



Forecasting with **SAP® APO DP?**

The Gap between Theory and Practice?

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SAP Easy Access Advanced Planning and Optimization

Menu Edit Favorites Extras System Help

Forecast in Interactive Planning; Change Mode

10001-00000-01

The chart displays demand data for the year 2008. The Y-axis represents demand volume, ranging from 0 to 45,000. The X-axis shows months from 3.08 to 1.13. A jagged orange line represents the actual demand, which fluctuates significantly, peaking at approximately 42,000 in late 2008. A smooth grey line represents the forecast, which follows the general upward trend of the demand. A green line shows a different forecast model, and a cyan line shows a sharp drop in demand in early 2009.

Month	Actual Demand (Approx.)	Forecast (Approx.)
3.08	0	0
4.08	10,000	8,000
1.09	18,000	10,000
2.09	15,000	11,000
3.09	18,000	12,000
4.09	22,000	13,000
1.10	20,000	14,000
2.10	23,000	15,000
3.10	22,000	16,000
4.10	20,000	17,000
1.11	18,000	17,000
2.11	20,000	18,000
3.11	18,000	18,000
4.11	42,000	18,000
1.12	25,000	18,000
2.12	23,000	18,000
3.12	18,000	18,000
4.12	18,000	18,000
1.13	18,000	18,000

Profile Model Horizons Parameters Forecast Errors Settings Messages Time Series

You have chosen the constant model

Exponential Smoothing or Mean Value Creation

With constant alpha Moving average
Alpha Factor: 0,10 Weighted moving average
Time Series: []

With alpha optimization
Error Measure: MAD
Alpha Start Value: 0,10 Alpha End Value: 0,50 Alpha Increment: 0,10

ST...

SAP | TAP (1) 001 | HAMA0170 | INS | 15:38

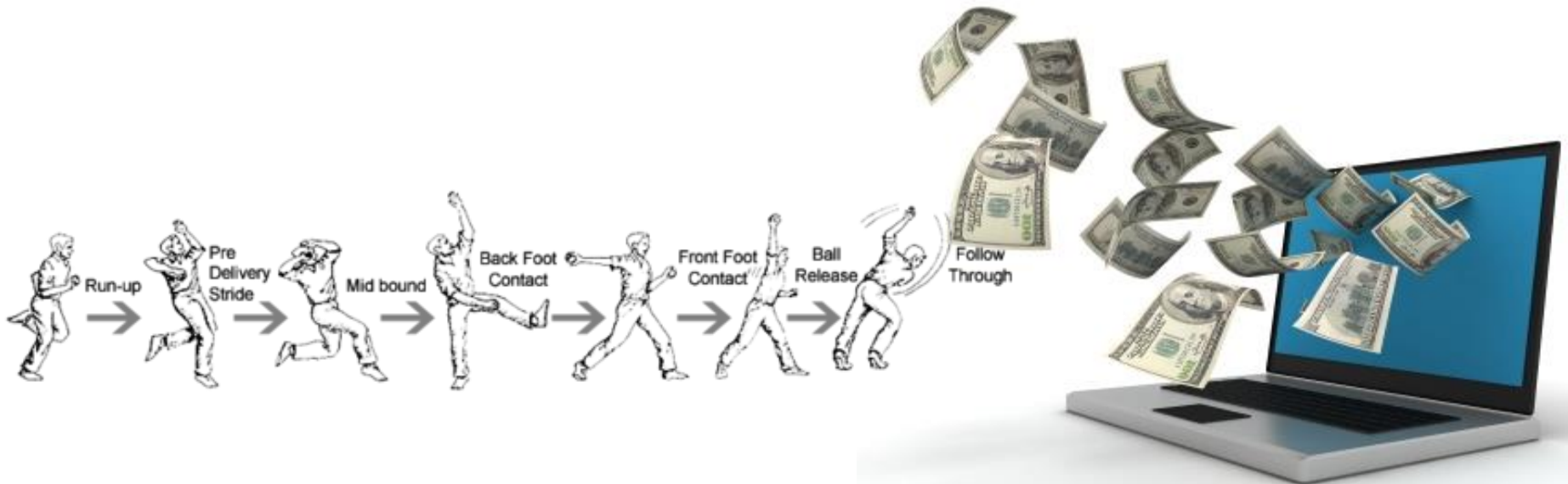


Disclaimer

***Slagging of IT is
always in fashion***

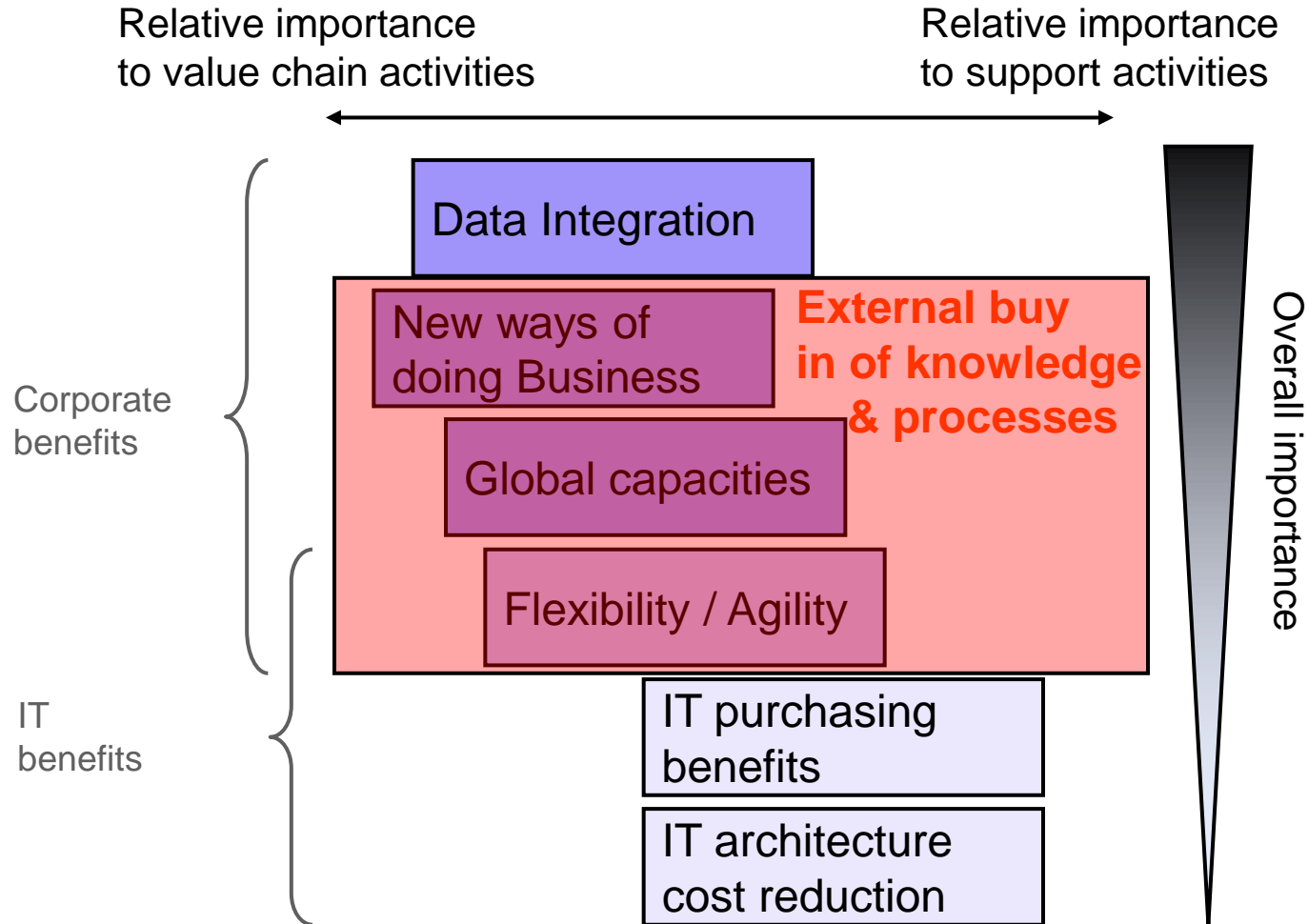
...

but its too simple!



Disclaimer

Objectives of ERP Systems



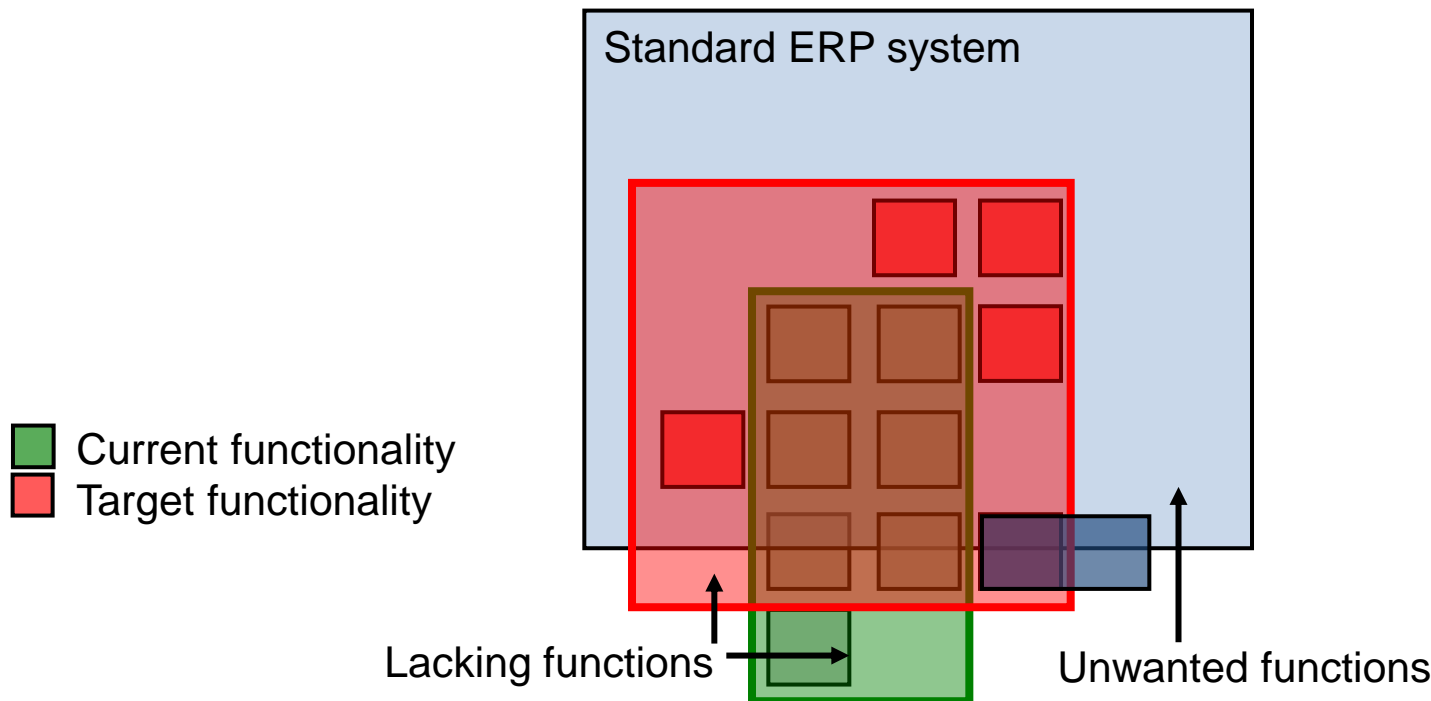
[Martin et al. (2002) p.182]

→ Functionality is only one of many aspects in ERP/APS implementation



System Design Objectives

- ERP / APS systems offer >3000% functionality
- Functionality is accessible in 1000+ “best practice” processes → customise
→ **normal implementation aims at 80%-85% coverage!**



→ 100% (or more) functionality is **NOT** the aim of standard ERP/APS systems!

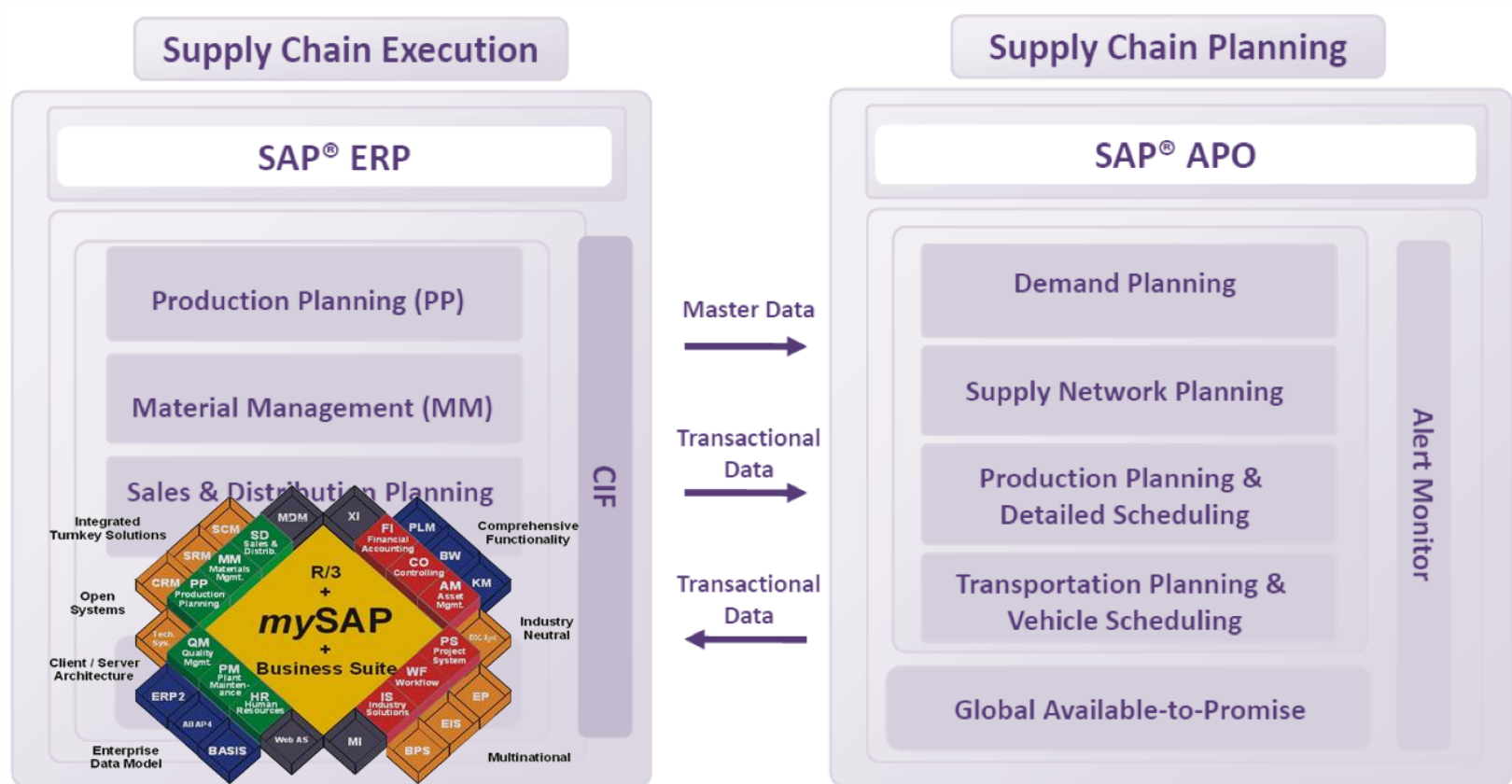


Disclaimer

Objectives of SAP APO

SAP APO is more than just a forecasting tool

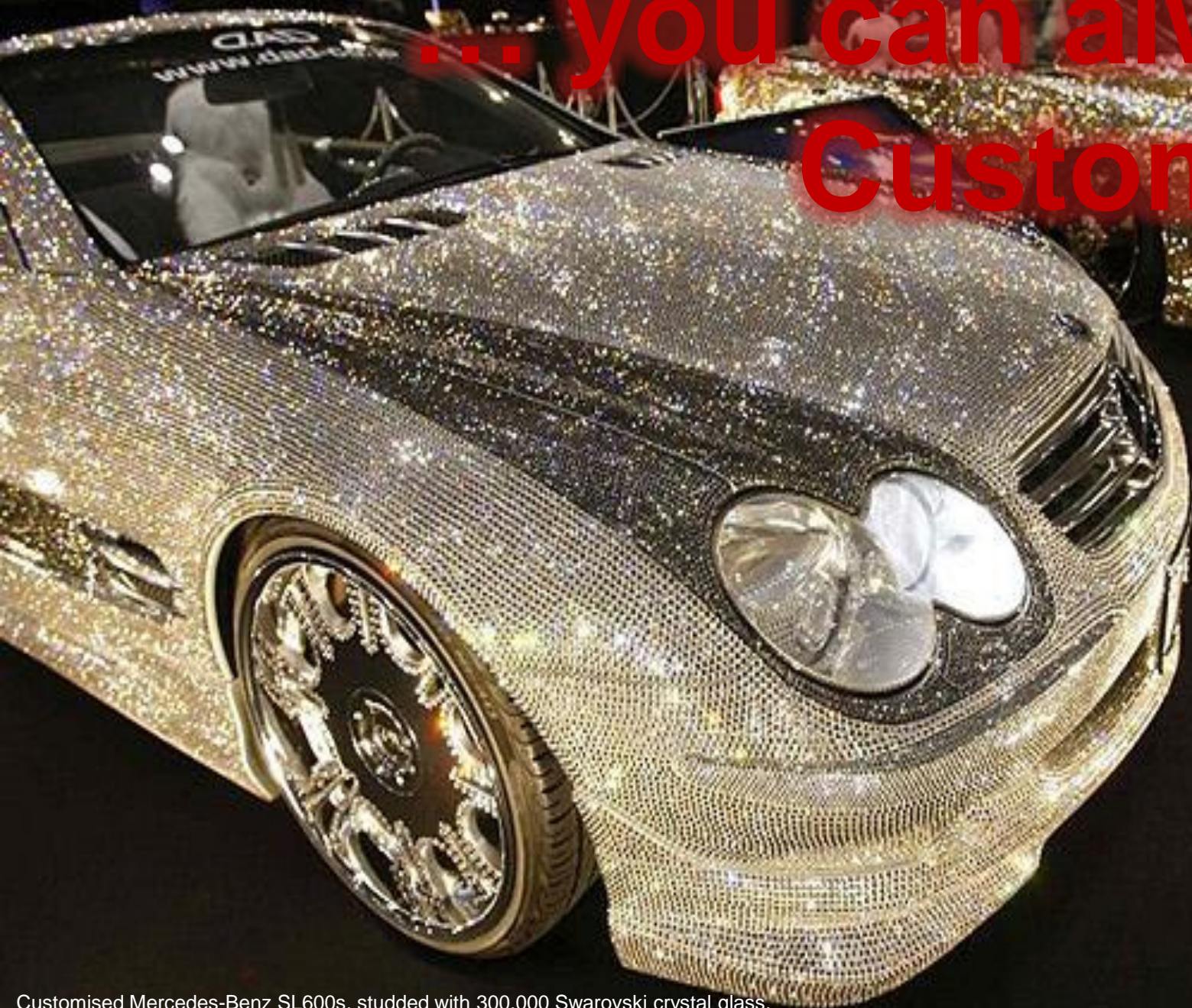
- Holistic integrated planning suite
- Communication with legacy systems



→ need to evaluate overall SAP® APO based on total functionality



... you can always
Customise!



Customised Mercedes-Benz SL600s, studded with 300,000 Swarovski crystal glass,

Disclaimer

Cases of misuse of SAP APO

“Buying the most expensive

Hammer ...

...does not make you

the best **Carpenter!**”



→ A forecasting system is only a *tool* in the hands of a forecaster!
→ Yields very different results by Craftstman vs. Novice (DP/IT)

Not today!



Forecasting with SAP® APO DP

1. Disclaimer
2. How do companies use APO DP?
 - Evidence from a survey
 - System(s), Orga, Setup, Methods ...!
3. “Best Practices” in APO DP?
 - Forecasting Science as benchmark
 - Data Exploration, Model Selection ...
 - Promo Forecasting, New Products ...



Study Methodology

Survey of Practitioners

• Questionnaire Design

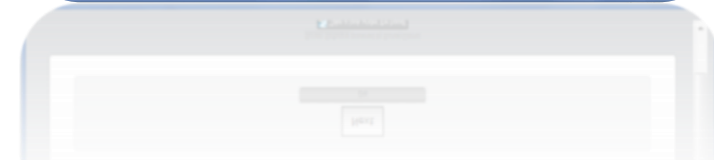
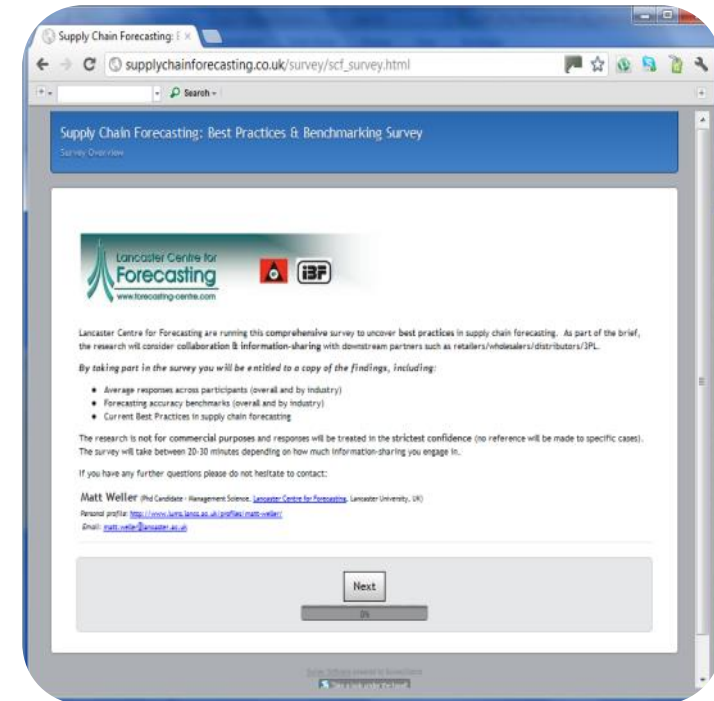
- Pilot study in 2011 (to ensure validity)
- Final version pre-tested with 18 FMCG forecasters
- Questionnaire implemented online
- Conducted January 2012-August 2012

• Survey Sample Design

- Specified target group: demand planning & forecasting professionals (in manufacturing)
- LCF Mailing list, forecasting lists / blogs (ISF, SAS)
- 100s of LinkedIn Groups
- 2000+ personalised LinkedIn invites
- Multiple reminders sent

• Response

- 540 responses
 - 260 incomplete (reminders sent, to only speculative interest, unwilling to give email address (although not mandatory), Atrophy (number of repeated questions), unsuitable respondent (industry sector & position))
 - 15 complete responses discarded (Consultants/academics, rushed surveys (10-15 mins), highly inconsistent answers, middle-clicking { same answer for every question in groups})



→ **263 complete surveys** with usable forecasting systems information
→ 200 surveys from forecasters in Manufacturing → representative!





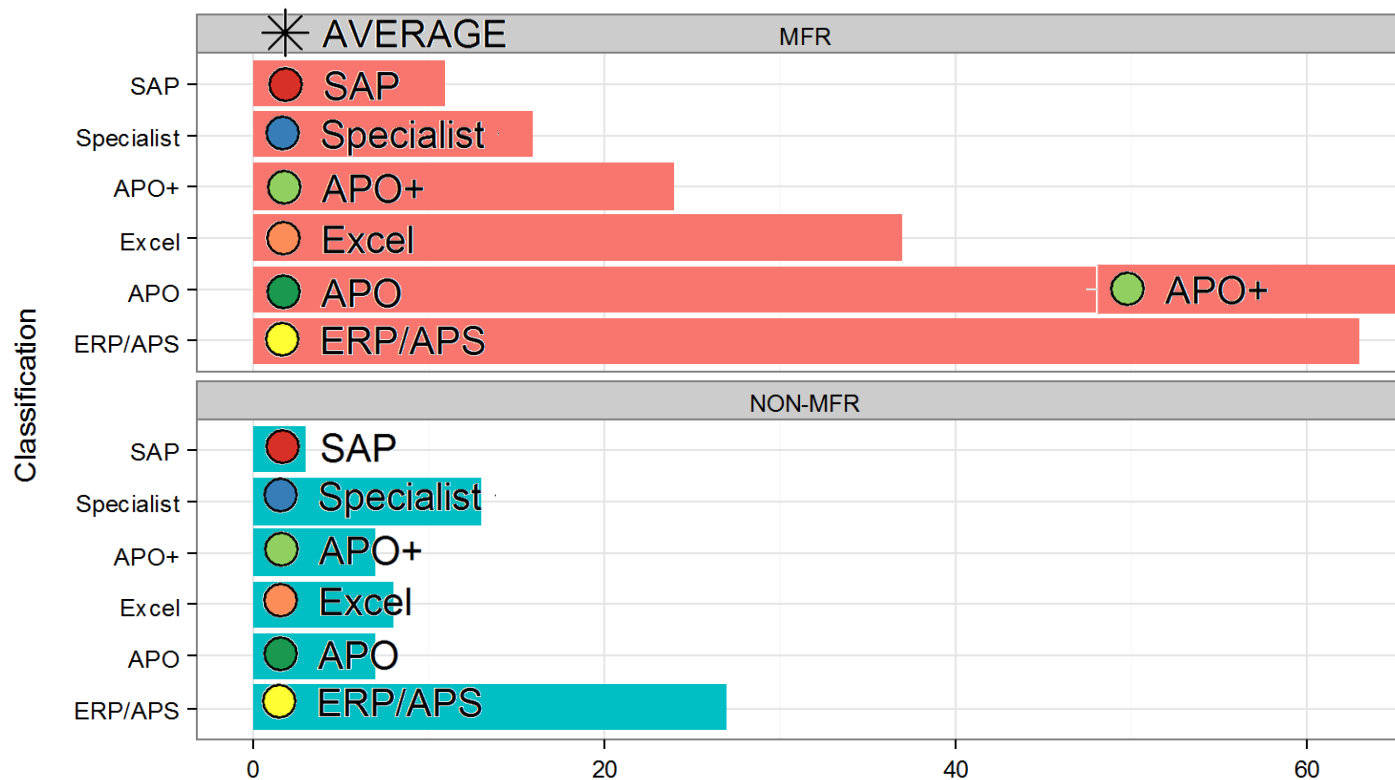
Study Results

Systems use of Respondents

Group responses by a forecasting software – plus average response!

