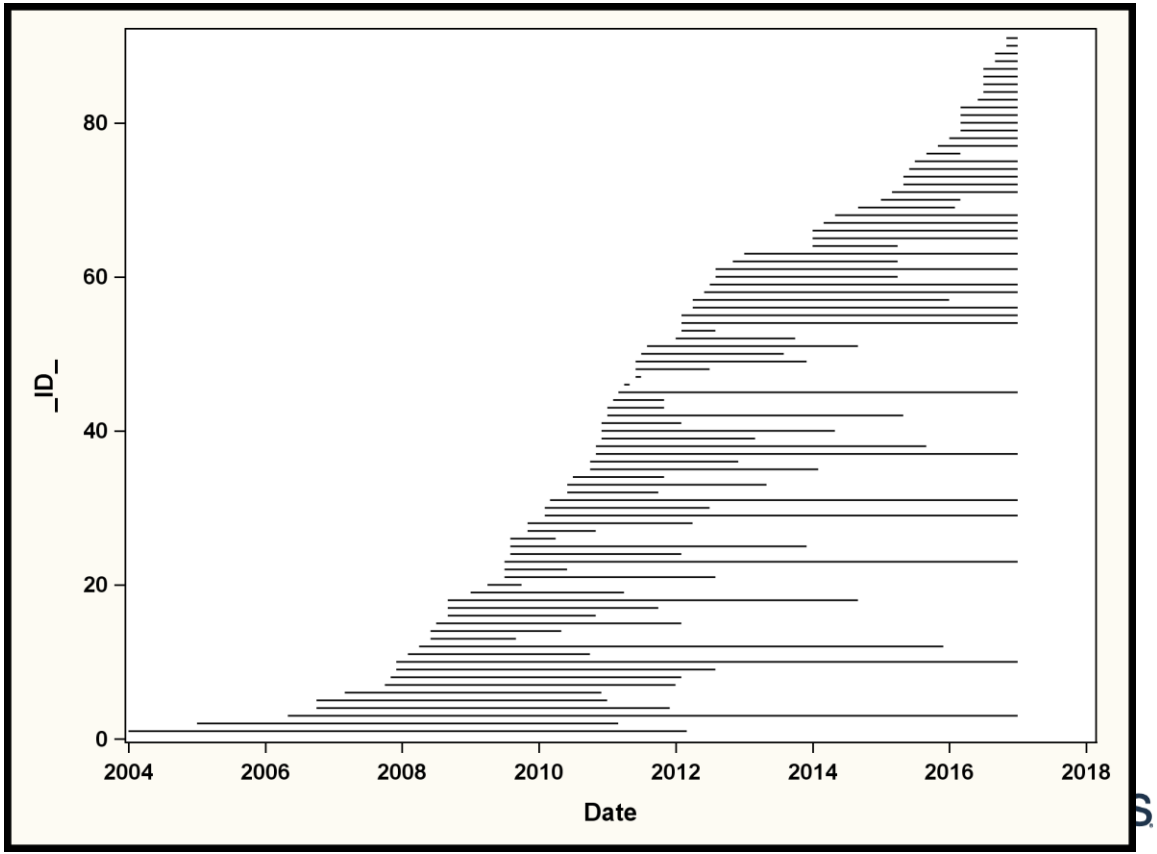


Can assumptions about the average length of time intervals be made, even if most of the endpoints have not yet been observed?

Survival analysis methods: Kaplan-Meier estimates
Cox Proportional Hazards regression
Survival Data Mining

Nicht zu allen Mitarbeitern haben wir ein „Ereignis-Datum“ (Glücklicherweise)

- Betrachten der Karrieren pro Mitarbeiter
  - Unterschiedliche Länge
  - Kündigung oder „zensiert“

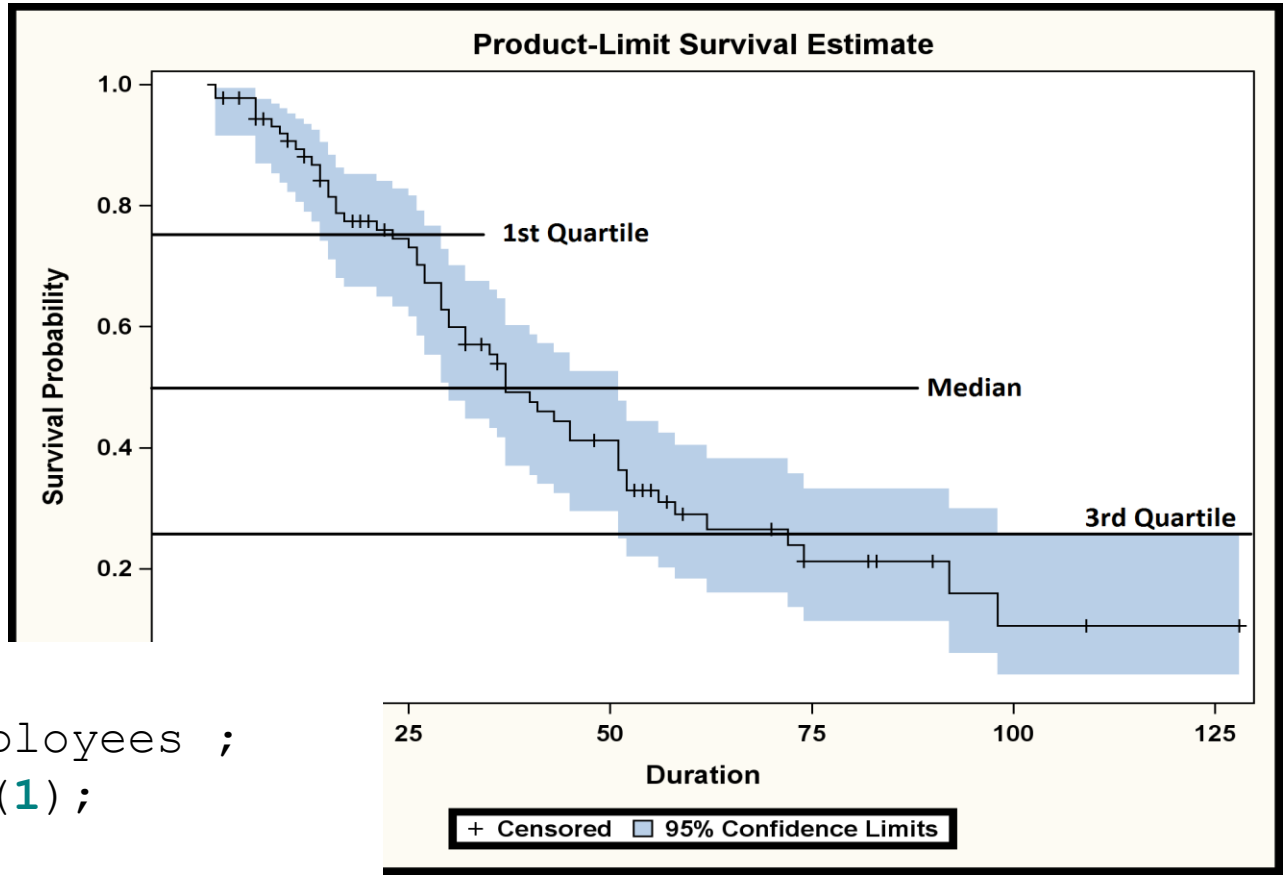


Interpretation der Survival Kurve

Für alle Abteilungen

Quartile Estimates				
	Point	95% Confidence Interval		
Percent	Estimate	Transform	[Lower	Upper)
75	72.000	LOGLOG	51.000	.
50	37.000	LOGLOG	30.000	51.000
25	23.000	LOGLOG	14.000	29.000

Mean	Standard Error
46.757	3.813

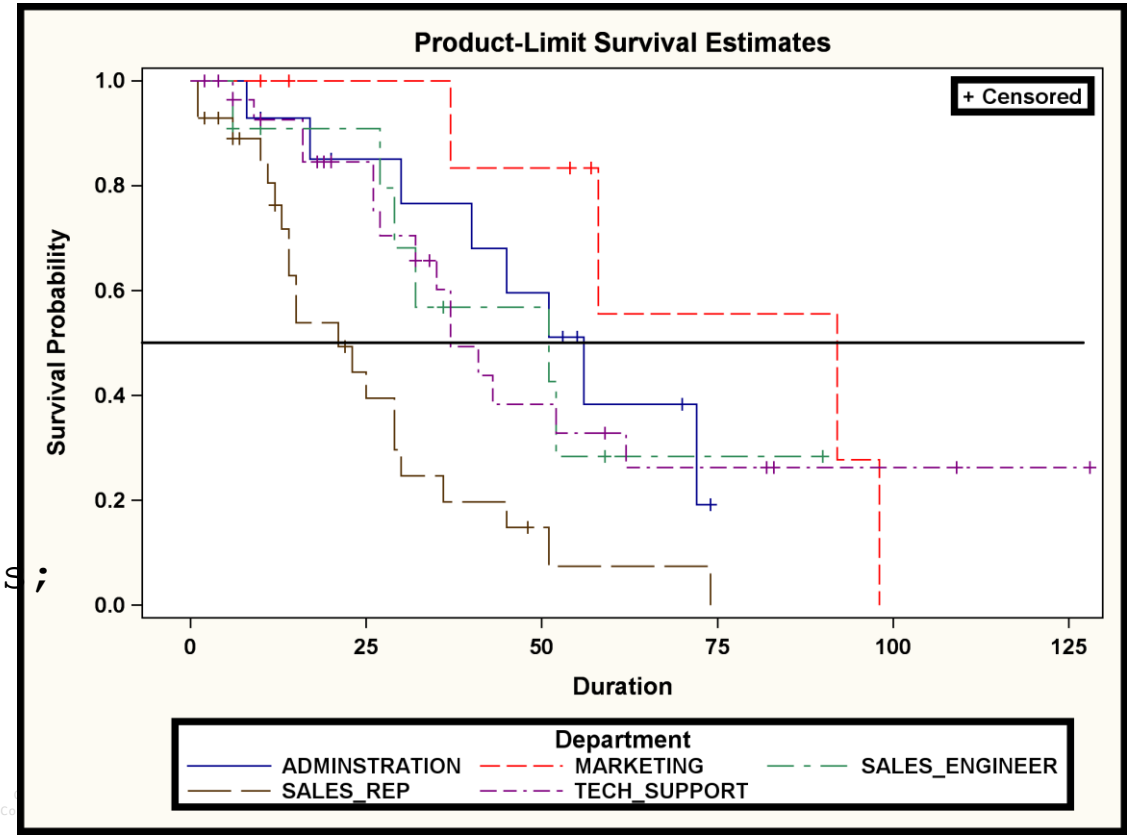



```
ods graphics on;
proc lifetest data=employees ;
 time Duration*Status(1);
run;
```

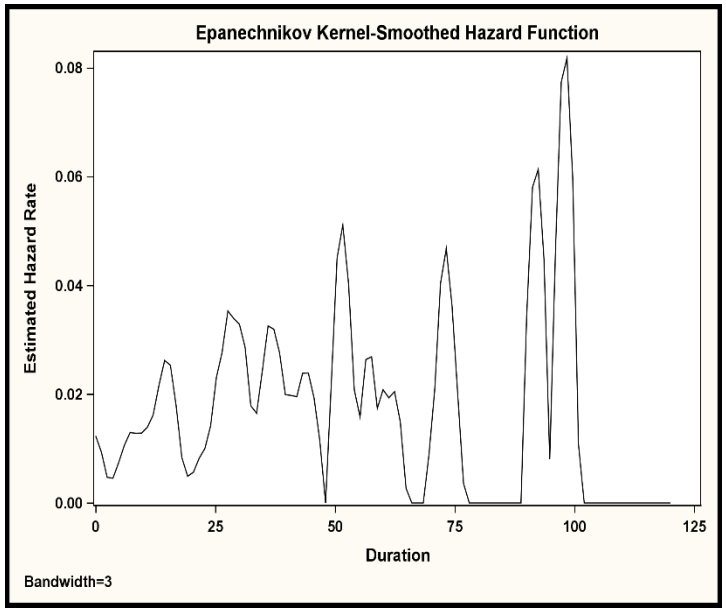
Survival-Kurve pro Abteilung

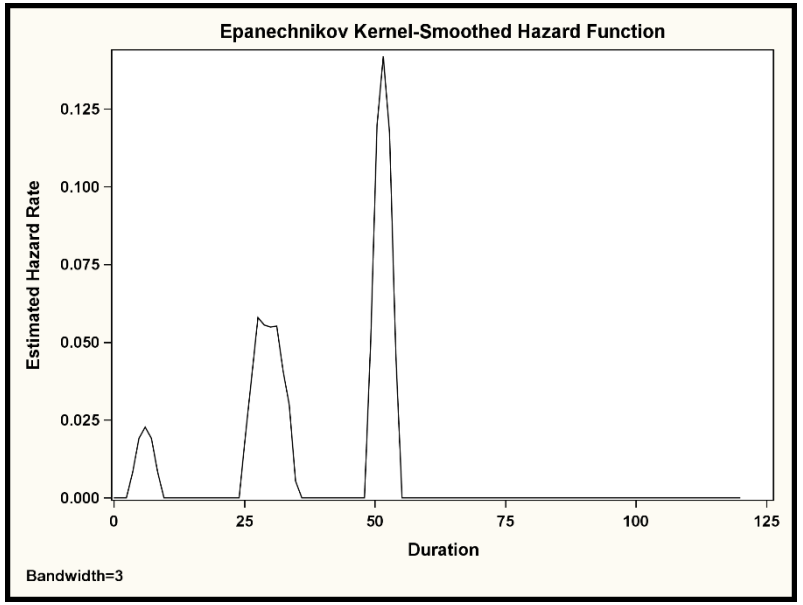
Referenz-Linie für den Median

```
PROC LIFETEST DATA=employees;
  TIME Duration*Status(1);
  STRATA department;
RUN;
```



Analyse der Hazard Kurve

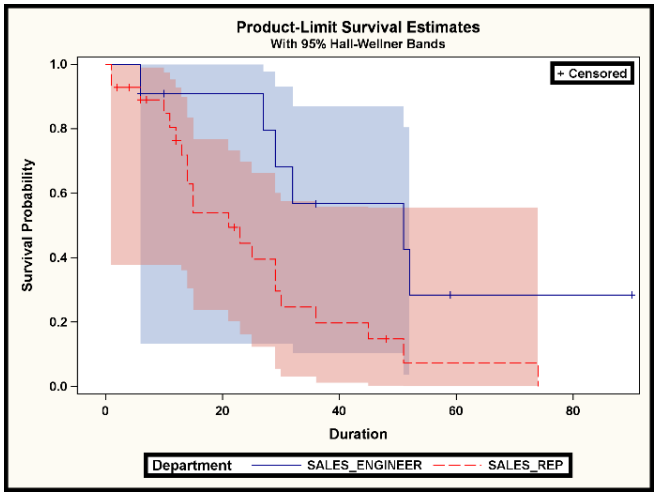


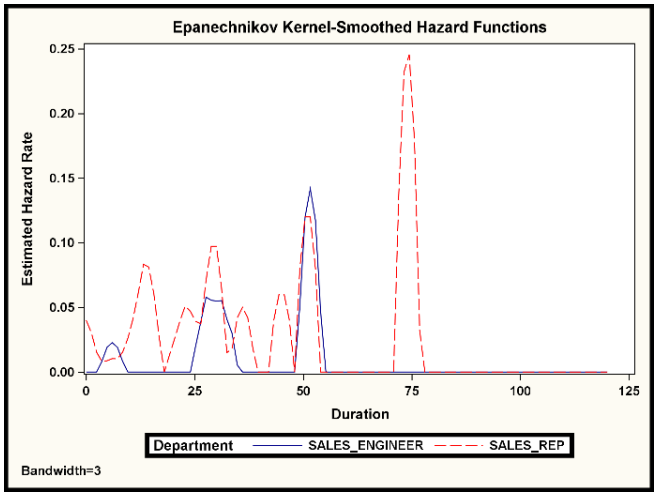



```
PROC LIFETEST DATA=employees plots=(hazard(bandwidth=3 maxtime=120));
 TIME Duration*Status(1);
RUN;
```

Konfidenz-Bänder mit der LIFETEST Procedure

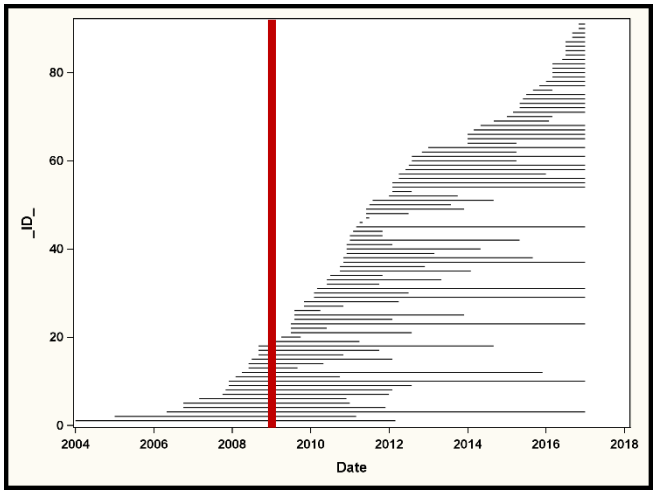
```
proc lifetest data=employees outsurv = survplot
              plots=(hazard(bandwidth=3 maxtime=120)
              survival(cb=hw));
 time duration*status(1);
 strata department;
 where department  in ("sales_rep", "sales_engineer");
run;
```

