5.5 Selection of Software Tools

Dimensions of Software

1) Statistical capabilities
2) Data Mining
3) Simulation
4) Optimization
5) Visualization / Reporting

Others: User-friendliness, costs (cost of license vs. open-source), maintenance, transparency,…

5.5 Selection of Software Tools

Software	Statistical	Data Mining	Simulation	Optimisation	Visualisation
Excel	Medium	Medium	Low	Low	High
Access	Medium	Medium	Low	Low	Low
SQL	Low	Medium	Low	Low	Low
R	High	High	Medium	Medium	Low
KNIME	Medium	High	Low	Low	Medium
WEKA	Medium	High	Low	Low	High
SPSS	High	High	Low	Low	Medium
SAS	High	Medium	Medium	High	Medium
Rapidminer	Medium	High	Low	Low	Medium
Matlab	Medium	Medium	High	High	Medium

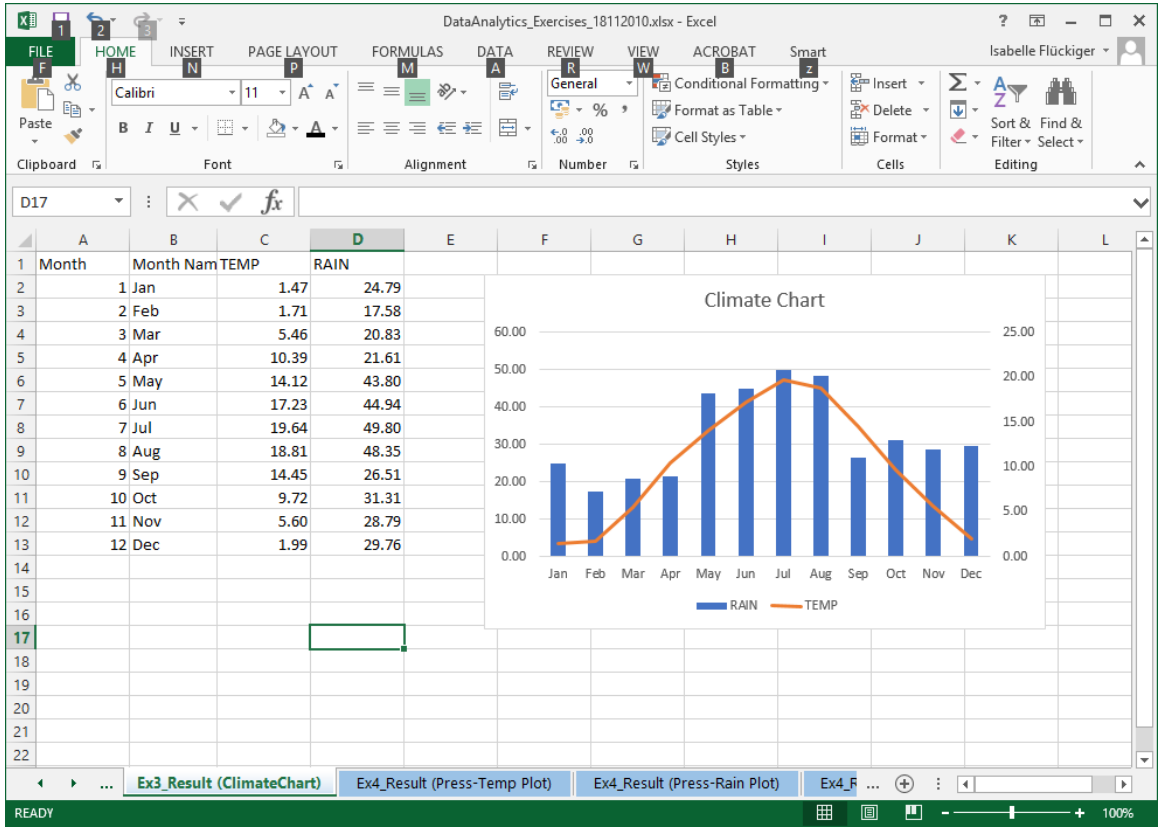
5.5 Selection of Software Tools

Software	Statistical	Data Mining	Simulation	Optimisation	Visualisation
@Risk	Medium	Low	High	Medium	High
Crystal Ball	Medium	Low	High	Low	Medium
Python (incl pandas)	High	High	Medium	Medium	Low
Julia	High	High	Medium	Medium	Low
Vensim	Low	Low	High	Medium	Medium
PowerSim	Low	Low	High	Medium	Medium
Anylogic	Low	Low	High	Medium	Low
Qlik (QlikView, Qlik Sense)	Low	Medium	Low	Low	High
Tableau	Low	Medium	Low	Low	High

5.5 Selection of Software Tools

Microsoft Excel

- *Microsoft Office Application*
- *"easy to use" spreadsheet tool*
- *It contains calculations, graphic tools and pivot tables*
- *Additionally, macro programming is integrated, called Visual Basic for Applications (VBA)*
- *Advantage: all companies have this*
- *There are add-on like @Risk such that even more statistical analyses and stochastic simulation can be performed*

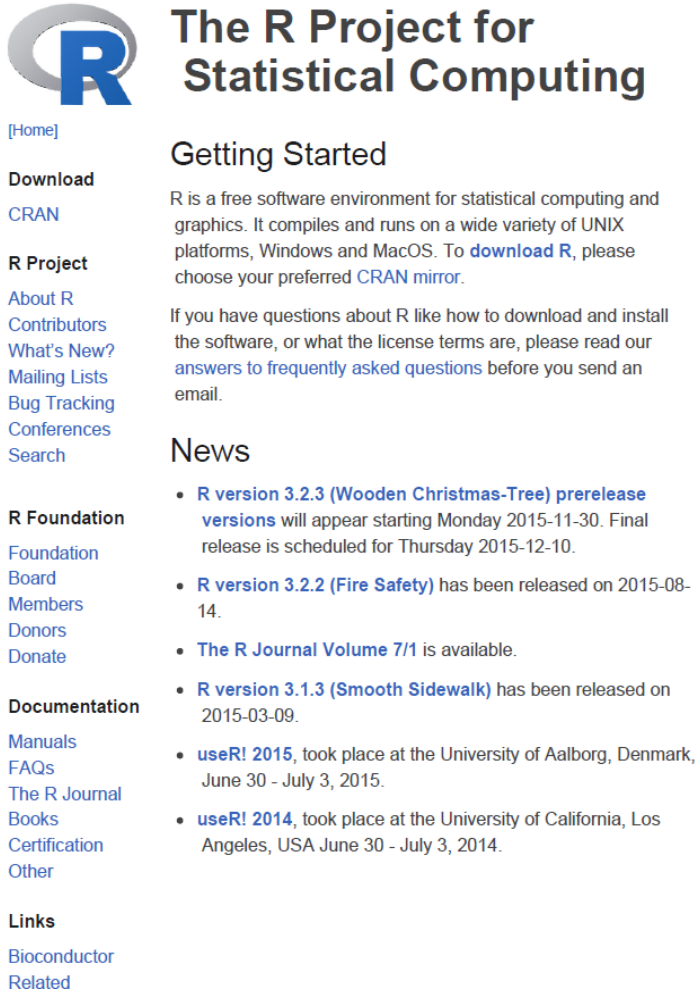


Month	Month Nam	TEMP	RAIN
1	Jan	1.47	24.79
2	Feb	1.71	17.58
3	Mar	5.46	20.83
4	Apr	10.39	21.61
5	May	14.12	43.80
6	Jun	17.23	44.94
7	Jul	19.64	49.80
8	Aug	18.81	48.35
9	Sep	14.45	26.51
10	Oct	9.72	31.31
11	Nov	5.60	28.79
12	Dec	1.99	29.76