Classification: ● APO ● APO+ ● ERP/APS ● Excel ● SAP ● Specialist ✱ AVERAGE

Number of responses in each category



→ APO and APO+ (incl. specialists FSS add-ons) dominate today's market!





Study Results

Systems use of Respondents

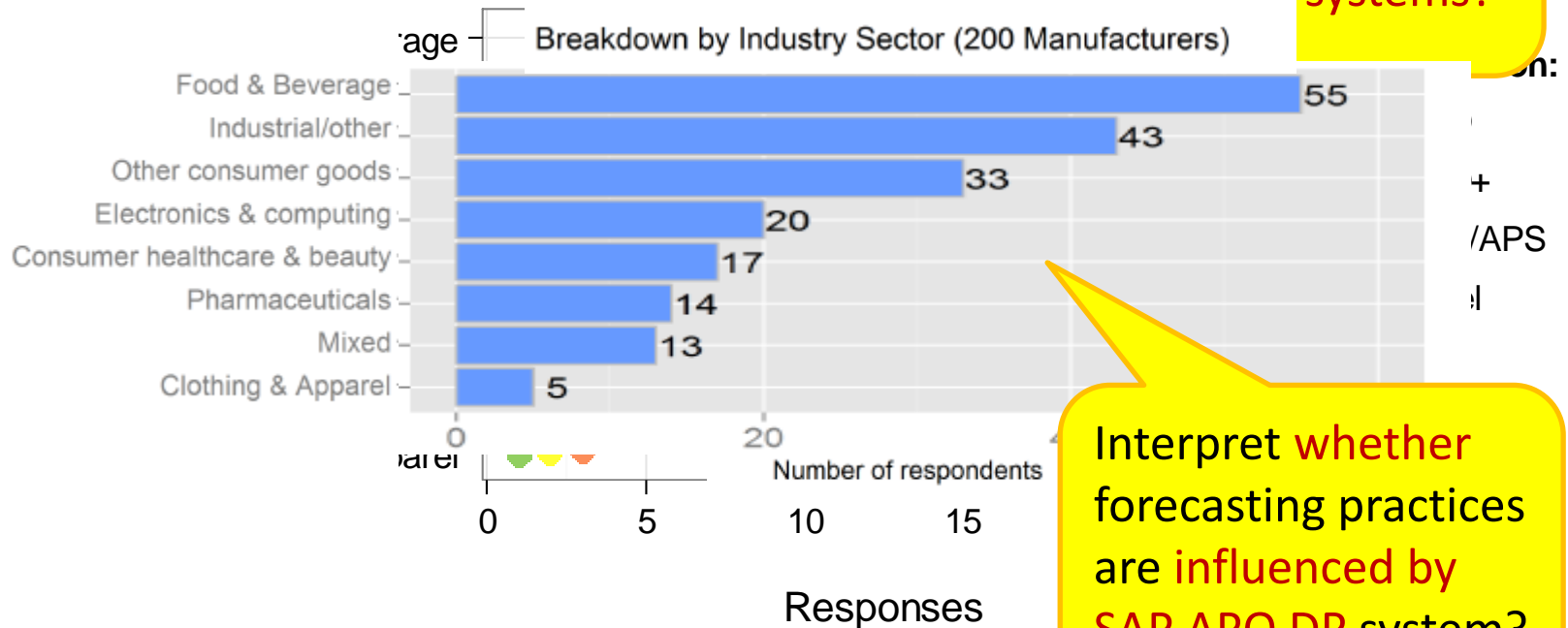
Group responses by a forecasting software – plus average response!

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Breakdown of responses

Interpret **general** forecasting practices and **use of systems?**

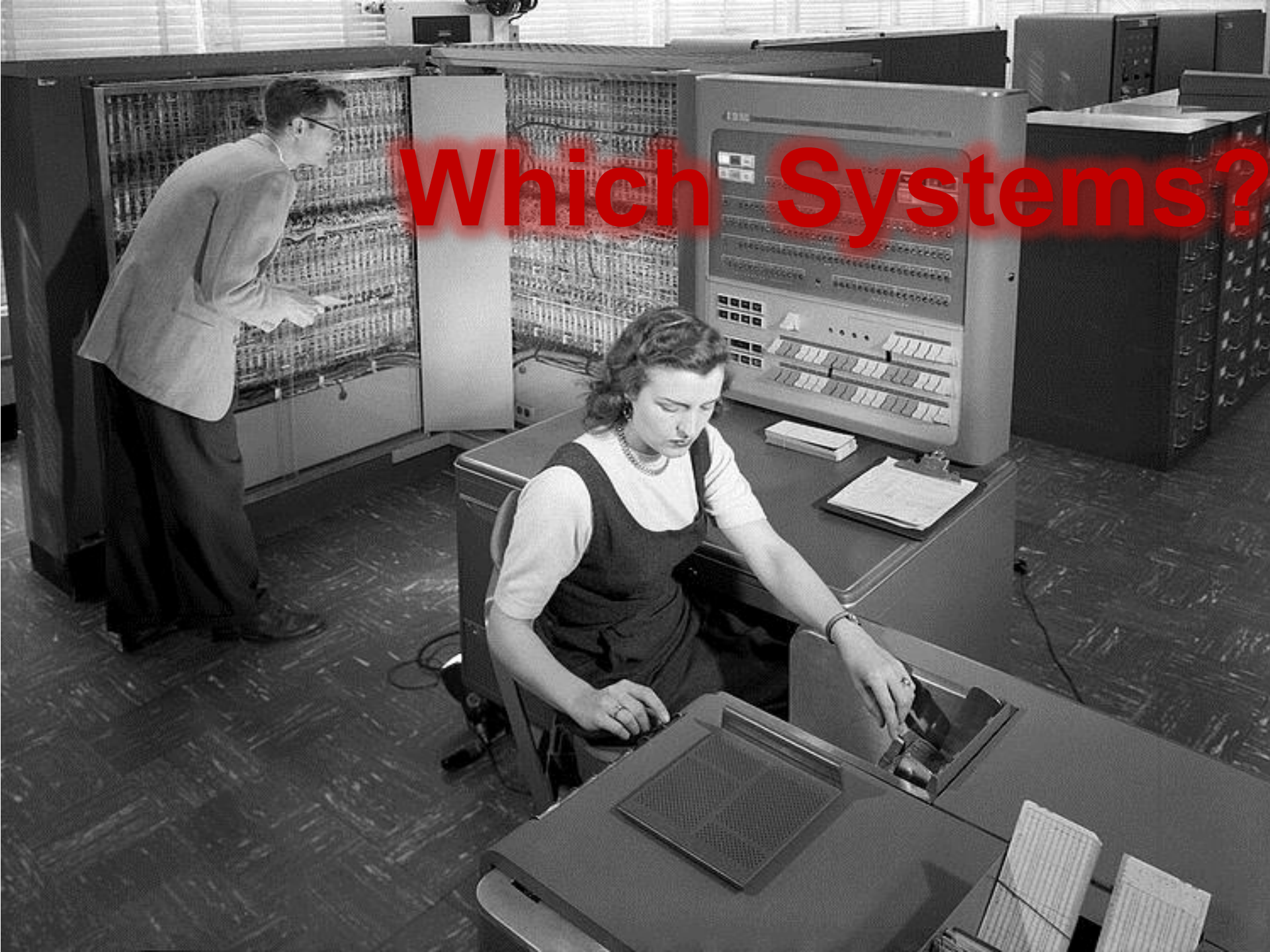
Industry Sector



Interpret **whether** forecasting practices are **influenced by SAP APO DP system?**

- mostly **large manufacturers** active in the **FMCG / CPG industry**
- Allows insight into different forecasting practices by systems → APO DP!?



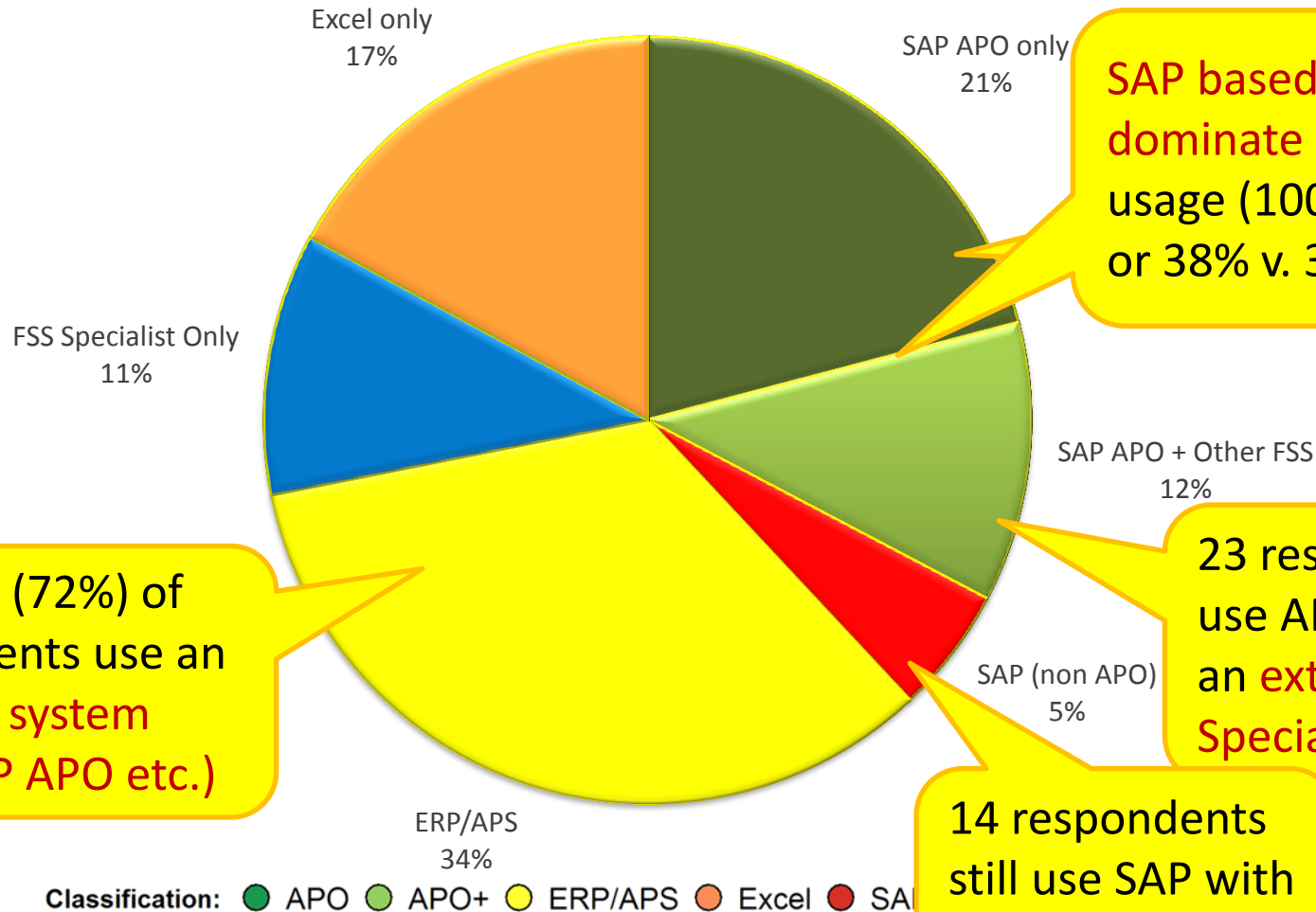


Which Systems?



Study Results

Systems use of Respondents



SAP based solutions dominate all of ERP usage (100 v. 89 users or 38% v. 34% in %)

Majority (72%) of respondents use an ERP/APS system (incl. SAP APO etc.)

23 respondents use APO DP plus an extra FSS Specialist system

14 respondents still use SAP with no APO modules (e.g. R/3 MM ...)

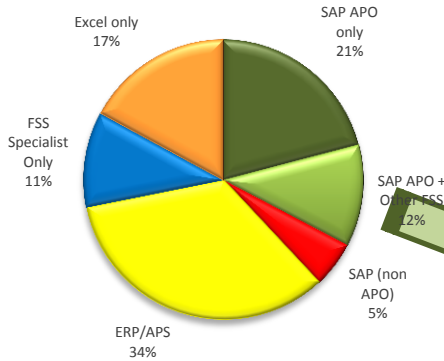
→ Heterogeneous market of ERP/APS vs. stand-alone FSS & combination





Study Results

Systems use of APO+ Respondents



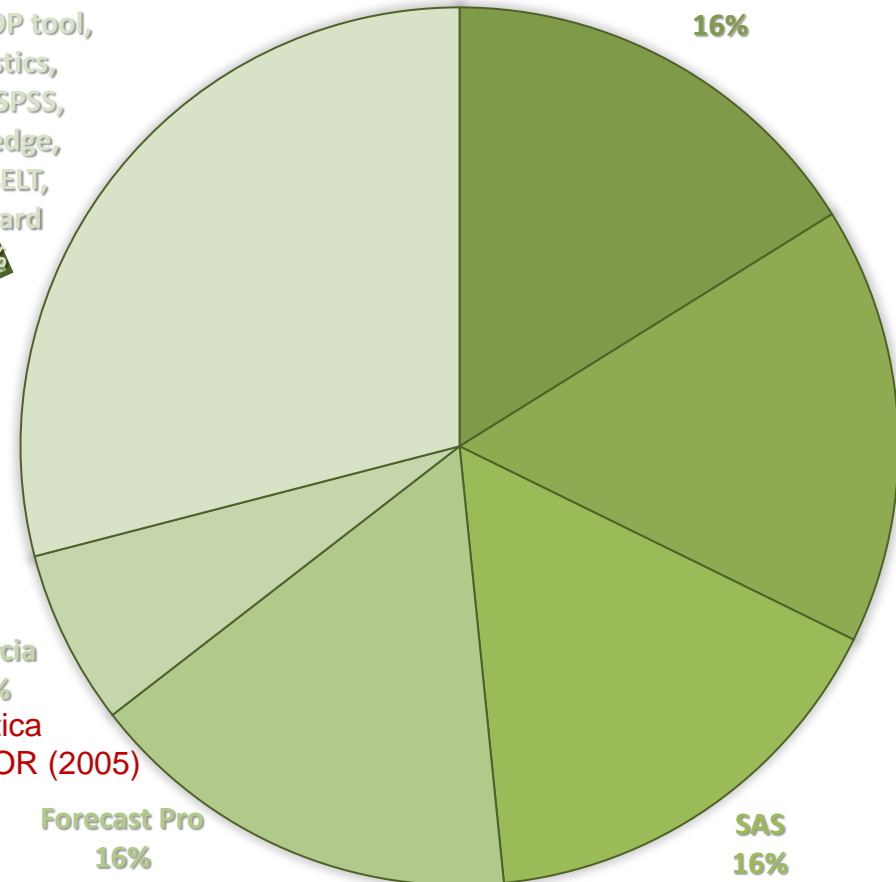
Arkieva/Zemeter,
Demand
Solutions, Oliver
Wight eSOP tool,
Servigistics,
SO99+, SPSS,
Steelwedge,
TOOLBELT,
Vanguard

29%

SAP APO+ FSS

JDA
16%

Forecast X
16%



23 users apply
SAP APO DP
plus an additional
Specialist FSS

Classification: ● APO ● APO+ ● ERP/APS ● Excel ● SAP ● Specialist ✱ AVERAGE

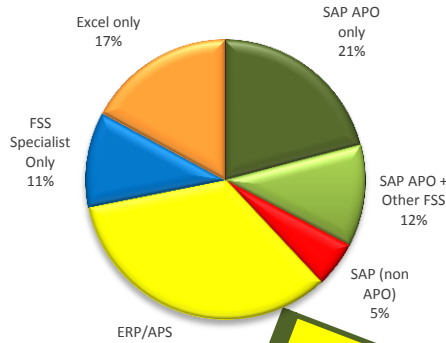
→ Additional tool indicate shortcomings of SAP APO DP
→ No clear market leader / equal share of additional FSS tools used





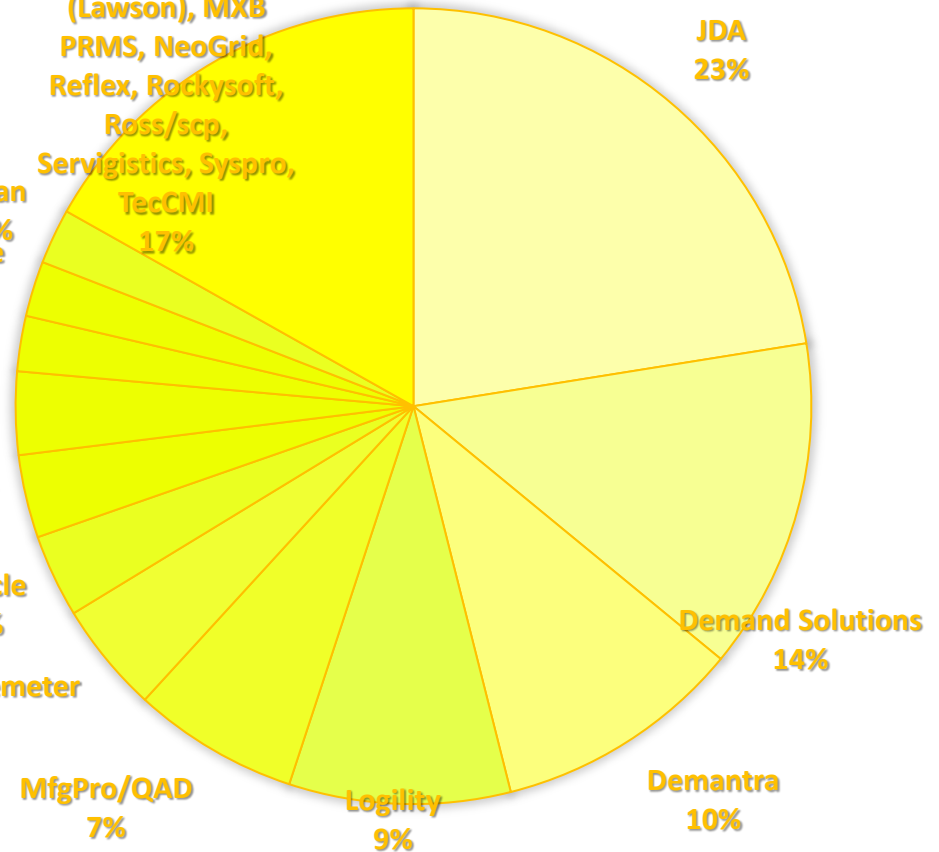
Study Results

Systems use of Respondents



add*one, ASW,
COMPASS, Epicor
iScala, GPAO/Oracle,
Kinaxis, M3
(Lawson), MXB
PRMS, NeoGrid,
Reflex, Rockysoft,
Ross/scp,
Servigistics, Syspro,
TecCMI

ERP/APS SYSTEMS (NON-SAP)



BUT: 4 non SAP users of ERP/APS also use extra FSS specialist software (ForecastPro, eTXT, Steelwedge etc.)

Classification: ● APO ● APO+ ● ERP/APS ● Excel ● SAP ● Specialist ✱ AVERAGE

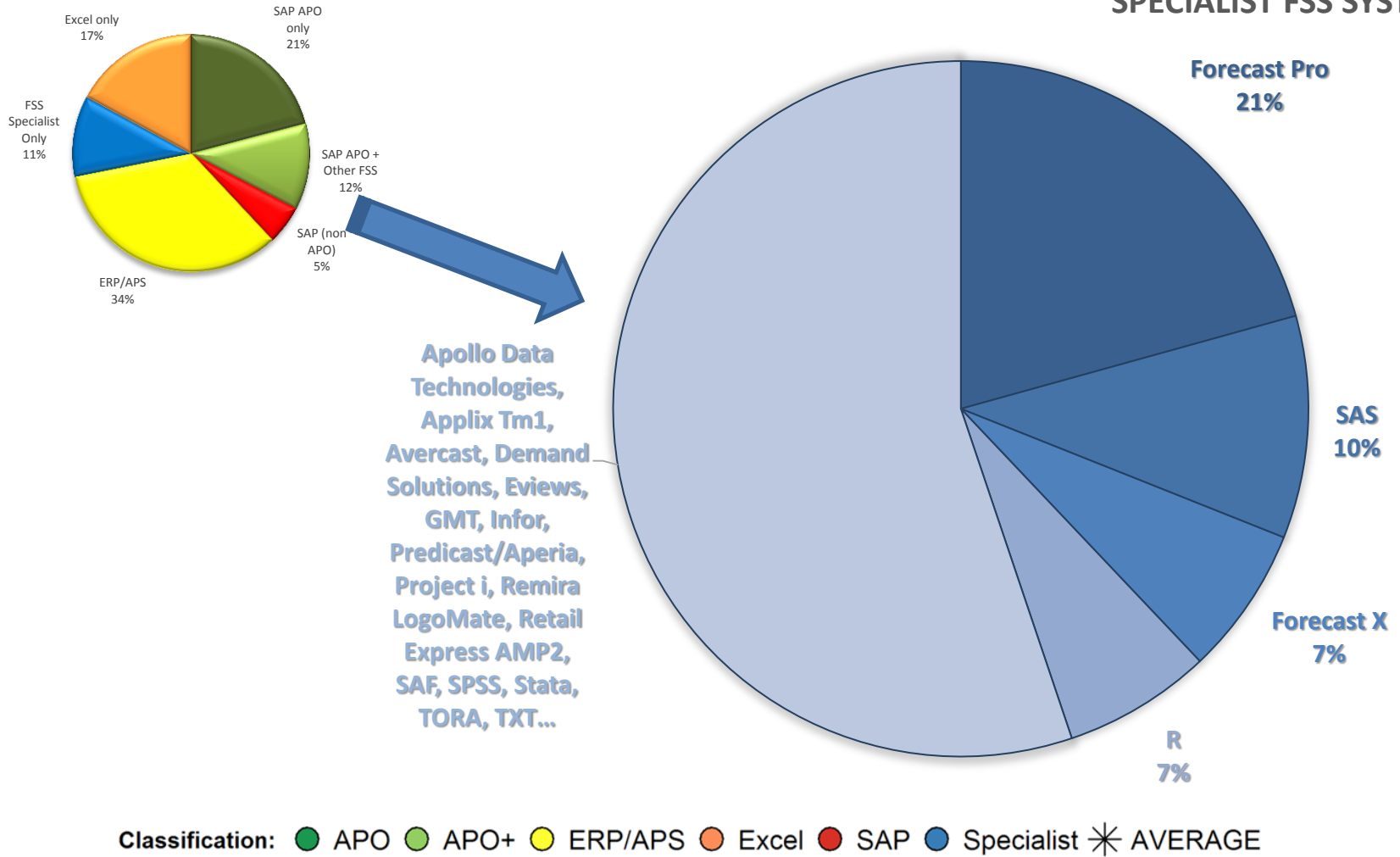




Study Results

Systems use of FSS Specialist Respondents

SPECIALIST FSS SYSTEMS



→ Large variety of software packages, led by ForecastPro

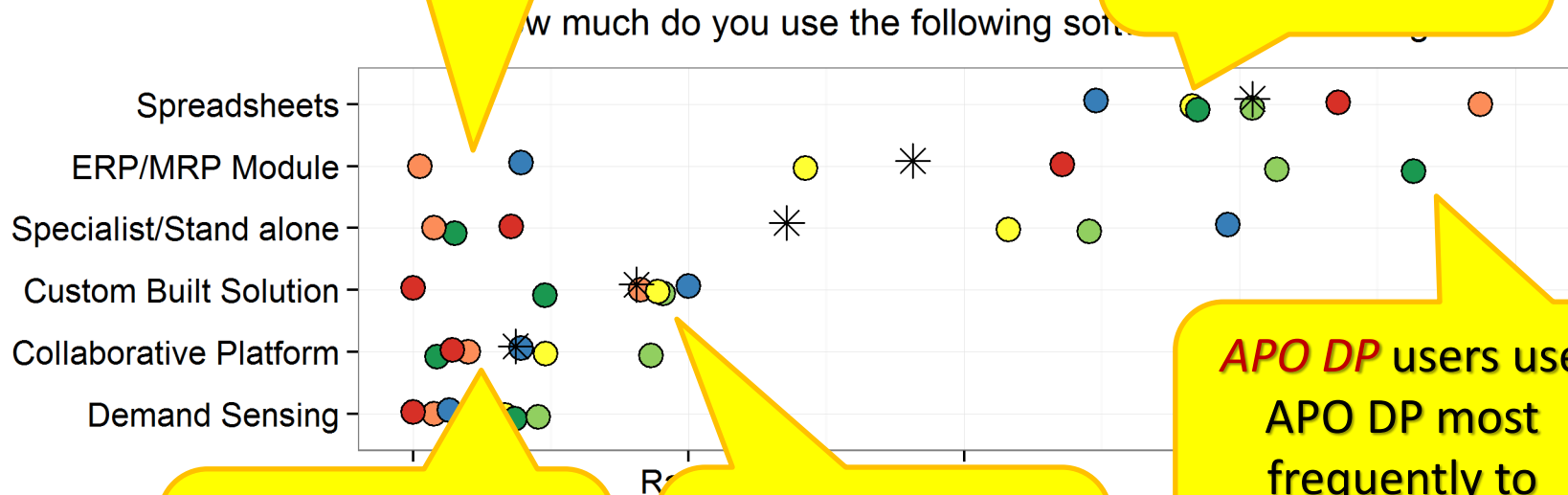


Study Results (all industries)

Use of Software Packages

Excel & FSS users don't use ERP/APS systems

APO DP users use MS Excel as well to make forecasts!



Demand Sensing & CPFR systems are rarely used by anyone!

Few companies today still use a *custom made (in-house)* solution

APO DP users use APO DP most frequently to make forecasts

Classification: ● APO ● APO+ ● ERP/APS ● Excel ● SAP ● Specialist * AVERAGE

→ Companies use multiple software together → lack of functionality!
 → Adoption of standard packages (ERP/APS/FSS) → individual dies out



Planners use SAP APO and Excel and FSS ...