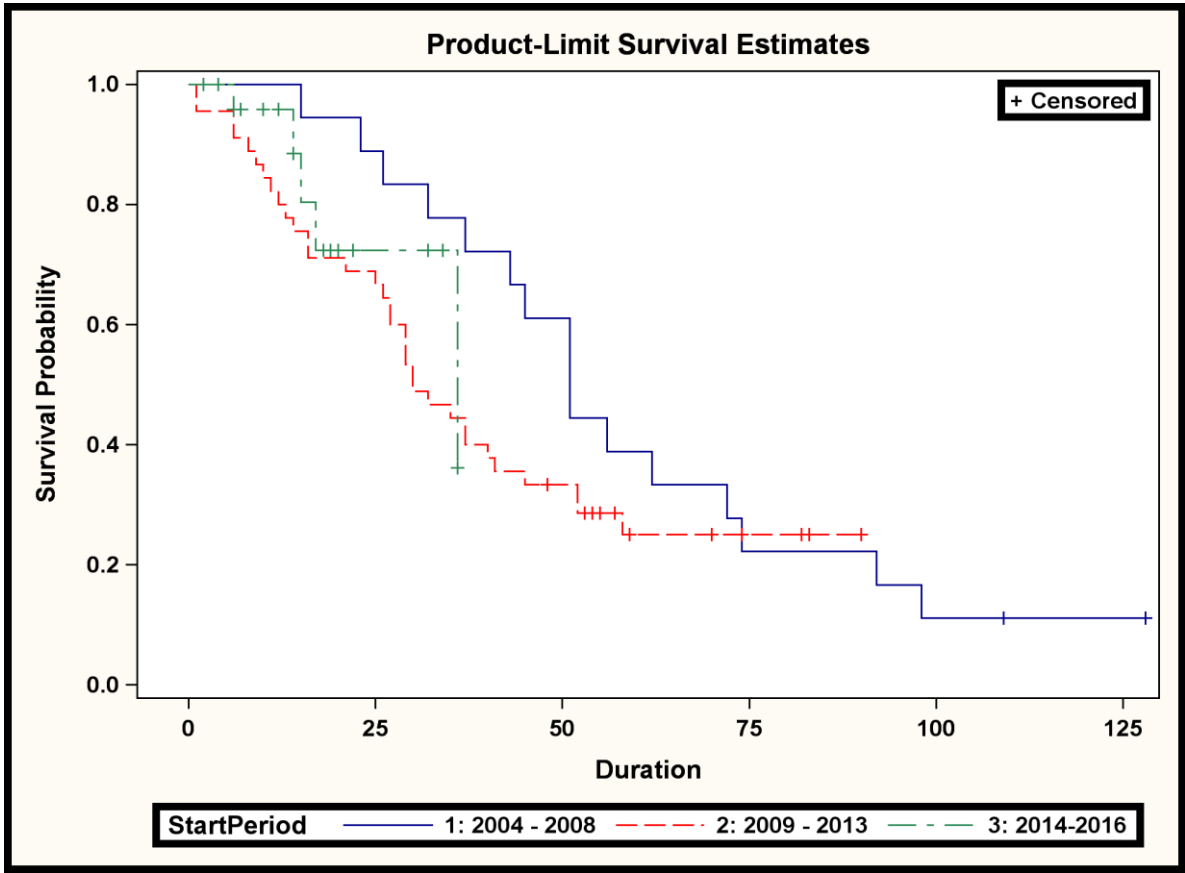




In den „guten alten Zeiten“ war alles beser

- Daten stehen seit 01/2009 zur Verfügung
- Unternehmen wurde 01/2004 gegründet
- Pre-Selection der Daten!





Analyse von Input-Variablen mit der PHREG Procedure

Class Level Information					
Class	Value	Design Variables			
Department	ADMINSTRATION	-1	-1	-1	-1
	MARKETING	1	0	0	0
	SALES_ENGINEER	0	1	0	0
	SALES_REP	0	0	1	0
	TECH_SUPPORT	0	0	0	1
Gender	F	-1			
	M	1			
TechKnowHow	NO	-1			
	YES	1			

Analysis of Maximum Likelihood Estimates							
Parameter		DF	Parameter Estimate	Standard Error	Chi-Square	Pr > ChiSq	Hazard Ratio
Department	MARKETING	1	-1.15513	0.47794	5.8414	0.0157	0.606
Department	SALES_ENGINEER	1	0.82336	0.52244	2.4838	0.1150	4.380
Department	SALES_REP	1	0.62976	0.29224	4.6436	0.0312	3.609
Department	TECH_SUPPORT	1	0.35572	0.29940	1.4117	0.2348	2.744
TechKnowHow	YES	1	-0.63474	0.27370	5.3781	0.0204	0.281

Variable (Category)	Coefficient	p-Value
Department MARKETING	-1.155	0.016
Department SALES_ENGINEER	0.823	0.115
Department SALES_REP	0.630	0.031
Department TECH_SUPPORT	0.356	0.235
Department ADMIN	-0.654	
TechKnowHow YES	-0.635	0.020

$$-[(-1.155)+0.823+0.630+0.356] = -0.654$$

```
PROC PHREG DATA=Employees;
 CLASS department gender TechKnowHow / PARAM=effect REF=first;
 MODEL Duration*Status(1)= department gender TechKnowHow /
                           SELECTION=stepwise;
RUN;
```

Analyse der „Explained Variation“ mit der PHREG Procedure

```
PROC PHREG DATA=Employees EV;
 CLASS department gender TechKnowHow/ PARAM=effect REF=first;
 MODEL Duration*Status(1)= department gender TechKnowHow;
RUN;
```

Predictive Inaccuracy and Explained Variation		
Predictive Inaccuracy (Smaller is Better)		Percent
Without Covariates	With Covariates	Explained Variation
0.3600	0.2921	18.84

Variables in the Model	Explained Variation
Department	13.7 %
TechKnowKow	2.0 %
Department, TechKnowKow	17.2 %
Department, TechKnowKow, Gender	18.4 %

„Wie lange wird Gerhard Svolba noch in unserem Unternehmen sein?“

Vorhersage der Verweildauer für indivudelle Mitarbeiter

Ausgehend von bestimmten Risikofaktoren

wie hoch ist die erwartete Survival in 6 Monaten

und die „Überlebens“-wahrscheinlichkeit für die nächsten 6 Monate

EmpNo	Department	Gender	TechKnowH...	_T_	EM_SURVFCST	EM_SURVEVENT	T_FCST
1003	TECH_SUPPORT	M	YES	128	0.240	0.000	134
1010	TECH_SUPPORT	M	YES	109	0.240	0.011	115
1023	SALES_ENGINEER	M	YES	90	0.108	0.313	96
1029	TECH_SUPPORT	M	YES	83	0.386	0.133	89
1031	TECH_SUPPORT	F	YES	82	0.177	0.219	88
1037	ADMINSTRATION	M	NO	74	0.471	0.066	80
1045	ADMINSTRATION	M	NO	70	0.494	0.053	76
1054	TECH_SUPPORT	F	YES	59	0.316	0.102	65
1055	SALES_ENGINEER	M	YES	59	0.313	0.103	65

Vorhersage der Survival mit der PHREG Procedure

```
PROC PHREG DATA=Employees outest = ParamEstimates;
 CLASS department gender TechKnowHow StartPeriod/
                    PARAM=effect REF=first;
 MODEL Duration*Status(1)= department gender /
                    SELECTION=stepwise;
 OUTPUT OUT=surv_pred survival=SurvPred
                      Atrisk  =ObsAtRsik
                      LD      =DisplacmLikelihood;
RUN;
```

	EmpNo	Department	Gender	Start	End	Status	TechKnowHow	Duration	ObsAtRsik	SurvPred	DisplacmLikelihood
1	1001	MARKETING	M	01JAN2004	01MAR2012	0	NO	98	3	0.3000662358	0.0342095828
2	1002	SALES_REP	M	01JAN2005	01MAR2011	0	NO	74	9	0.0152709689	0.3883756359
3	1003	TECH_SUPPORT	M	01MAY2006	.	1	YES	128	1	0.2160216763	0.1379484728
4	1004	TECH_SUPPORT	M	01OCT2006	01DEC2011	0	YES	62	12	0.4732932188	0.0030581462
5	1005	SALES_ENGINEER	M	01OCT2006	01JAN2011	0	YES	51	25	0.4301588168	0.0038343292
6	1006	ADMINSTRATION	F	01MAR2007	01DEC2010	0	NO	45	28	0.5577228186	0.0137046542
7	1007	ADMINSTRATION	F	01OCT2007	01JAN2012	0	NO	51	25	0.5038628656	0.0073694734
8	1008	SALES_REP	M	01NOV2007	01FEB2012	0	NO	51	25	0.0842551576	0.0501603566
9	1009	ADMINSTRATION	F	01DEC2007	01AUG2012	0	NO	56	17	0.4368117997	0.007699317
10	1010	TECH_SUPPORT	M	01DEC2007	.	1	YES	109	2	0.2160216763	0.1379484728
11	1011	TECH_SUPPORT	M	01FEB2008	01OCT2010	0	NO	32	41	0.3835067447	0.0013479246
12	1012	MARKETING	M	01APR2008	01DEC2015	0	NO	92	4	0.3978245623	0.0317086643
13	1013	SALES_REP	M	01JUN2008	01SEP2009	0	NO	15	63	0.6635274122	0.0094219574
14	1014	SALES_REP	M	01JUN2008	01MAY2010	0	NO	23	52	0.5451210355	0.0056891192
15	1015	TECH_SUPPORT	M	01JUL2008	01FEB2012	0	YES	43	29	0.6640788277	0.0379949482

The CODE statement generates SAS code that predicts the survival function at specified years

```
proc phselect data=mycas.Customers;
   class Area(ref='Urban') LifeChange(ref='None')
         PlanType(ref='B') Satisfaction(ref='Poor')
          Smoking(ref='No') / param=ref;
   model Time*Status(0) = Age Area Education Income
                          LifeChange PlanType
                          Satisfaction Smoking;

   selection method=forward(select=bic stop=bic);
   code file='ScoreCode.txt' timepoint=12 24 36 48 60;
run;
```

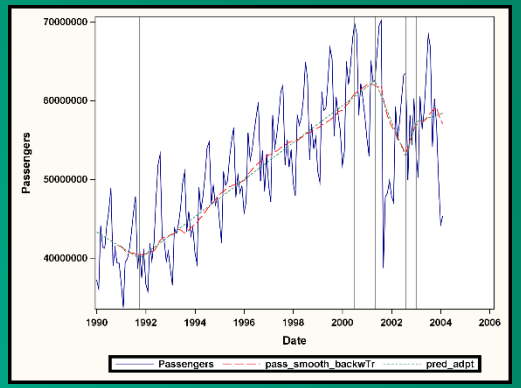
The score code predicts retention probabilities for new customers at the specified years

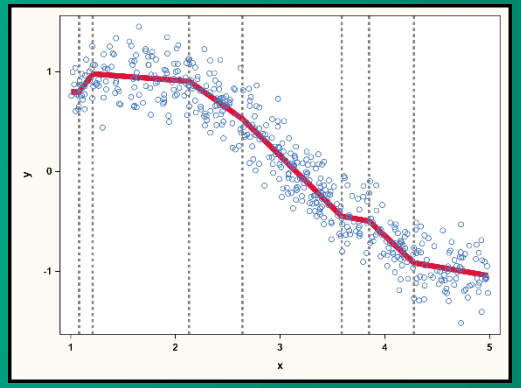
```
data Retention;
   set NewCustomers;
   %include 'ScoreCode.txt';
run;
```

Area	Satisfaction	Life Change	Years of Education	Retention Probability at 1 Year	Retention Probability at 2 Years	Retention Probability at 3 Years	Retention Probability at 4 Years	Retention Probability at 5 Years
Rural	Poor	New Job	13	0.671	0.455	0.315	0.221	0.155
Urban	Good	Married	14	0.718	0.520	0.383	0.285	0.212
Rural	Excellent	New Job	8	0.711	0.512	0.373	0.276	0.204
Urban	Poor	New Job	11	0.652	0.431	0.290	0.198	0.136
Rural	Excellent	Child	17	0.786	0.622	0.498	0.402	0.324

Data Science in Action: #2

Detecting Structural Changes and Outliers in Longitudinal Data



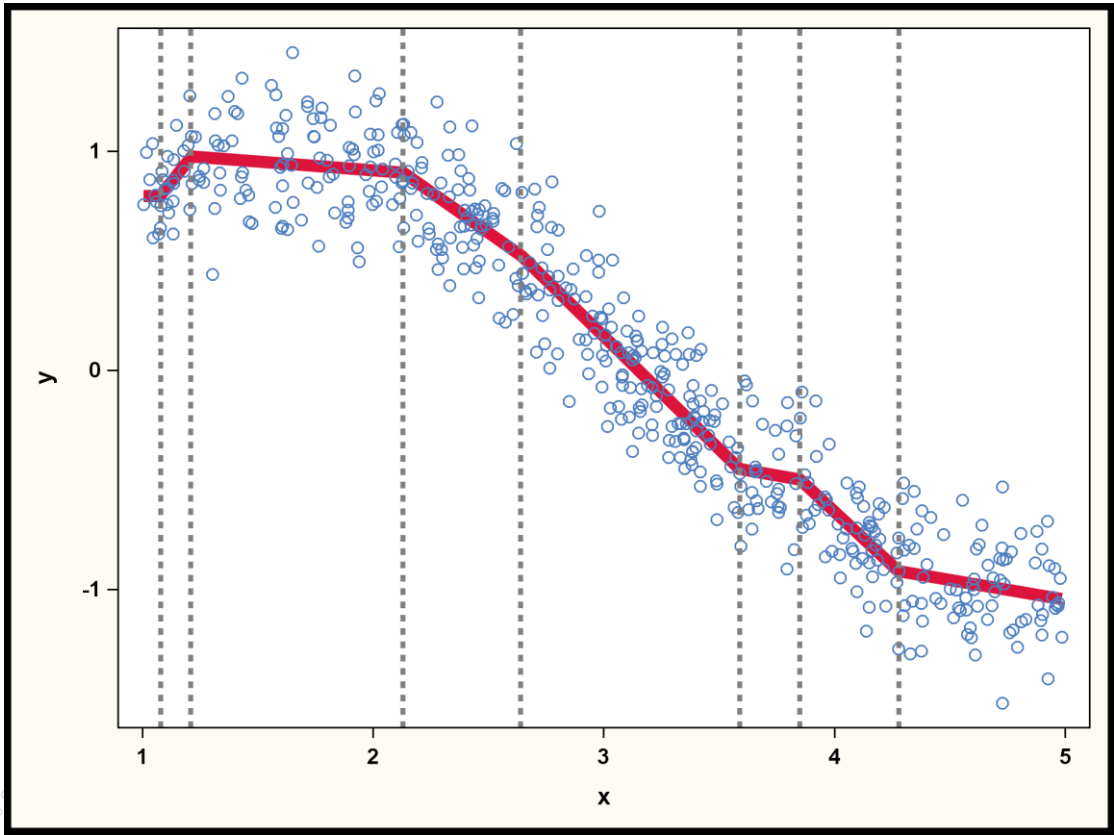


Can events and changes in the course over time be automatically detected?