5.5 Selection of Software Tools

R (https://www.r-project.org/)

- "R is a language and environment for statistical computing and graphics."
- Open Source (GNU licenses)
- You have many, many contributed packages… (https://cran.r-project.org/web/packages/available_packages_by_name.html)



5.5 Selection of Software Tools

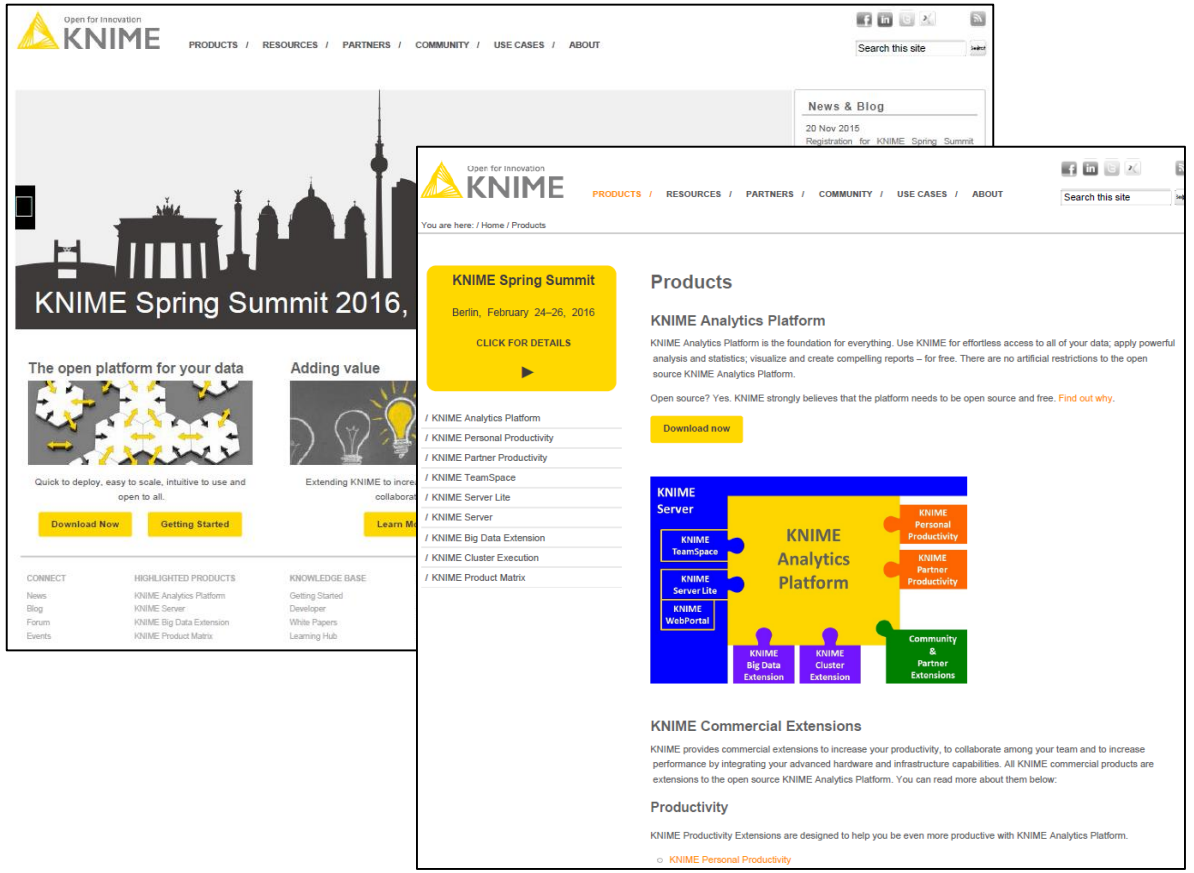
Example: R packages related to descriptive, predictive and prescriptive analytics:

R PACKAGES						
caret	kernlab	Gmodels	mlr			
abind	dichromat	igraph	pkgmaker	ROracle	TSP	
AER	digest	iplots	playwith	roxygen2	urca	
and	doParallel	irlba	pls	rpart	utils	
ArDec	dplyr	iterators	plyr	rpart.plot	vcd	
arm	dse	jsonlite	png	rpartOrdinal	whisker	
			princomp			
arules	dtw	KernSmooth	pROC	RpgSQL	WriteXLS	
	e1071	kknn				
arulesViz	eeptools	knitr	proto	RPostgreSQL	XLConnect	
assertthat	EMCC	labeling	qcc	RQuantLib	xlsReadWrite	
ast	evaluate	lattice	quantmod	RSNNS	xlsx	
base	extremevalues	lazyeval	quantreg	RSQLite	xlsx	
bayesclust	ff	lme4	R2HTML	rstudioapi	xml2	
bclust	ffbase	lmtest	R2PPT	sampleSelection	xtable	
BH	foreach	lubridate	R6	sandwich	xts	
biclust	forecast	magrittr	randomForest	scales	yaml	
bitops	foreign	maptools	rCharts	scatterplot3d	zoo	
boot	formatR	markdown	RColorBrewer	seriation		
bootstrap						
brew	fpc	MASS	Rcpp	shiny		
cairoDevice	gbm	Matrix	RcppEigen	sp		
car	gcExplorer	mclust	RCurl	SPARQL		
caTools	gclus	memisc	registry	SparseM		
chron	gdata	memoise	regr	spatial		
class	ggplot2	methods	regr0	splines		
clue	ggvis	mgcv	rEMM	sqldf		
clues	git2r	mime	reshape	stasts		
cluster	googleVis	minqa	reshape2	statnet		
clusterGeneration	gplots	mlogit	response	stats		
clusterSim	graphics	Modalclust	rggobi	stats4		
clustsig	grDevices	moments	rgl	stringi		
clv	grid	multcomp	RGtk2	stringr		
clValid	gridBase	munsell	rJava	survival		
coda	gtable	mvoutlier	RJDBC	tcltk		
codetools	gtools	neuralnet	RJSONIO	termstrc		
colorspace	gWidgets	nlme	Rlof	tidyr		
compiler	gWidgetsRGtk2	nloptr	rmarkdown	timsac		
curl	highr	NMF	Rmongo	tm		
data.table	htmltools	nnet	RMYSQL	tools		
datasets	httpuv	nortest	rngtools	translations		
DBI	httr	outliers	ROCR	tree		
Design	hybridHclust	parallel	RODBC	truncreg		
devtools	iCluster	pbkrtest	RODM	TSclust		