... all in parallel!

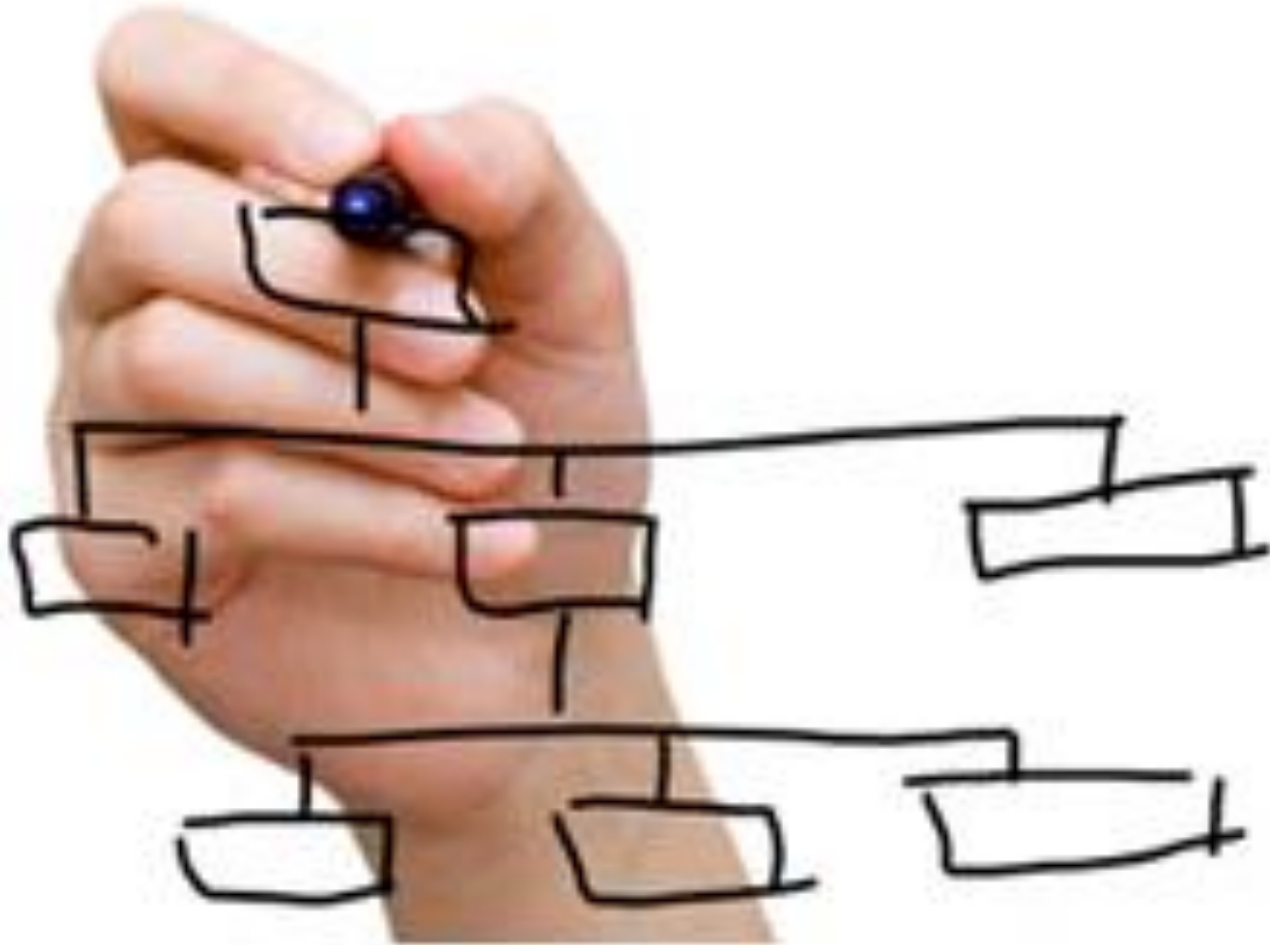
(requires additional data exchange, process coordination, extra time & effort ...)



What systems do you use?



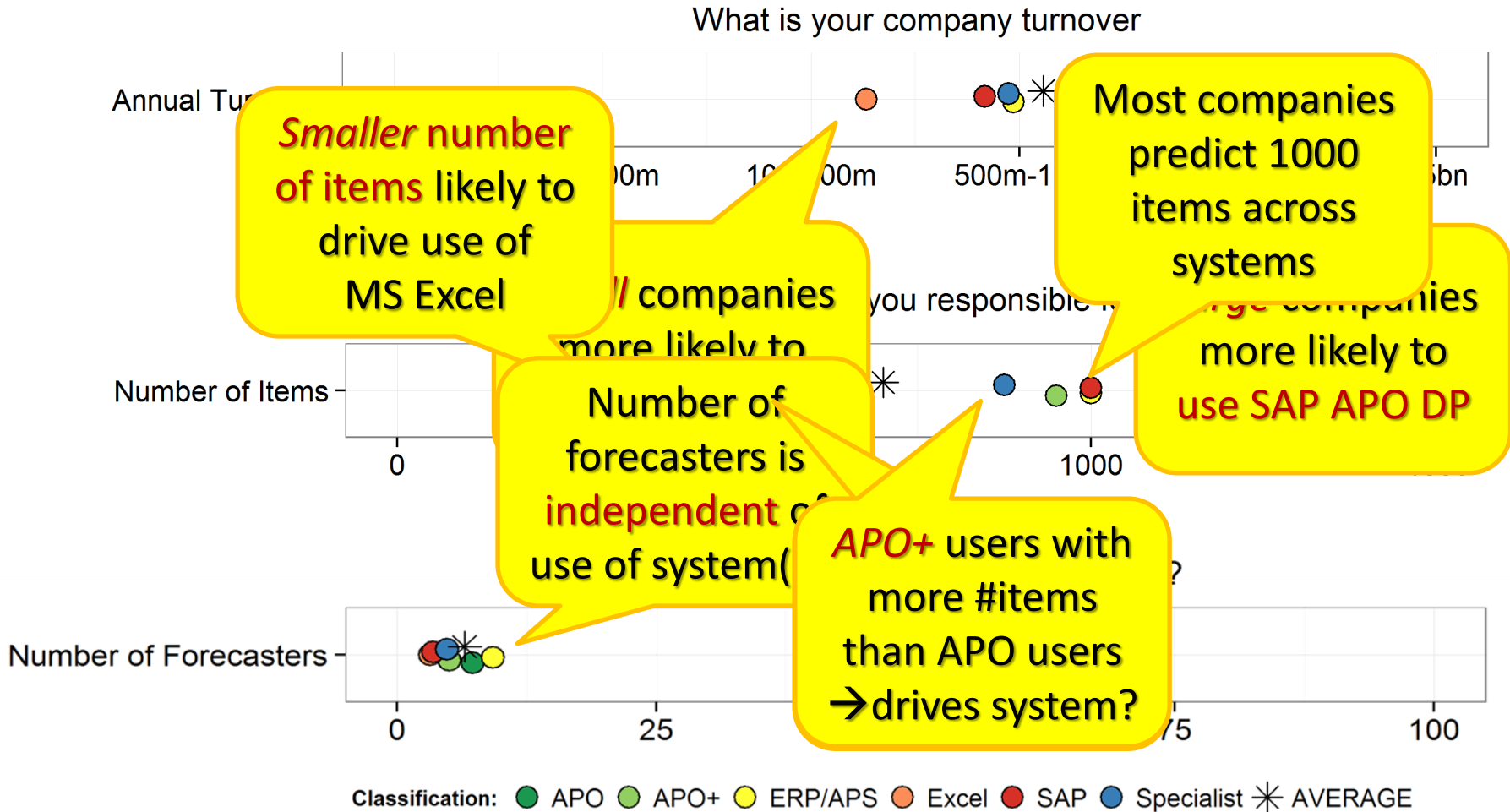
Which Organisation?





Study Results (all industries)

Organisational Setup



→ # of items & company turnover drives APO DP adoption

→ # of Forecasters seems independent of #SKUs and # of revenue?

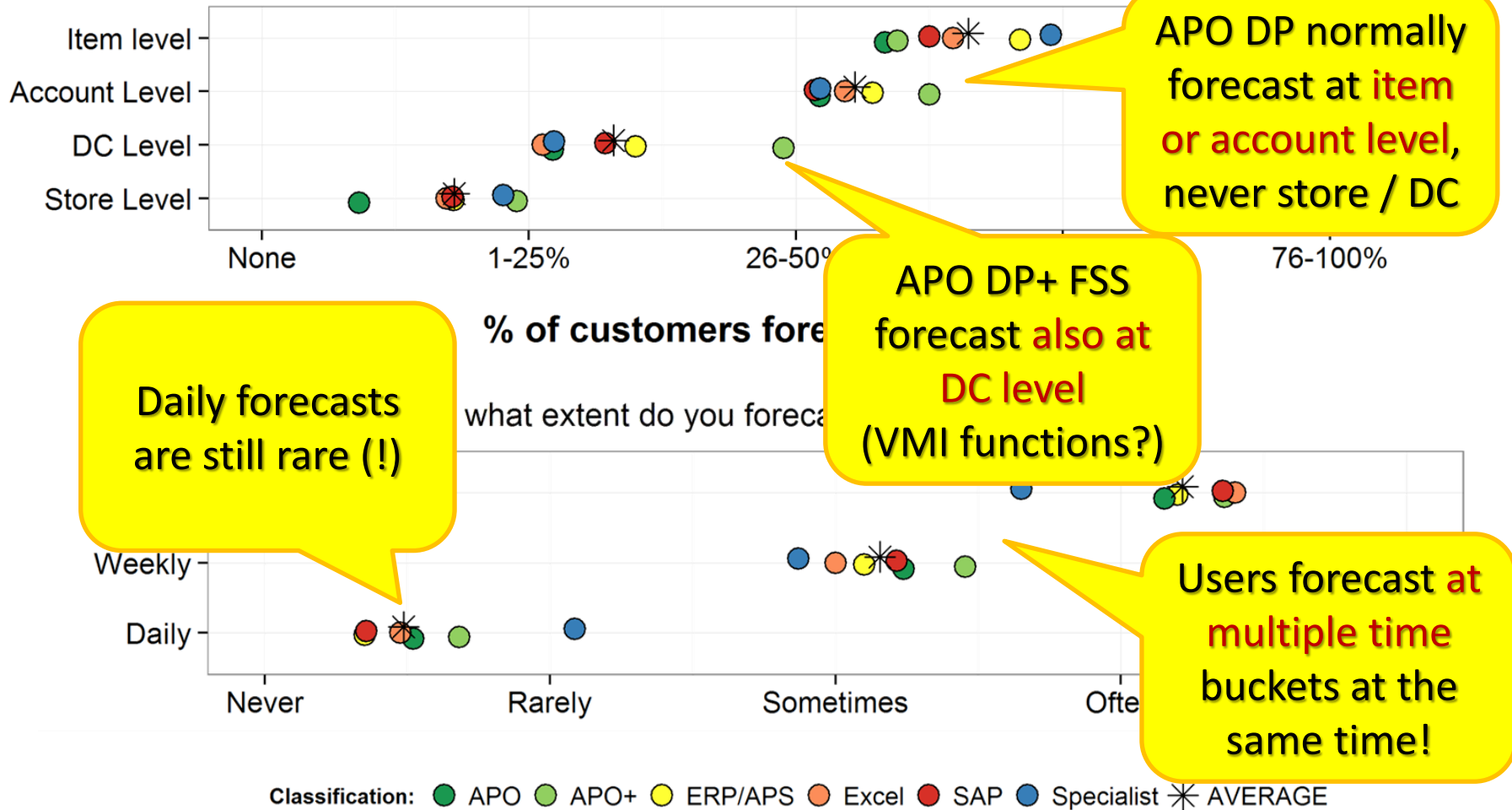




Study Results (all industries)

Forecasting Setup

What level of supply chain aggregation do you use?



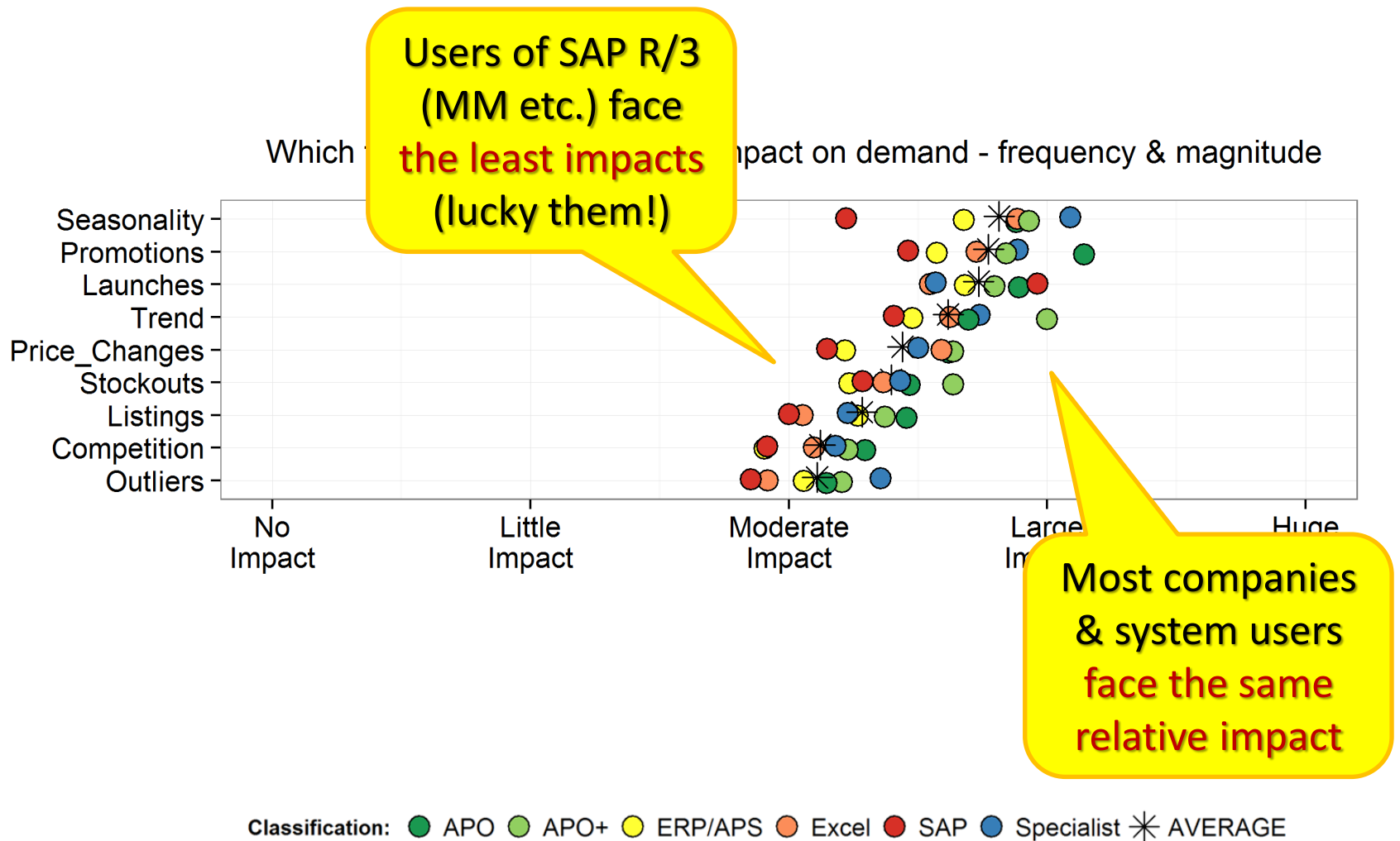
→ Similar setup: companies forecast on multiple levels & time buckets
→ How is this (best) supported by SAP APO DP?





Study Results (all industries)

Drivers of Forecasting



→ Market complexities impact all business equally, regardless of system



What organisation do you use?



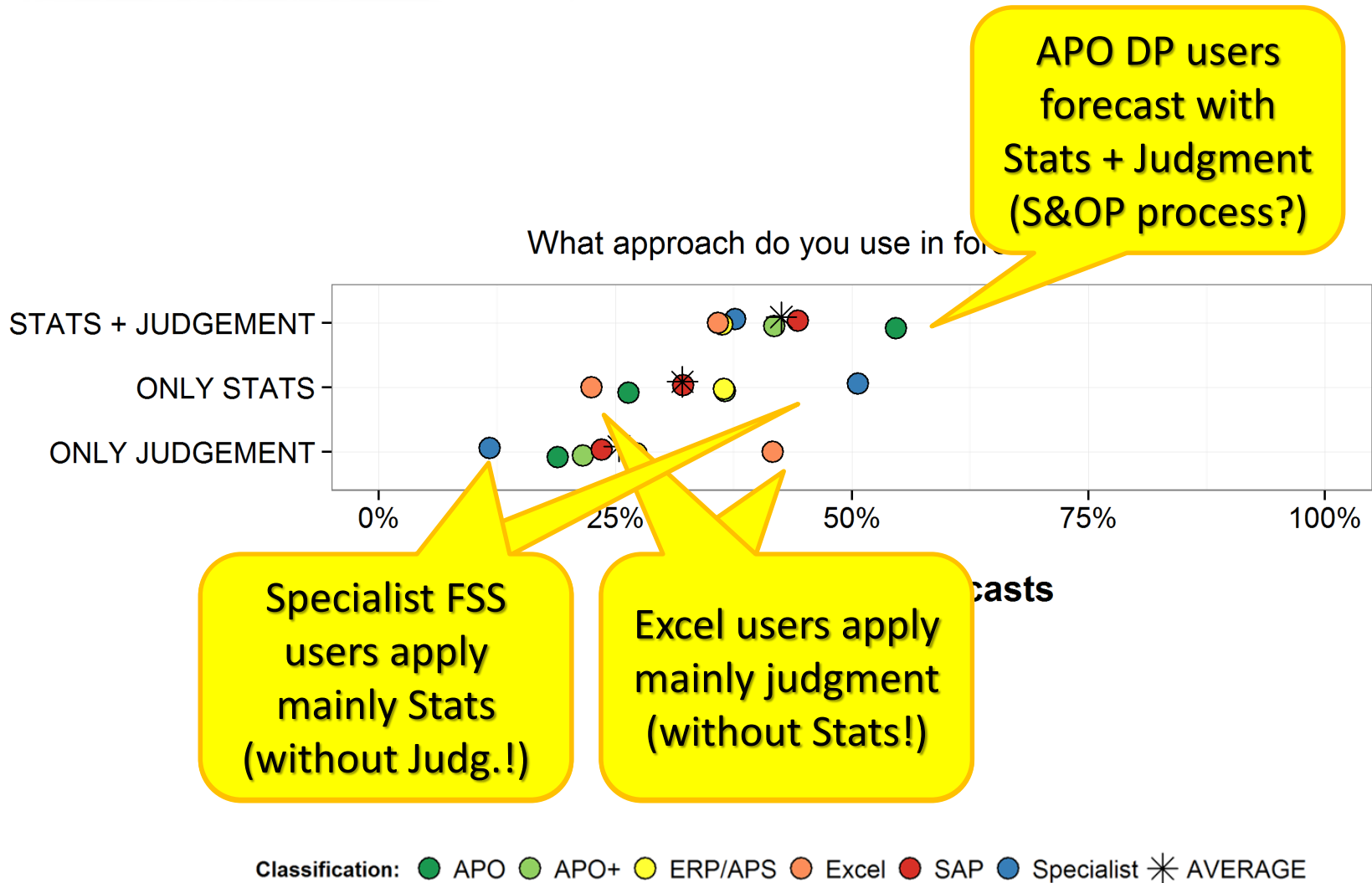
Which Tools?





Study Results (all industries)

Use of Forecasting Methods



→ Typical SAP APO usage employs 25% only stats, 25% only judgment
→ ... and 50% a combination of Statistics & Judgment

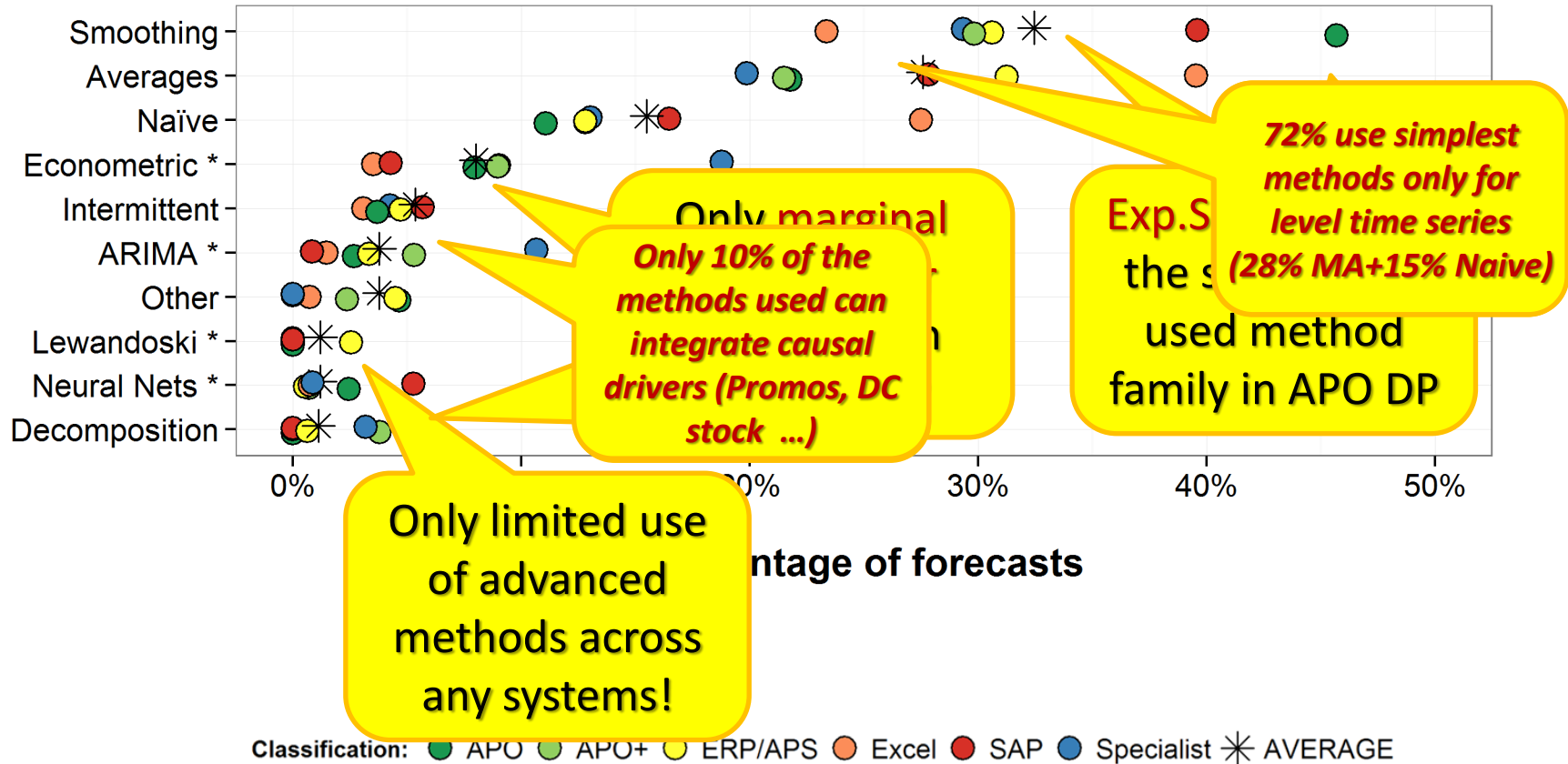




Study Results (all industries)

Use of Forecasting Methods

What statistical forecasting methods do you use?



Only limited use of advanced methods across any systems!

Only 10% of the methods used can integrate causal drivers (Promos, DC stock ...)

Only marginal

Exp.S the s used method family in APO DP

72% use simplest methods only for level time series (28% MA+15% Naive)

→ APO DP: 78% (45% ETS + 22% Av+ 11% Naïve) use simple methods!
 → APO drives **use of simpler methods** than average software packages



What algorithms do you use?