Smoothing Of Longitudinal Data
Multivariate Adaptive Regression Splines
Automatic Breakpoint Detection
Automatic Detection of Outliers with ARIMA Models

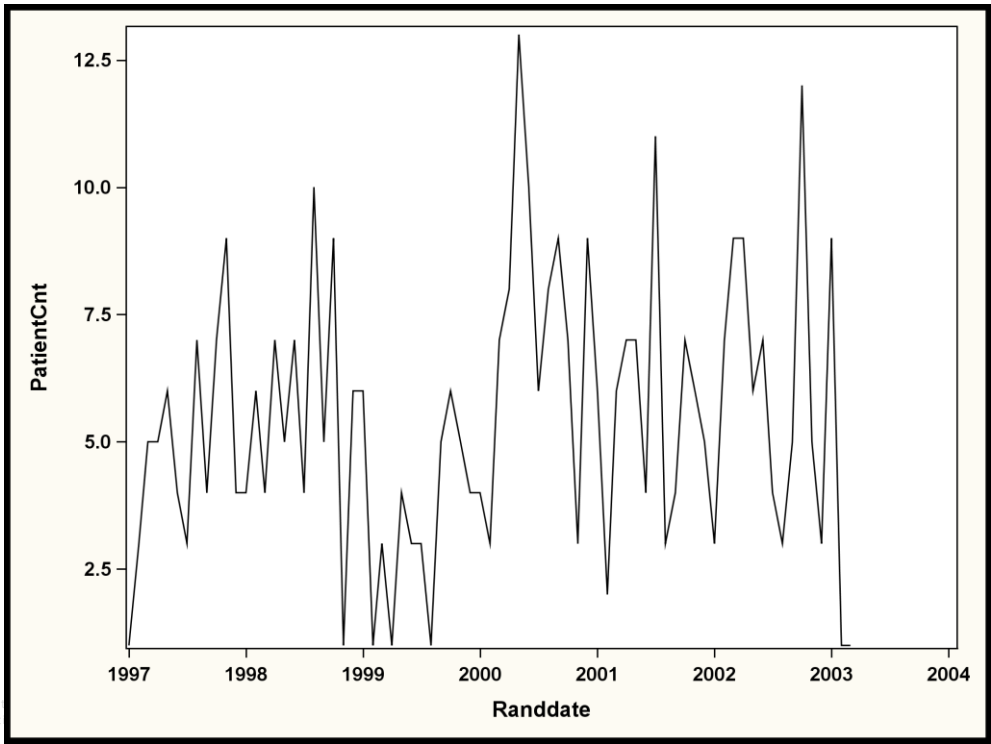
Multivariate Adaptive Regression Splines mit der ADAPTIVEREG Procedure

```
proc adaptivereg data=Demo_xy
                 plots=all
                 details=bases;
 model y = x ;
 ods output BWDParams=KnotPoints;
 output out=Demo_xy_Data_y_adpt
        predicted=pred_y;
run;
```

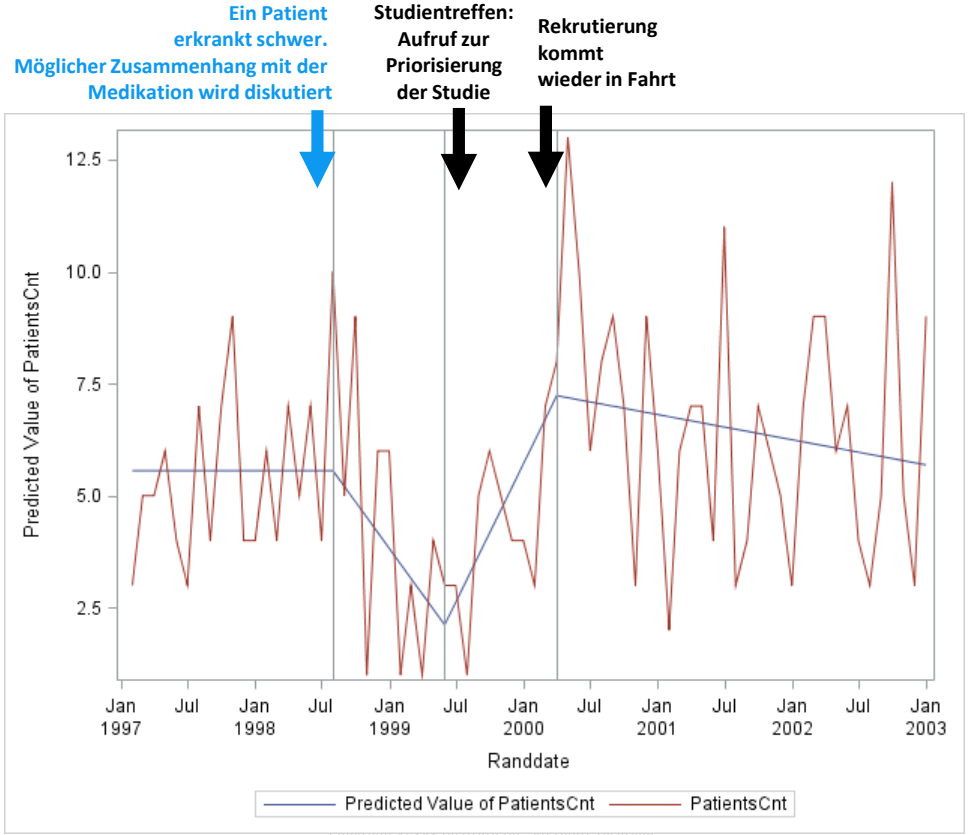


Anzahl der rekrutierten Patienten in einer klinischen Studie im Zeitverlauf

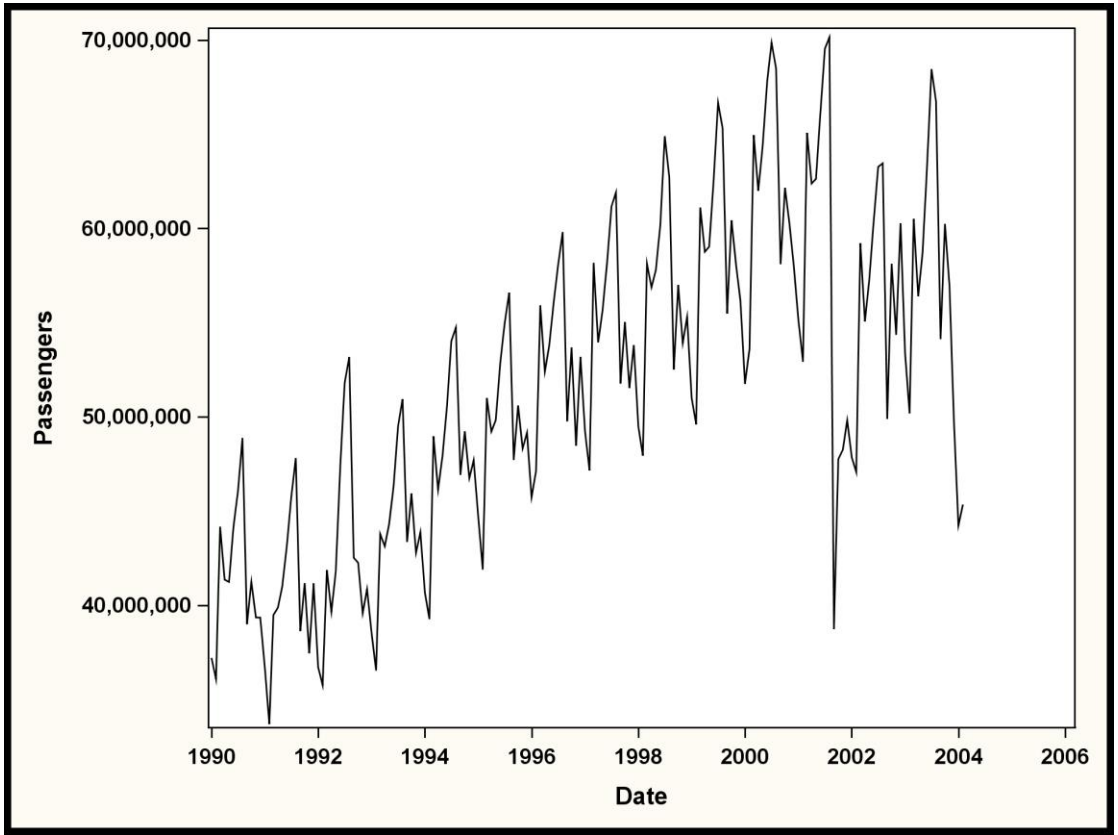
```
proc adaptivereg data=patients_recruitment plots=all;
  model PatientCnt = randdate;
  ods output BWDParams=KnotPoints;
  output out=recruit_adpt
         predicted=pred_adpt;
run;
```



Was ist zu bestimmten Zeitpunkten in meiner klinischen Studie passiert?



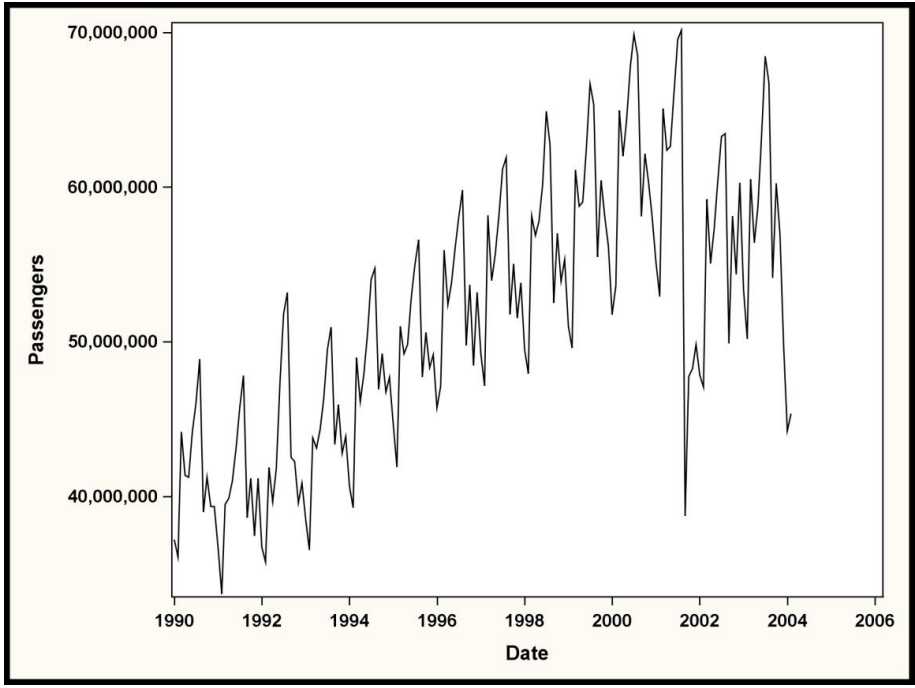
Anzahl der Flug-Passagiere in den Jahren 1990 bis 2004

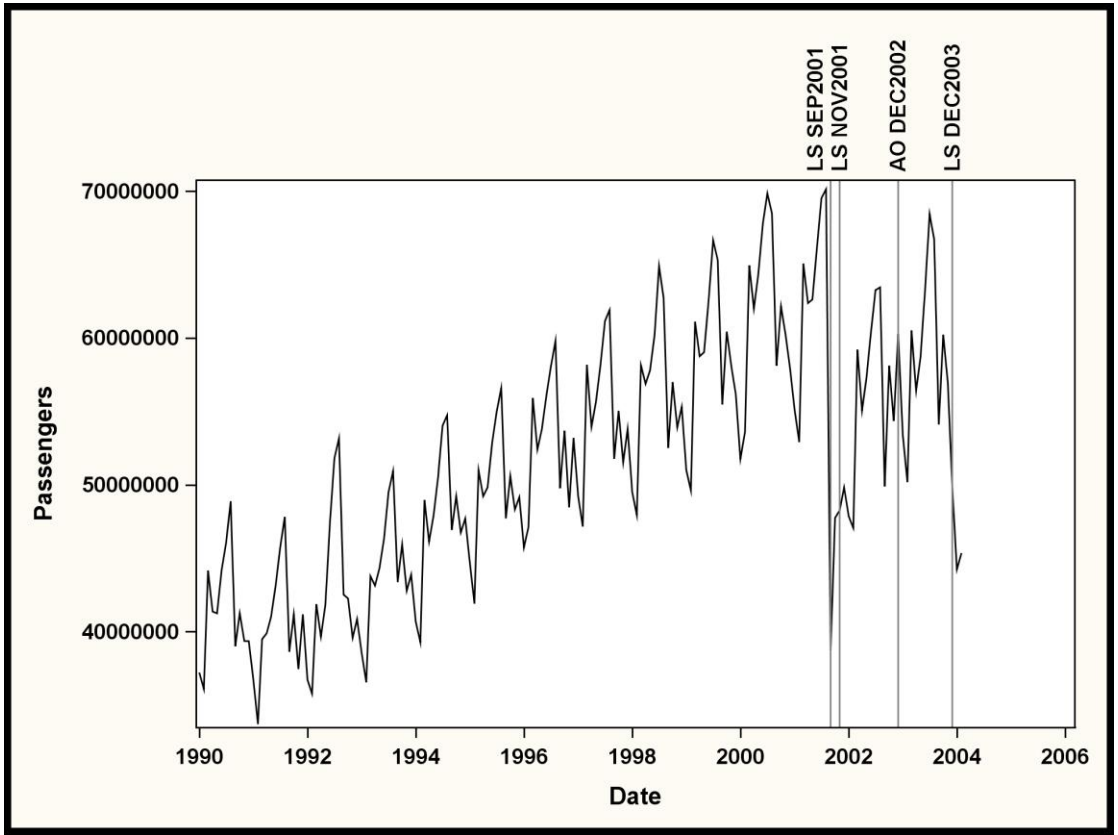


Automatische Ausreißer-Erkennung mit der X13-Procedure

```
proc x13 data=flights_911 date=date;
   var passengers;
   arima model=( (0,1,1)(0,1,1) );
   outlier;
run;
```

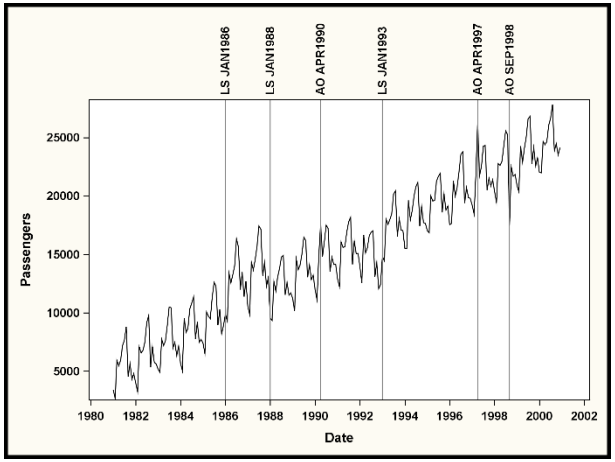
Regression Model Parameter Estimates For Variable Passengers						
Type	Parameter	NoEst	Estimate	Standard Error	t Value	Pr > |t|
Automatically Identified	LS SEP2001	Est	-17993818	1113414.76	-16.16	<.0001
	LS NOV2001	Est	5939640.53	1123179.20	5.29	<.0001
	AO DEC2002	Est	5039786.79	1111284.48	4.54	<.0001
	LS DEC2003	Est	-8531934.1	1249512.29	-6.83	<.0001



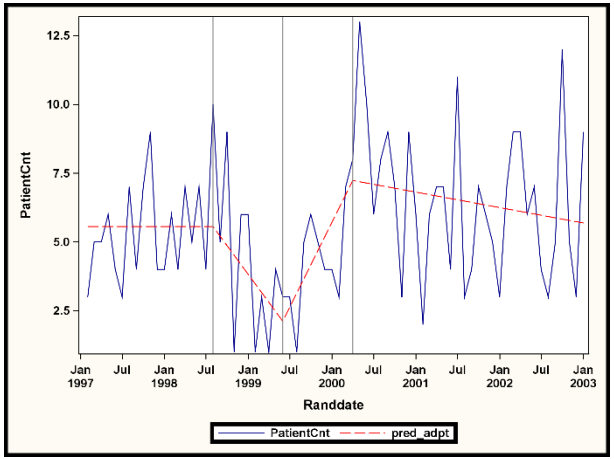

LS SEP2001
LS NOV2001
AO DEC2002
LS DEC2003
70000000
60000000
50000000
40000000
Passengers
1990
1992
1994
1996
1998
2000
2002
2004
2006
Date

Automatisches Erkennen von Breakpoints und Ausreißern

Anwenden von analytischen Methoden zum Erkennen von Zeitpunkten, wo der Verlauf der Daten vom „normalen“ Muster abweicht.



Erkennen von Shifts und Pulse Events mit ARIMA Modellen

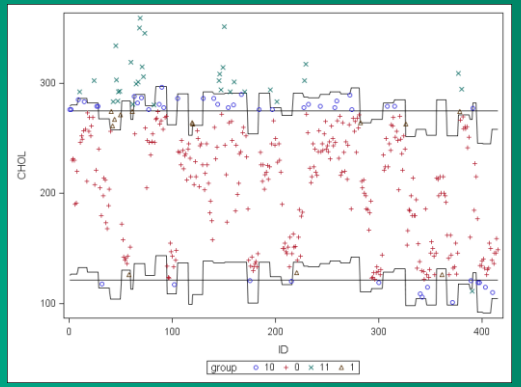


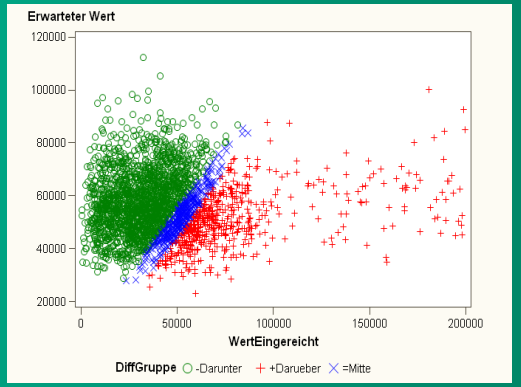
Verwenden von Multivariate Adaptive Regression Splines zum Auffinden von Bruchpunkten

Data Science in Action: #3

Proving a reference value that considers all available co-information

Can analytics help me to reduce the "Yes, but … " sentences in my business dicussions?