5.5 Selection of Software Tools

KNIME (https://www.knime.org/)

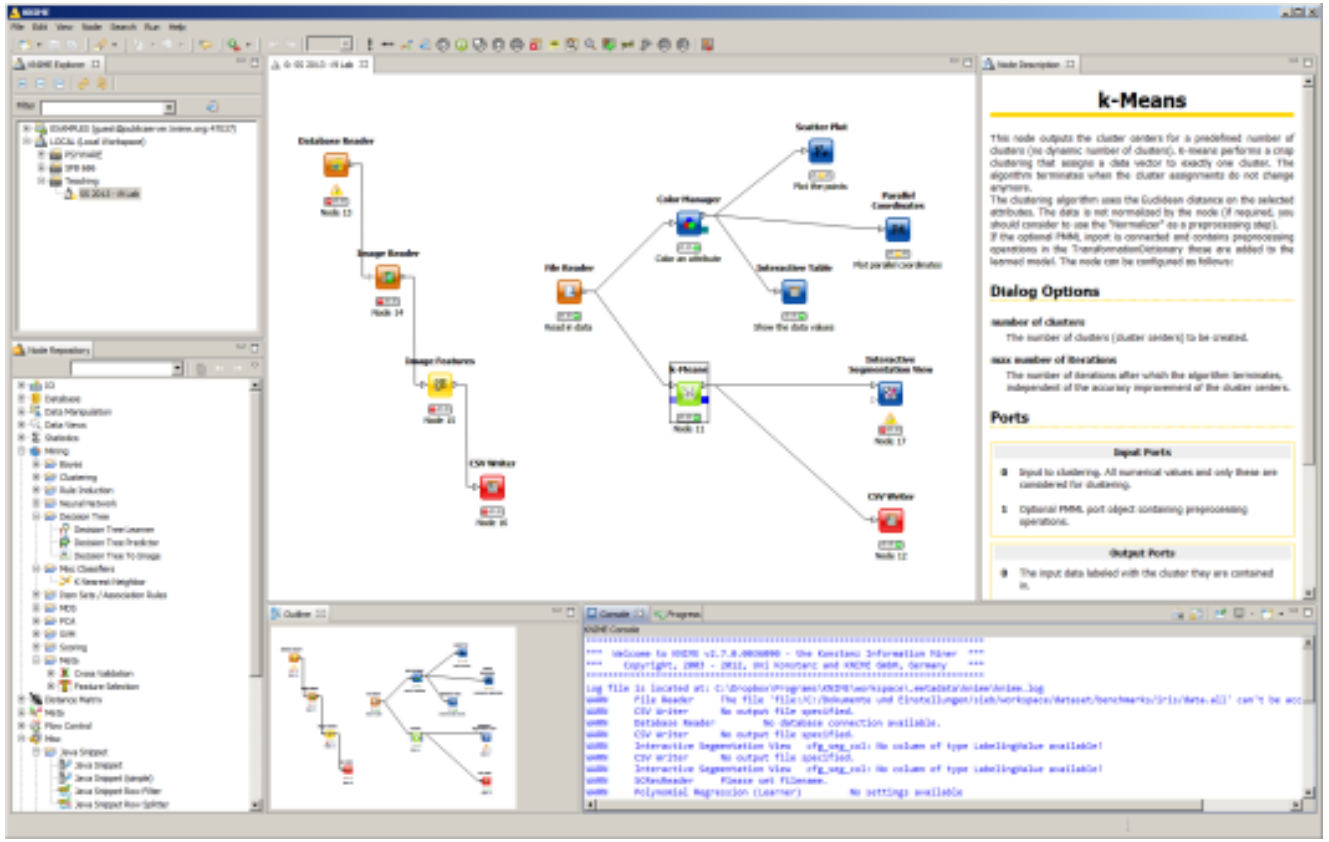
- Konstanz Information Miner
- Data mining, machine learning, reporting and reporting / visualization
- R and WEKA integration
- Java based
- Open Source



5.5 Selection of Software Tools

KNIME
(https://www.knime.org/)

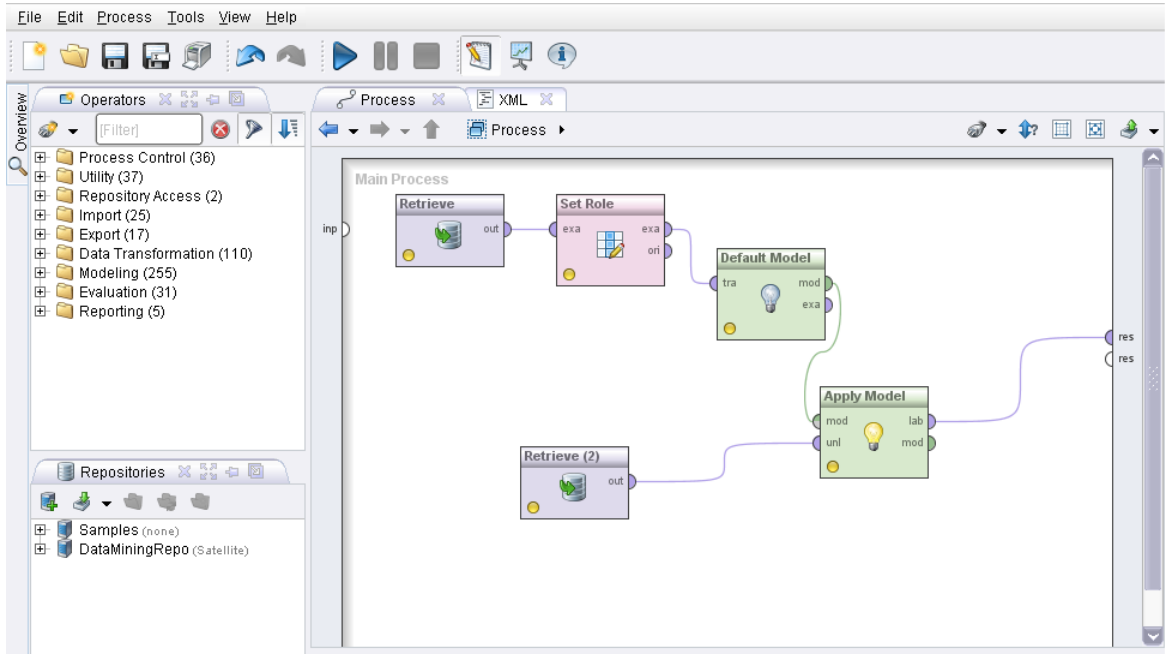
- Graphical interface
- Works with nodes and data flows