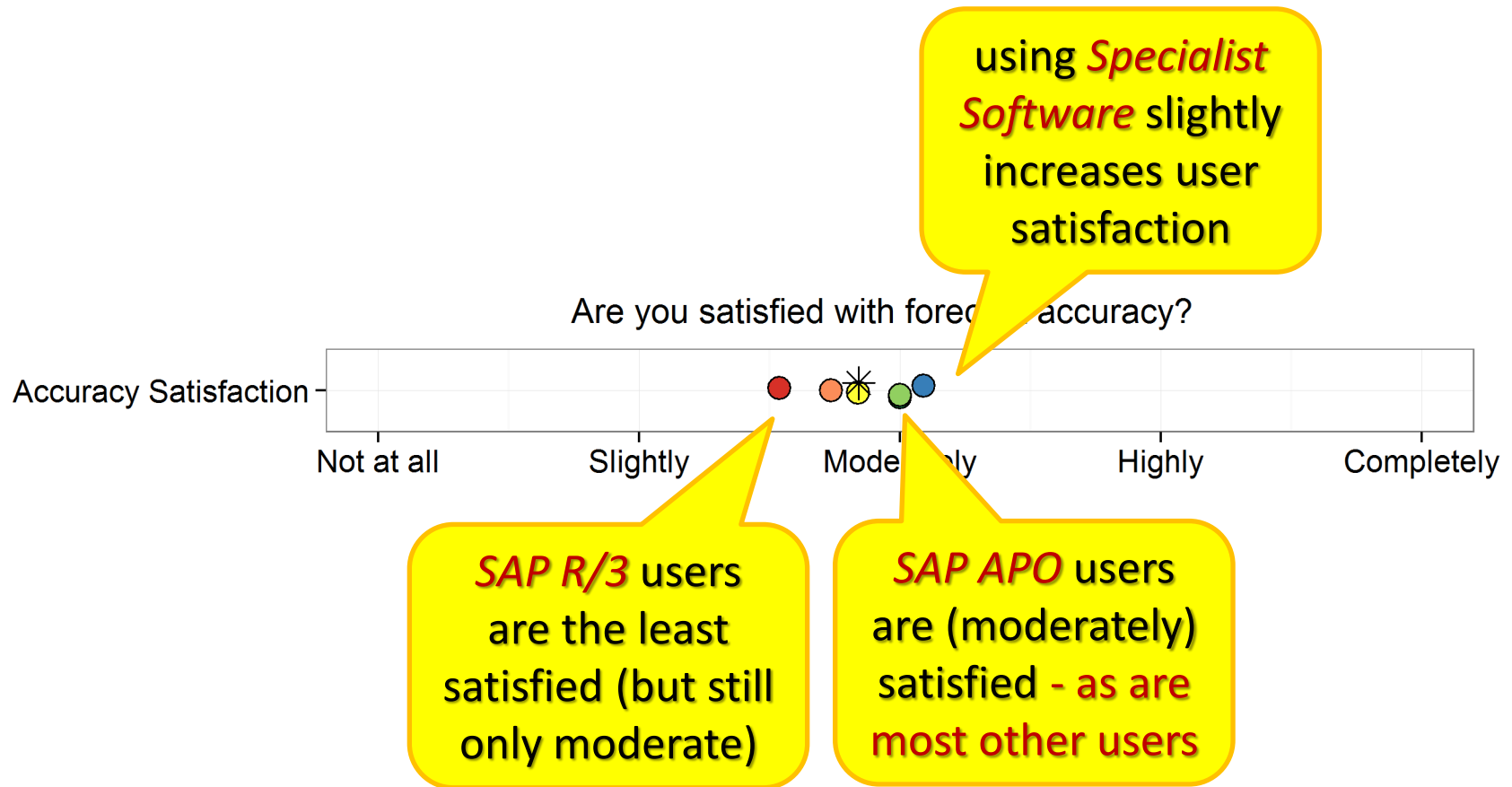






Study Results (all industries)

Satisfaction with Forecast Accuracy



Classification: ● APO ● APO+ ● ERP/APS ● Excel ● SAP ● Specialist ✱ AVERAGE

→ All users are only moderately happy with their forecast accuracy
→ APO DP not worse off than SAP R/3, ERP or Specialist software

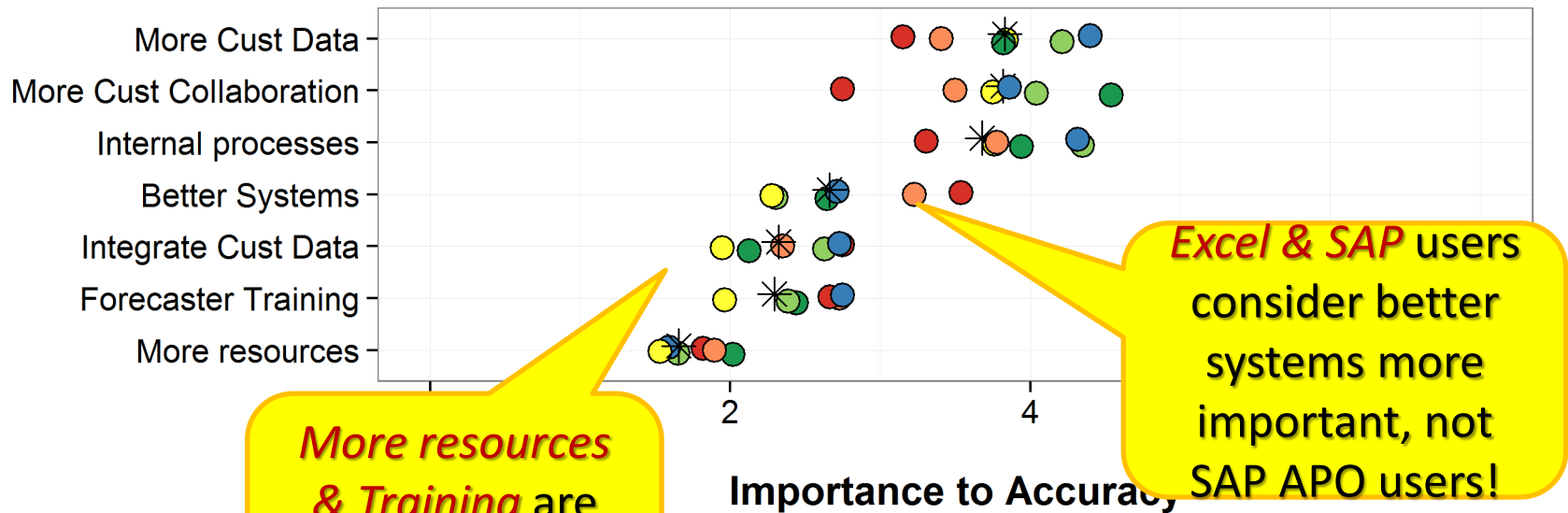




Study Results (all industries)

Satisfaction with Forecast Accuracy

Which factors would best improve forecast accuracy in the future?



More resources & Training are considered least important

Excel & SAP users consider better systems more important, not SAP APO users!

Classification: ● APO ● APO+ ● ERP/APS ● Excel ● SAP ● Specialist * AVERAGE

→ Users seem satisfied that better systems will not improve accuracy!
→ BUT: will more customer data not require new system (functions)?





Study Results (all industries)

Satisfaction with Forecast Software

How satisfied are you with your forecasting software?



APO & APO+ users are generally satisfied with their forecast software

Classification: ● APO ● APO+ ● ERP/APS ● Excel ● SAP ● Specialist ✱ AVERAGE

→ Users seem generally satisfied with their systems
→ Tricky interpretation, as ERP/APS/Excel can be customised!



Forecasting with SAP® APO DP

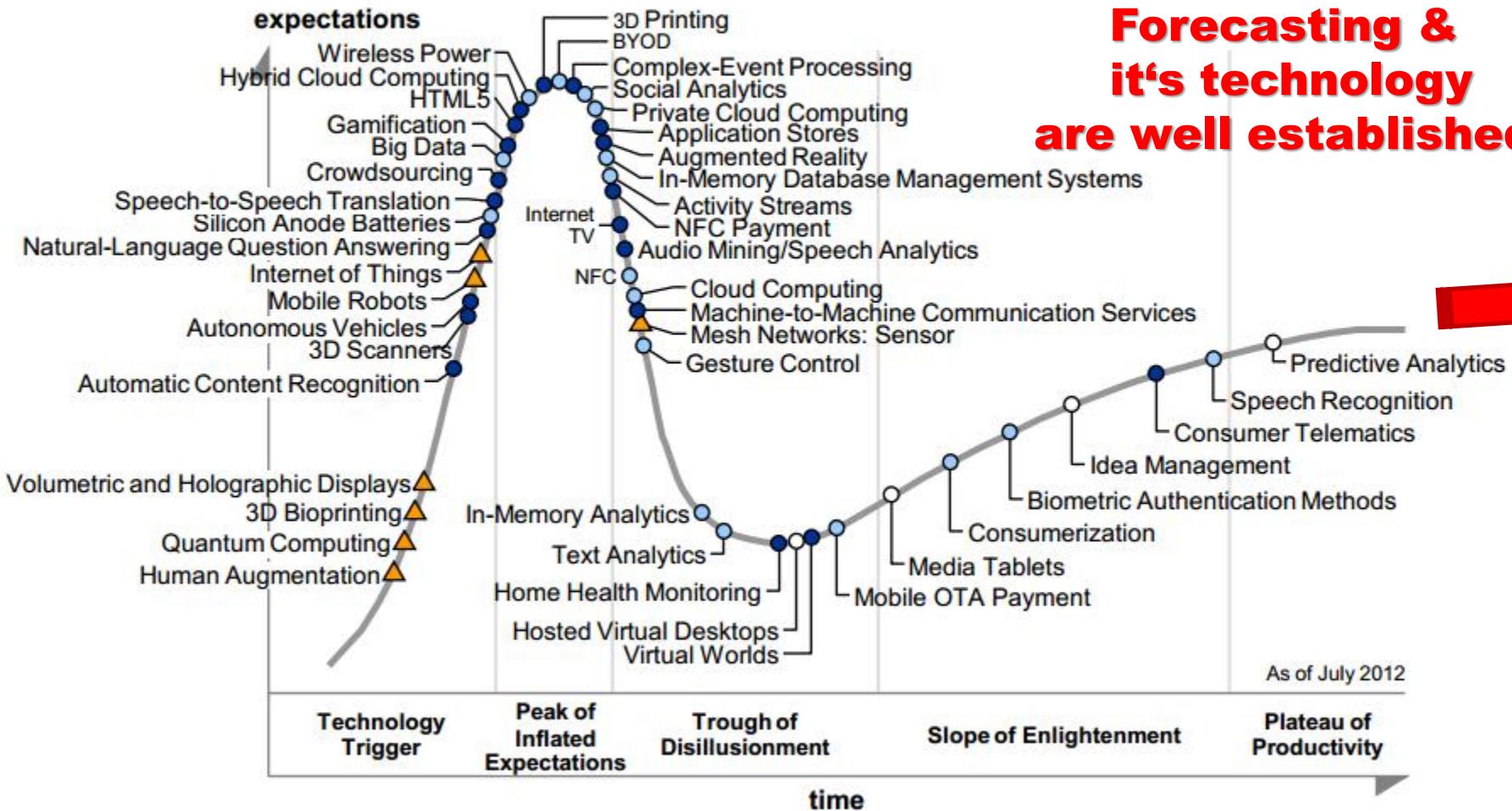
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 - *Evidence from a survey*
 - *System(s), Orga, Setup, Methods ...!*
3. “Best Practices” in APO DP?
 - *Forecasting Science as benchmark*
 - *Data Exploration, Model Selection ...*
 - *Promo Forecasting, New Products ...*

NON-

Disclaimer



Emerging Technologies Hype Cycle 2012

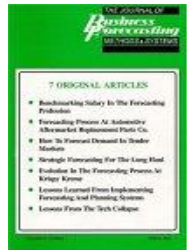




Advances in Forecasting

25 years of Scientific Insights!

- Founding of the International Institute of Forecasters
→ “unify the field and bridge the gap between theory & practice”
- Publication of 2 core interdisciplinary journals – Peer Reviewed!
 - International Journal of Forecasting 1985, Journal of Forecasting 1982
 - Various publications in Operational Research, Management Science, Finance, Econometrics, Economics, Marketing, Retailing journals
- Publication of Practitioner oriented journals – Peer Reviewed!
 - Foresight – The Journal of Practical Forecasting (JBF to a lesser extent)
- Annual conferences
 - The International Symposium on Forecasting (ISF) → Peer Review
 - Professional conferences (Forecasting Summit, commercial IBF, iE, SAS, Terra etc.) are typically non-peer review
- 4 Nobel Prizes for research in forecasting & related areas
 - Clive Granger & Robert Engle
 - Daniel Kahneman



→ Forecasting has developed as a **scientific discipline of its own right**
→ State of the art know-how from 25 years of R&D *plus* practice !!!