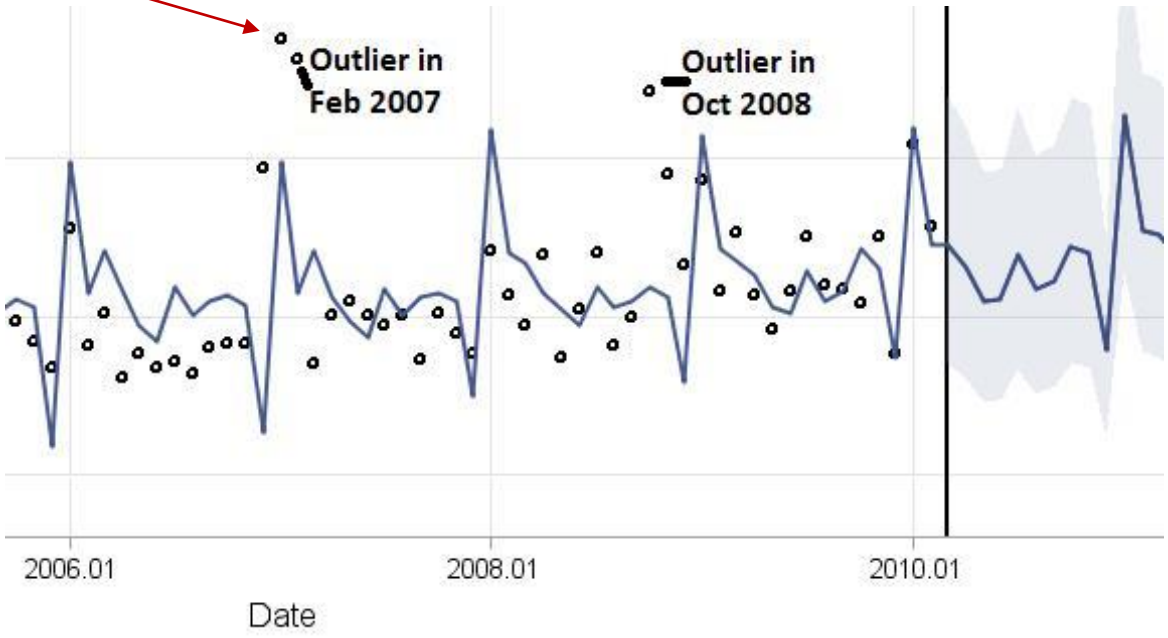




- Linear Regression
- Decision Trees
- Time Series Analysis

„Ja, aber …. im Jänner haben wir immer deutlich mehr Ereignisse“

Plausibler Wert für Jänner 2007
weil Jänner-Werte immer
höher sind

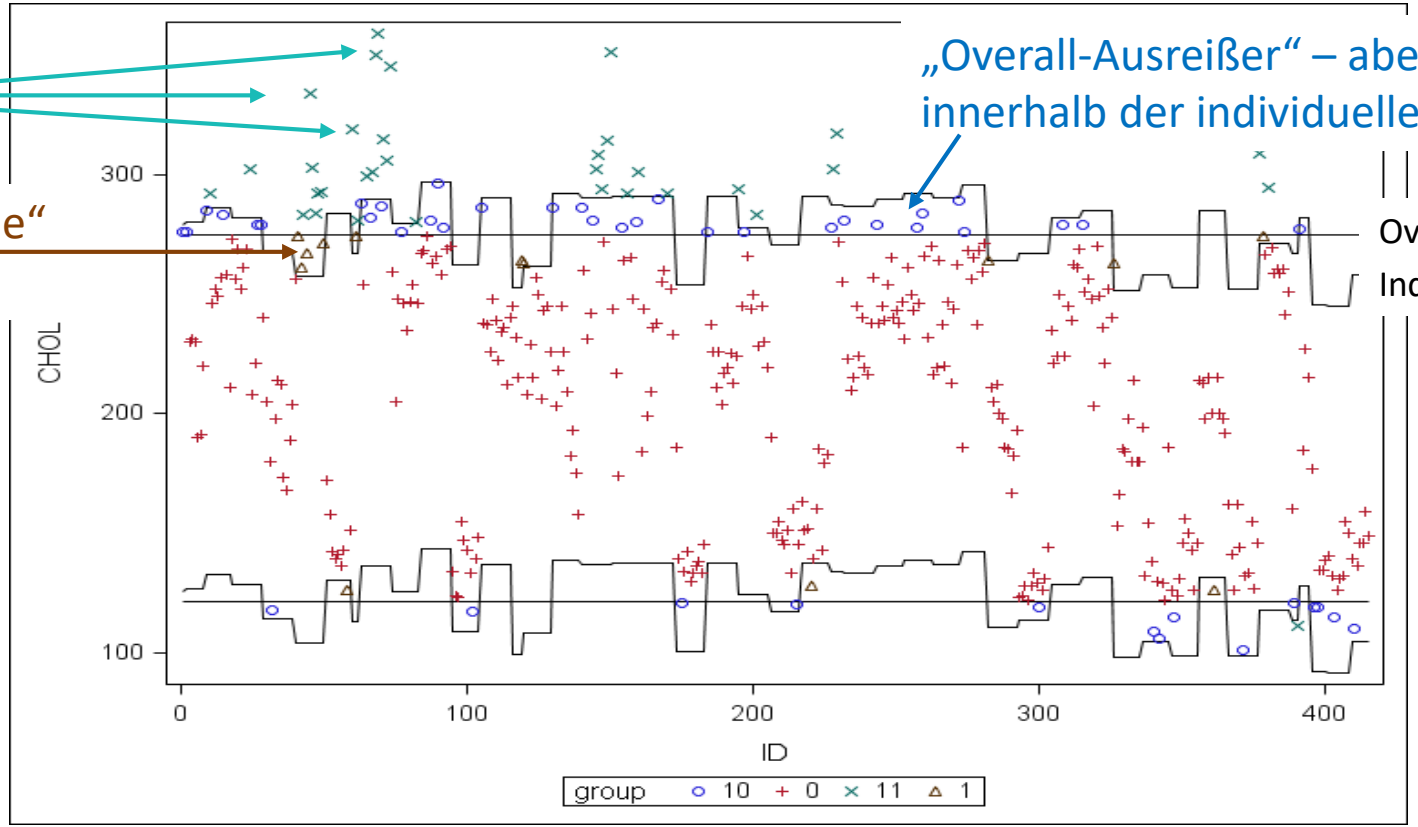


„Alle deren Wert größer x ist, sind Ausreißer! - Wirklich?“

Ausreißer

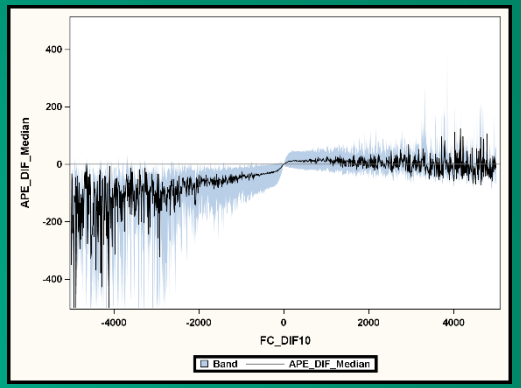
„Übersehene“ Ausreißer

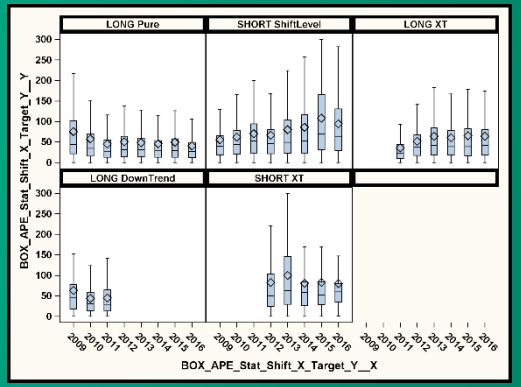
„Overall-Ausreißer“ – aber innerhalb der individuellen Limits



Data Science in Action: #4

Explaining Forecast Errors and Deviations



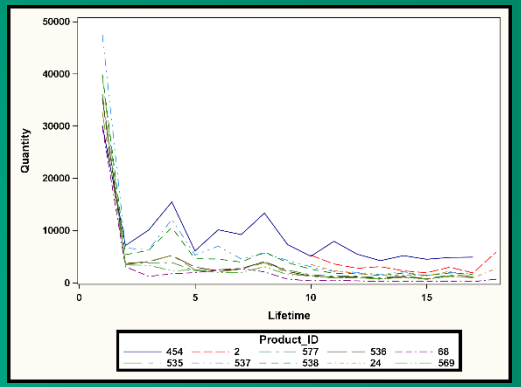


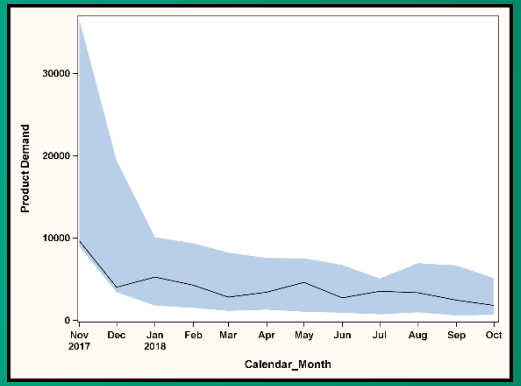
Do the demand planners really improve forecast accuracy with their manual overwrites?

Linear Regression
Quantile Regression
Descriptive Statistics

Data Science in Action: #5

Forecasting the Demand for New Products





Can the expected demand of products that are introduced only right now be estimated for forecast planning?

Poisson Regression
Cluster Analysis
Similarity Search

NOVELTY FORECASTING

- Training data from previous collections
- Generalized linear model

- Predictors
  - Product attributes
  - Time-dependant influence factors
  - Number of shops
  - Actual order intake
  - Actual sell-through

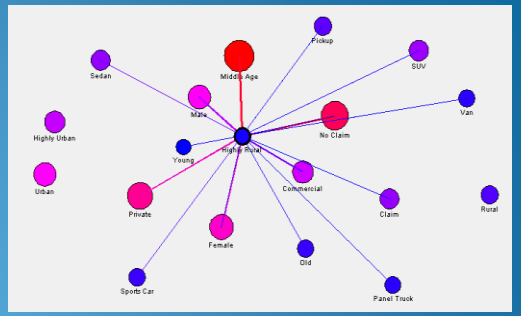
Nirvana ring

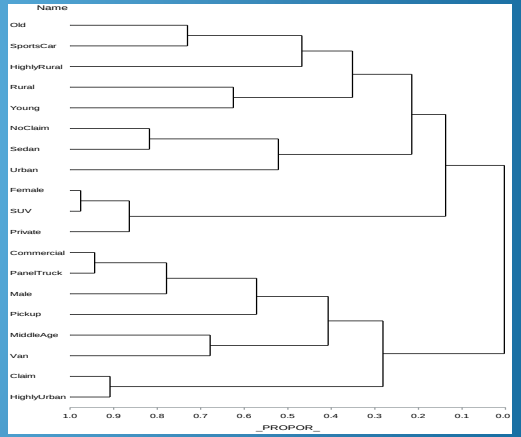
SWAROVSKI

Data Science in Action: #6

Listening to Your Data – Discover Relationships with Unsupervised Analysis Methods

Can your data tell you stories about your analysis subjects, even if you don't ask explicitly?





Unsupervised machine learning methods:
association analysis
variable clustering

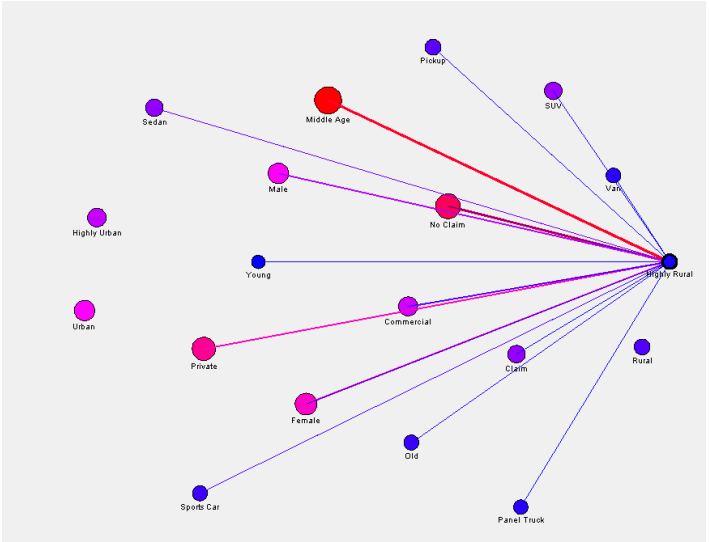
Lassen Sie ihre Daten sprechen!

Auffinden von Zusammenhängen in Ihren Analysedaten

- Daten aus der KFZ-Versicherung mit 6 Eigenschaften pro Versicherungsnehmer

Variable	Feature
AGE	YOUNG, MIDLIFE, OLD
GENDER	MALE, FEMALE
DENSITY	HIGHLY URBAN, URBAN, HIGHLY RURAL, RURAL
CAR_TYPE	VAN, SPORTS CAR, SUV, SEDAN, PICK UP
CAR_USAGE	PRIVATE, COMMERICIAL
CLM_FLAG	CLAIM, NO CLAIM

- Anwenden von unsupervised machine learning (Assoziationsanalyse) um Zusammenhänge zwischen den Eigenschaften aufzudecken.



Trauen Sie sich! Transponieren Sie die Daten, so wie Sie es sonst typischerweise nicht tun.

One-Row-Per-Subject

POLICYNO	CLM_FLAG	CAR_USE	CAR_TYPE	AGE	GENDER	DENSITY
160	No	Private	Sedan	60	M	Highly Urban
24836	No	Commercial	Sedan	43	M	Highly Urban
28046	No	Private	Van	48	M	Urban
28960	No	Private	SUV	35	F	Highly Urban
40933	No	Private	Sedan	51	M	Highly Urban
55277	No	Private	SUV	50	F	Urban
63212	Yes	Commercial	Sports Car	34	F	Highly Urban
69651	No	Private	SUV	54	F	Highly Urban
88070	Yes	Private	Sedan	40	M	Urban
93553	No	Commercial	SUV	44	F	Rural
127444	Yes	Commercial	Van	37	M	Highly Urban
141509	Yes	Private	SUV	34	F	Highly Urban
145326	No	Commercial	Van	50	M	Rural
146809	Yes	Private	Sports Car	53	F	Urban
148250	No	Private	Sedan	43	F	Rural
157851	No	Commercial	Van	55	M	Urban

Multple-Row-Per-Subject
Key-Value Tabelle

POLICYNO	Feature
160	Highly Urban
160	No Claim
160	Sedan
160	Private
160	Male
160	Old
24836	Highly Urban
24836	No Claim
24836	Sedan
24836	Commercial
24836	Male
24836	Middle Age

Lassen Sie ihre Daten sprechen!

Männer fahren kaum Sportwägen?

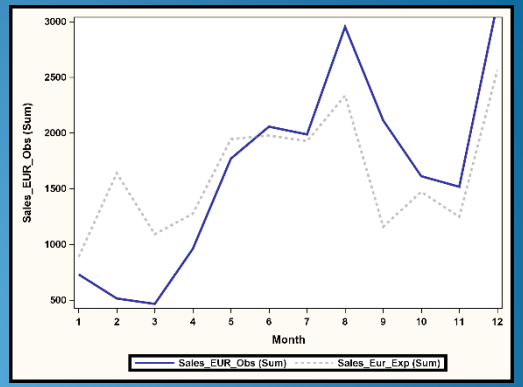
Regel 278 besagt, dass Sportwägen nur in 2,54 % der Fälle von Männern gefahren werden (erwartet wären 46 %)

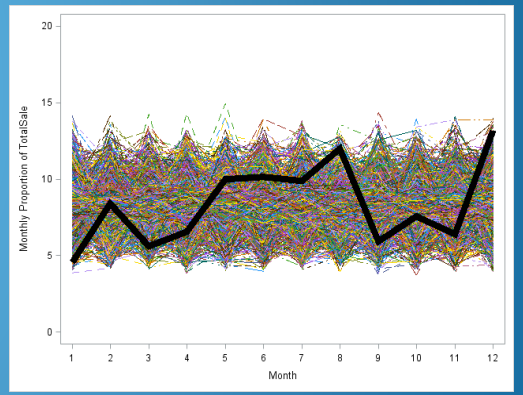
index	RULE	_LHAND	_RHAND	COUNT	SUPPORT	EXP_CONF	CONF	LIFT
267	Commercial ==> Sports Car	Commercial	Sports Car	200.00	1.94	11.44	5.28	0.46
268	Rural ==> Claim	Rural	Claim	102.00	0.99	26.66	6.52	0.24
269	Claim ==> Rural	Claim	Rural	102.00	0.99	15.18	3.71	0.24
270	Young ==> Highly Urban	Young	Highly Urban	10.00	0.10	34.93	8.33	0.24
271	Highly Rural ==> Claim	Highly Rural	Claim	32.00	0.31	26.66	6.30	0.24
272	Claim ==> Highly Rural	Claim	Highly Rural	32.00	0.31	4.93	1.17	0.24
273	Van ==> Female	Van	Female	117.00	1.14	53.82	12.70	0.24
274	Female ==> Van	Female	Van	117.00	1.14	8.94	2.11	0.24
275	Panel Truck ==> Female	Panel Truck	Female	40.00	0.39	53.82	4.69	0.09
276	Male ==> SUV	Male	SUV	99.00	0.96	27.98	2.08	0.07
277	SUV ==> Male	SUV	Male	99.00	0.96	46.18	3.43	0.07
278	Sports Car ==> Male	Sports Car	Male	30.00	0.29	46.18	2.54	0.06

- Kann anzeigen, dass in unserer Datenbasis tatsächlich Sportwägen in erster Linie von Frauen gefahren warden.
- Möglicherweise bietet ein Mitbewerber eine Polizze für Männer zu einem deutlich besseren Preis an.
- Ein fachliche Erklärung kann sein, dass der Sportwagen das 2. oder 3. Auto in der Familie ist, und dieser aus steuerlichen Gründe auf die Ehefrau registriert ist.
- Kann auch ein Trigger für eine detailliertere Analyse der Datenqualität sein.