5.5 Selection of Software Tools

Rapidminer
(https://rapidminer.com/)

- Machine learning, data mining, text mining, web mining, predictive analytics and business analytics
- Community Edition for free, licensing for more comprehensive versions



5.5 Selection of Software Tools

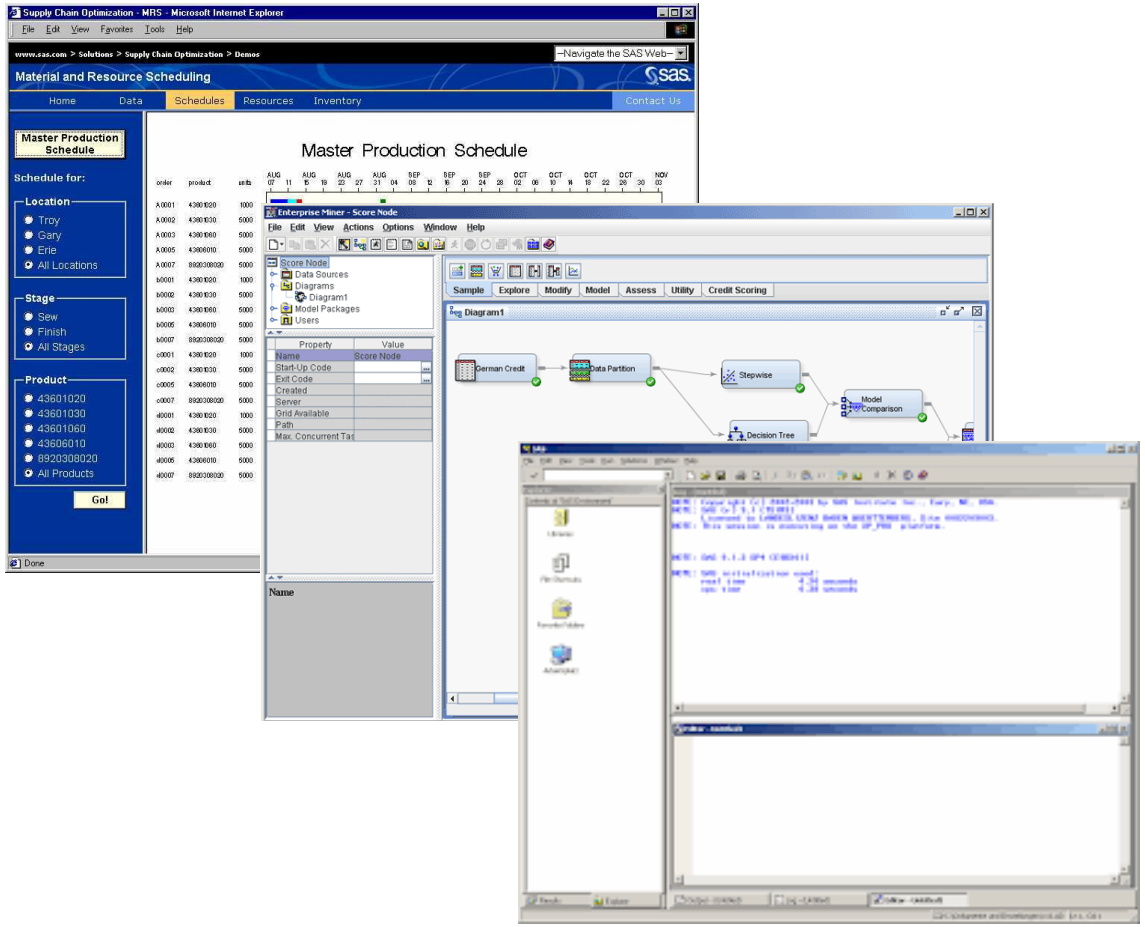
WEKA (http://www.cs.waikato.ac.nz/~ml/weka/index.html)

- Waikato Environment for Knowledge Analysis
- Data preprocessing, regression, clustering, classification, feature / attribute selection, and visualization
- Open Source

5.5 Selection of Software Tools

SAS
(http://www.sas.com/en_gb/home.html)

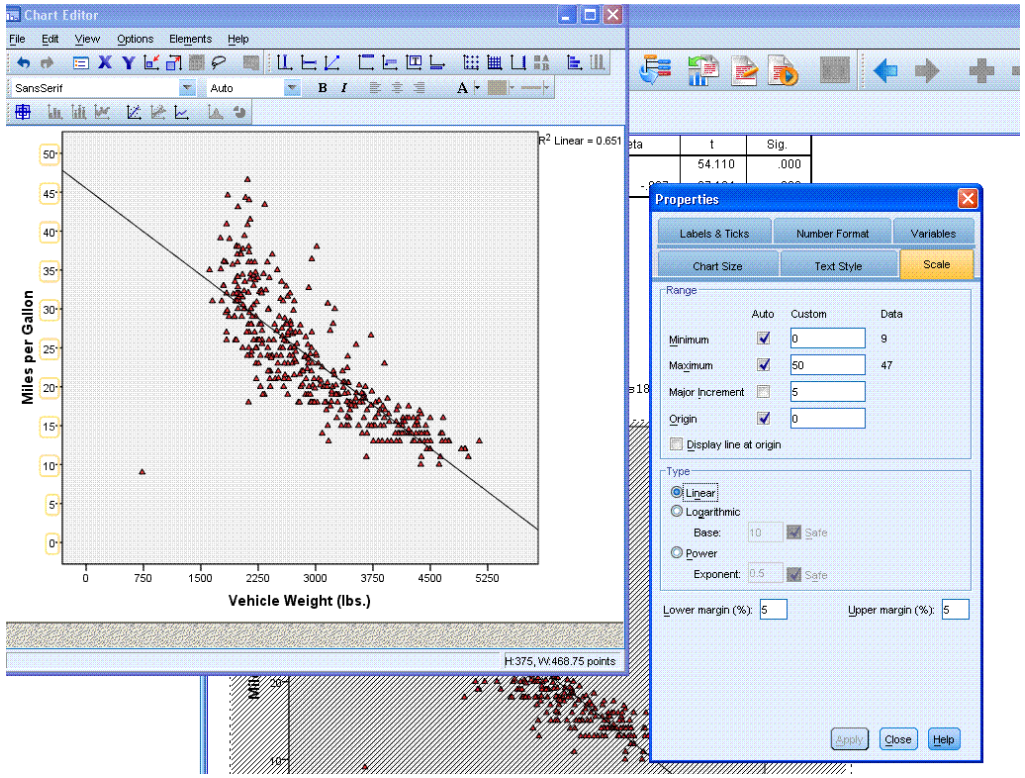
- Statistical programming language for data analytics, data management, business intelligence, risk management, supply chain management
- Various industry specific solutions
- Licensing model
- Very often used in industries to proceed large amount of data