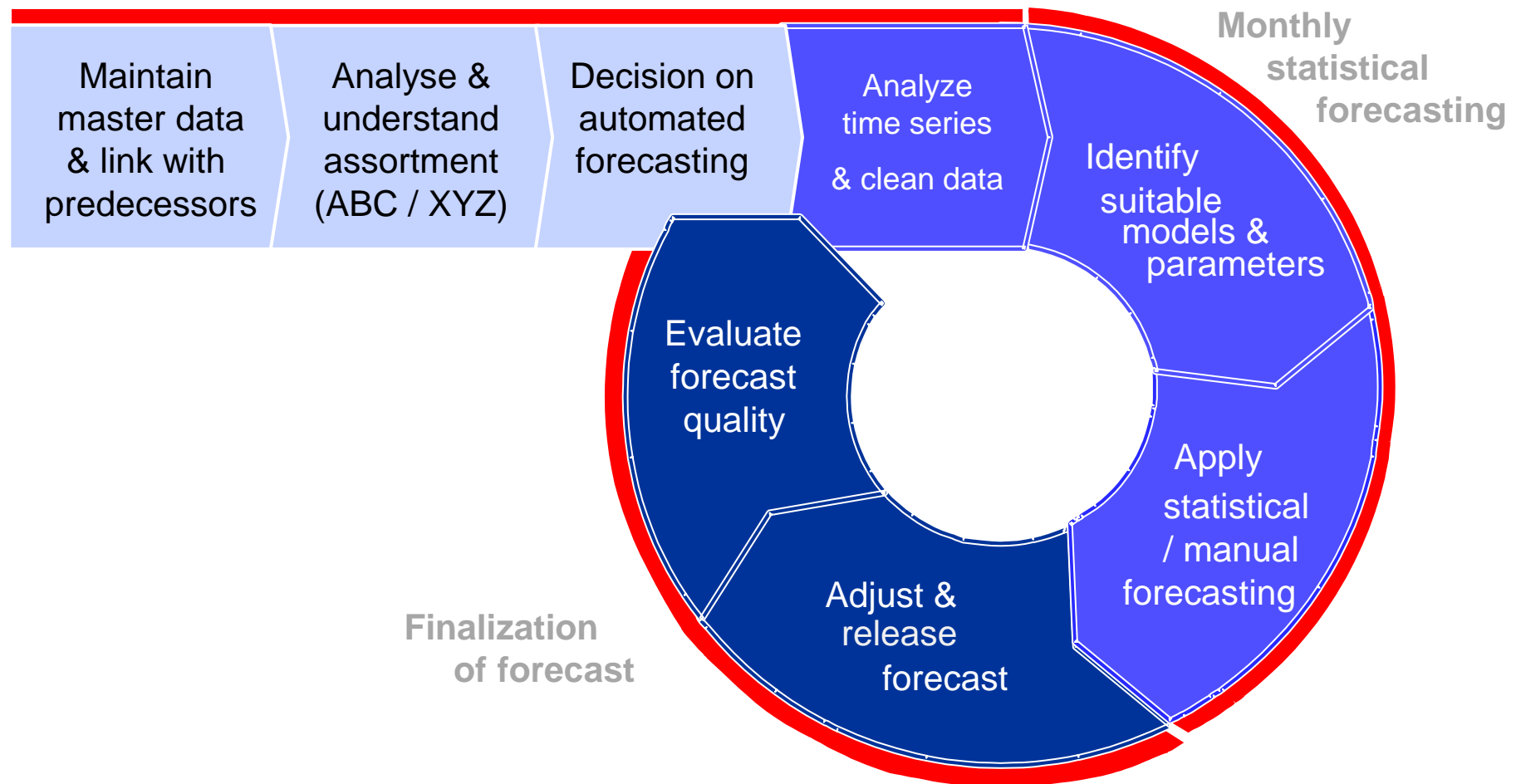




The Forecasting Process

Statistical Modelling: Model Application

Initialization via overall analysis

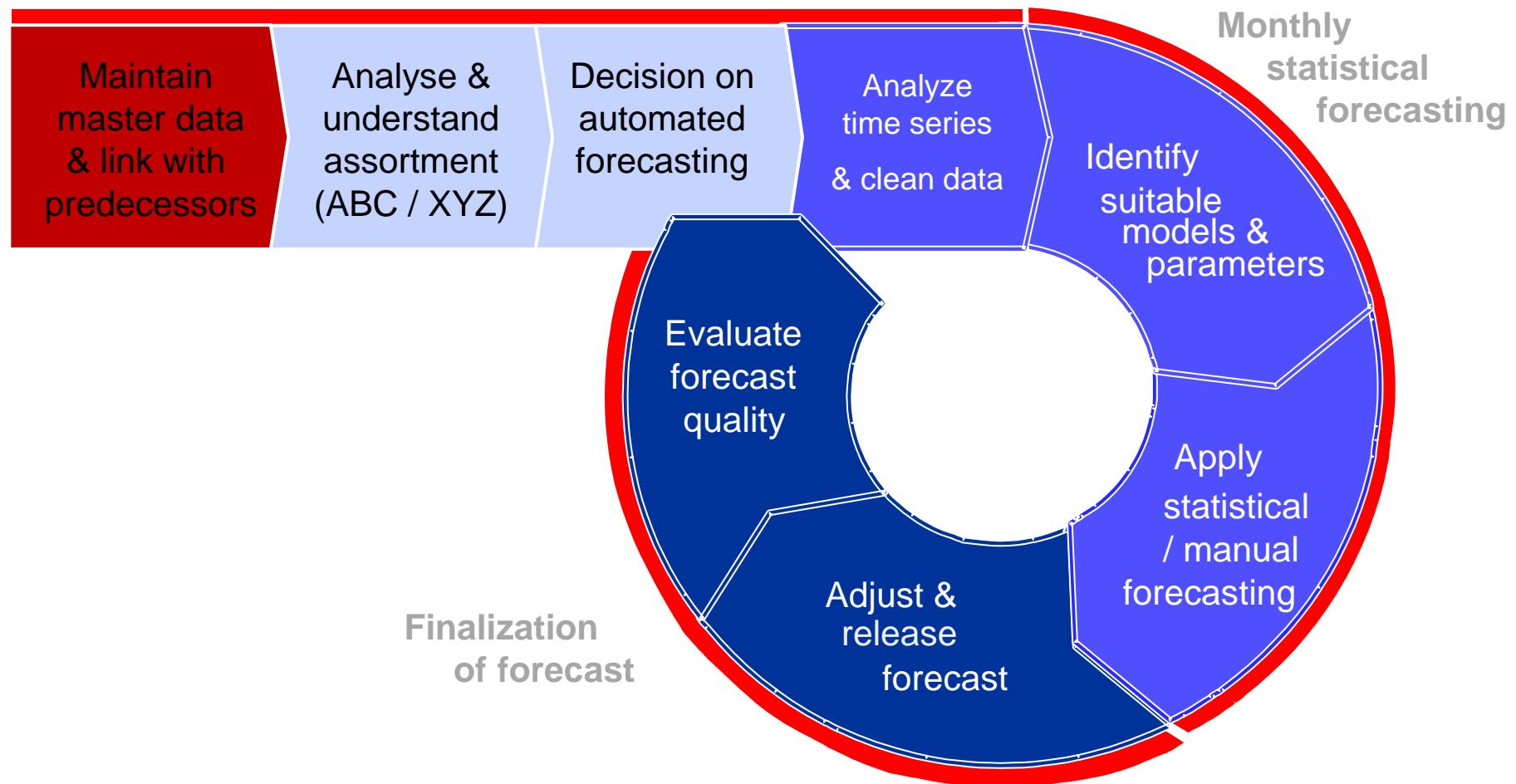


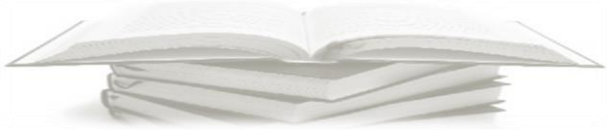


The Forecasting Process

Statistical Modelling: Model Application

Initialization via overall analysis

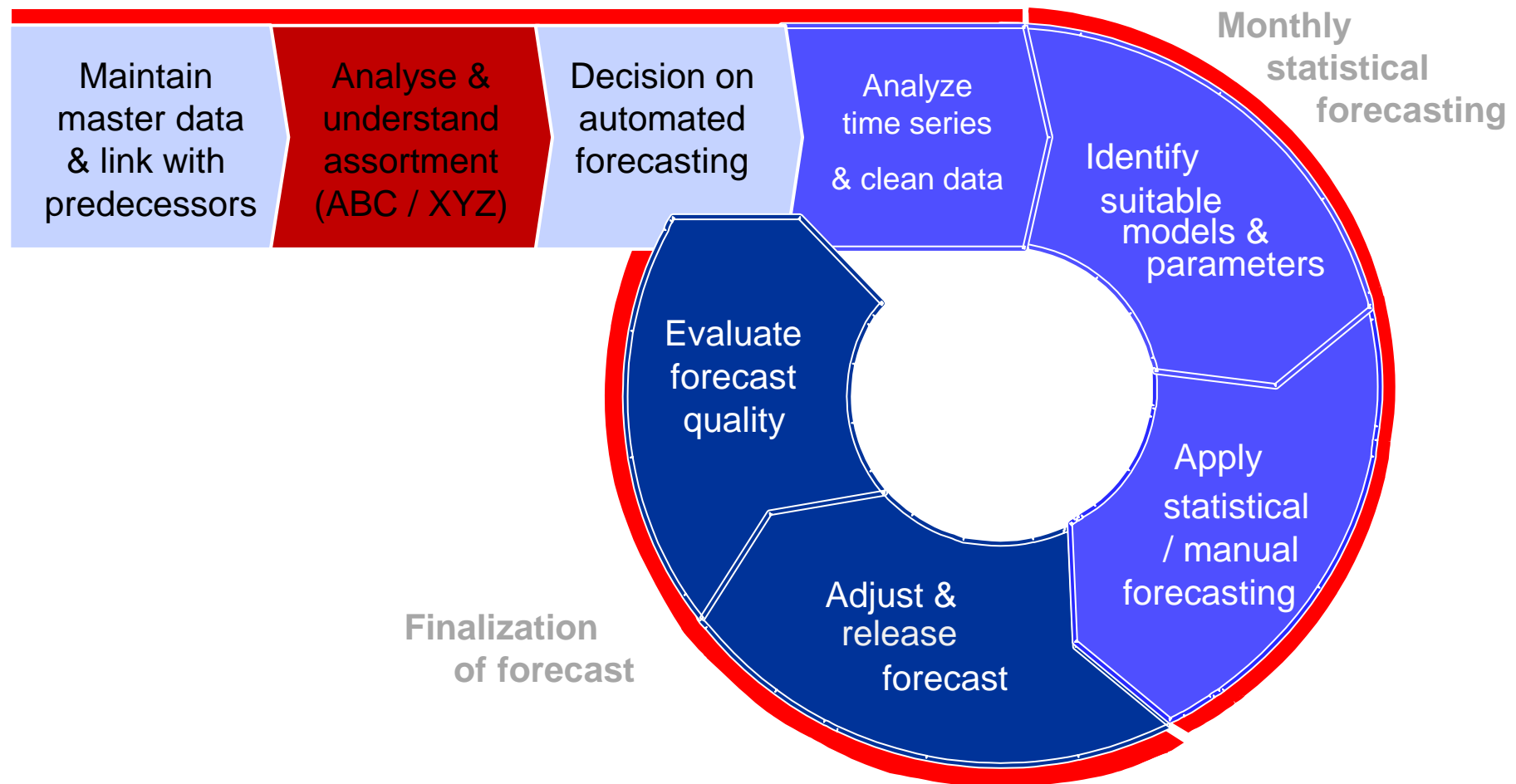




The Forecasting Process

Statistical Modelling: Model Application

Initialization via overall analysis

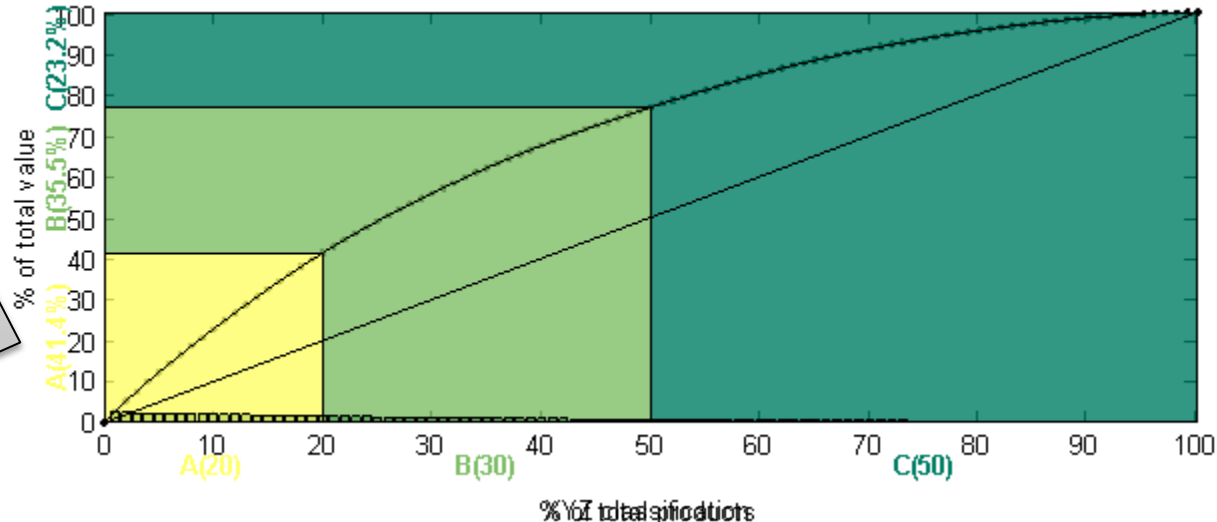




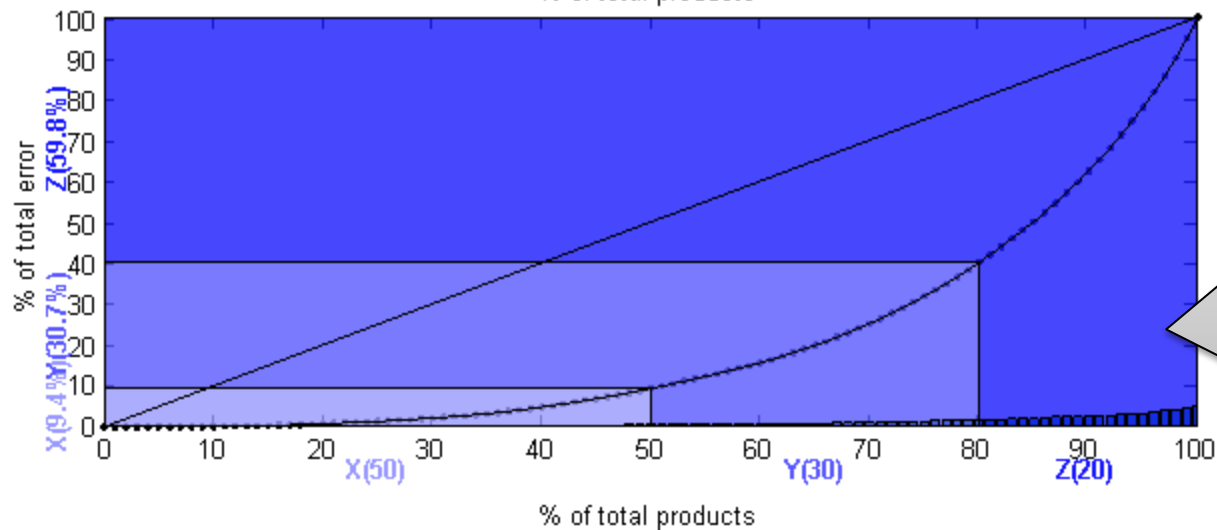
Analysing Assortments

ABC-XYZ ... Analysis

ABC classification



41.4% of profit comes from 20% of products



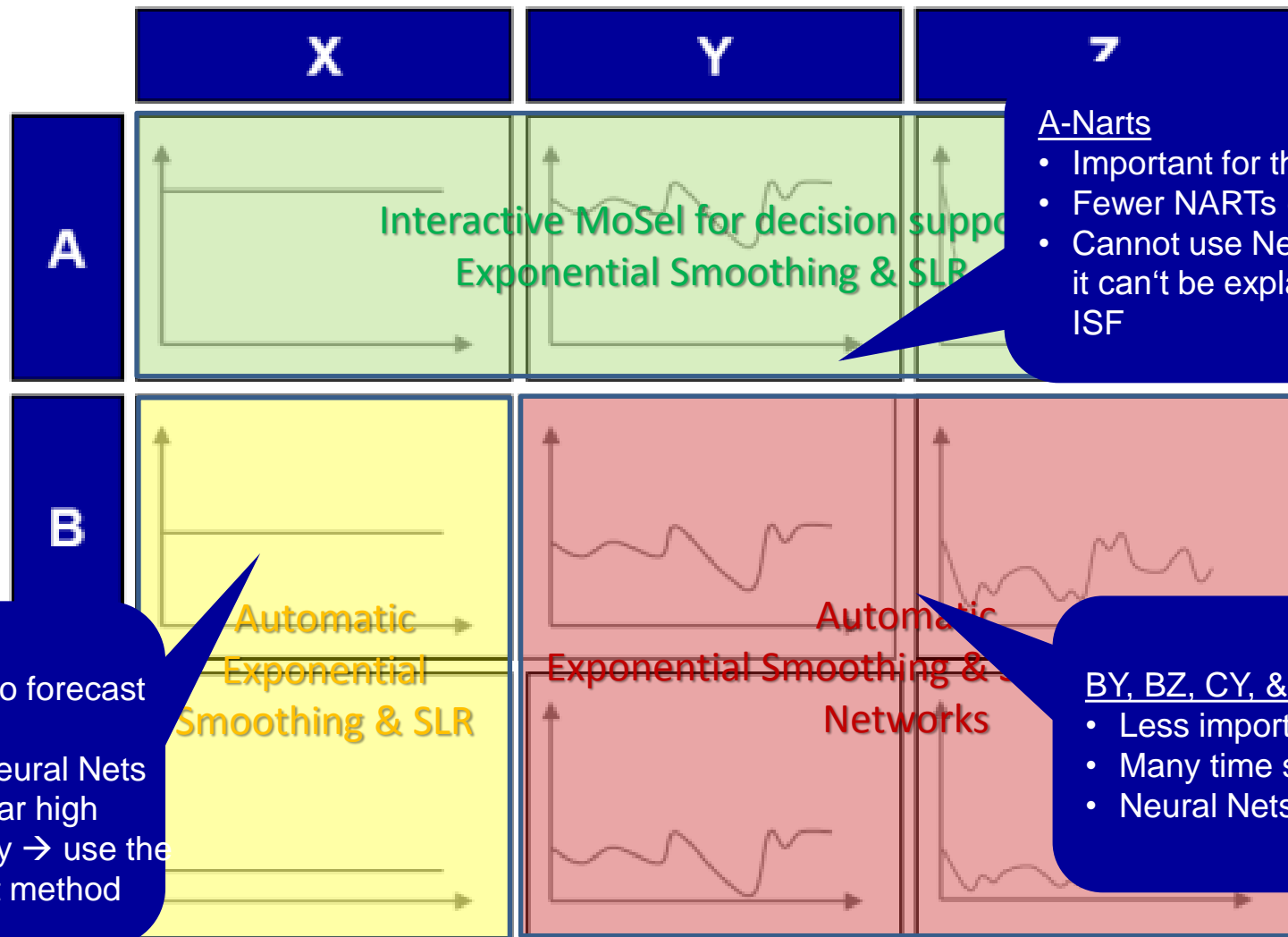
59.8% of forecasting error comes from 20% of products





Analysing Assortments

ABC-XYZ ... Analysis



A-Narts

- Important for the business
- Fewer NARTs (20%)
- Cannot use Neural Nets as it can't be explained in e.g. ISF

X-Narts

- Simple to forecast NARTs
- Avoid Neural Nets → similar high accuracy → use the simplest method

BY, BZ, CY, & CZ -Narts

- Less important
- Many time series (50%)
- Neural Nets can be used

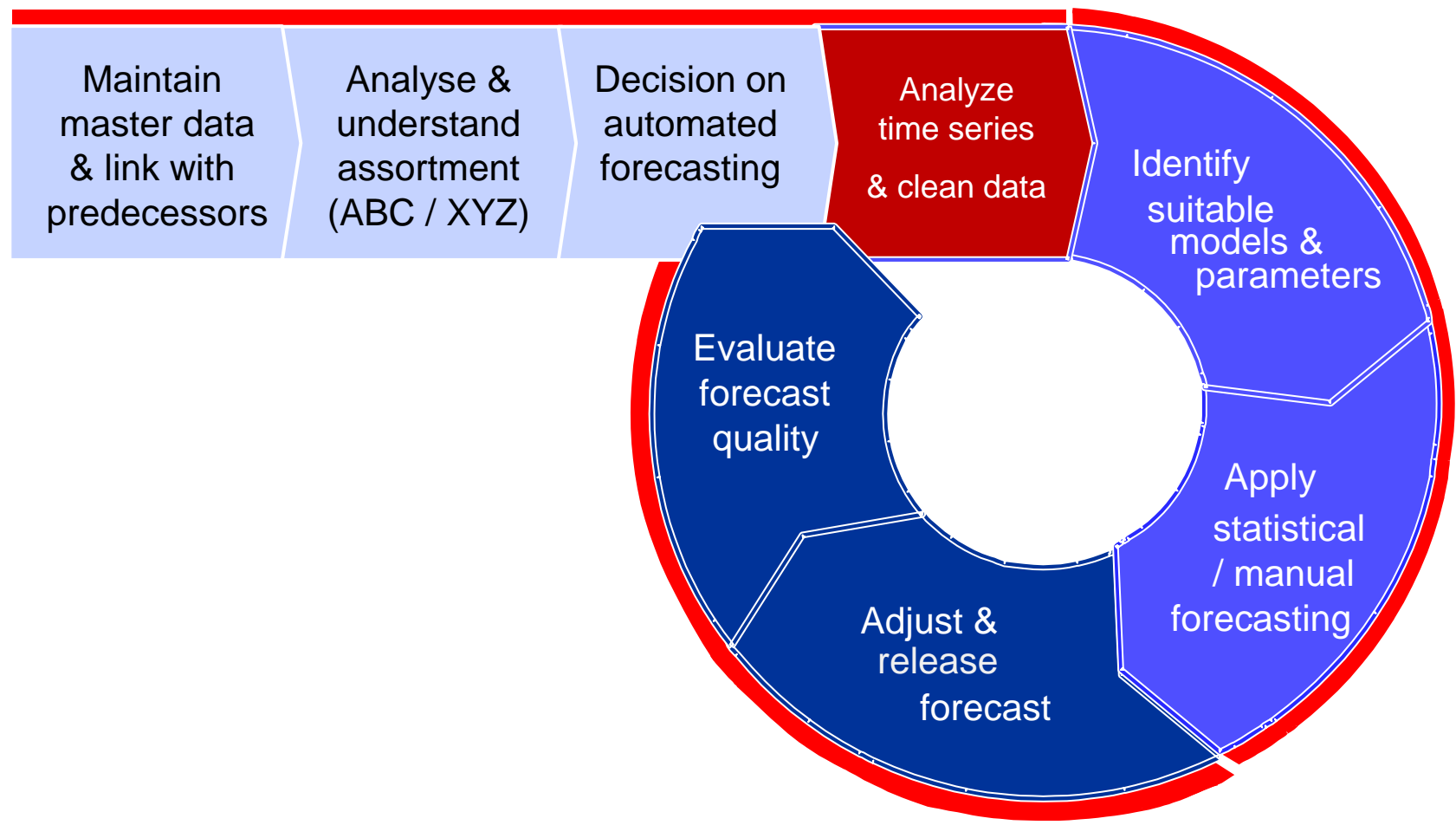
→ No provision of **process know-how** on how to use & apply it ...

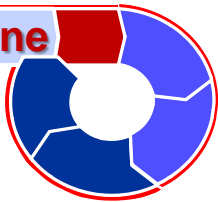




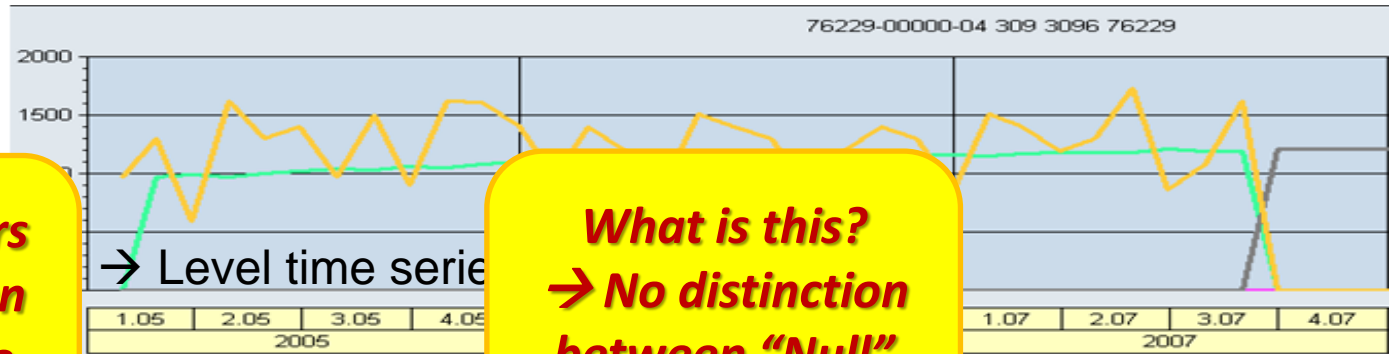
The Forecasting Process

Data Analysis & Exploration

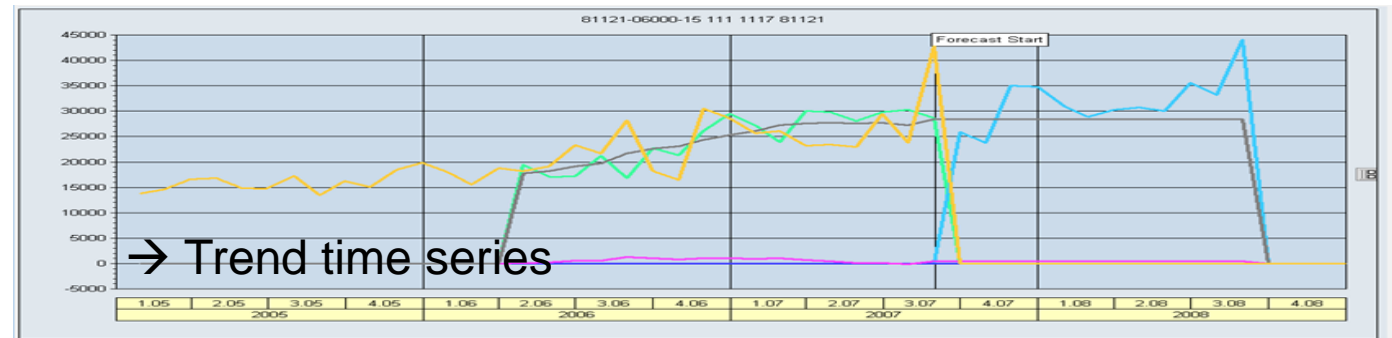
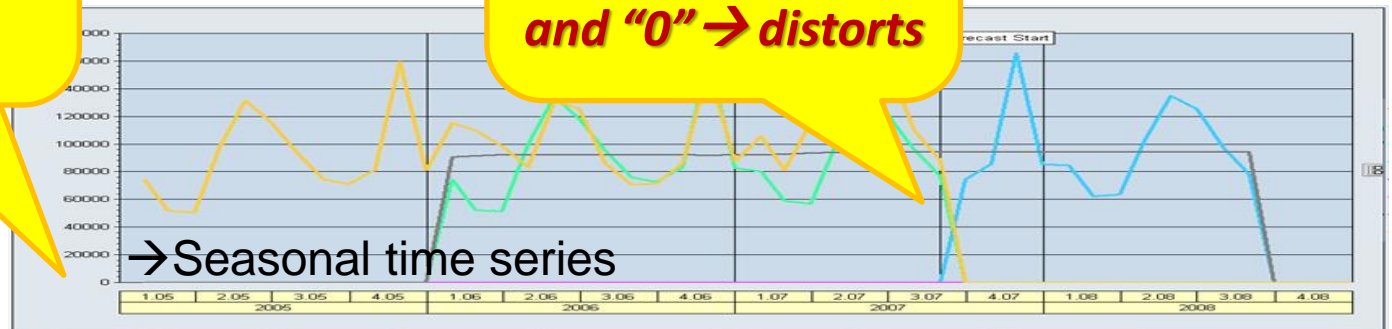




Standard colours are poor & often not changeable due to setup

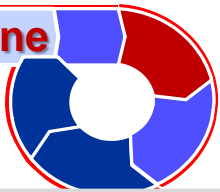


*What is this?
→ No distinction between "Null" and "0" → distorts*



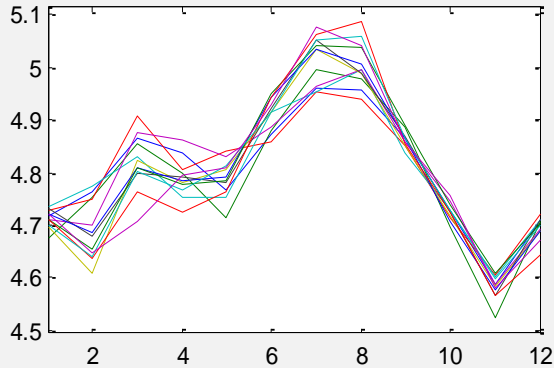
→ Visualisation is needed for Model Selection & Outlier Detection



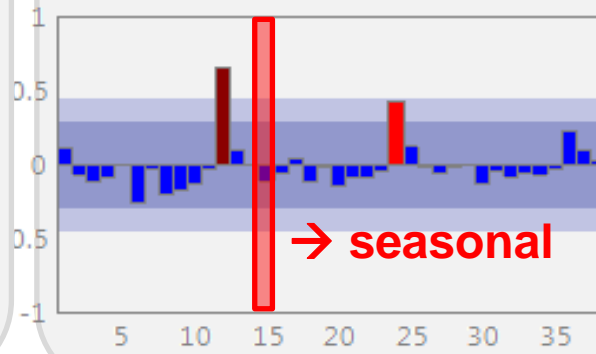


Seasonal Plots

Seasonal Diagram

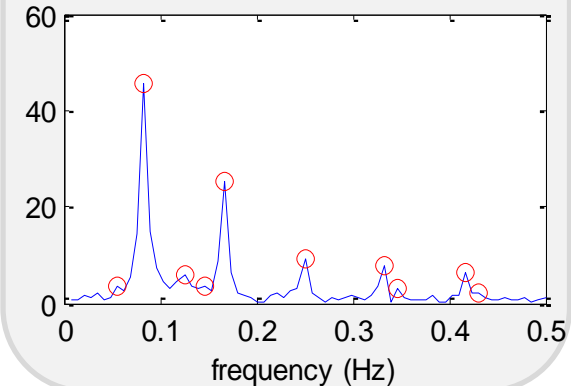


ACF Plots



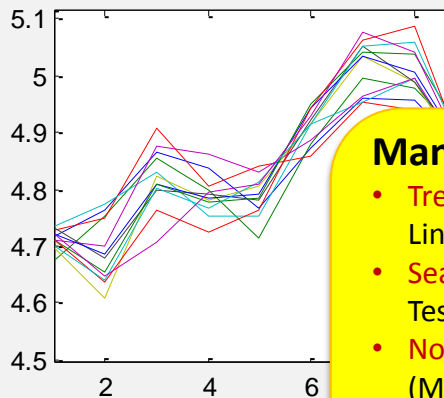
Spectral Plots

Amplitude



Statistical tests, e.g. F-Test

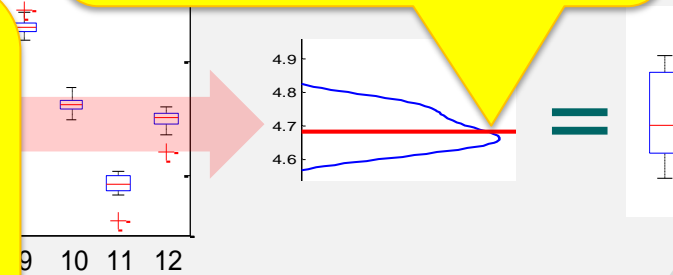
Seasonal Diagram



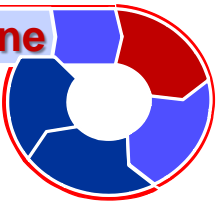
Many others exist:

- **Trend** (Kendall's Test, Spearman's Rho, Cox-Stuart, Linear Coefficient, Noether's Cyclical)
- **Seasonality** (Kruskal Wallis Test, Chi-Squared-Mod-Test, F-Test, ACF-Heuristic)
- **Noise** (Cox-Stuart Dispersion, Runs (Mean), Runs (Median), Runs (Up-Down))
- **Model form** (Level Shifts, Outliers, nonlinearity ...)
- **Series Characteristics** (Zero Values → Intermittent Demand, Length → New Products)

Compare distributions using F-test (parametric) or Freidman's (nonparametric)



→ Together with data transformations (detrend, deseasonalise, log transforms etc.)



Planning Book: [Live] DEMAND PLANNING ITALY / SEASONAL DIAGRAM

Y_IT_DP_TRAINING_10
Y_IT_DP_TRAINING_09
Y_IT_DP_TRAINING_08
Y_IT_DP_TRAINING_07
Y_IT_DP_TRAINING_06
Y_IT_DP_TRAINING_05
Y_IT_DP_TRAINING_04
Y_IT_DP_TRAINING_03
Y_IT_DP_TRAINING_02
Y_IT_DP_TRAINING_01
Y_IT_DP_TRAINING_11

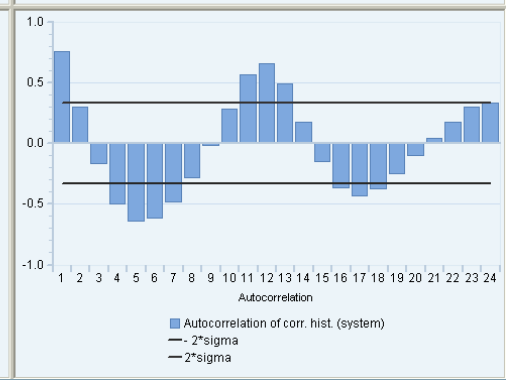
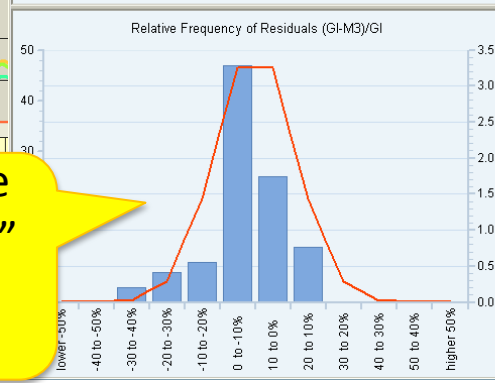
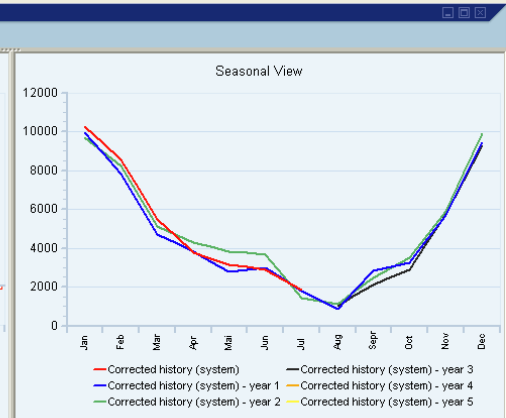
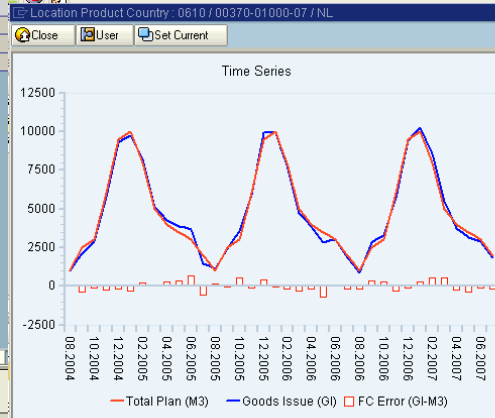
	M 02.2006	M 03.2006	M 04.2006	M 05.2006	M 06.2006	M 07.2006	M 08.2006	M 09.2006	M 10.2006
Total pl.	2.172	5.424	4.176	3.828	4.164	3.720			
History	5.749	10.806	5.562	2.208	5.051	5.059			
History	4.432	4.638	3.391	4.280	3.835	3.377			

Y_XX_FCST_TRAINING2

SEASONAL DIAGRAM

Create simple seasonal diagram as planning book

Program interactive "graphics container" with multiple diagrams for APO

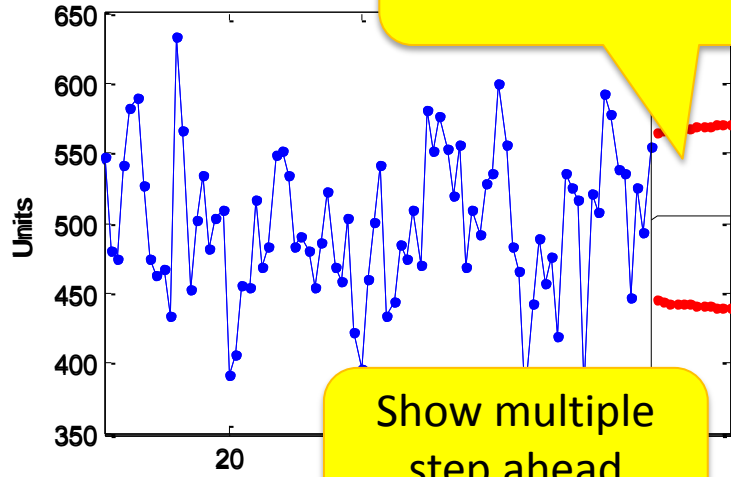


→ Together with data transformations (detrend / deseasonalise, log transforms etc.)