Data Science in Action: #7

Checking the Alignment with Predefined Pattern





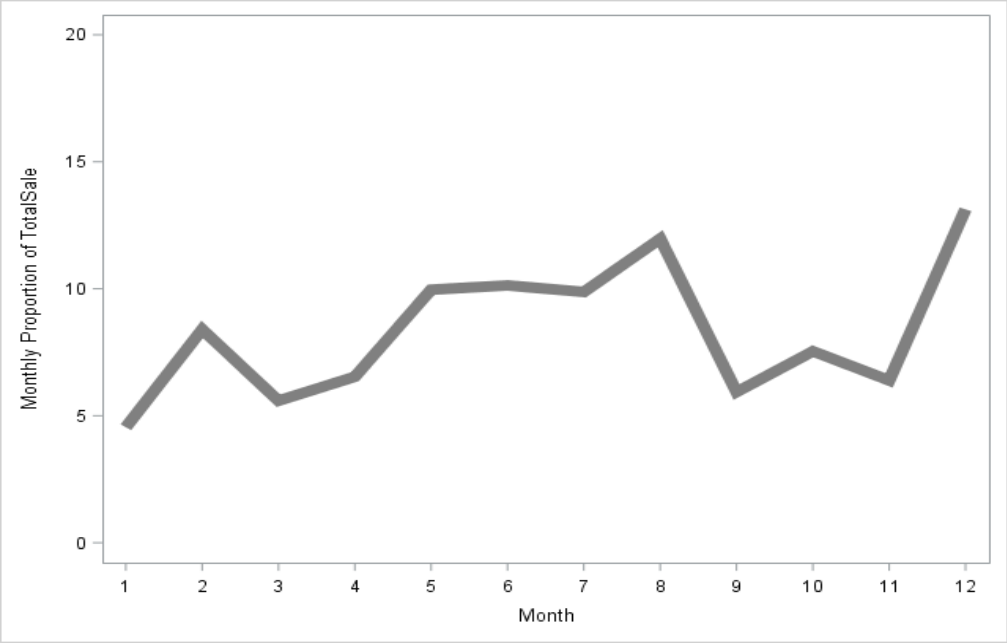
Which customers show a behavior that is far from what you expected?

Chi2 independency test
Benford's law
Time Series Similarity

“Welche meiner Verkäufer halten sich kaum an unsere Vorgaben?”

Der Bedarf an “Sub-Contracts” für ein Cateringunter-nehmen variiert im Verlauf eines Kalenderjahres

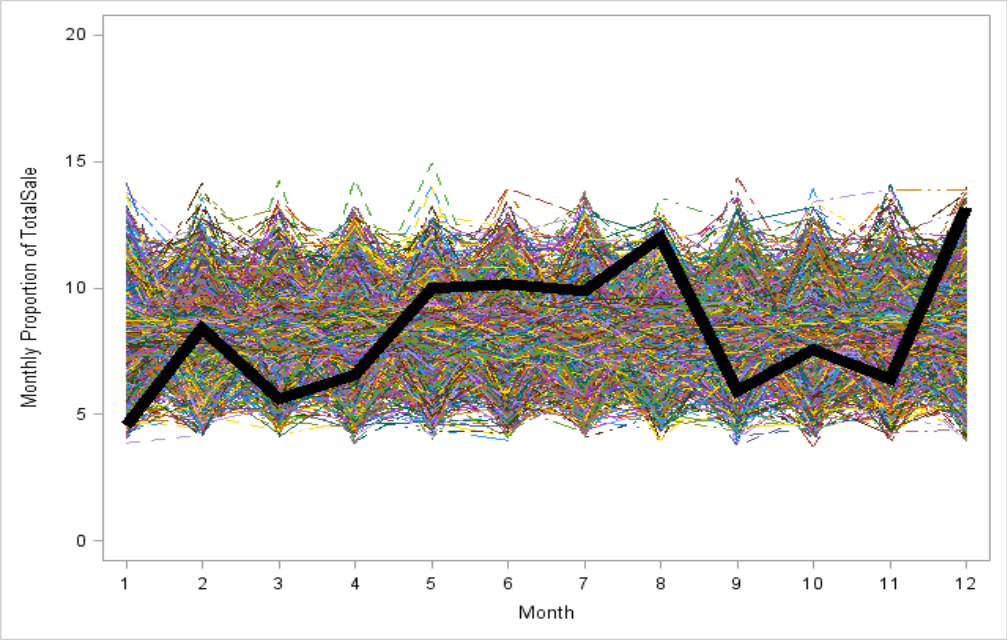
Verkäufer sind angehalten, entsprechend dieses Musters Verträge zu akquirieren.



Anzeige der Jahresverläufe pro Verkäufer hilft nicht wirklich

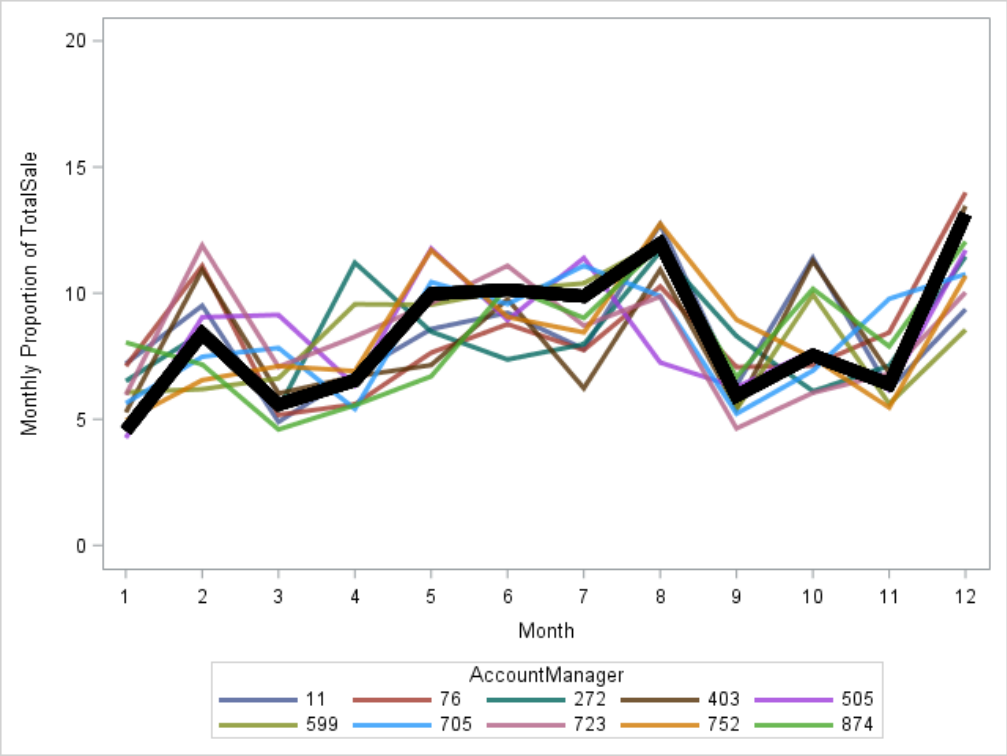
Kein klares Bild.

Unmöglich,
alle Linien einzeln
durchzusehen.



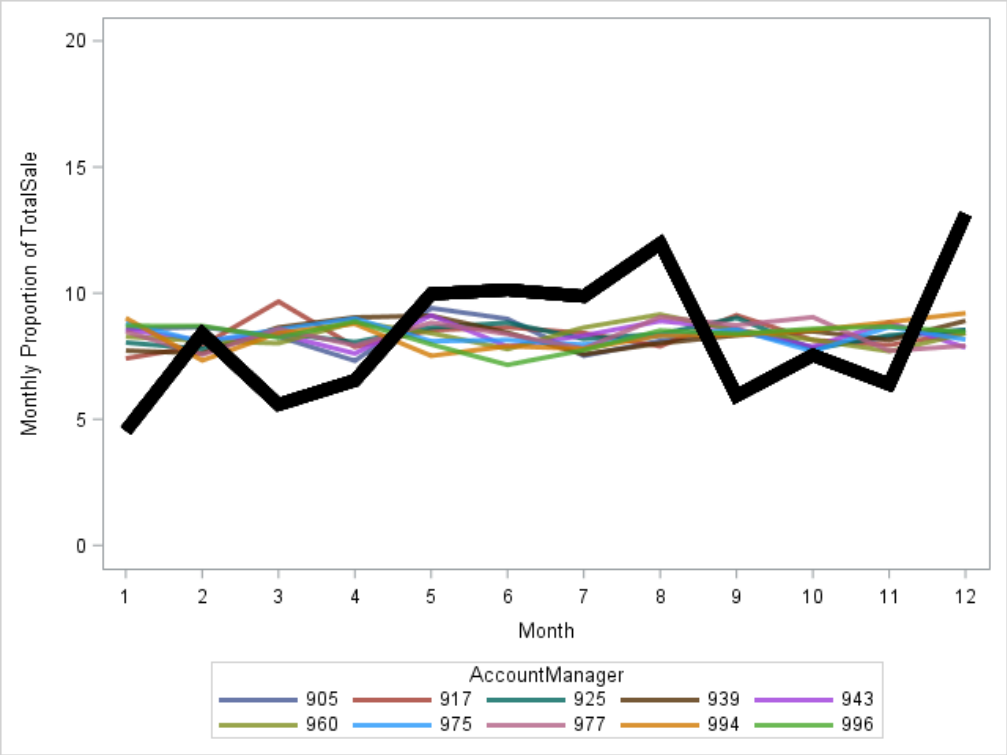
Ranking der Verkäufer mit analytischen Methoden (1)

Top 10 Verkäufer bzgl. “Alignment” mit der Vorgabe



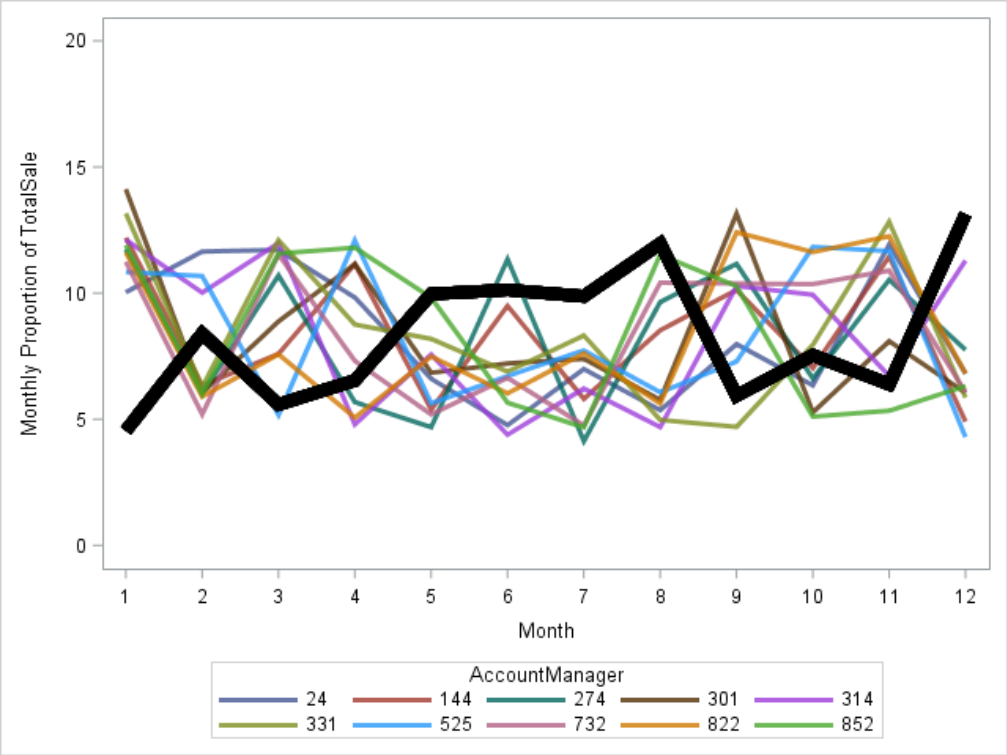
Ranking der Verkäufer mit analytischen Methoden (2)

Top 10 Verkäufer, für die es keine saisonale Variation gibt.

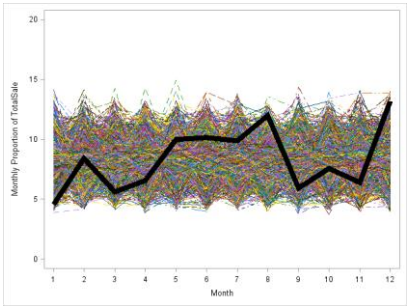


Ranking der Verkäufer mit analytischen Methoden (3)

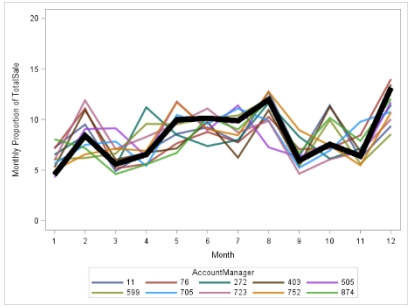
Top 10 Verkäufer die “gegen” das Muster arbeiten

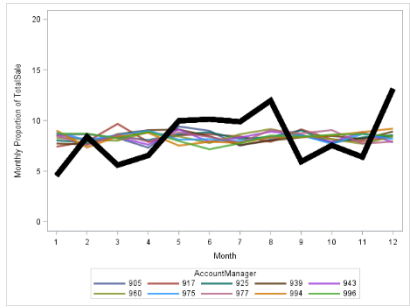


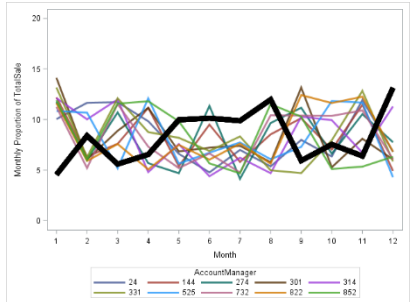
Analytik hilft mir, ein klareres Bild zu gewinnen!



Data Science Methoden





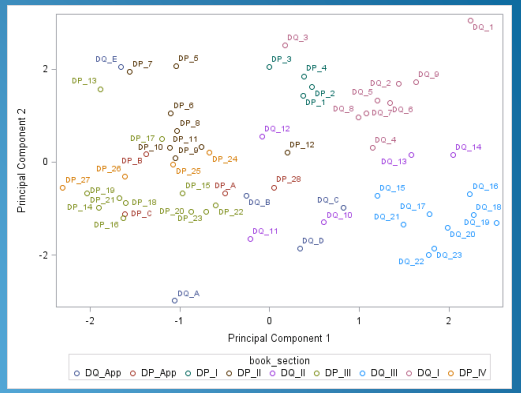


Vom „Rauschen“

zu interpretierbaren Segmenten

Data Science in Action: #8

Topic Search Documents and Clustering



Can I automatically find clusters of documents with similar content?

Text Mining
Text Parsing (Synonyme, Stemming, Stop-Listen)
Term by Document Weights

Kann ich ähnliche Kapitel erkennen, ohne die Bücher (von Gerhard ☺) erst lesen zu müssen?