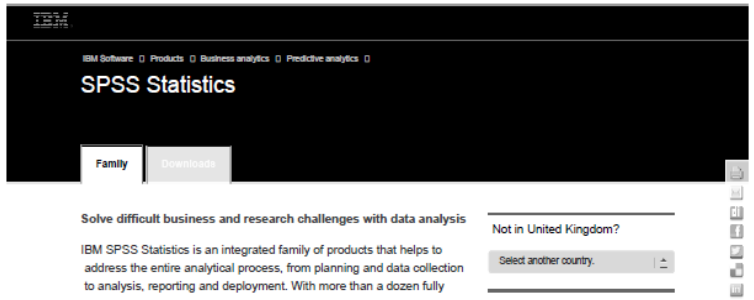
5.5 Selection of Software Tools

IBM SPSS Statistics (http://www-03.ibm.com/software/products/en/spss-statistics)

- Professional vendor suite
- Licensing system i.e. for each module one needs a license and has to pay
- “addresses the entire analytical process, from planning and data collection to analysis, reporting and deployment”



5.5 Selection of Software Tools



SPSS Data Preparation: Perform faster, more accurate data preparation and validation.
| Product
Features | Pricing support
SPSS Decision Trees: Explain categorical results in a clear, intuitive manner.
| Product
Features | Pricing support
SPSS Direct Marketing: Improve your campaigns and maximize marketing ROI.
| Product
Features | Pricing support
SPSS Exact Tests: Analyze small datasets or those with rare occurrences more accurately.
| Product
Features | Pricing support
SPSS Forecasting: Build sophisticated time-series forecasts regardless of your skill level.
| Product
Features | Pricing support
SPSS Missing Values: Estimate missing data so you can draw more valid conclusions.
| Product
Features | Pricing support
SPSS Neural Networks: Find more complex relationships in your data.
| Product
Features | Pricing support
SPSS Regression: Classify your data into groups and predict categorical outcomes.
| Product
Features | Pricing support
SPSS SamplePower: Find the right sample size for your research project.
| Product
Features | Pricing support
SPSS Statistics Base: Get essential tools for every step of the analytical process.
| Product
Features | Pricing support
SPSS Statistics Campus: Provide unlimited numbers of users with access to analytics.
| Product
Features support
SPSS Statistics Developer: Create custom features for SPSS Statistics using R and Python.

SPSS Statistics Faculty Pack: Incorporate analytics into your undergraduate or graduate curricula.
| Product
Features support
SPSS Statistics GradPack: Develop advanced analytical skills using this affordable student software package.
| Product
Features support
SPSS Statistics Premium: An all-in-one edition for enterprise businesses with multiple advanced analytics requirements.
| Product
Features | Pricing support
SPSS Statistics Professional: Tools to address the challenges of the entire analytic lifecycle.
| Product
Features | Pricing support
SPSS Statistics Programmability Extension: Add procedures written in Python, R, Java and Microsoft Visual Basic.NET.
| Product
Features support
SPSS Statistics Standard: Fundamental analytical capabilities for a range of business and research questions
| Product
Features | Pricing support
SPSS Statistics for Linux on System z: Combine analytical power with the security and stability of System z.
Features
SPSS Text Analytics for Surveys: Turn open text survey responses into quantifiable data through programmatic text analysis.
| Product
Features | Pricing support
SPSS Visualization Designer: Create and share customized data visualizations, from simple charts to advanced graphics.

5.5 Selection of Software Tools

SQL

- Structured Query Language
- Language for managing structure data held typically called “data in a relational database management system”
- Advanced “filtering” tool, i.e. query data
- Used in all database types like Oracle, SAP, IBM DB, Microsoft and so on

```
    (SALES      ASC) PCTFREE 10
ALLOW REVERSE SCANS;

SELECT SALES_DATE, SALES_PERSON FROM DB2ADMIN.SALES
 FETCH FIRST 15 ROWS ONLY;

--Imported SQL statements
--Script: C:\Documents and Settings\hardikpa\Desktop\Script736.sql
CREATE TABLE DB2ADMIN.PROJECT (
     PROJNO CHAR(6) NOT NULL,
    PROJNAME VARCHAR(24) NOT NULL,
    DEPTNO CHAR(3) NOT NULL,
    RESPEMP CHAR(6) NOT NULL,
    PRSTAFF DECIMAL(5 , 2),
    PRSTDATE DATE,
    PRENDATE DATE,
    MAJPROJ CHAR(6)
);

CREATE UNIQUE INDEX DB2ADMIN.PROJ_IDX
    ON DB2ADMIN.PROJECT
    (PROJNO     ASC)
    PCTFREE 10
    ALLOW REVERSE SCANS;
--End of imported SQL statements
```

5.5 Selection of Software Tools

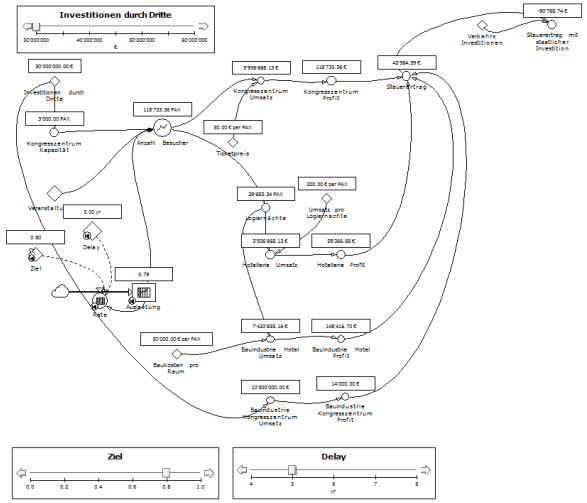
And there are many more programming languages or frameworks used like