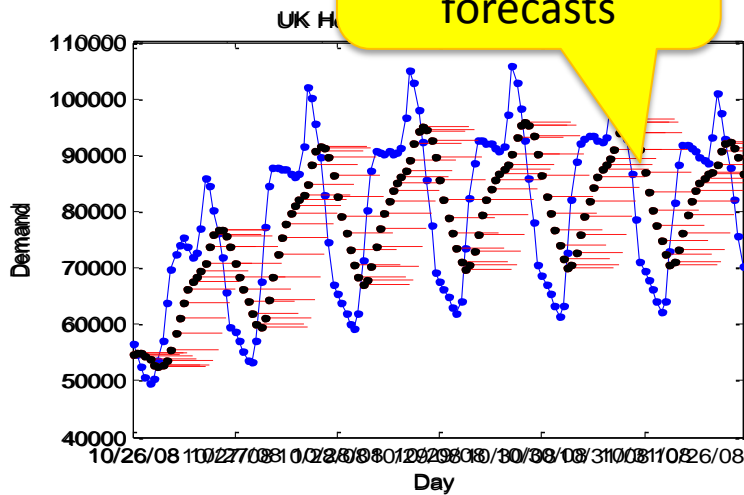
Baseline



Show prediction intervals



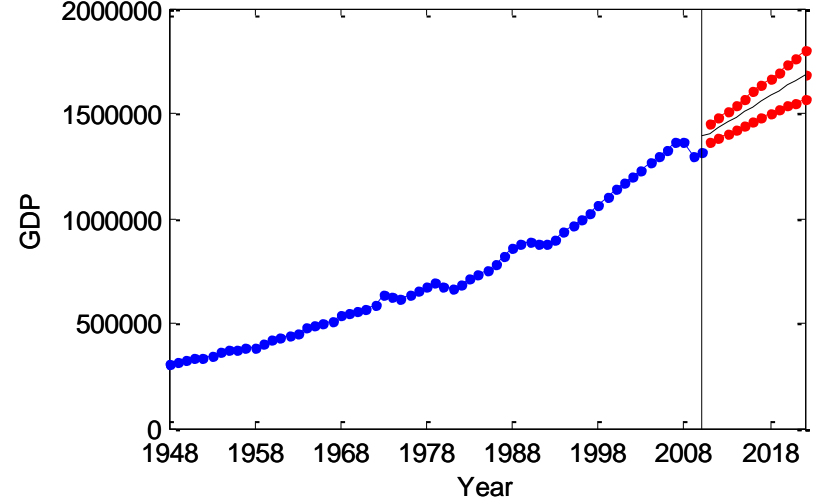
Show multiple step ahead forecasts



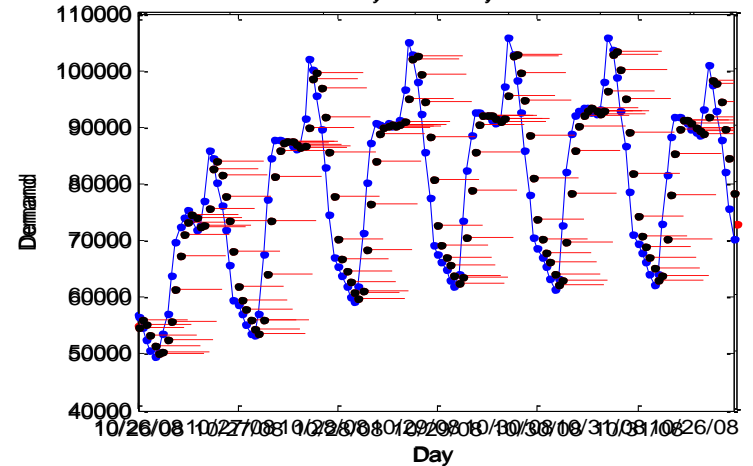
Data Analysis

Understanding Regular Patterns

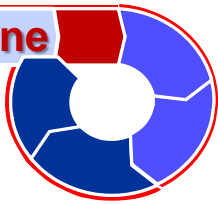
UK Gross Domestic Product: chained volume measures



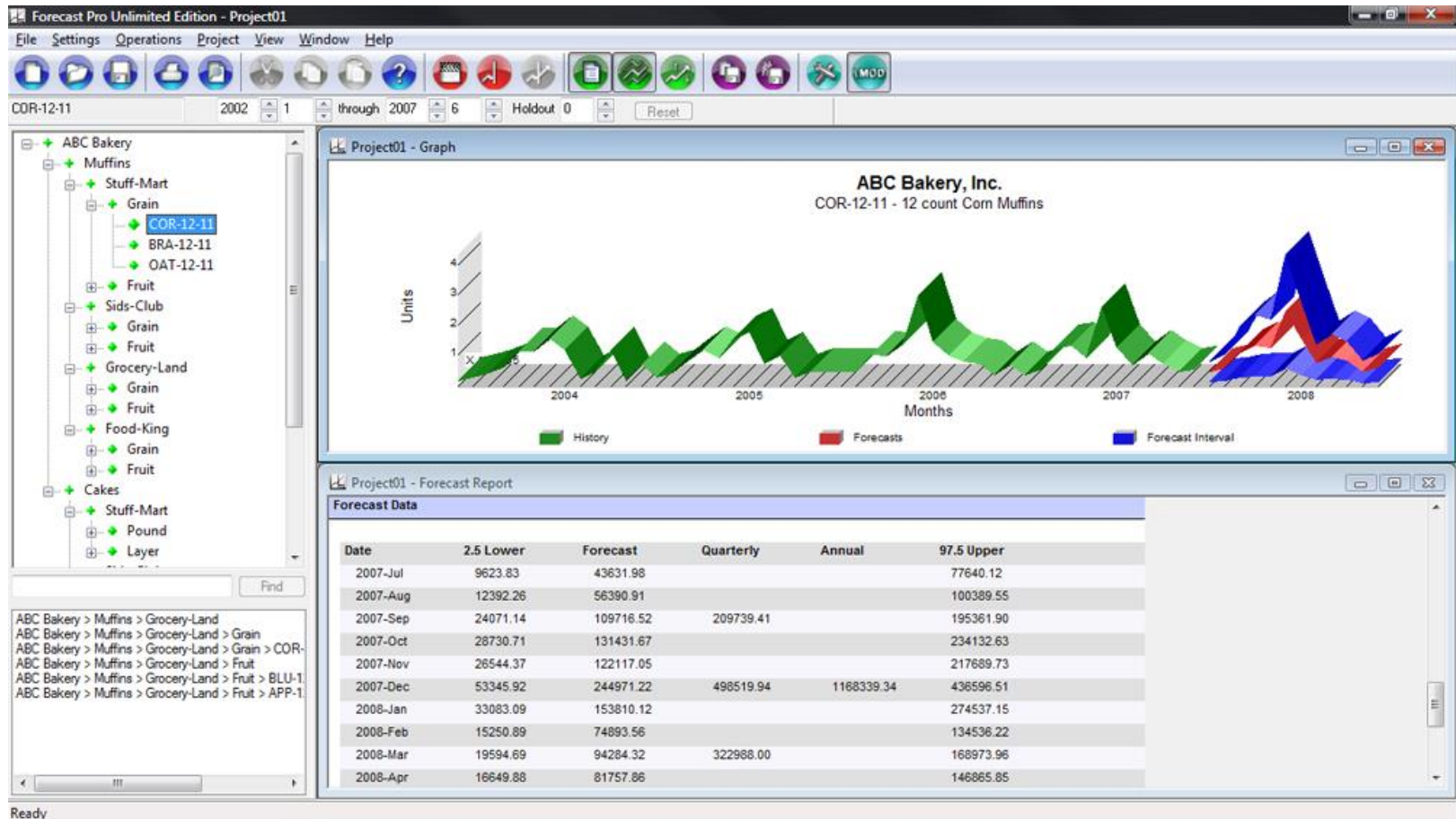
UK Hourly Electricity Demand



→ Together with data transformations (detrend / deseasonalise, log transforms etc.)



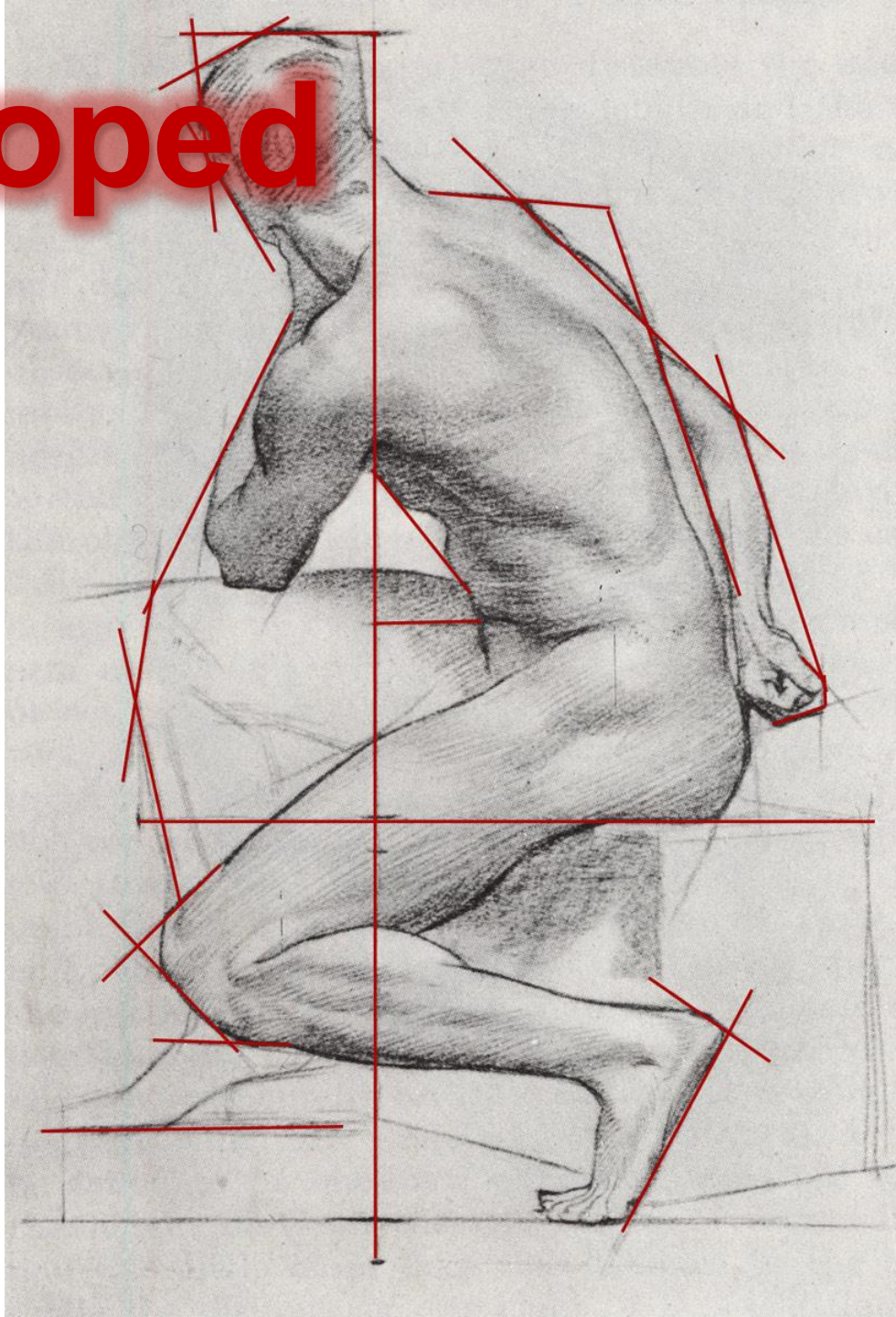
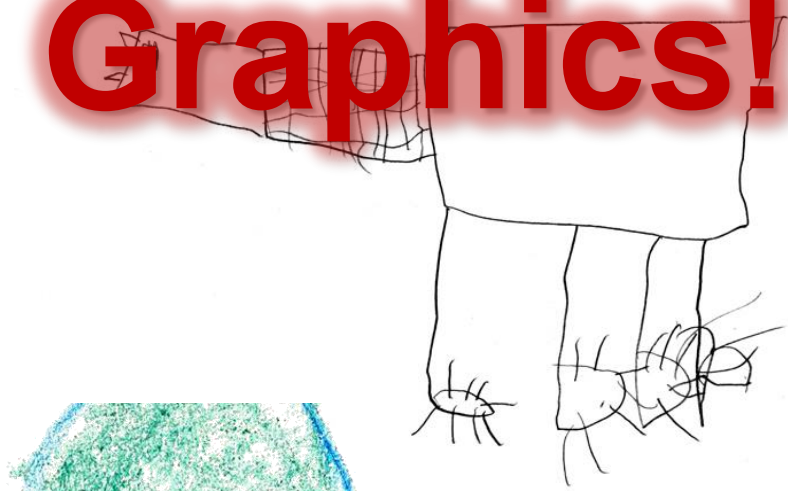
Forecast Pro



→ Not every “fancy” visualisation is helpful!

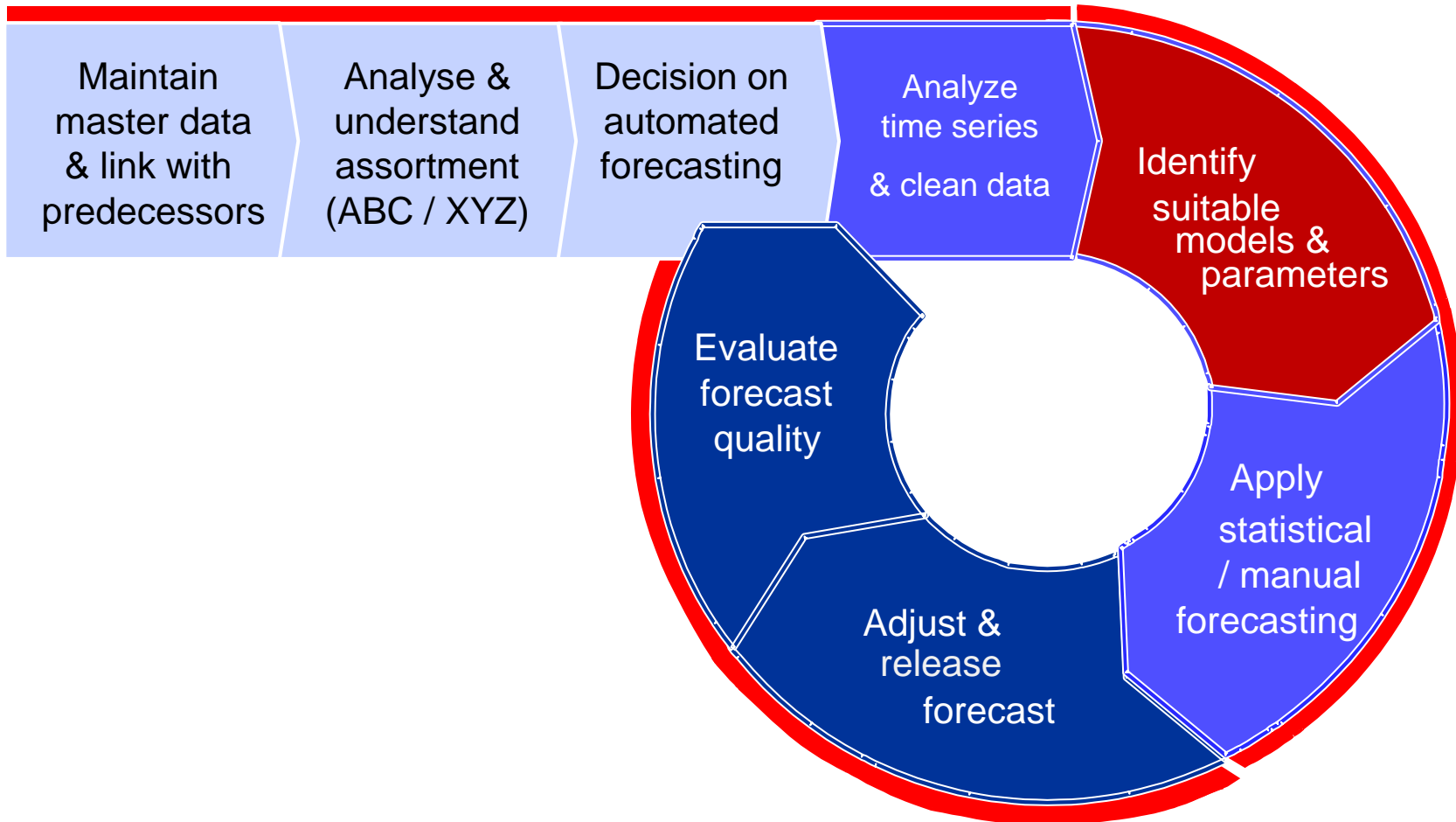


Underdeveloped Graphics!



The Forecasting Process

Model Selection & Parameterisation





Model Selection

Why Model Selection?

SAP Easy Access Advanced Planning and Optimization

Forecast in Interactive Planning; Change Mode

10001-00000-01

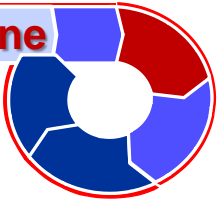
3.08	4.08	1.09	2.09	3.09	4.09	1.10	2.10	3.10	4.10	1.11	2.11	3.11	4.11	1.12	2.12	3.12	4.12	1.13	
2008																			

Type of Forecast Model

- Constant Models
 - Croston Method
 - Auto. Model Sel. 1
 - Auto. Model Sel. 2
- Trend Models
 - Linear Regression
 - Seasonal Trend Model
 - Season + Linear Regr.
 - Median Method
- Seasonal Models
 - Manual Forecastng
 - History
 - External Forecast
 - No Forecast

ST...

TAP (1) 001 | HAMA0170 | INS



Model Selection

Model Selection in APO DP

–Various selections required in SAP APO DP:

- **Methods:** Exponential Smoothing: Single, Trend, Seasonal, Trend-Seasonal, Linear regression, Seasonal Linear Reg., ...
 → **Choice of “98” forecasting methods in SAP APO DP!**

Type of Forecast Model

<input type="radio"/> Constant Models	<input type="radio"/> Trend Models	<input type="radio"/> Seasonal Models
<input type="radio"/> Croston Method	<input checked="" type="radio"/> Linear Regression	<input type="radio"/> Manual Forecastng
<input type="radio"/> Auto. Model Sel. 1	<input type="radio"/> Seasonal Trend Model	<input type="radio"/> History
<input type="radio"/> Auto. Model Sel. 2	<input type="radio"/> Season + Linear Regr.	<input type="radio"/> External Forecast
	<input type="radio"/> Median Method	

2 options for
a **fully automatic**
Model Selection

Supports mainly
a **manual** Model
Selection by Forecaster

[0,...,1], Beta [0,...,1], Gamma [0,...,1]

Choice of 100x100x100 parameter combinations!

→ 14 ETS models x 100 x 100 x 100 parameters

→ offer 14.000.000 choices per time series for each planner!

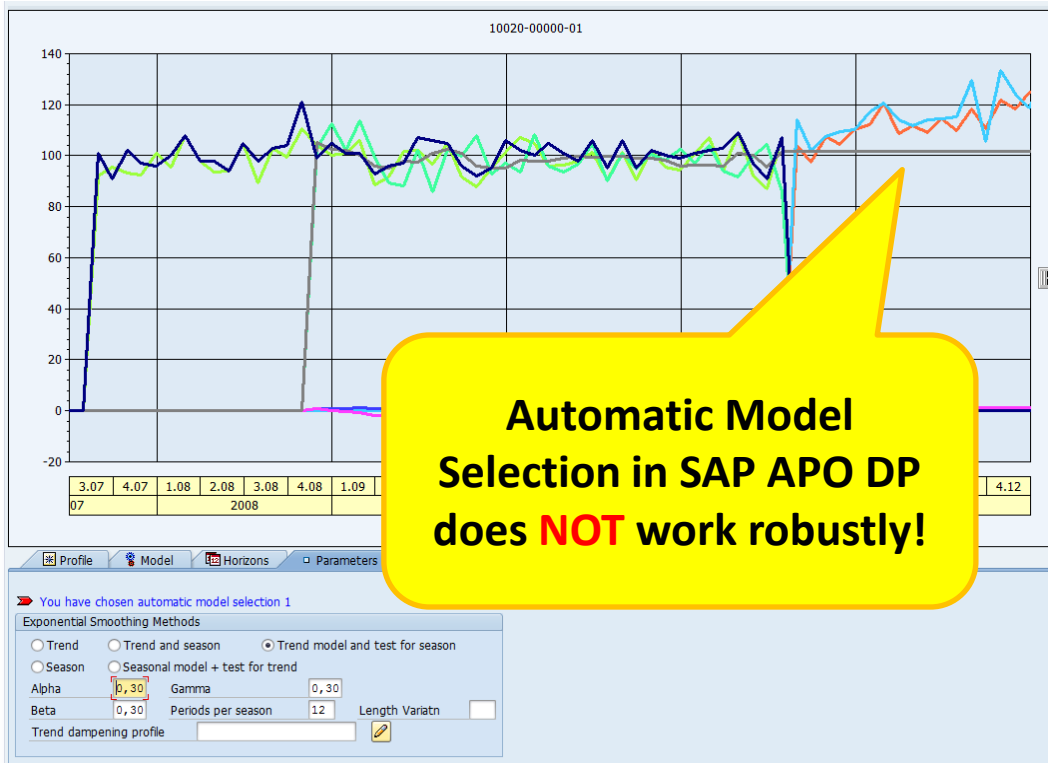




Model Selection

Model Selection in APO DP

- 2 Options for Automatic Model Selection in SAP APO DP (2 magic buttons?)
 - Option 1 NOR Option 2 always work (→ after testing)



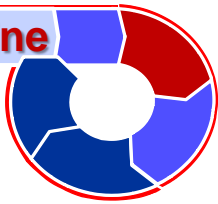
Mean Improvement	average	
Judgmental FC	0%	for X
FC Pro	-1%	for X
Intelligent Forecaster	-1%	for X
AMSP2 – SAP APO	-3%	for X
Judgmental FC	3%	for Y
FC Pro	1%	for Y
Intelligent Forecaster	-9%	for Y
AMSP2 – SAP APO	-81%	for Y
Judgmental FC	33%	for Z
Intelligent Forecaster	21%	for Z
FC Pro	15%	for Z
AMSP2 – SAP APO	-65%	for Z

→ Works sometimes, but not always ... cannot trust the system!

→ Cannot run automatically in the background!



Baseline

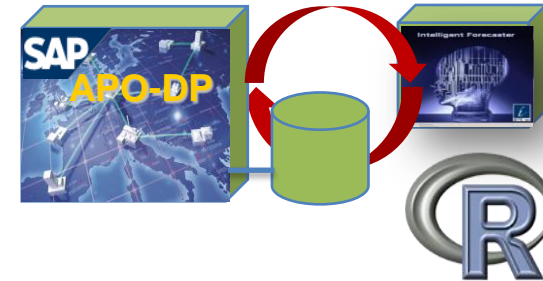


Model Selection

Model Selection in APO DP

Solutions exist

- Train demand planners in model selection
- Use bolt-on systems for model selection



ForecastPRO®

Start Date: 01.04.08 | 52 | [Navigation icons]

Profile | Model | Horizons | Parameters | Forecast Errors | Settings | Messages | Time Series

Forecast Profile

Forecast Profiles

Master Forecast Prfl.	XX_99B	▼
Univariate Profile	XX_99B	⊕
MLR Profile		⊕
Composite Forecast Prfl.		⊕

Master Prof. | Master Prof.

Model Type

Seasonal Models

Manual Forecastng

History

External Forecst

No Forecast

Mosel-specific Settings

1	Model category	:	C
2	Save assignment in IF	:	X
3		:	
4		:	
5		:	

- Can train demand planners (**preferred!**)
- Can integrate systems to do model selection for you

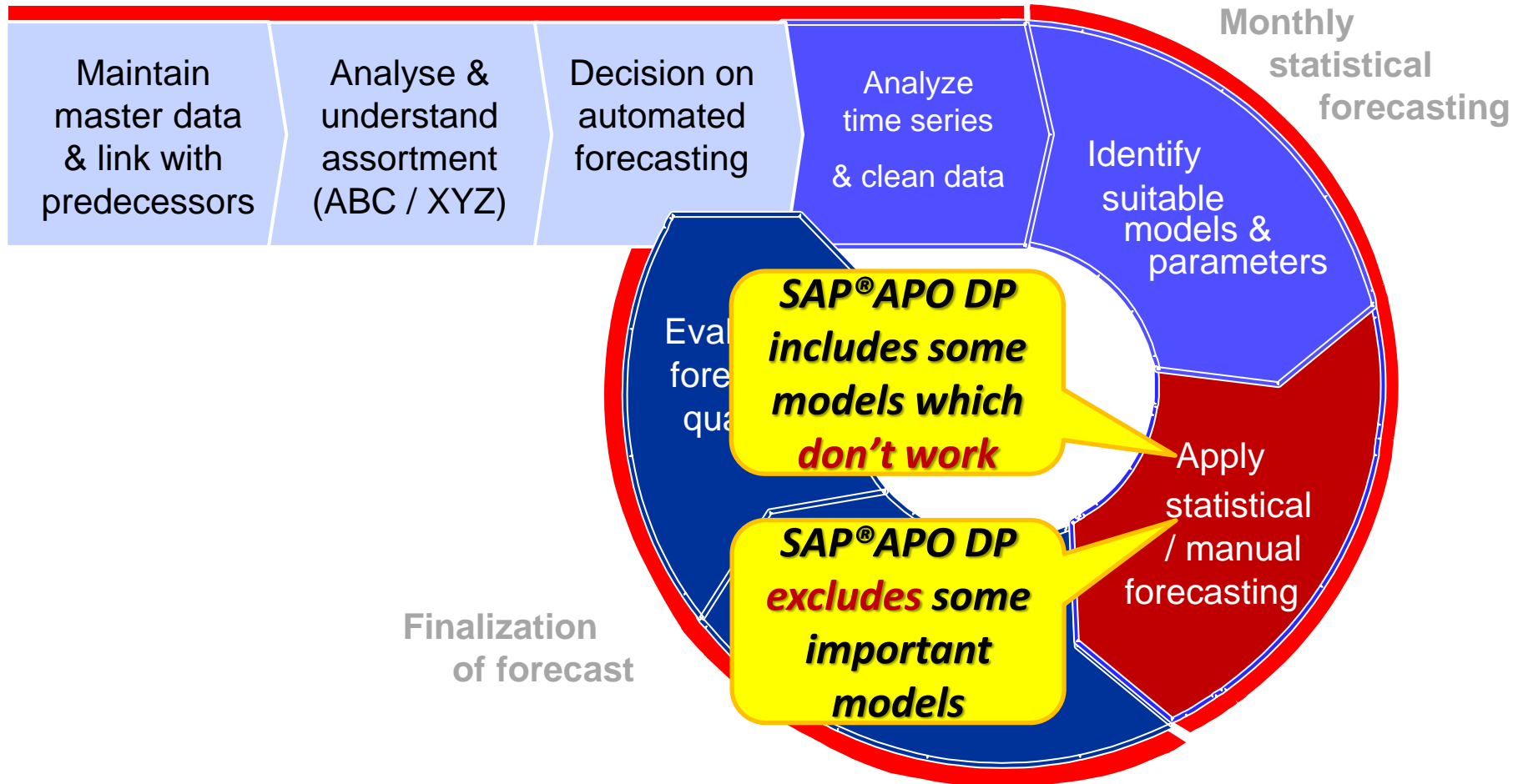
Poor Model Selection!



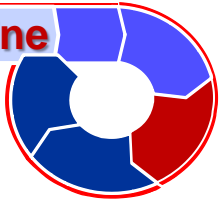
The Forecasting Process

Model Application

Initialization via overall analysis

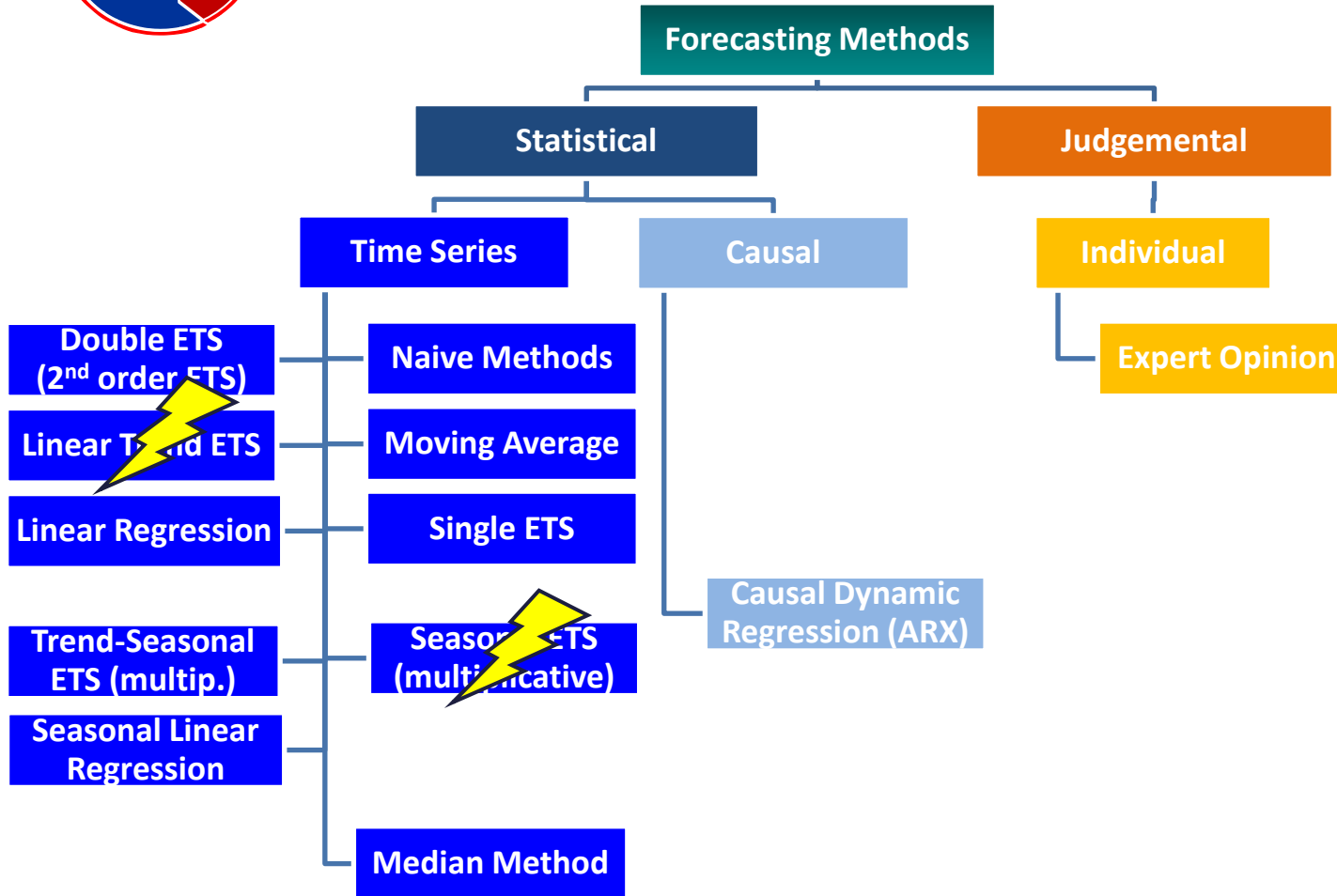


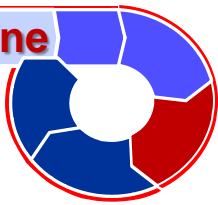
Baseline



Model Application

Models in APO not functional

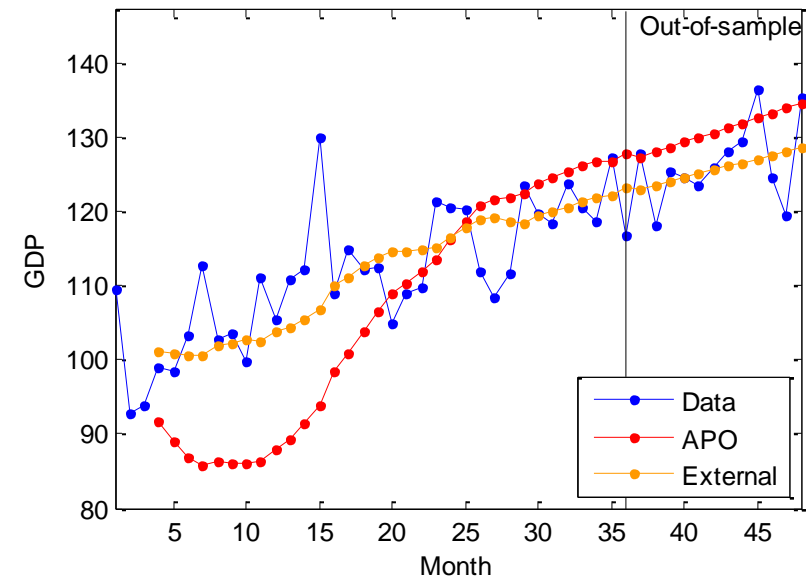
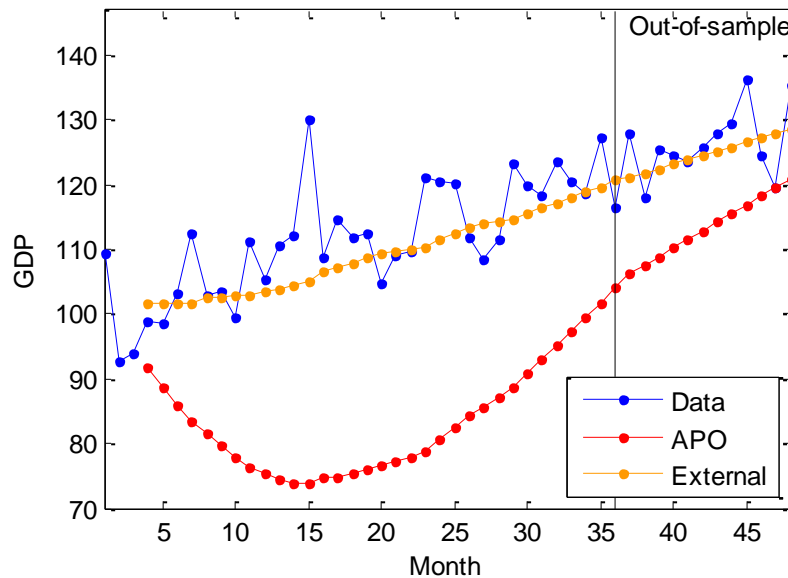




Model Application

Models in APO not functional

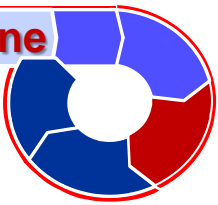
Exponential Smoothing require an “Initialisation” to forecast
 → poor “Naïve” Initialisation will impair forecast



3 years in-sample not enough to forget bad initialisation, requires higher smoothing parameters → Filter noise adequately?

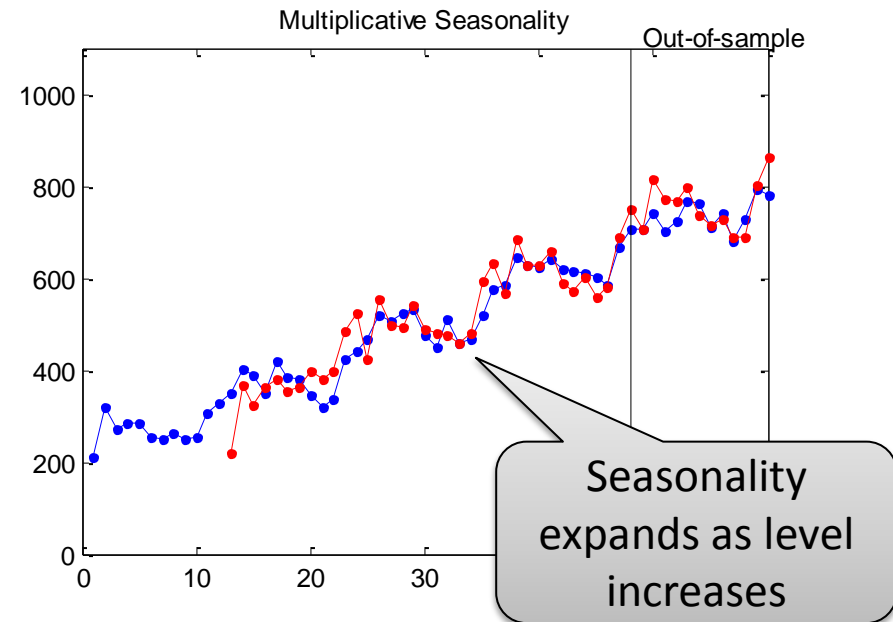
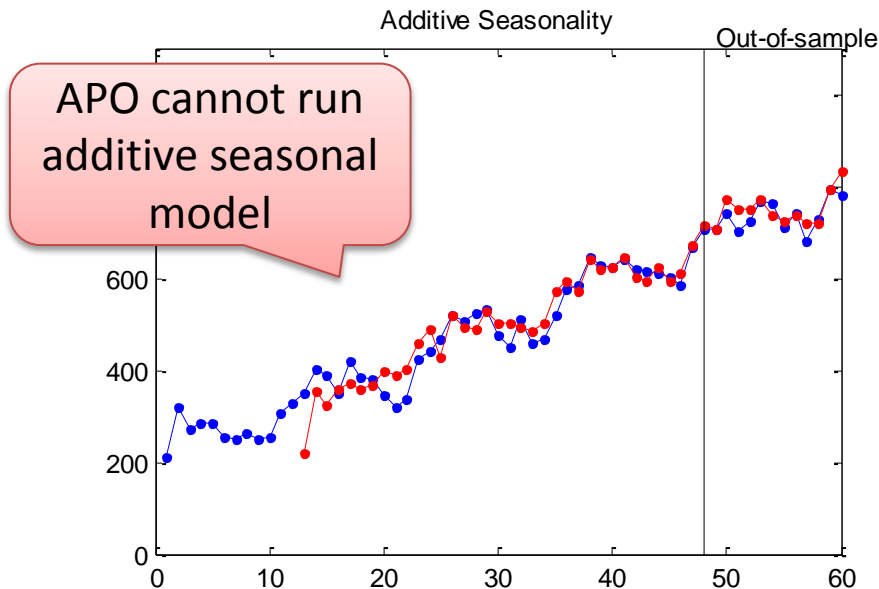
→ Initialisation problem for ETS trend models is significant → better avoid them!
 → Similarly: avoid 2nd order Exponential Smoothing





Exponential Smoothing Models in APO DP -Seasonal Models

In APO DP there is only multiplicative seasonal exponential smoothing. When there is no trend or level shifts there is little difference between additive and multiplicative models; however, this is not the case for trended time series.



This restricts the valid usage of the seasonal trend model in APO DP

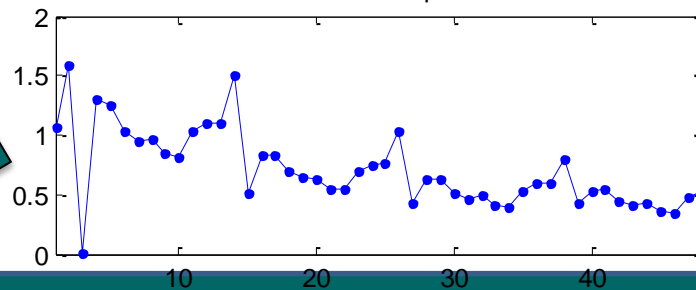
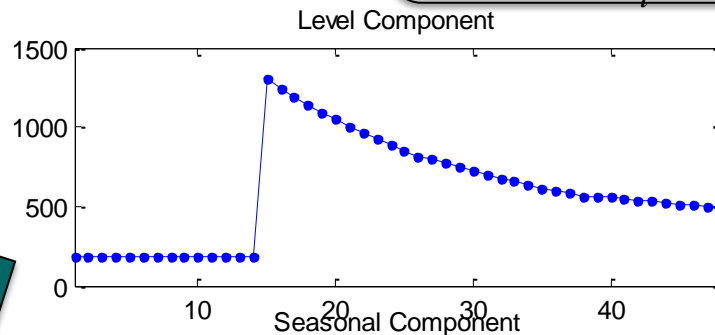
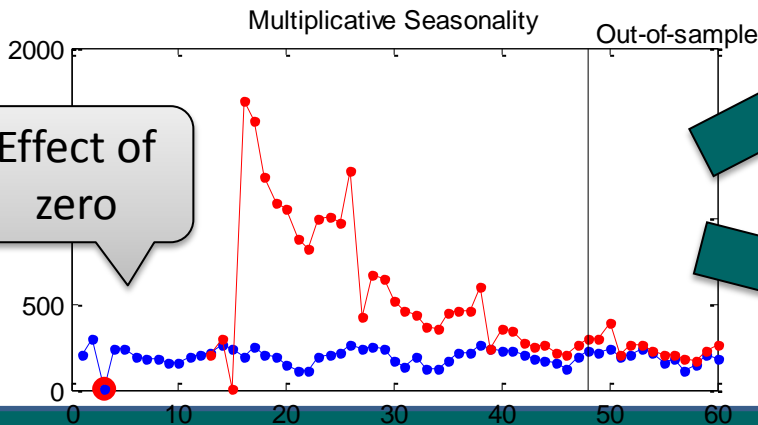
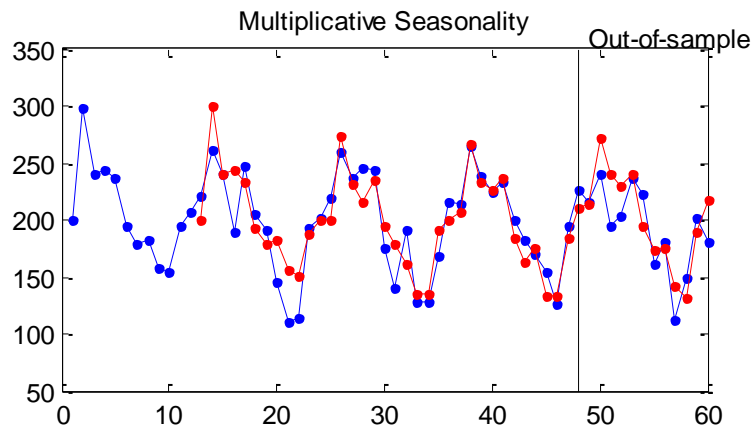


Exponential Smoothing Models in APO DP -Seasonal Models

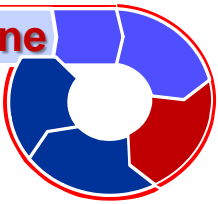
Because APO has only multiplicative seasonal EXSM, any time series that has values close to zero becomes impossible to forecast.

$$L_t = \alpha \cdot \frac{A_t}{S_{t-s}} + (1 - \alpha)L_{t-1}$$

$$S_t = \gamma \frac{A_t}{L_t} + (1 - \gamma) \cdot S_{t-s}$$

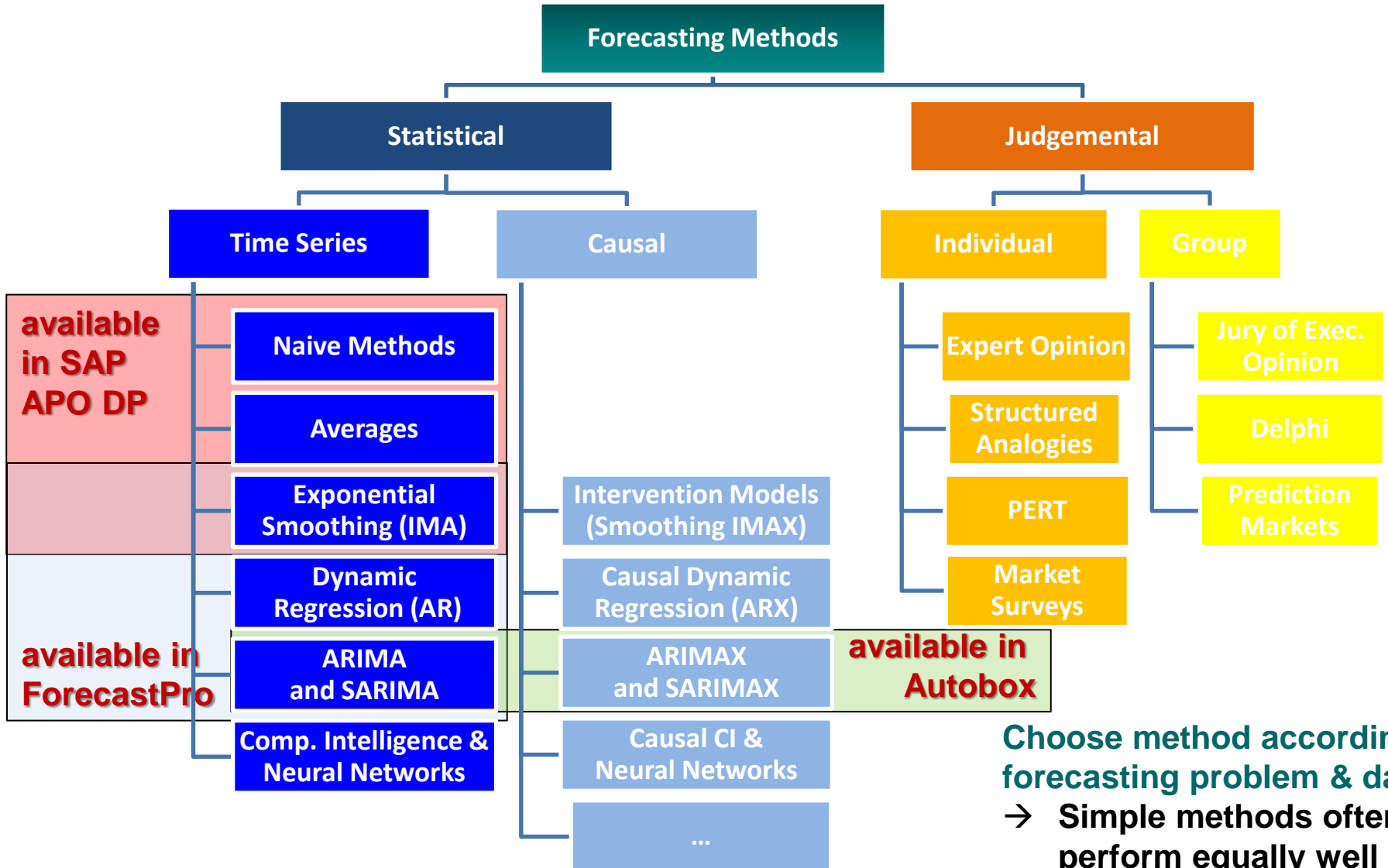


Very small values break down multiplicative seasonal models → use additive



Model Application

Models in APO missing

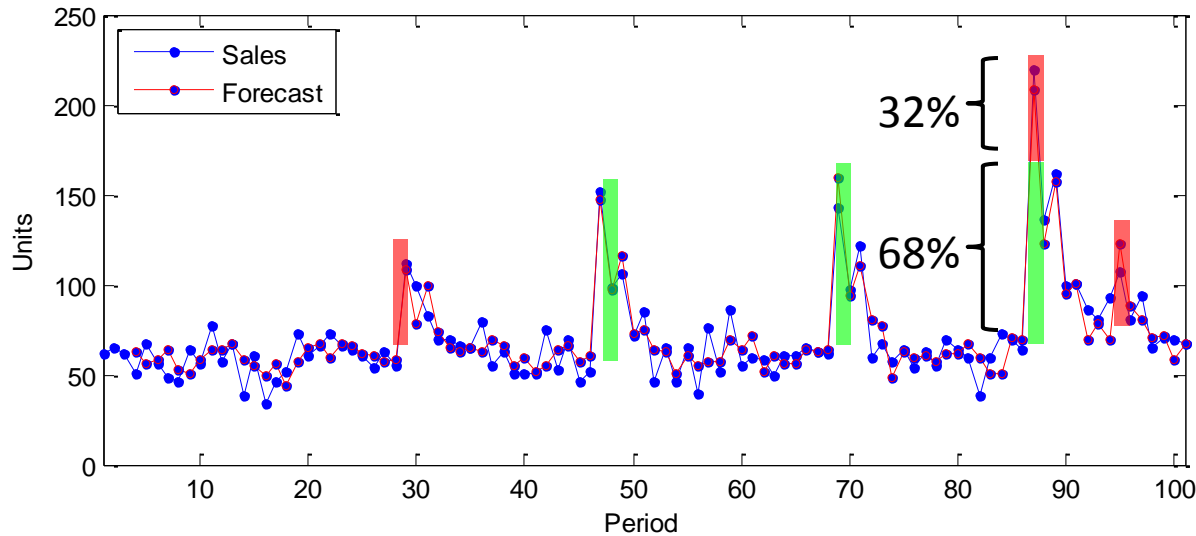


Choose method according to forecasting problem & data
 → Simple methods often perform equally well
 → Problem dependent

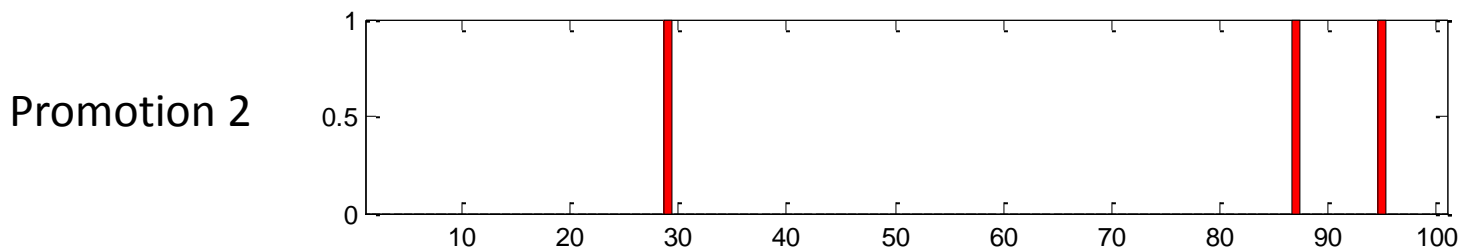
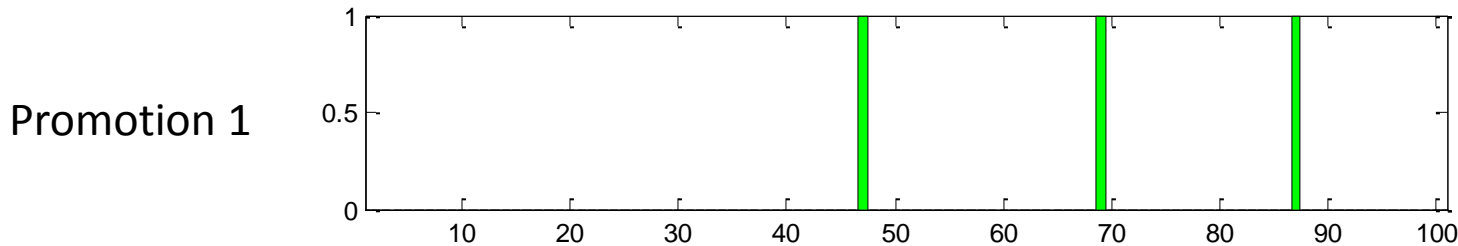


Causal Modelling

That can get more complicated...



$$\hat{y} = 25.36 + 0.40y_{t-1} + 0.42y_{t-2} - 0.24y_{t-3} + 98.23(Promot1) + 46.98(Promot2)$$



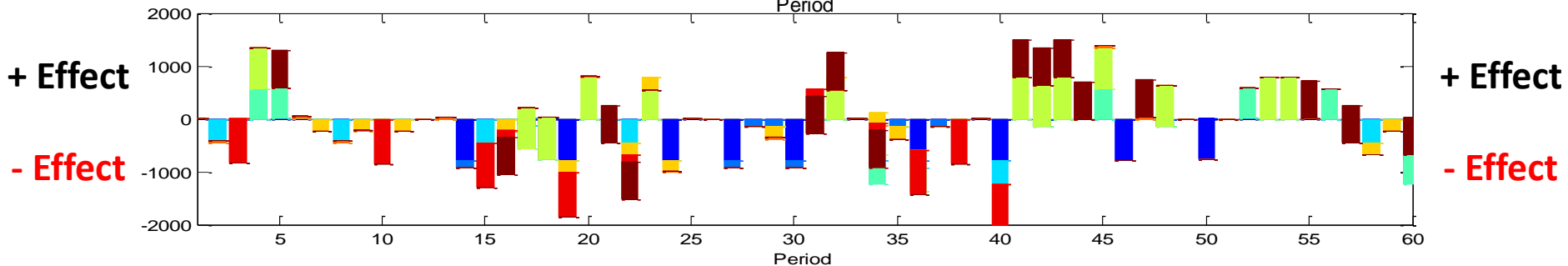
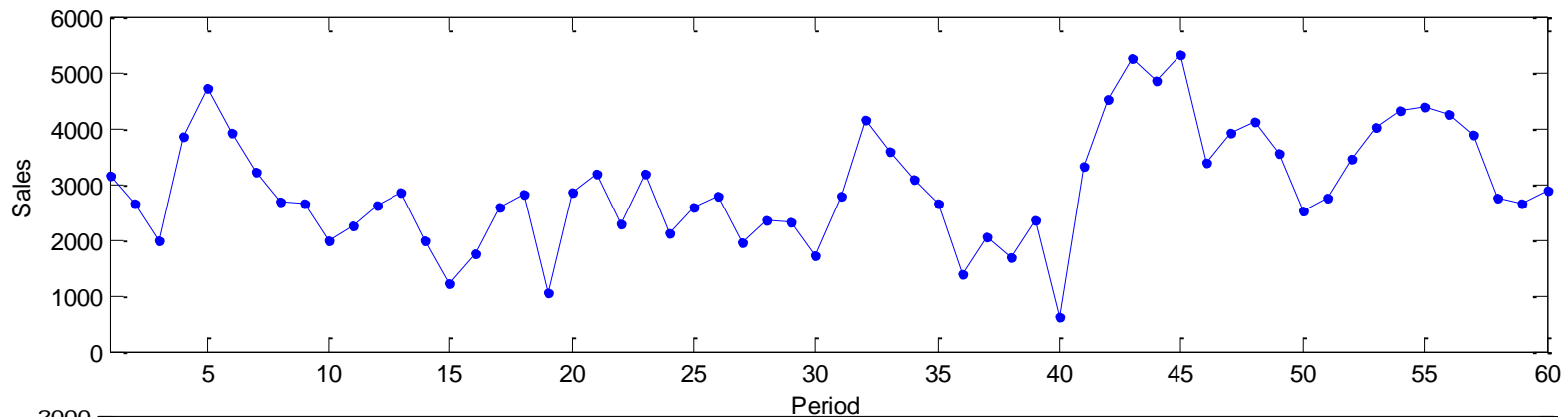
The ScanPRO model

$$Q_{kjt} = \left[\prod_{r=1}^n \left(\frac{p_{krt}}{\bar{p}_{krt}} \right)^{\beta_{rj}} \prod_{l=1}^3 \gamma_{lrj}^{D_{lkrt}} \right] \left[\prod_{t=1}^T \delta_{jt}^{X_t} \right] \left[\prod_{k=1}^K \lambda_{kj}^{Z_k} \right] e^{\varepsilon_{kjt}}$$

Cross-effects between products → Interactions & cannibalism

Cross-effects between promotions → Interactions, support & cannibalism

Cross-effects between stores → Spatial cannibalisation & competition

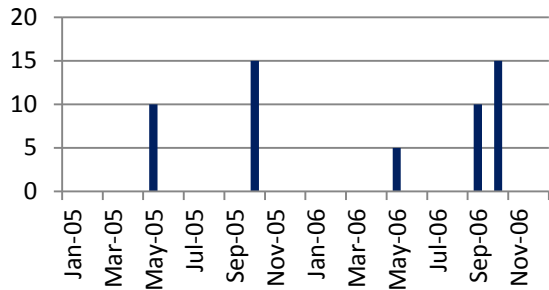


APO DP Best Practices and Limitations

Croston – Intermittent Demand

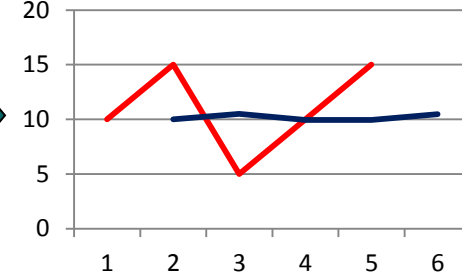
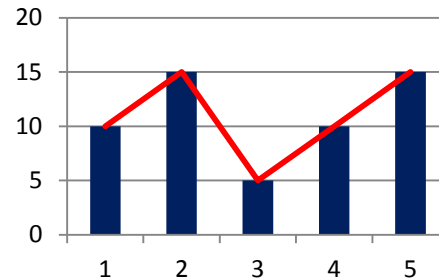
Croston method is designed to deal with these type of products.

Intermittent Time Series



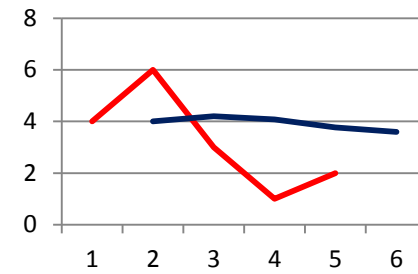
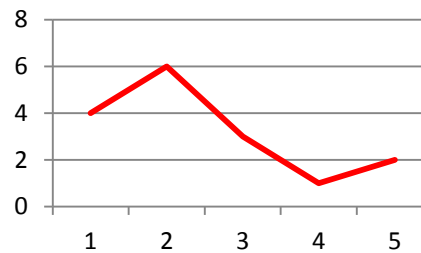
12 months of data

Demand Only 5 months of data!



Forecast them with the same single exponential smoothing model

Time Interval



Count every how many months there is demand

Advanced Intermittent methods are missing, e.g. neural nets, Bootstrapping, Zero-inflated demand



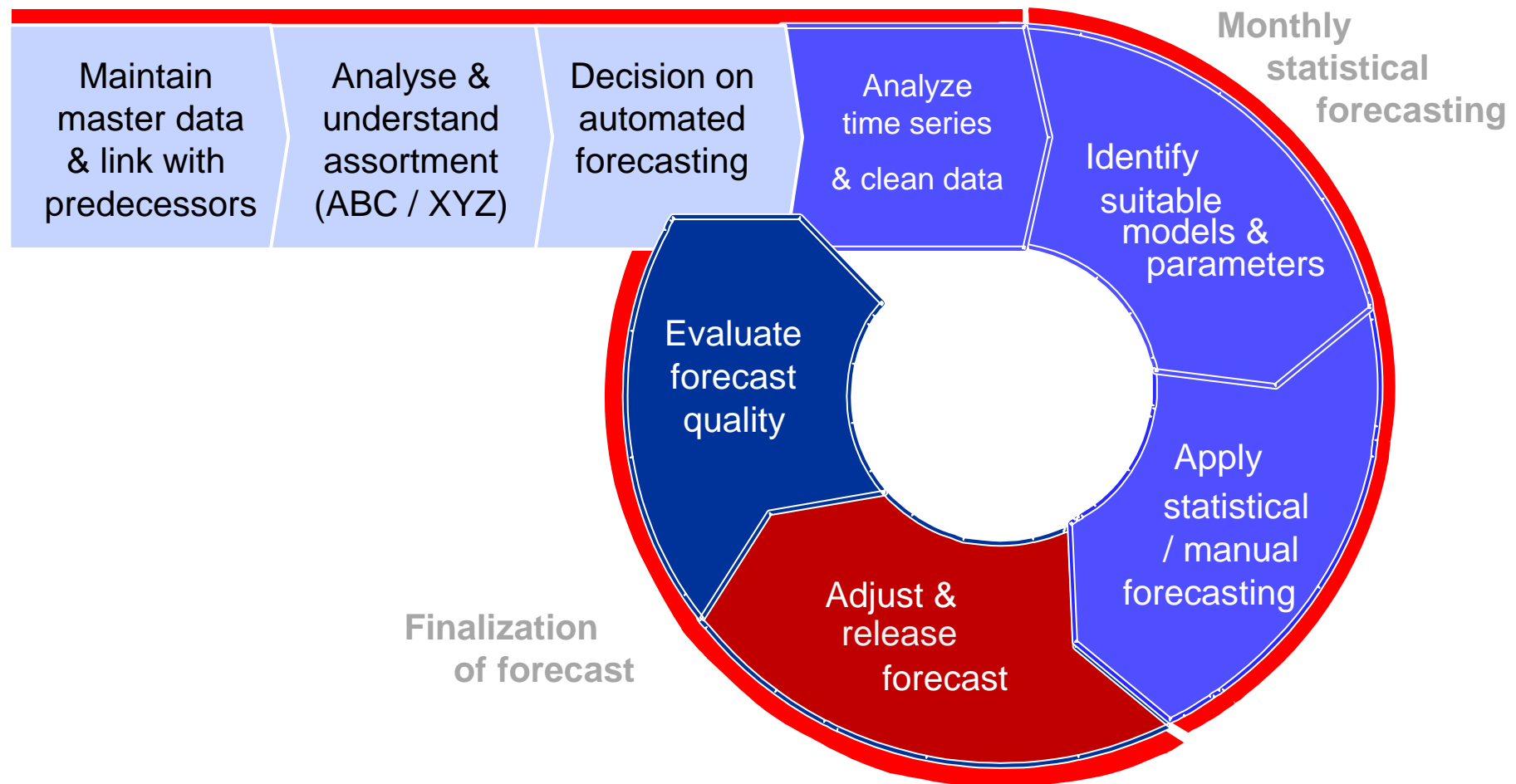
**Limited Model
Functionality!**

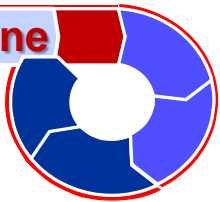


The Forecasting Process

Statistical Modelling: Model Application

Initialization via overall analysis





Allows various overrides for promo planning, history correction, ...

Planning Book: [Live] FORECAST

Selected Objects

FORECAST TABLE	M 02.2008	M 03.2008	M 04.2008	M 05.2008	M 06.2008	M 07.2008	M 08.2008	M 09.2008	M 10.2008	M 11.2008
open orders										
goods issue qty										
corrected history (system)	98	106	95							
corrected forecast (system)				103	98	105	98	104	102	
promotions forecast										
dependent demand forecast										
adjustment of forecast (percentage)										
adjustment of forecast										
FOC forecast										
external forecast										
calculated forecast								104	102	
overwrite of forecast										
total plan								104	102	

Can add notes

Y_XX_DP_FORECAST 10011-00000-01

→ No explicit systems support of judgmental decision making in system!



HUMAN CAUSES

*Rational
Human
Causes*

– e.g. biases
from company
policy

*Irrational
Human Causes*

– limited
information
processing
capacity

THE PROBLEM

**Sub-optimal
sales forecast
accuracy from
Human
Judgment**

- How to avoid systematic errors in final forecast?

THE REMEDIES

- Training
- Decomposition
- Don't adjust
- Use Analogies
- Develop systems
- FSS features to **support** judgment
- FSS features to **constrain** judgement

Side effects:
Lower user
acceptance



→ Support Judgement with Analogous Information
→ Improve Forecasting Support Systems (FSS)



Promotion Forecast

Product A - May 2005

Promotion of the month

There will be a 2-week promotion of 3 For 2 at Somerfield

May'05 sales forecasts

System Baseline Sales Forecast =

Promotional Effect Forecast = units OR %

Calculator

+ =

The 3 past promotions that are the most similar to the current promotion

Similarity	Month	Duration	Promotion Type	Store Chain	Baseline Sales	Promotional Effect	% Increase over Baseline
1st	Oct-03	2-week	3 For 2	Waitrose	16481	36467	221%
2nd	Dec-02	2-week	3 For 2	Waitrose	17615	39445	224%
3rd	Dec-04	2-week	40% Off	Waitrose	17710	38882	220%

All promotions on the product between May'02 and Apr'05

Month	Duration	Promotion Type	Store Chain	Baseline Sales	Promotional Effect	% Increase over Baseline
Apr-05	1-week	3 For 2	Tesco	18009	42120	234%
Mar-05	1-week	10% Off	Somerfield	16496	24950	151%
Jan-05	2-week	30% Off	Sainsbury's	17182	37868	220%
Dec-04	2-week	40% Off	Waitrose	17710	38882	220%
Oct-04	1-week	40% Off	Somerfield	17450	31862	183%
Sep-04	1-week	10% Off	Waitrose	17662	24235	137%
Aug-04	2-week	10% Off	Somerfield	16570	28803	174%
Jul-04	2-week	40% Off	Waitrose	16897	41468	245%
Jun-04	1-week	3 For 2	Sainsbury's	17212	39483	229%
Apr-04	1-week	10% Off	Waitrose	16303	23773	146%
Mar-04	1-week	30% Off	Tesco	17089	33215	194%
Feb-04	1-week	30% Off	Somerfield	17557	26489	151%
Jan-04	2-week	10% Off	Somerfield	15471	29413	190%
Dec-03	1-week	3 For 2	Waitrose	15433	36499	236%
Nov-03	1-week	30% Off	Tesco	15551	32913	212%

% Increase ratios

When other characteristics of promotions were identical, the relative percentage increases above baseline (due to the promotions) were:

Duration
2-week vs. 1-week = 1.11 : 1

Promotion Type
3 For 2 vs. Buy 1 Get 1 Free = 0.99 : 1
vs. 40% Off = 1.01 : 1
vs. 30% Off = 1.18 : 1
vs. 10% Off = 1.47 : 1

Store Chain
Somerfield vs. Tesco = 0.84 : 1
vs. Sainsbury's = 0.92 : 1
vs. Waitrose = 1 : 1

If the ratio is 'N/A', it means that no appropriate past cases is available for the comparison.

Similarity judgment support

Memory support

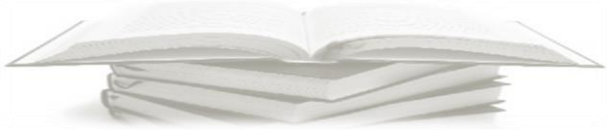
Adaptation judgment support

→ Test what type of support works best using ANOVA
 → Interactively select & store similar promotional cases



Limited Support of Judgment!

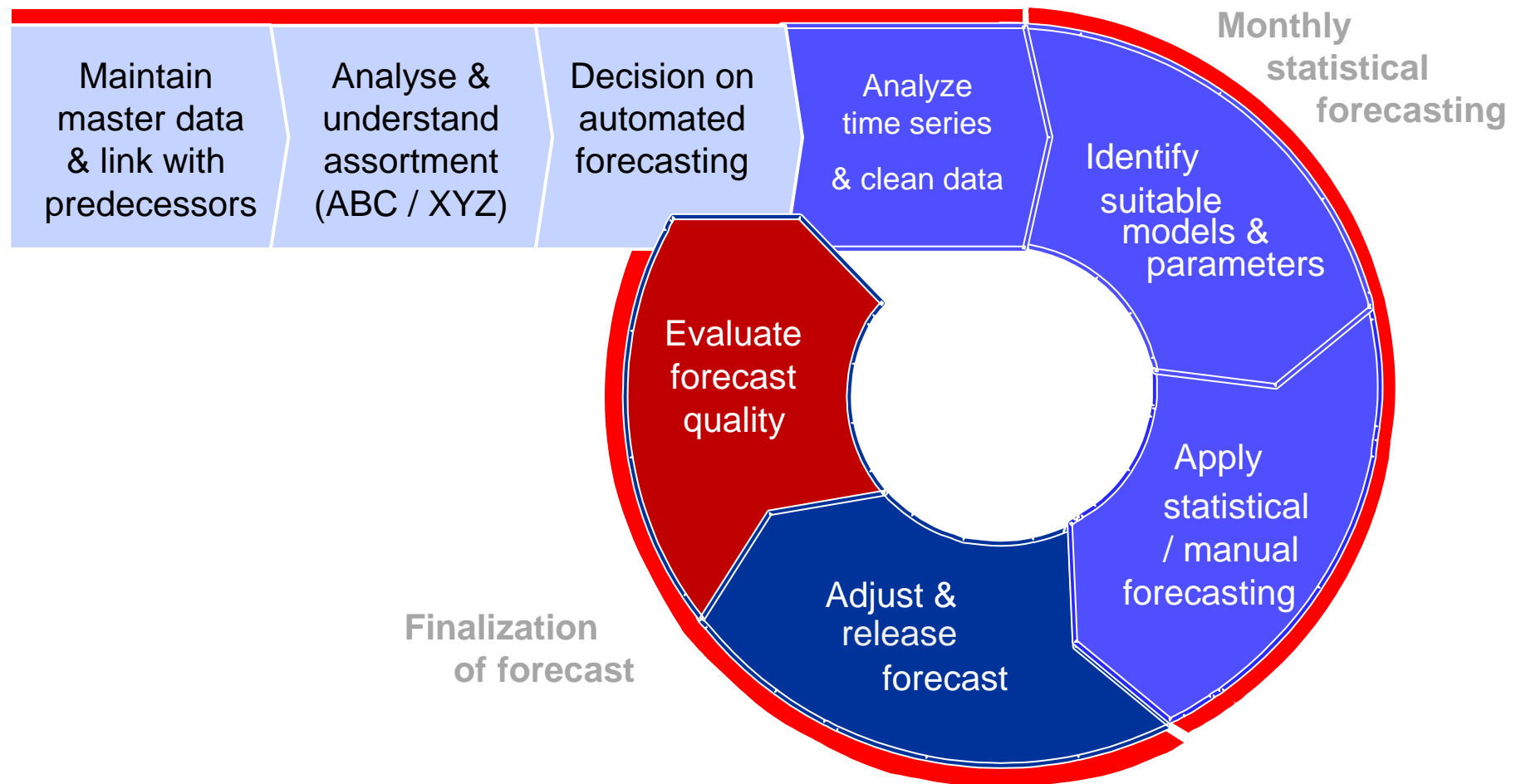




The Forecasting Process

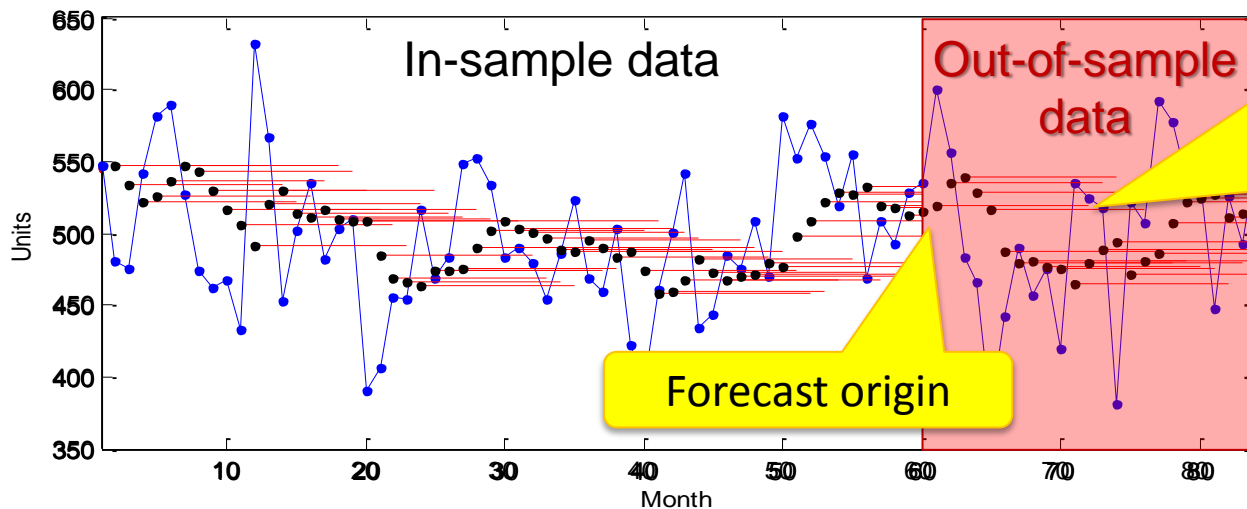
Statistical Modelling: Model Application

Initialization via overall analysis



Model Evaluation

Misleading Error Measures



1 forecast origin
→ only 1 measurement
→ low confidence in the measurement accuracy
→ BUT: more data (24) is available

→ Assess accuracy correctly: out of sample, rolling, good measures!

Model Evaluation

Model Wrappers

Fit **all possible models** and measure the errors:

$$MSE = \frac{1}{n} \sum_{i=1}^n (A_i - F_i)^2$$

$$MAPE = \frac{1}{n} \sum_{i=1}^n \frac{|A_i - F_i|}{|A_i|}$$

$$MAE = \frac{1}{n} \sum_{i=1}^n |A_i - F_i|$$

$$sMAPE = \frac{1}{n} \sum_{i=1}^n \frac{|A_i - F_i|}{(|A_i| + |F_i|)/2}$$

Robust versions
of MAPE exist

$$RE_t = \frac{A_t - F_t}{A_t - F_{Naive}}$$

$$GMRAE = \left(\prod_{i=1}^n \frac{|A_i - F_i|}{|A_i - F_{Naive}|} \right)^{1/n}$$

Relative Errors
missing

... use **Information Criteria**
for model selection?

$$AIC = -2 \ln(L) + 2k$$

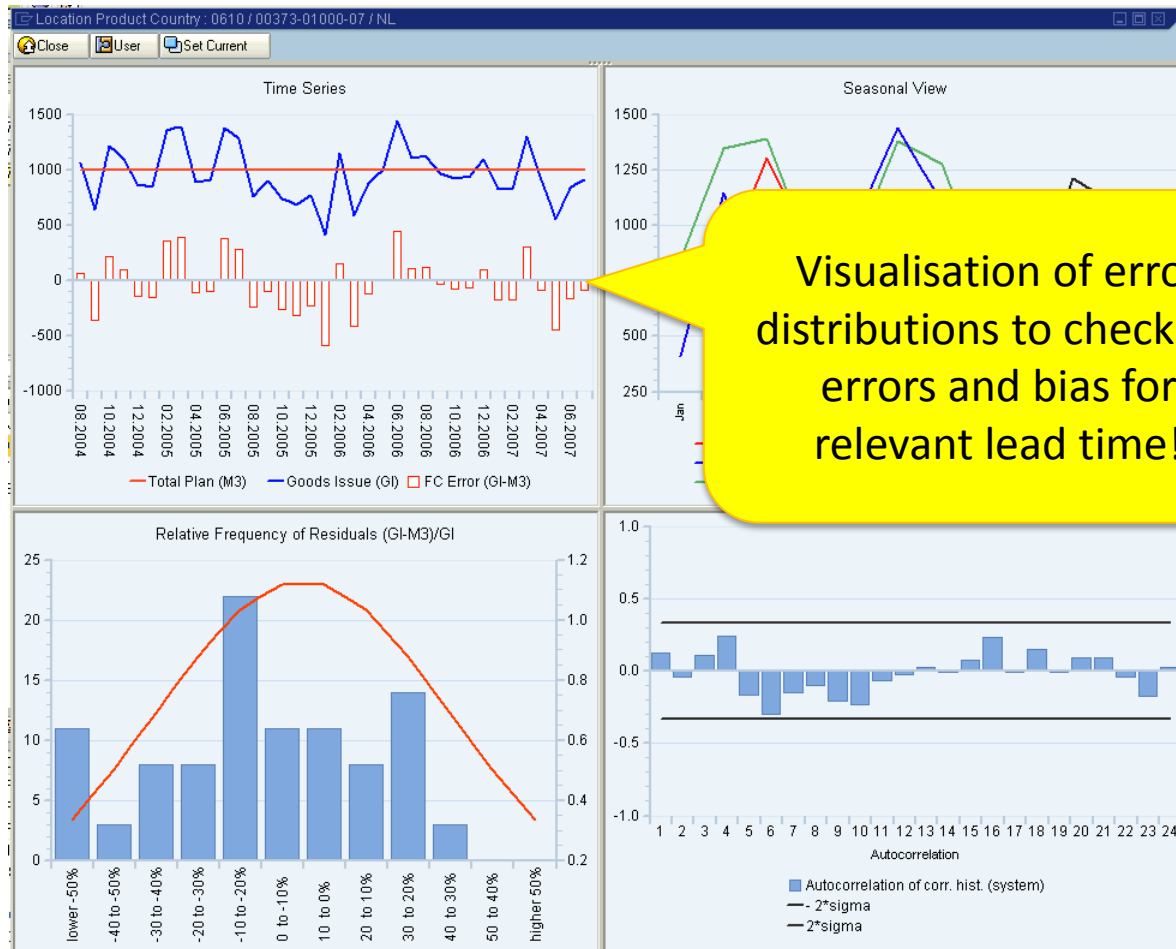
$$BIC = -2 \ln(L) + k \ln(n)$$

$$MASE = \frac{1}{n} \sum_{i=1}^n \frac{|A_t - F_t|}{MAE_{in-sample 1-step-ahead Naive}}$$

→ Assess accuracy correctly: out of sample, rolling, good measures!

Model Evaluation

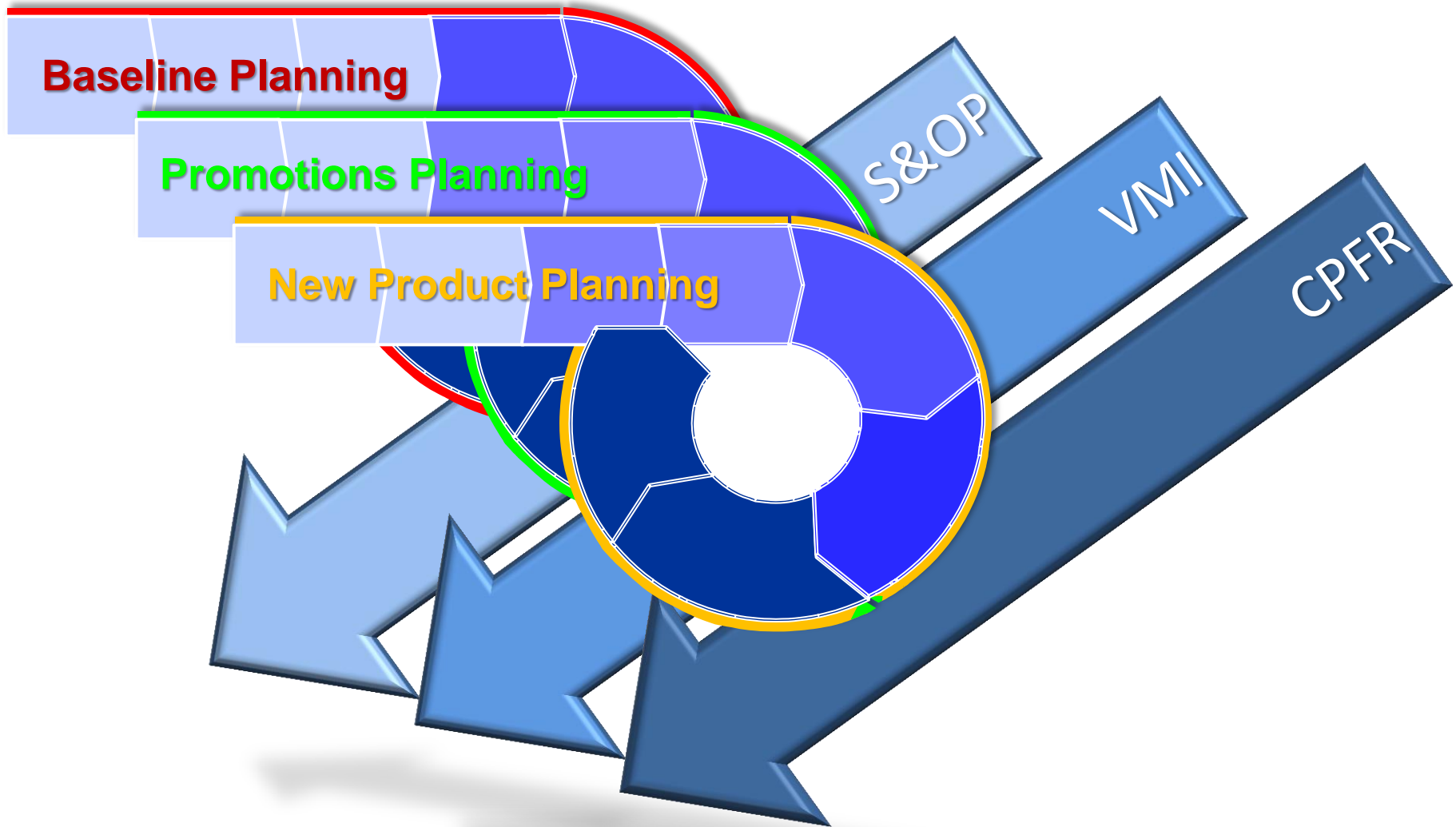
Model Wrappers



→ Assess accuracy correctly: out of sample, rolling, good measures!

The Forecasting Process

Triage of Baseline | Promo | New



Take aways

- Companies are using SAP APO with multiple other systems and still use simple methods & little data
→ does not reflect Marketing hype & S.o.t.A.!
- Data exploration can be enhanced
→ poor graphics & visualisation – customisable?
- Model Selection can be enhanced
→ enough model selection & models for you?
- Judgmental Adjustments are not supported well
→ smart notes to support & constrain judgment!
- Review your SAP APO DP setup
→ possibly new releases / customisation flawed?

... making SAP APO DP work for you!





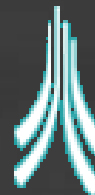
... Discussion?

Questions?

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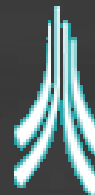
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