Topic > +access,+file,+text,+relational,+relational database

PAGE 104 Data Preparation for Analytics Using SAS Chapter 13: Accessing Data PAGE 103 Part 3 Data Mart Coding and Content Chapter 13 Acces
Transposing One- and Multiple-Rows-per-Subject Data Structures 115 Chapter 15 Transposing Longitudinal Data 131 Chapter 16 Transformations of
Chapter 17 Transformations of Categorical Variables 161 Chapter 18 Multiple Interval-Scaled Observations per Subject 179 Chapter 19 Multiple Catego

PAGE 38 Data Preparation for Analytics Using SAS Chapter 5: The Origin of Data PAGE 43 Part 2 Data Structures and Data Modeling Chapter 5 The
Models 45 Chapter 7 Analysis Subjects and Multiple Observations 51 Chapter 8 The One-Row-per-Subject Data Mart 61 Chapter 9 The Multiple-Rows-p
Data Structures for Longitudinal Analysis 77 Chapter 11 Considerations for Data Marts 89 Chapter 12 Considerations for Predictive Modeling 95 Introdu

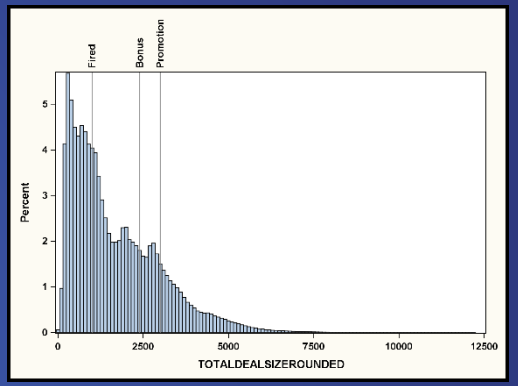
PAGE 178 Data Preparation for Analytics Using SAS Chapter 17: Transformations of Categorical Variables PAGE 177 Chapter 17 Transformations
Introduction 17.2 General Considerations for Categorical Variables 162 17.3 Derived Variables 164 17.4 Combining Categories 166 17.5 Dummy Codi
Multidimensional Categorical Variables 172 17.7 Lookup Tables and External Data 176 17.1 Introduction In this chapter we will deal with transformatio

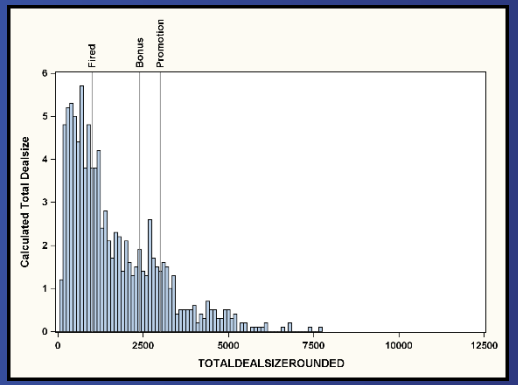
40 Data Quality for Analytics Using SAS Chapter 3: Data Availability 41 Chapter 3: Data Availability 3.1 Introduction 32 3.2 General Considerations 32 Re
data availability 32 Availability and usability 32 Effort to make data available 33 Dependence on the operational process 33 Availability and alignment in t
of Historic Data 34 Categorization and examples of historic data 34 The length of the history 35 Customer event histories 35 Operational systems and a

PAGE 382 Data Preparation for Analytics Using SAS Appendix B: The Power of SAS for Analytic Data Preparation PAGE 381 Appendix B The Power
369B.1 Motivation B.2 Overview 370 B.3 Extracting Data from Source Systems 371 B.4 Changing the Data Mart Structure: Transposing 371 B.5 Data Mar
Multiple-Rows-per-Subject Data Sets 372 B.6 Selected Features of the SAS Language for Data Management 375 B.7 Benefits of the SAS Macro Langu

Data Science in Action: #9

Using Monte Carlo Simulations to Understand the Outcome Distribution





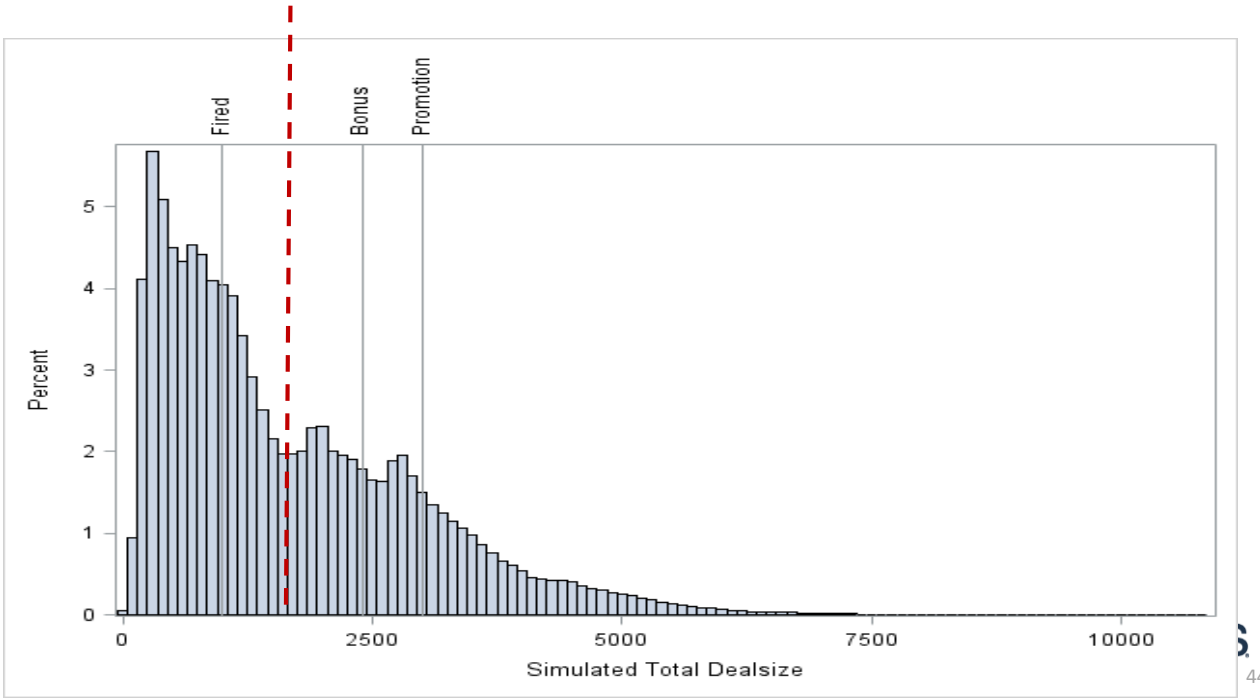
When the sales manager looks at the project pipeline, does the sum of weighted averages give him or her a full picture?

Monte Carlo simulations
Mathematical programming

Wird der Sales Manager seinen Job behalten?

ProjectID	DealSize (1000 $)	Proba-bility
1	1500	10%
2	10	65%
3	500	20%
4	50	50%
5	100	40%
6	30	90%
7	10	60%
8	150	20%
9	200	25%
10	180	10%
11	900	10%
12	750	20%
13	600	10%
14	320	20%
15	100	40%
16	50	80%
17	2000	5%
18	400	20%
19	2500	10%
20	1700	15%

Gewichtetes Mittel:
$ 1.661.500

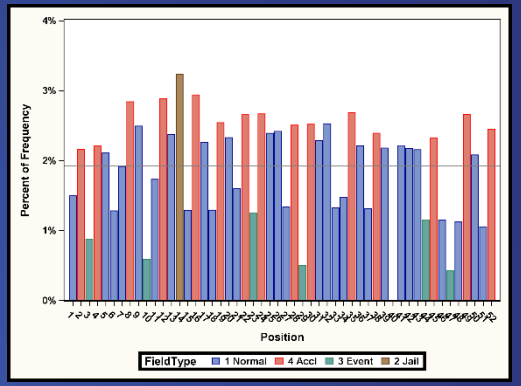


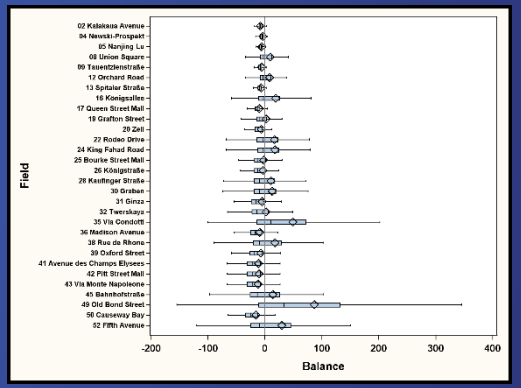
Data Science
in Action: #10

Studying Complex Systems – Simulating the Monopoly Board Game

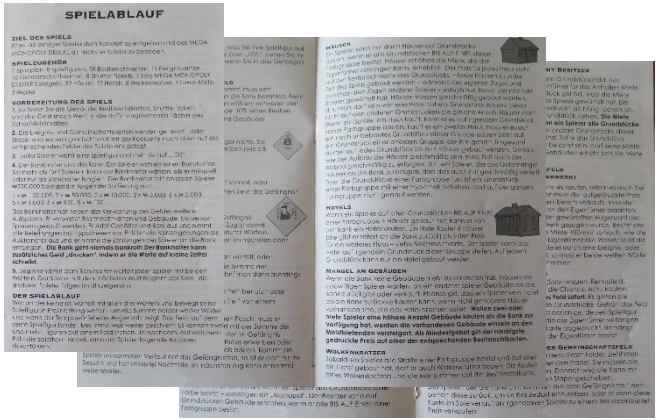
How can you simulate complex environments to get insight in the most frequent processes?

Monte Carlo Simulations

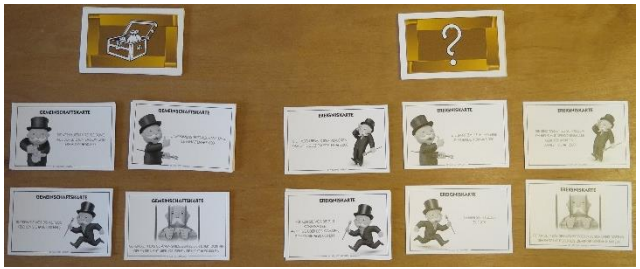




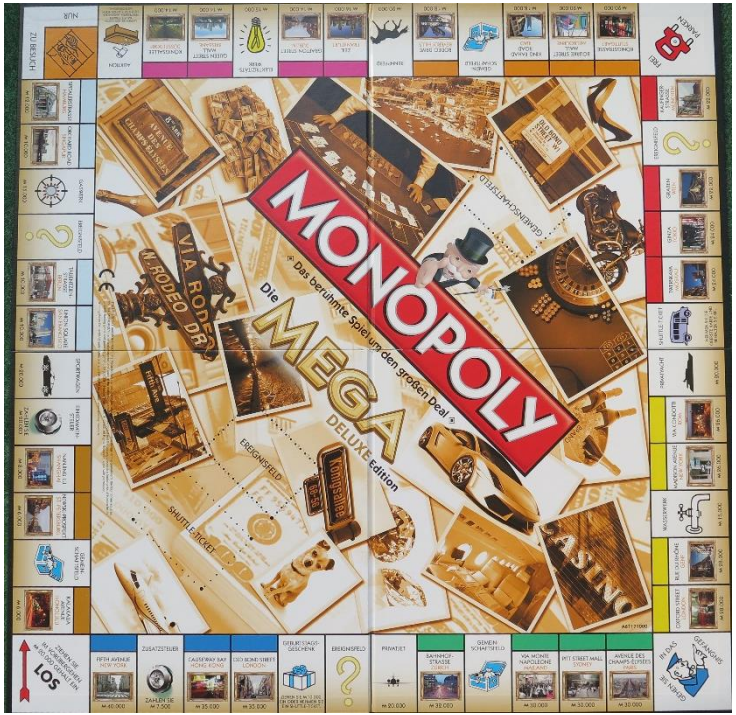
Das Monopoly Spiel ist vielen Frameworks im Geschäftsleben gar nicht so unähnlich



Komplexe Regeln



Zusätzliche Anweisungen



Rahmenwerk von Möglichkeiten und Ereignissen

Monetäre Dimension

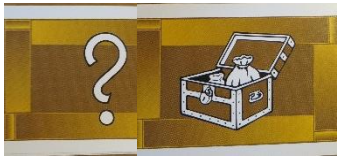
Dynamische Komponenten

Zufällige Komponenten

Simulation komplexer Prozesse erlaubt mir Einblick in Zusammenhänge (die ich sonst nicht gesehen hätte)

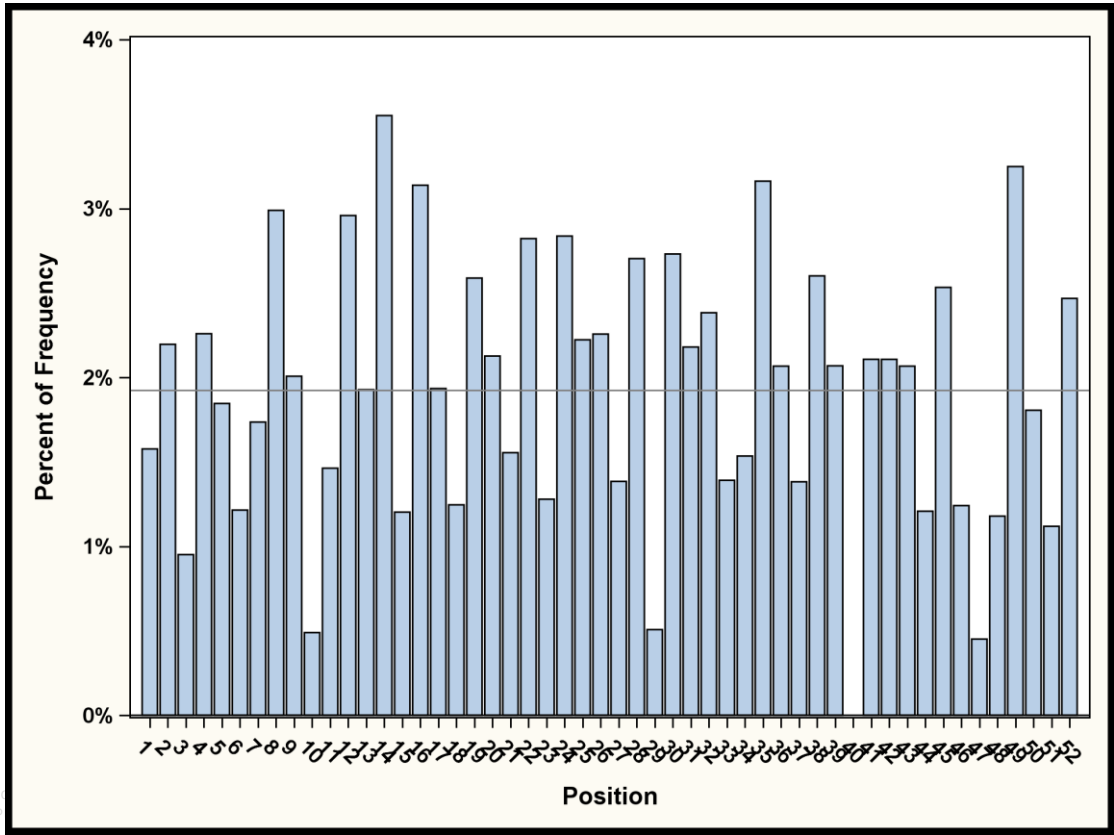
Würfel-Summe

Gehe ins Gefängnis!



Ereignis Felder

Accelerator Würfel



Key Takeaways

Analytics und Data Science sind da um Ihnen zu helfen!

- Sie sehen ein klareres, objektiveres Bild Ihrer Daten und Analyse-Subjekte
- Sie erhalten explizite Ergebnisse anstatt die Nadel im Heuhaufen zu suchen
- Die Daten sprechen zu Ihnen und Sie erhalten die Ergebnisse automatisch statt manuell
- Do it again! – Behandeln Sie Ihre Modelle als “Asset” und wiederholen Sie Ihre Analyse

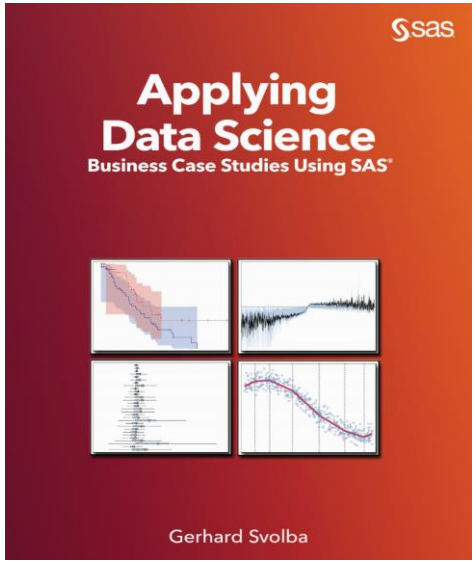
Machine Learning and Data Science sind das Kernstück der SAS Analytic Platform

- Umfassendes Set an Methoden – Entdecken und Produktivstellen
- Offen für unterschiedliche Benutzertypen (Coding, Point&Click, SAS, R, Python, …)

More Information

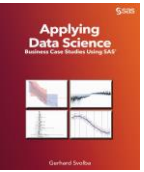
Gerhard Svolba – Principal Analytic Solutions Architect

sastools.by.gerhard@gmx.net



- Applying Data Science – Business Case Studies Using SAS, SAS Press 2017
- Eight Case Studies showing how Data Science and Analytics can be applied to provide insight into yout data and improve your business decisions
- http://www.sascommunity.org/wiki/Applying_Data_Science_-_Business_Case_Studies_Using_SAS

Further Links and Downloads



- Cases #1-2, 4-7, 9-10:
  - http://www.sascommunity.org/wiki/Applying_Data_Science_-_Business_Case_Studies_Using_SAS
  - http://www.sascommunity.org/wiki/DOWNLOAD_SECTION:_Applying_Data_Science_-_Business_Case_Studies_Using_SAS
- #1 – Survival
  - *SAS/STAT® 14.2 User's Guide. The LIFETEST Procedure*. http://support.sas.com/documentation/onlinedoc/stat/142/lifetest.pdf (accessed 1 March 2017).
  - Allison, P. 1995. *Survival Analysis Using SAS®: A Practical Guide, Second Edition*. Cary, NC: SAS Institute Inc.
- #2 – Detecting Breakpoints and Outliers
  - Kuhfeld, W., and W. Cai. 2013. "Introducing the New ADAPTIVEREG Procedure for Adaptive Regression." SAS Global Forum Proceedings. http://support.sas.com/resources/papers/proceedings13/457-2013.pdf (Paper 457-2013).
- #3 – Individual Reference Values: http://www.sascommunity.org/wiki/Data_Quality_for_Analytics
- #4 – Forecast Error Analysis
  - SGF2018 – Paper 1673 - *Getting More Insight into Your Forecast Errors with the GLMSELECT and QUANTSELECT Procedures*
  - KSFE 2015: Gerhard Svolba: Mehr als linear oder logistisch – ausgewählte Möglichkeiten neuer Regressionsmethoden in SAS - Download the presentation and the paper

Further Links and Downloads (Forts.)

- #6 – Feature Data Mining: http://www.sascommunity.org/wiki/Data_Preparation_for_Analytics
- #8 – Text Mining
  - KSFE 2017 : Beitrag „SAS Text Analytics findet Zusammenhänge in Texten – Ergebnisse eines Selbstversuchs“
  - SAS Club 2015: SAS Contextual Analysis in Action – Erfahrungen aus einem Selbstversuch
- #9 – Sales Manager Simulation
  - SAS Club : 2016, Mihai Paunescu: Simulationen und Mathematische Programmierung mit SAS
  - KSFE 2018 (to be prepared)
- #10 – Monopoly Simulation
  - KSFE 2017 : "Gewinnen beim Monopoly® Spiel – Alles nur Zufall? Oder gibt es doch ein paar Muster, die man kennen sollte?"
  - SAS Club 2007: Simulationen und Monte-Carlo Analysen mit SAS

SAS Tipps und Tricks Session

Mihai Paunescu (Bundesministerium für Finanzen)

Gerhard Svolba (SAS)

Listen to Your Data!

Unsupervised Machine Learning Techniken zeigen Ihnen Zusammenhänge in Ihren Daten

(Mihai Paunescu)

Lassen Sie ihre Daten sprechen!

Auffinden von Zusammenhängen in Ihren Analysedaten

- Daten aus der KFZ-Versicherung mit 6 Eigenschaften pro Versicherungsnehmer

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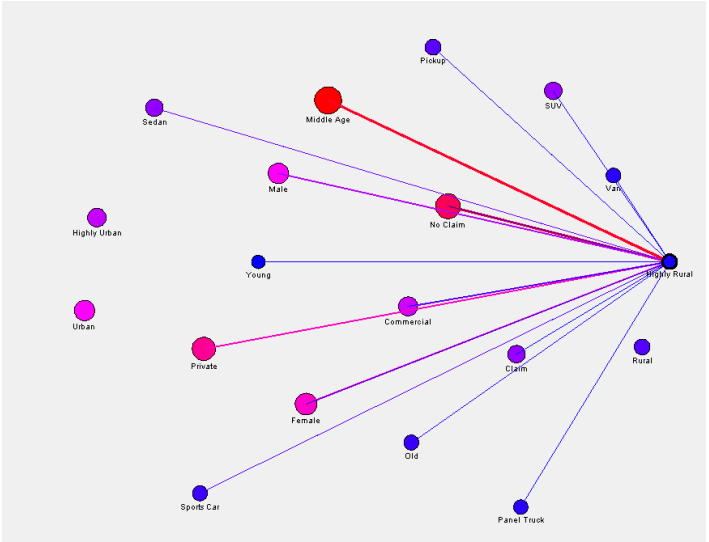
- Anwenden von unsupervised machine learning (Assoziationsanalyse) um Zusammenhänge zwischen den Eigenschaften aufzudecken.



Vorbereitung der Daten: von one-row-per subject in eine multiple-row-per-subject Struktur

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160	Old
24836	Highly Urban
24836	No Claim
24836	Sedan
24836	Commercial
24836	Male
24836	Middle Age

Vorbereitung der Daten: von one-row-per subject in eine multiple-row-per-subject Struktur: SAS Code

SAS Datastep

```
data claims_feature(keep = policyno
                           feature);
 set claims_nodup;
 format Feature $40.;
 *** 1. Gender;
 if gender = 'M' then Feature = 'Male';
  else Feature = 'Female';
 output;
*** 2. Age;
 if 0 < Age < 26 then feature = 'Young';
  else if 26 <= age <= 55 then feature =
   'Middle Age';
  else feature = 'Old';
 output;
 *** 3. Density;
 feature = Density; output;
 *** 4. Car Type;
 feature = Car_type; output;
 *** 5. Car Use;
 feature = Car_use; output;
 *** 6. Claim Flag;
 if clm_flag = 'Yes' then feature =
   'Claim';
 else feature = 'No Claim';
 output;
run;
```

oder

PROC TRANSPOSE

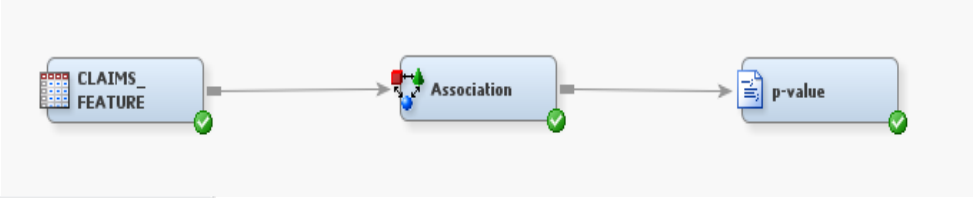
```
data claims_nodup2;
 set claims_nodup;
 Age=round(Age,10);
run;


proc transpose data=claims_nodup2
               out=claims_Long;
 by policyno ;
 var age gender Density car_type car_use
     clm_flag;
run;

data Key_Value(drop =_label_ col1
               rename=(_name_ = Key));
 set claims_Long;
  Value = strip(col1);
  Feature = catx('=',_name_,Value);
run;
```

Association Analysis zur Auffinden der Kombinationen

Unsupervised Machine Learning mit dem SAS Enterprise Miner



ID	claimsfeature
Name	CLAIMS_FEATURE
Variables	
Decisions	
Role	Transaction

Variables - CLAIMS_FEATURE

(Ohne) not Ist gleich

Columns: Label

Name	Role	Level
Feature	**Target**	**Nominal**
POLICYNO	**ID**	**Interval**

Association	
Maximum Items	2
Minimum Confidence Level	1
Support Type	Count
Support Count	1
Support Percentage	5.0
Sequence	
Rules	
Number to Keep	10000
Sort Criterion	Default
Number to Transpose	5000
Export Rule by ID	No
Recommendation	No

Lassen Sie ihre Daten sprechen!

Männer fahren keine Sportwägen?

Rule 278 shows that sports cars are only driven in 2.54% of the cases by men, whereas this was expected in around 46% of the cases.

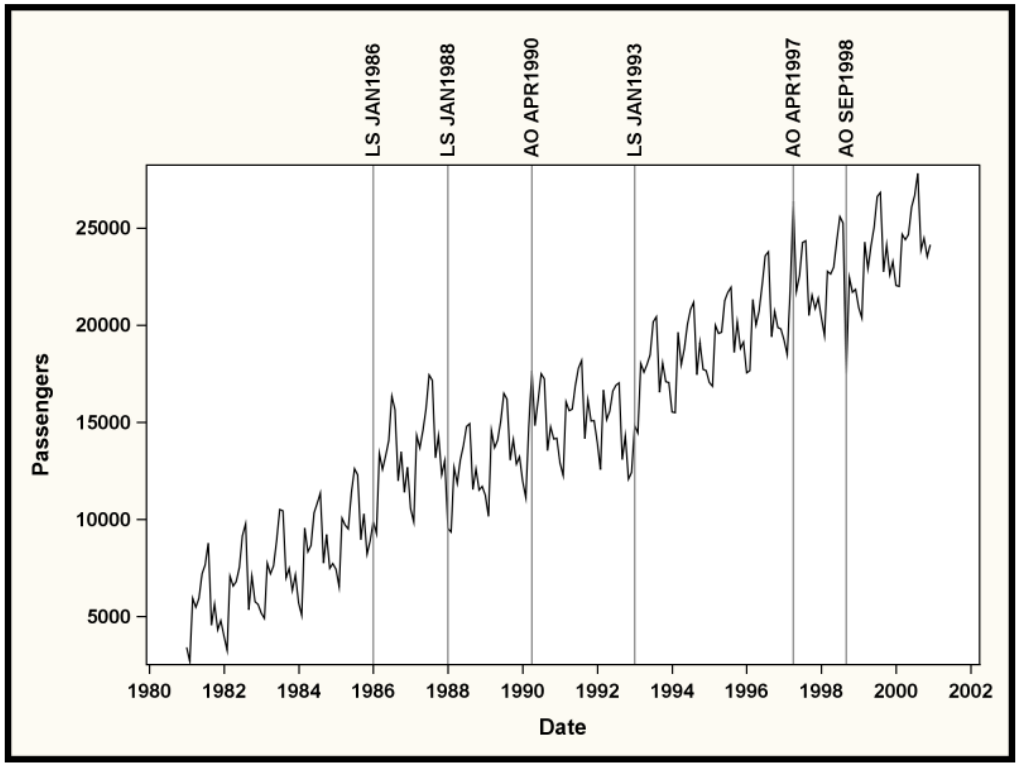
index	RULE	_LHAND	_RHAND	COUNT	SUPPORT	EXP_CONF	CONF	LIFT
267	Commercial ==> Sports Car	Commercial	Sports Car	200.00	1.94	11.44	5.28	0.46
268	Rural ==> Claim	Rural	Claim	102.00	0.99	26.66	6.52	0.24
269	Claim ==> Rural	Claim	Rural	102.00	0.99	15.18	3.71	0.24
270	Young ==> Highly Urban	Young	Highly Urban	10.00	0.10	34.93	8.33	0.24
271	Highly Rural ==> Claim	Highly Rural	Claim	32.00	0.31	26.66	6.30	0.24
272	Claim ==> Highly Rural	Claim	Highly Rural	32.00	0.31	4.93	1.17	0.24
273	Van ==> Female	Van	Female	117.00	1.14	53.82	12.70	0.24
274	Female ==> Van	Female	Van	117.00	1.14	8.94	2.11	0.24
275	Panel Truck ==> Female	Panel Truck	Female	40.00	0.39	53.82	4.69	0.09
276	Male ==> SUV	Male	SUV	99.00	0.96	27.98	2.08	0.07
277	SUV ==> Male	SUV	Male	99.00	0.96	46.18	3.43	0.07
278	Sports Car ==> Male	Sports Car	Male	30.00	0.29	46.18	2.54	0.06

- This might indicate a situation that for the customer base, sports cars are really predominantly driven by women.
- It could be a trigger to an investigation of the quality status of your data.
- A business interpretation could be that in a family, the sports car is the 2nd or 3rd car that is registered in the wife's name for financial reasons.
- The competitor is offering a policy to men for a much more attractive price.

Erzeugen Sie Ihre individuellen Simulationsdaten mit SAS

Erzeugen Sie Ihre individuellen Simulationsdaten mit SAS

- Saisonalität
- Trend
- Level Shifts
- Ausreißer



http://www.sascommunity.org/wiki/A_simple_and_powerful_way_to_simulate_your_individual_time_series_data

Erzeugen saisonaler Muster über Formate

```
proc format;
 invalue fl_mon
      1 =438
      2 =426
      3 =516
      4 =494
      5 =506
      6 =536
      7 =566
      8 =573
      9 =478
     10 =508
     11 =479
     12 =490;
run;
```

```
data flights_simul;
 *** Initialize the seed for the random number generator;
 call streaminit(20886); *** you can use any number;
 format Date yymmp7. Passengers 8.;
 drop year month;
  do Year = 1981 to 2000; *** Loop over Years;
     do month = 1 to 12;  *** Loop over Months;
        *** Prepare the TIME Variable;
        date = mdy(month,1,year);
        *** Use the INPUT function to retrieve values from the INFORMAT;
        passengers = (input(month, fl_mon.)-400)*40;
        *** Add a linear trend to the data;
        passengers =  Passengers + (year-1981[illegible])*1000;
        *** Add random variation to the dat[illegible]
        passengers = passengers + rand('[illegible]orm')*1000;
        *** Add outliers and level s[illegible]
        if year in (1986,1987) th[illegible]gers = passengers * 1.2;
        passengers =  Passeng[illegible]in (1992)) * (-month*300);
                                                  passengers * 1.25;
                                                  passengers * 0.8;
                                                  passengers * 1.2;
 e
run
```

Vermeidung ineffizienter „if then..:“ oder „case“ Konstrukte durch SAS Formate

Erzeugen von Trends

```
proc format;
 invalue fl_mon
      1 =438
      2 =426
      3 =516
      4 =494
      5 =506
      6 =536
      7 =566
      8 =573
      9 =478
     10 =508
     11 =479
     12 =490;
run;
```

```
data flights_simul;
 *** Initialize the seed for the random number generator;
 call streaminit(20886); *** you can use any number;
 format Date yymmp7. Passengers 8.;
 drop year month;
  do Year = 1981 to 2000; *** Loop over Years;
     do month = 1 to 12;  *** Loop over Months;
         *** Prepare the TIME Variable;
         date = mdy(month,1,year);
         *** Use the INPUT function to retrieve values from the INFORMAT;
         passengers = (input(month, fl_mon.)-400)*40;
         *** Add a linear trend to the data;
         passengers =  Passengers + (year-1981+1)*1000;
         *** Add random variation to the data;
         passengers = passengers + rand('uniform')*1000;
         *** Add outliers and level shifts;
         if year in (1986,1987) then passengers = passengers * 1.2;
         passengers =  Passengers + (year in (1992)) * (-month*300);
         if date = '01APR1997'd then passengers = passengers * 1.25;
         if date = '01SEP1998'd then passengers = passengers * 0.8;
         if date = '01APR1990'd then passengers = passengers * 1.2;
         *** Output the record;
         output;
     end;
  end;
run;
```

Erzeugen von Zufallsvariation

```
1  proc format;
2   invalue fl_mon
3        1 =438
4        2 =426
5        3 =516
6        4 =494
7        5 =506
8        6 =536
9        7 =566
10       8 =573
11       9 =478
12      10 =508
13      11 =479
14      12 =490;
15 run;
```

```
18 data flights_simul;
19  *** Initialize the seed for the random number generator;
20  call streaminit(20886); *** you can use any number;
21  format Date yymmp7. Passengers 8.;
22  drop year month;
23   do Year = 1981 to 2000; *** Loop over Years;
24      do month = 1 to 12;  *** Loop over Months;
25          *** Prepare the TIME Variable;
26          date = mdy(month,1,year);
27          *** Use the INPUT function to retrieve values from the INFORMAT;
28          passengers = (input(month, fl_mon.)-400)*40;
29          *** Add a linear trend to the data;
30          passengers =  Passengers + (year-1981+1)*1000;
31          *** Add random variation to the data;
32          passengers = passengers + rand('uniform')*1000;
33          *** Add outliers and level shifts;
34          if year in (1986,1987) then passengers = passengers * 1.2;
35          passengers =  Passengers + (year in (1992)) * (-month*300);
36          if date = '01APR1997'd then passengers = passengers * 1.25;
37          if date = '01SEP1998'd then passengers = passengers * 0.8;
38          if date = '01APR1990'd then passengers = passengers * 1.2;
39          *** Output the record;
40          output;
41      end;
42   end;
43 run;
```

Erzeugen von Shifts

```
1  proc format;
2   invalue fl_mon
3        1 =438
4        2 =426
5        3 =516
6        4 =494
7        5 =506
8        6 =536
9        7 =566
10       8 =573
11       9 =478
12      10 =508
13      11 =479
14      12 =490;
15 run;
```

```
18 data flights_simul;
19  *** Initialize the seed for the random number generator;
20  call streaminit(20886); *** you can use any number;
21  format Date yymmp7. Passengers 8.;
22  drop year month;
23   do Year = 1981 to 2000; *** Loop over Years;
24      do month = 1 to 12;  *** Loop over Months;
25          *** Prepare the TIME Variable;
26          date = mdy(month,1,year);
27          *** Use the INPUT function to retrieve values from the INFORMAT;
28          passengers = (input(month, fl_mon.)-400)*40;
29          *** Add a linear trend to the data;
30          passengers =  Passengers + (year-1981+1)*1000;
31          *** Add random variation to the data;
32          passengers = passengers + rand('uniform')*1000;
33          *** Add outliers and level shifts;
34          if year in (1986,1987) then passengers = passengers * 1.2;
35          passengers =  Passengers + (year in (1992)) * (-month*300);
36          if date = '01APR1997'd then passengers = passengers * 1.25;
37          if date = '01SEP1998'd then passengers = passengers * 0.8;
38          if date = '01APR1990'd then passengers = passengers * 1.2;
39          *** Output the record;
40          output;
41      end;
42   end;
43 run;
```

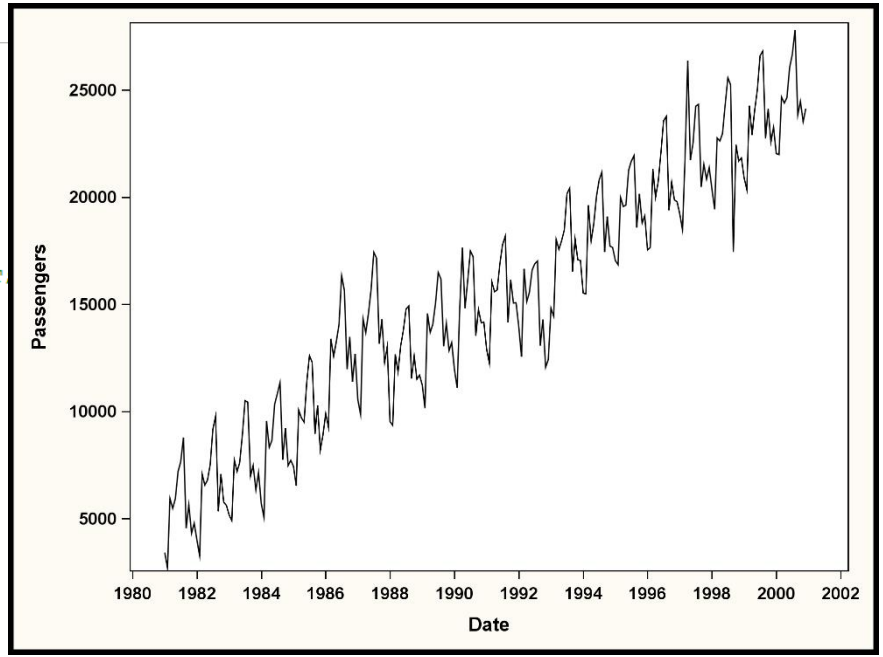
Erzeugen von Ausreißern

```
proc format;
 invalue fl_mon
      1 =438
      2 =426
      3 =516
      4 =494
      5 =506
      6 =536
      7 =566
      8 =573
      9 =478
     10 =508
     11 =479
     12 =490;
run;
```

```
data flights_simul;
 *** Initialize the seed for the random number generator;
 call streaminit(20886); *** you can use any number;
 format Date yymmp7. Passengers 8.;
 drop year month;
  do Year = 1981 to 2000; *** Loop over Years;
     do month = 1 to 12;  *** Loop over Months;
         *** Prepare the TIME Variable;
         date = mdy(month,1,year);
         *** Use the INPUT function to retrieve values from the INFORMAT;
         passengers = (input(month, fl_mon.)-400)*40;
         *** Add a linear trend to the data;
         passengers =  Passengers + (year-1981+1)*1000;
         *** Add random variation to the data;
         passengers = passengers + rand('uniform')*1000;
         *** Add outliers and level shifts;
         if year in (1986,1987) then passengers = passengers * 1.2;
         passengers =  Passengers + (year in (1992)) * (-month*300);
         if date = '01APR1997'd then passengers = passengers * 1.25;
         if date = '01SEP1998'd then passengers = passengers * 0.8;
         if date = '01APR1990'd then passengers = passengers * 1.2;
         *** Output the record;
         output;
     end;
  end;
run;
```

Plotten der Ergebnisse

```
18 data flights_simul;
19  *** Initialize the seed for the random number generator;
20  call streaminit(20886); *** you can use any number;
21  format Date yymmp7. Passengers 8.;
22  drop year month;
23   do Year = 1981 to 2000; *** Loop over Years;
24      do month = 1 to 12;  *** Loop over Months;
25          *** Prepare the TIME Variable;
26          date = mdy(month,1,year);
27          *** Use the INPUT function to retrieve values from the INFORMAT
28          passengers = (input(month, fl_mon.)-400)*40;
29          *** Add a linear trend to the data;
30          passengers =  Passengers + (year-1981+1)*1000;
31          *** Add random variation to the data;
32          passengers = passengers + rand('uniform')*1000;
33          *** Add outliers and level shifts;
34          if year in (1986,1987) then passengers = passengers * 1.2;
35          passengers =  Passengers + (year in (1992)) * (-month*300);
36          if date = '01APR1997'd then passengers = passengers * 1.25;
37          if date = '01SEP1998'd then passengers = passengers * 0.8;
38          if date = '01APR1990'd then passengers = passengers * 1.2;
39          *** Output the record;
40          output;
41      end;
42   end;
43 run;
```

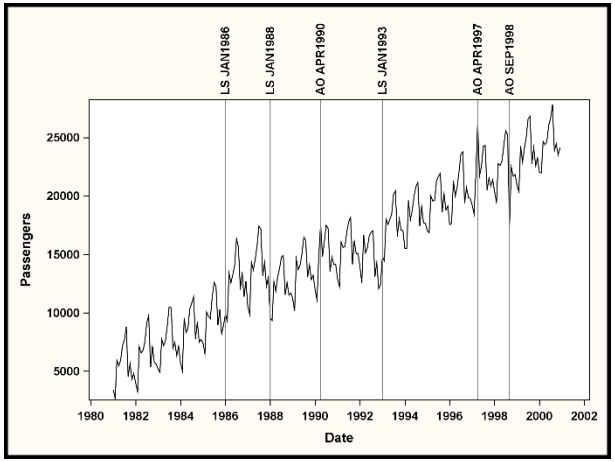



```
proc sgplot data=flights_simul;
 series x=date y=passengers;
run;
```

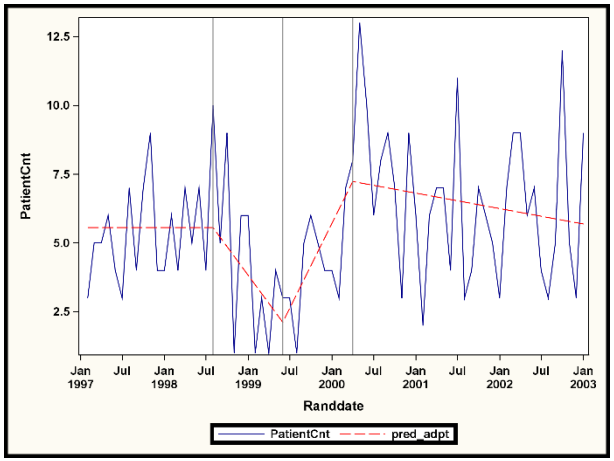
Automatisches Erkennen von Ausreißern und Break-Points mit SAS Analytics

Automatisches Erkennen von Breakpoints und Ausreißern

Anwenden von analytischen Methoden zum Erkennen von Zeitpunkten wo der Verlauf der Daten vom „normalen“ Muster abweicht.



Erkennen von Shifts und Pulse Events mit ARIMA Modellen



Verwenden von Multivariaten Regression Splines zum Auffinden von Bruchpunkten

Coding Tipp: Automatisches Anzeigen der vertikalen Referenz-Linien bei den jeweiligen Breakpoints (3 Schritte)

1

```
proc adaptivereg data=patients_1997_2002
                 plots=all details=bases ;
 format randdate date9.;
 model PatientsCnt = randdate  / maxbasis=100;
 output out=recruit_adpt predicted=pred;
 ods output BWDParams=BWDParams;
run;
```

	Name	Coefficient	Parent	Variable	Knot
1	Basis0	5.5580		Intercept	.
2	Basis1	0.02808	Basis0	Randdate	14396
3	Basis3	-0.01830	Basis0	Randdate	14701
4	Basis5	-0.01131	Basis0	Randdate	14092

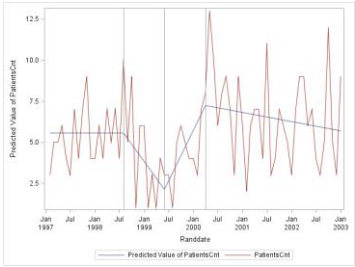
2

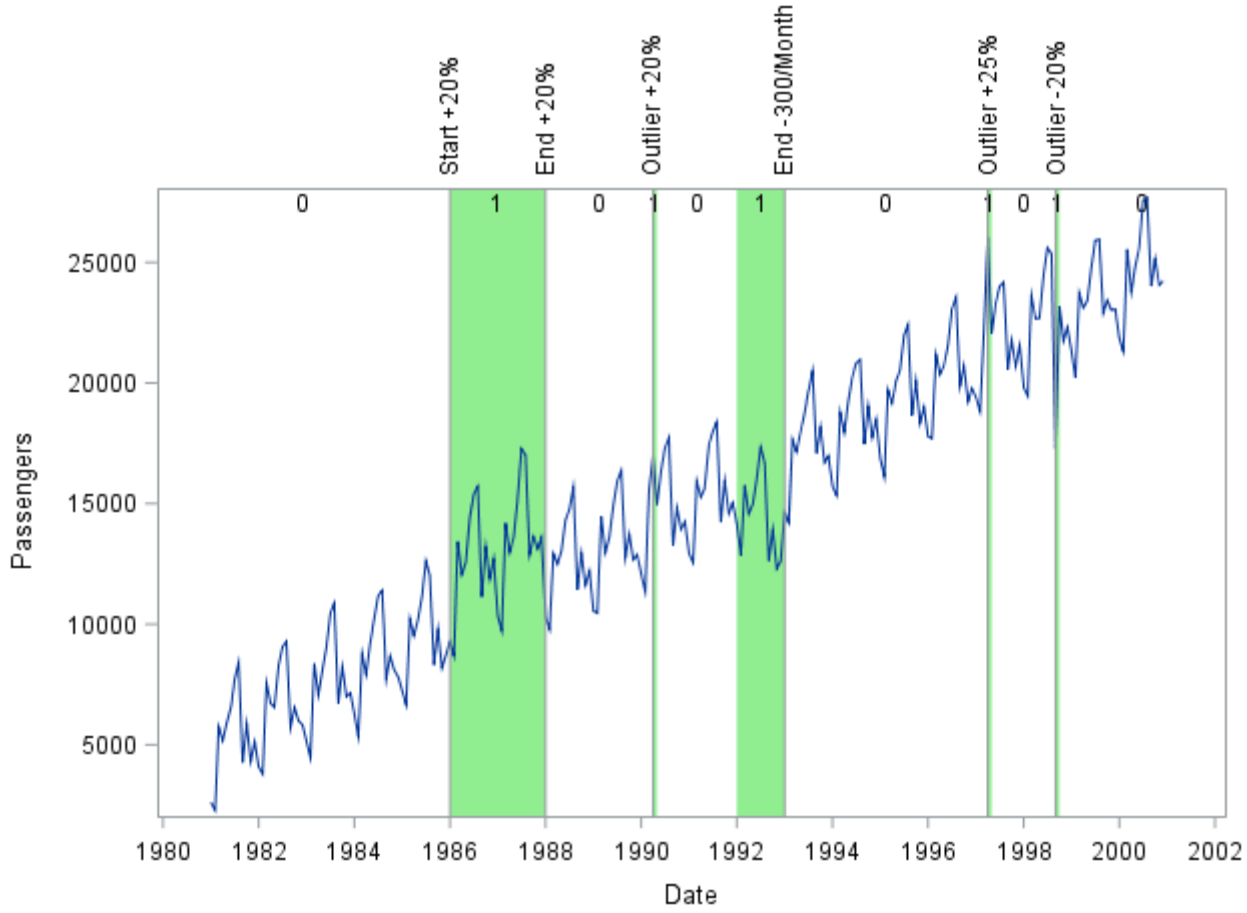
```
filename reflines 'c:/tmp/reflines.sas';
data _NULL_;
 set bwdparams;
 where upcase(variable) eq upcase('randdate');
 format knot 8.;
 file reflines;
  put @04 "refline " knot " / axis = x;";
run;
```

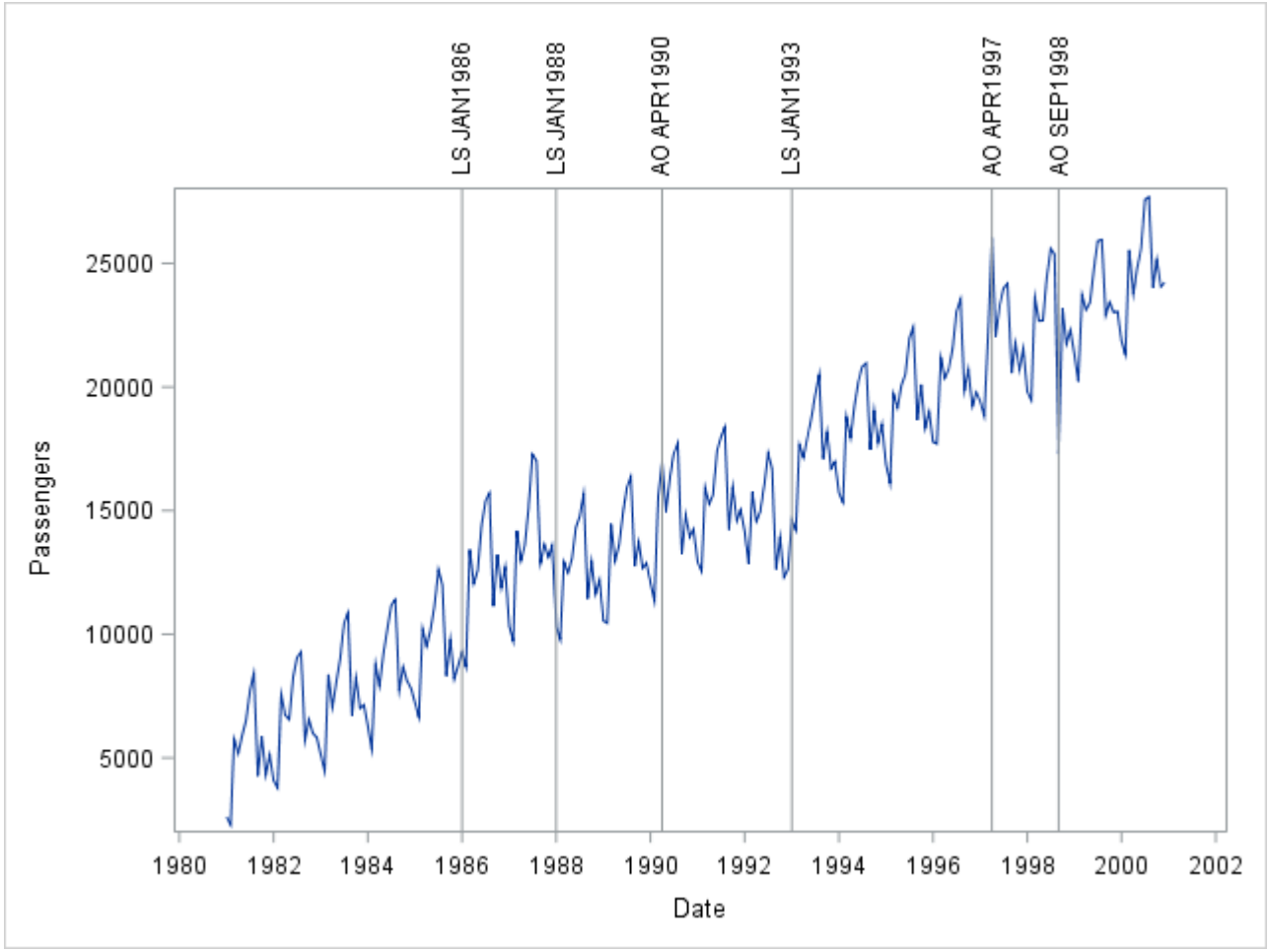
```
refline 14396  / axis = x;
refline 14701  / axis = x;
refline 14092  / axis = x;
```

3

```
proc sgplot data=recruit_adpt;
 series x=randdate y=pred;
 series x=randdate y=PatientsCnt;
 %include reflines;
run;
```






LS JAN1986
LS JAN1988
AO APR1990
LS JAN1993
AO APR1997
AO SEP1998
Passengers
25000
20000
15000
10000
5000
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
Date