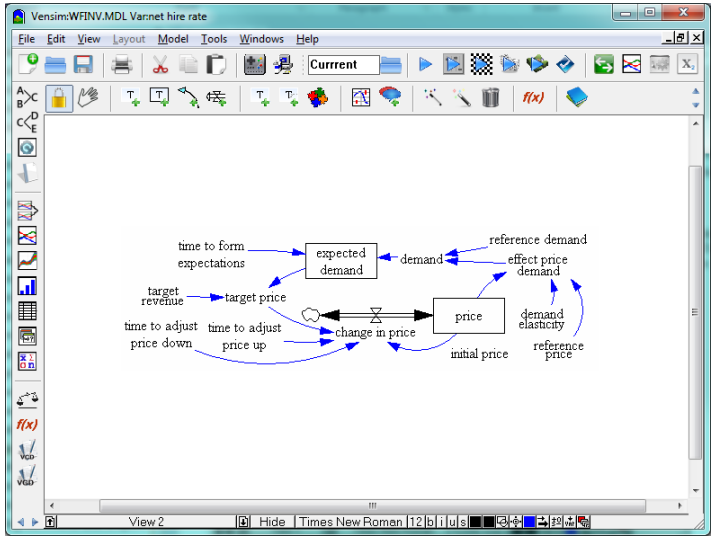
- *Apache Hadoop:* open-source software framework in Java "for distributed storage and distributed processing of very large data sets"
- *.NET Framework:* it is a software framework developed by Microsoft and includes user interfaces, data access management, database connectivity, cryptography, web application development, numeric algorithms and network communications. E.g C# is one part of it.
- *Java*
- *Julia (http://julialang.org/):* high-level dynamic programming language used for scientific computing, machine learning, data mining, large-scale linear algebra, distributed and parallel computing; it is a very efficient and effective language.
- and so on

5.5 Selection of Software Tools

System Dynamics Software

- PowerSim (http://www.powersim.com/)
- Vensim (http://vensim.com/): free edition for educational purpose





Excurse System Dynamics

What is System Dynamics?

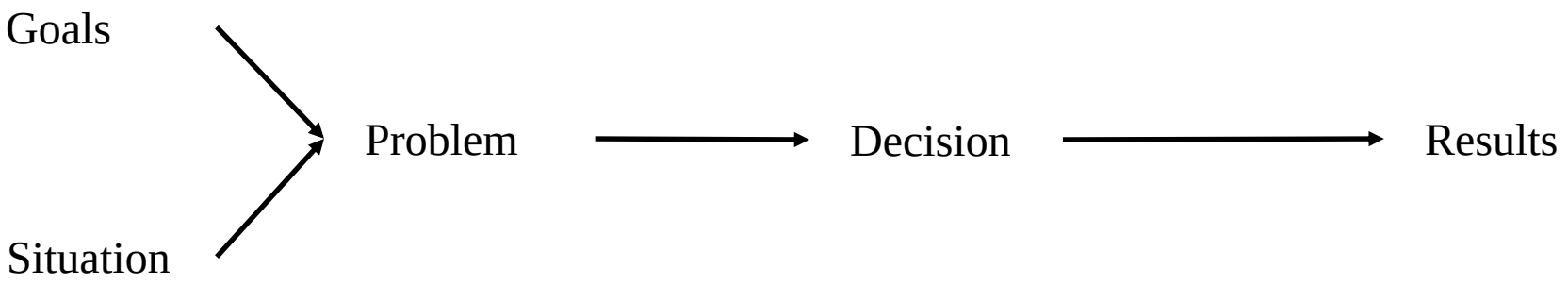
System Dynamics (SD) is a methodology for framing, modelling and understanding the dynamic of complex system.

It is used for the understanding of non-linear behavior of systems.

It is finally a tool to support us in system thinking.

Excurse System Dynamics

Typical thinking:

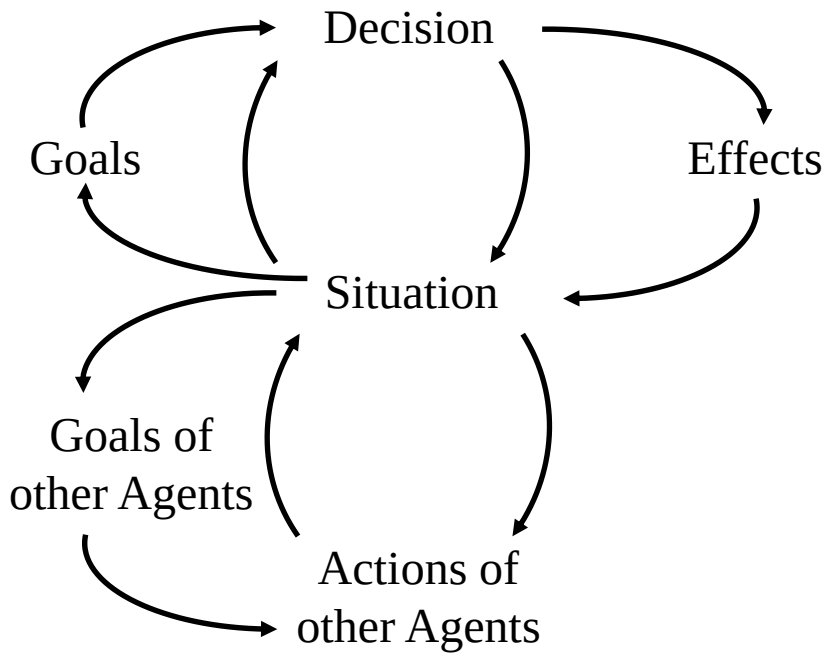


In the context of risks this is called “root – cause” analysis.

Excurse System Dynamics

Alternative thinking:

- move away from looking at isolated events and their causes
- start to look at the organization as a system made up of interacting parts



Excurse System Dynamics

Why system thinking is important?

Today's world and the business problem one has to solve are

- Dynamic and evolving over time
- Non-linear
- Have accumulations and delays
- And have typically feedback loops

Excurse System Dynamics

Patterns of Behavior

First, one is considering patterns of behavior of the variables that characterize the problem and/or situation.

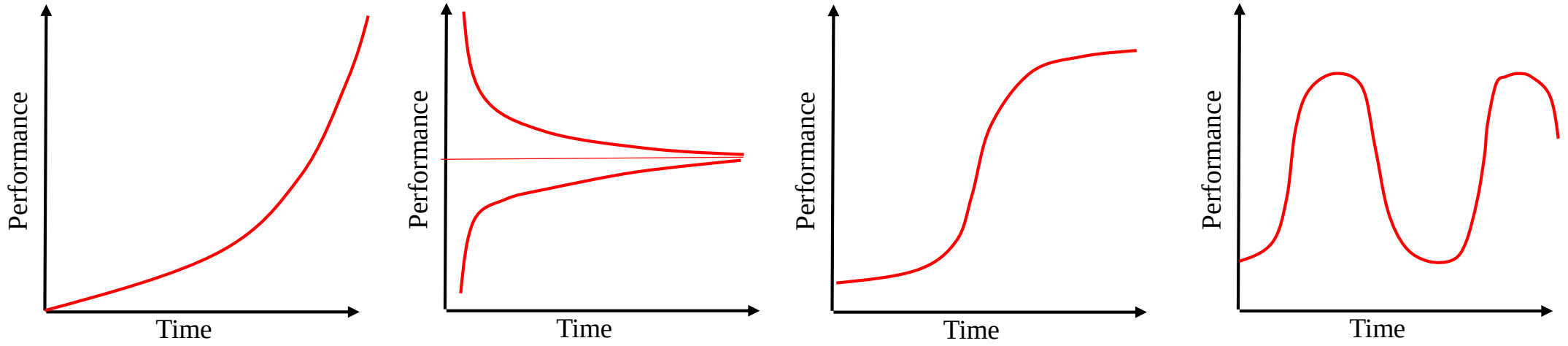
In a business context such variables are:

- Costs
- Sales
- Revenue
- Profit
- Market share
- Risk
- And so on

Excurse System Dynamics

Patterns of Behavior

Typical patterns of behavior over time are:



Exponential Goal-seeking S-Shape Oscillation

Excurse System Dynamics

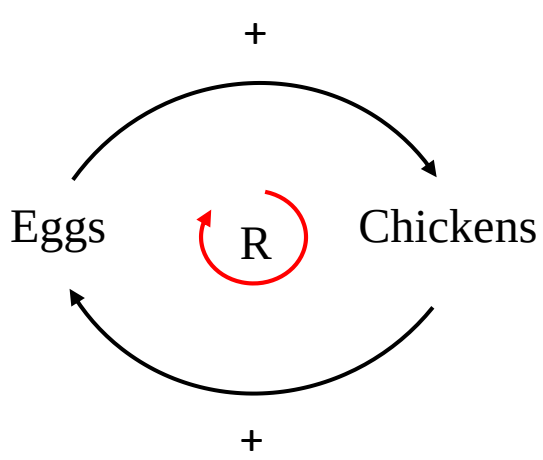
Patterns of Behavior

Common combinations of these four patterns:

- Exponential growth combined with oscillation
- Goal-seeking behavior combined with an oscillation whose amplitude gradually declines over time
- S-shaped growth combined with an oscillation whose amplitude gradually declines over time

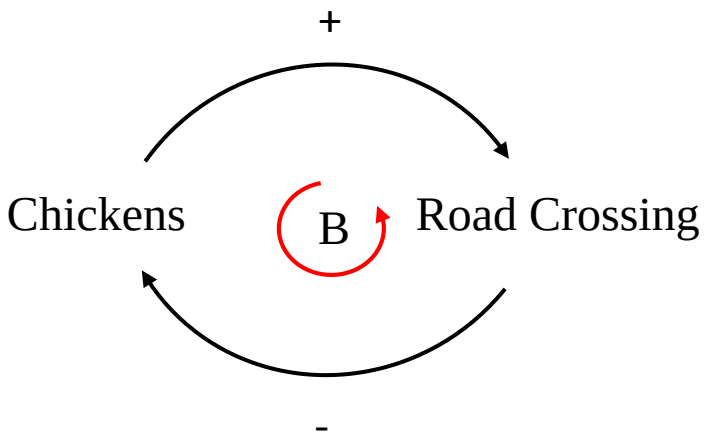
Excurse System Dynamics

Feedback and Causal Loop Diagrams



Positive Feedback:

Self-reinforcing (R)



Negative Feedback:

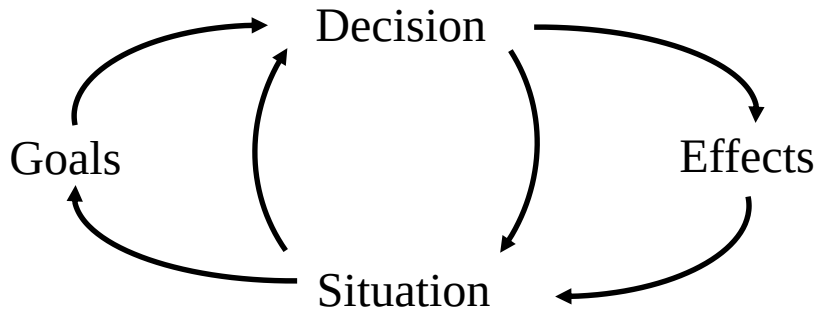
Self-Correcting / Balancing (B)

Excurse System Dynamics

Feedback and Causal Loop Diagrams

Definition: When an element of a system indirectly influences itself in the system then, this called a feedback loop or a causal loop.

I.e. a feedback loop is a closed sequence of causes and effects, that is, a closed path of action and information.

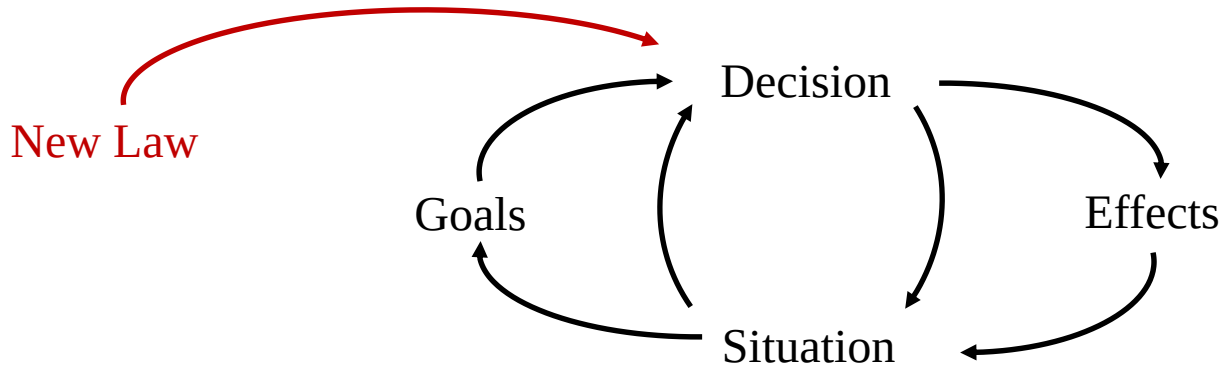


(G. P. Richardson and A. L. Pugh III, Introduction to System Dynamics Modeling with DYNAMO, Productivity Press, Cambridge, Massachusetts, 1981.)

Excurse System Dynamics

Feedback and Causal Loop Diagrams

Definition: An open loop is a linear chain of causes and effects which does not close back on itself



Excurse System Dynamics

How to set up a causal loop diagram (1/2)

1) Think of the elements in a causal loop diagram as variables which can go up or down
2) Use nouns or noun phrases to represent the elements e.g. “costs”
3) Actions in a causal loop diagram are represented by the arrows
4) Ensure that the definition of an element makes it clear which direction is “up” for the variable
5) Use an element name for which the positive sense is preferable e.g. “growth”
6) Causal links should imply a direction of causation, and not simply a time sequence i.e. “when A increases then B increases.”

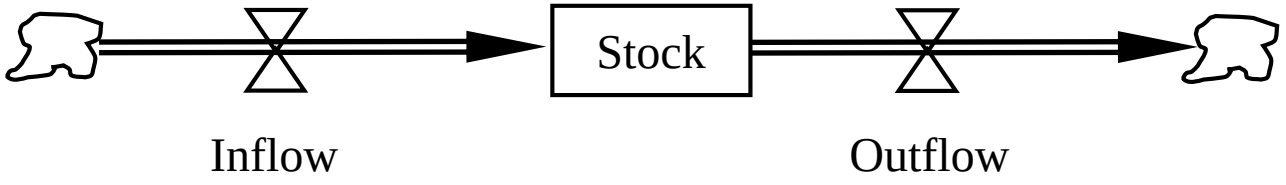
Excurse System Dynamics

How to set up a causal loop diagram (2/2)

7) Think about possible unexpected side effects which might occur in addition
8) For negative feedback loops, there is a goal
9) Include causal loop elements for both the actual value of a variable and the perceived value
10) There are often differences between short term and long term consequences of actions, and these may need to be distinguished with different loops
11) If a link between two elements needs a lot of explaining, you probably need to add intermediate elements between the two existing elements
12) Last but not least: Keep the diagram as simple as possible

Excurse System Dynamics

Stocks and Flows



Stock

Flow

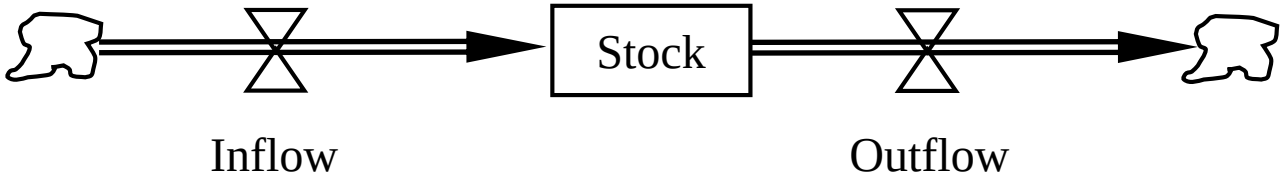
Valve (Flow Regulator)

Source or Sink

(Stocks outside model boundary)

Excurse System Dynamics

Stocks and Flows

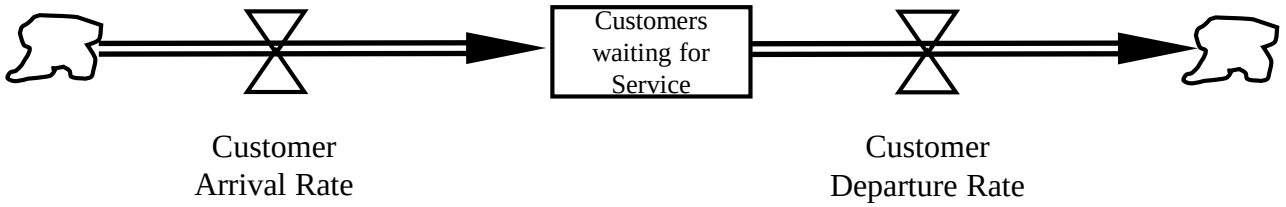


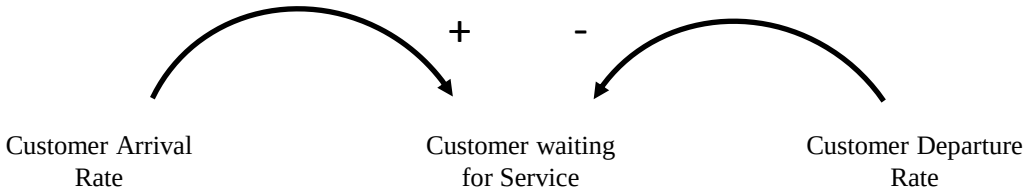
$$Stock(t) = \int_{t_0}^{t} [Inflow(s) - Outflow(s)]ds + Stock(t_0)$$

$$\frac{d(Stock)}{dt} = Net\ Change\ in\ Stock = Inflow(t) - Outflow(t)$$

Excurse System Dynamics

Stocks and Flows: Example





Excurse System Dynamics

Auxiliary Variables

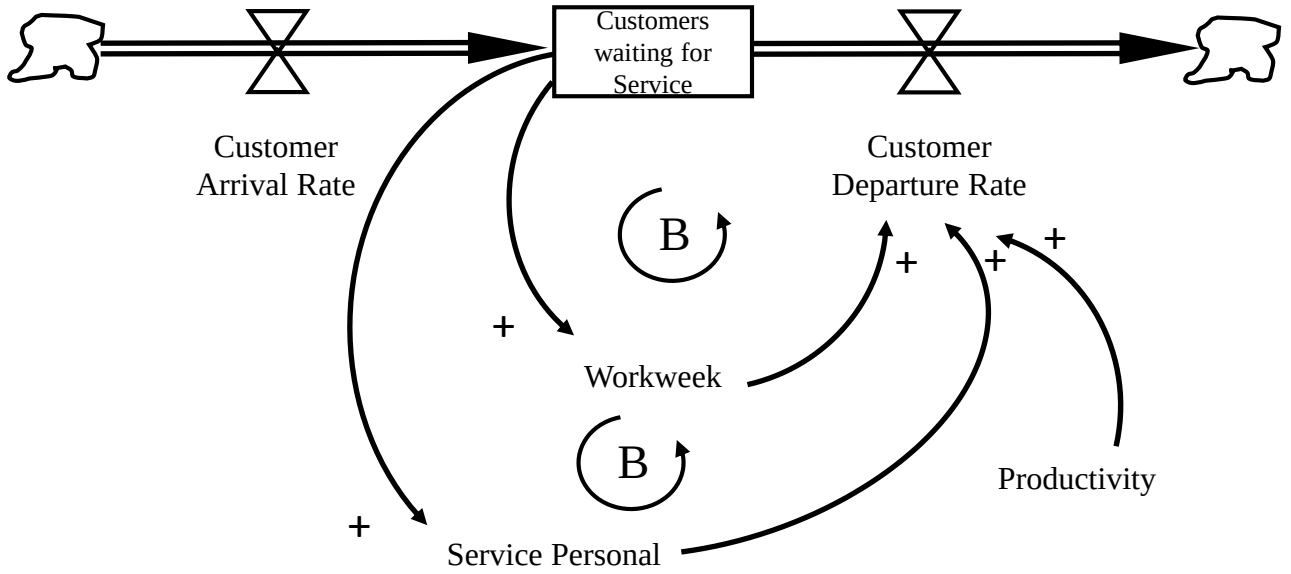
Assume: The rate at which customers can be processed depends on

- Number of service personal
- The productivity of the personal (customer processed per hour)
- Numbers of working hours per week

These variables are auxiliary variables which determine the dynamic.

Excurse System Dynamics

Auxiliary Variables



Excurse System Dynamics

Example: