Aalto University
School of Business

Business Analytics 1 – Conclusions

Realities of building optimization models

- Often it is not clear what the objective function is, or what are the constraints and the decision variables
  - In fact, problem structuring is often the most time-consuming (but valuable) part of model building

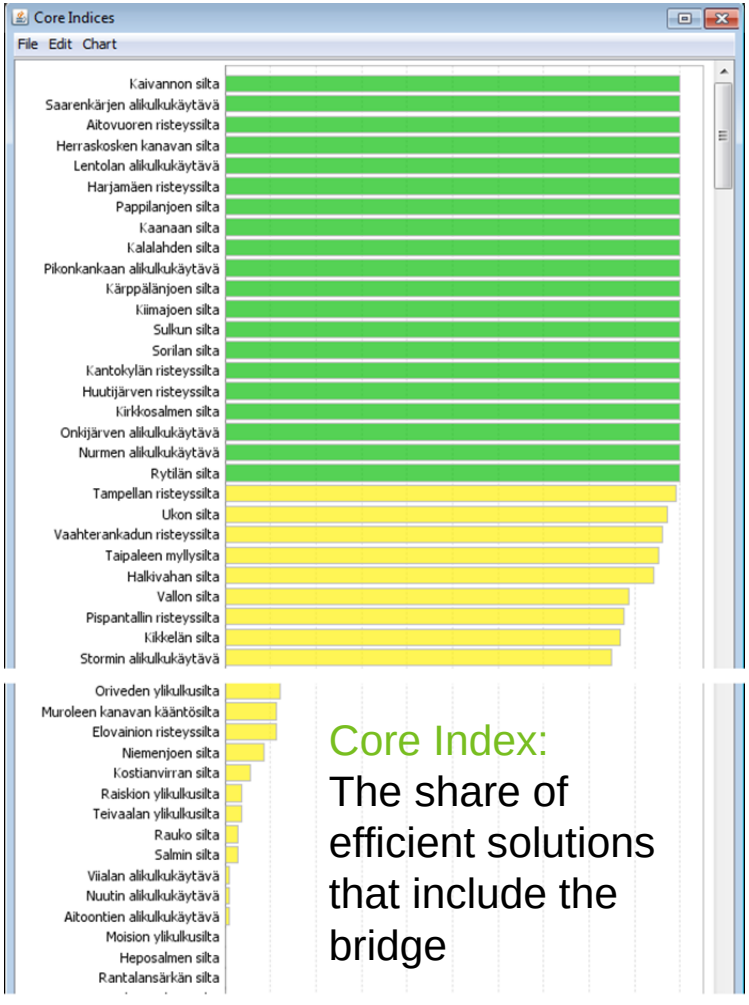
- Parameters almost never come in the form of a nice table
  - Often a large share of the objective function and constraint coefficients cannot be obtained from “hard data” but they require expert judgement

- A model is always an approximation of the real world
  - Not everything is modeled
  - Some simplifying assumptions or approximations always required
  - “All models are wrong, but some are more useful than others”

Case: Infrastructure Asset Management

- Which of the hundreds of bridges to repair?
  - Client: Road Districts of Finnish Road Administration
  - Repeated application 2008-2013

- MOZOLP with six objectives indicating urgency for repair for each bridge
  - E.g., ‘Damage index’, ‘Traffic significance’, ‘Visual appearance’
  - 0-1 decision variables (repair/not repair)
  - Constraints
    - Yearly repair budget
    - Bonus requirement: reduce Damage index by 15,000 units

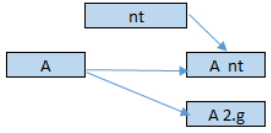


Case: Product Portfolio Construction

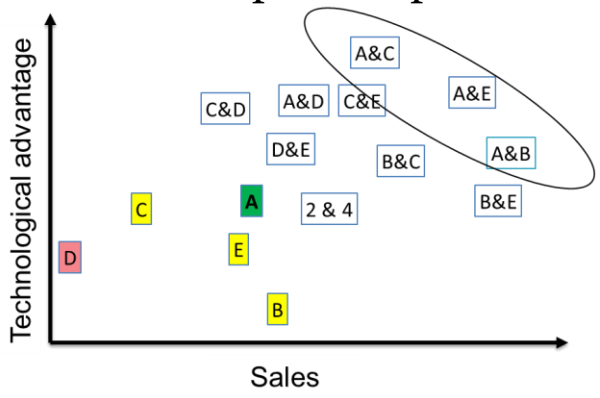
Which products to develop?

		Basic products	Products with New Technology		2. Generation products	
Market 1	1.1	A	A nt		A 2.g	
	1.2	B	B+ nt		B 2.g	
	1.3	C	C nt		C 2.g	
	1.4	D	D nt		D 2.g	
	1.5	A	A nt		A 2.g	
	1.6	E	B+ nt		E 2.g	
	1.7		C nt			
	1.8	E			E 2.g	
	1.9	E			E 2.g	
Market 2	2.1	B+	B+ nt			
	2.2	B+	B+ nt			
	2.3	C+	C+ nt			
	2.4	D+	D+ nt			
Market 3	3.1	F	F nt		B 2.g	
	3.2	F+	F+ nt			
	3.3	F+	F+ nt			
	3.4					
Market 4	4.1		H nt		H 2.g	
	4.2		H nt		H 2.g	
	4.3		H nt		H 2.g	
	4.4	G	G nt	H nt	G 2.g	H 2.g
	4.5	G	G nt	H nt	G 2.g	H 2.g
	4.6		H nt		H 2.g	
			nt			

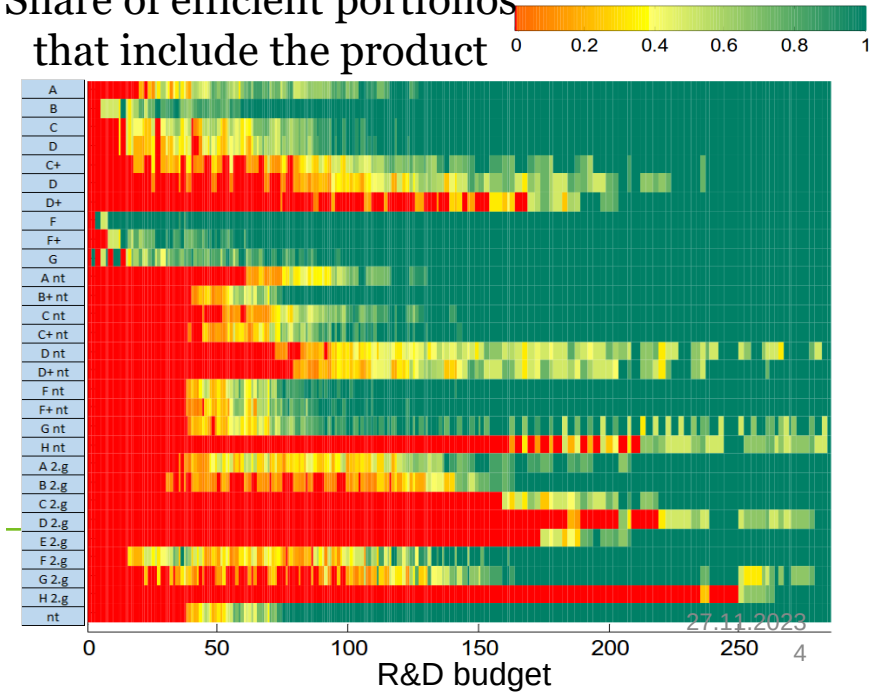
Logical dependencies between products



Efficient product portfolios

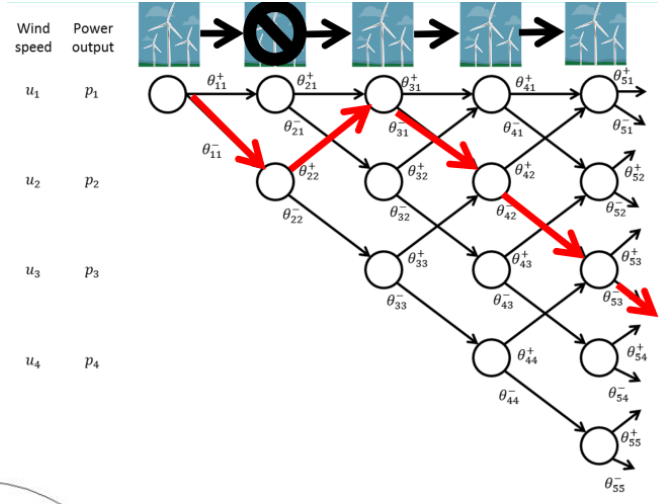


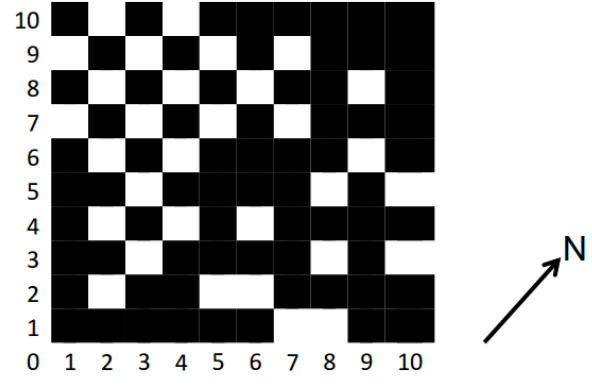
Share of efficient portfolios that include the product

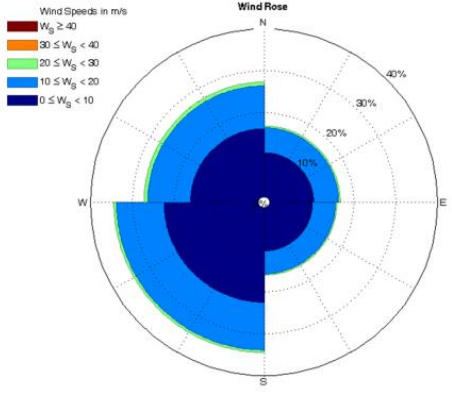


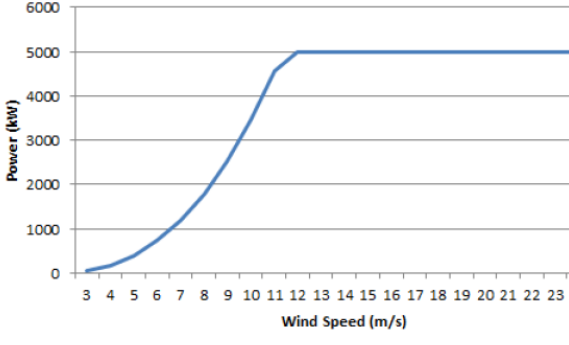
Case: Siting of off-shore wind farms

- MILP model with some 12000 decision variables and 10000 constraints
- Economic and environmental objectives
- Non-linear relationship between wind speed and power output
- Sites downwind experience the wake-effects
- Scenarios for wind speed and direction









Optimization terms in Finnish

Solution = ratkaisu
Optimal = optimaalinen
Feasible = käypä
Objective function = kohdefunktio
Multi-objective = monitavoite
LP = lineaarinen ohjelmointi / optimointi
ILP= lineaarinen kokonaislukuoptimointi
nonlinear= epälineaarinen
Efficient = tehokas
Constraint = Rajoite
MILP = lineaarinen sekalukuoptimointi

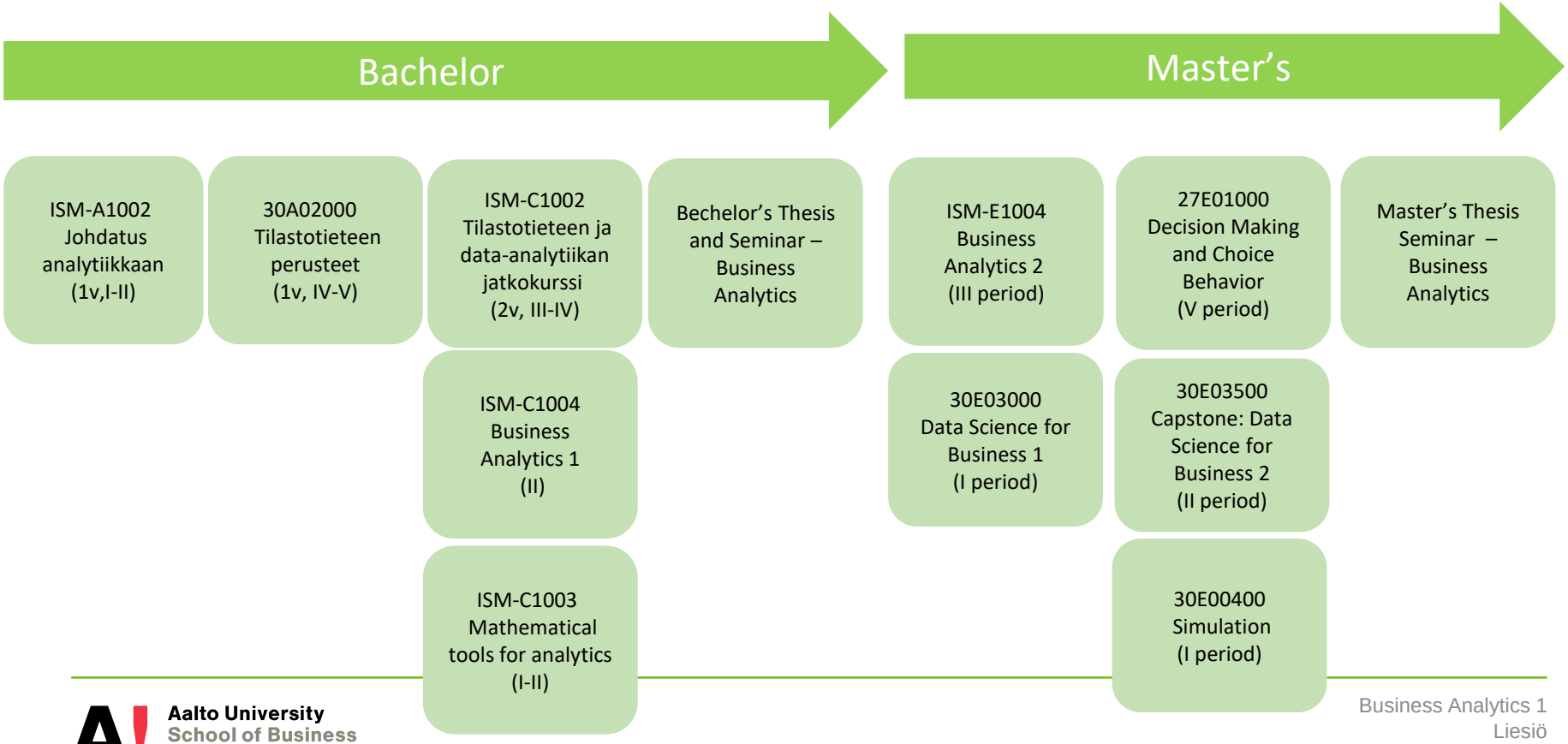
Business Analytics II – course

Goes deeper into Management Science methods - especially in the areas of modelling....

- ....Multiple decision objectives
  - Aggregating multiple objective functions into a overall value that represents the decision maker's preferences (cf. weighted sum approach)
    - Multi-Attribute Utility/Value Theory

- ....Uncertainty and risk
  - Decision trees for dynamic decision settings
  - Risk preferences (cf. variance in the Markowitz model)
  - Stochastic optimization (cf. scenarios in the Markowitz model)
  - Monte Carlo simulation

More Analytics / Management Science courses



FORS
FINNISH OPERATIONS RESEARCH SOCIETY

FORS membership free for students

UPCOMING
EURO and FORS will organize EUROs annual main event on 3.-6.7.2022 at the Aalto university campus in Espoo. Read the first announcement and join us in 2022!

About 60 people from business, public administration, and universities came together on March 15, 1973. They were all interested in Operations Research (OR). The Finnish Operations Research Society (FORS) was founded as a result of that meeting. Presently we have close to 180 members.

FORS was founded to promote and advance OR in our country and to serve as a link between people interested in this field. This purpose is still valid today, over 30 years later. The main activities of the society are seminars, excursions, training courses, and conferences.

We use our INFORS blog to inform the members of future activities. Also firms can use our channels to give information on the latest developments in our field. We also keep a mailing list through which we try to transmit the latest news concering the society. We are on Facebook and LinkedIn

The international perspective has always been central in the activities of the society. We are a member in the International Federation of Operational Research Societies (IFORS), the Association of European Operational Research Societies within IFORS (EURO), and the cooperative organization of the Nordic Operations Research Societies (NOAS). It should be mentioned that our representative Ms. Tuula Kinnunen acted as the second vice-president of EURO from 1993 to 1997.

www.operaatiotutkimus.fi

Two exams

Home > Business Analytics 1 (6) > Completion methods

ADD TO COURSE CART

Business Analytics 1 (6 cr)

ISM-C1004

Course version

2022-2023 (Aalto); 2023-2024 ...

Information sheet | Completion methods | Substitutions | Open university courses

Completion methods

METHOD 1

ASSESSMENT ITEM	TEACHING	
Participation in teaching (6 cr)	Lecture 23.10.2023–8.12.2023	SELECT
	Exam 29.1.2024	SELECT

Completion method 1

RECURRENCE OF TEACHING

The teaching is not set to recur

Parts to complete

Participation in teaching (6 cr)

Two exams

Teaching

Lecture 23.10.2023–8.12.2023

Basic information | Registration | Groups and teaching times

LECTURE

L01

Time: ma 23.10.–27.11.2023 9.15–12.00 Location: Undergraduate Centre, B-sali - Y203a Teacher: Juuso Liesiö

Time: ke 25.10.–29.11.2023 9.15–12.00 Location: Undergraduate Centre, B-sali - Y203a Teacher: Juuso Liesiö

EXAM

KT

Time: pe 8.12.2023 9.00–12.00 Location: Undergraduate Centre, U4 - U142 Teacher: Juuso Liesiö

Time: pe 8.12.2023 9.00–12.00 Location: Undergraduate Centre, U2 - U157 Teacher: Juuso Liesiö

Exam 29.1.2024

Remember to register

Basic information | Registration | Groups and teaching times

EXAM

T01

Time: ma 29.1.2024 16.00–19.00 Location: Undergraduate Centre, U2 - U157 Teacher: Juuso Liesiö

The exams

- Focus on topics covered in the lecture slides and the assignments
  - Additional support provided by the text book chapters:
    - "Introduction",
    - "An Introduction to Linear Programming"
    - "LP: Sensitivity Analysis and Interpretation of Solution"
    - "LP Applications in Marketing, Finance and Operations Management" / "LP Applications"
    - "Distribution and Network models" / "Transportation, Assignment and Transshipment Problems"
    - "Integer Linear Programming"
    - "Nonlinear Optimization Models"
    - "Multicriteria Decisions" / "Multicriteria Decision Problems"

- Exam problems test
  - Knowledge on theory and terminology (multiple choice, true/false), e.g.,
    - Redundant constraint
    - Unbounded LP problem
    - Efficient solution
    - …
  - Modelling skills (multiple choice, write the math formulation, fill spreadsheet cells, etc.), e.g.,
    - Graphical solution LP/ILP/MILP
    - Interpret sensitivity analysis reports
    - Math formulation from verbal problem description
    - Computer implementation from verbal problem description
    - …

Exam: An illustrative example question

FundStar Company invests in several types of funds. The board of directors has asked you to formulate and implement an LP model that supports deciding on a diversification strategy than maximizes expected returns for their initial capital of 10 million euros with the 3-year investment horizon. They have also provided you with the estimates on the investments expected rates of returns obtained from a comprehensive simulation model (see Table 1).

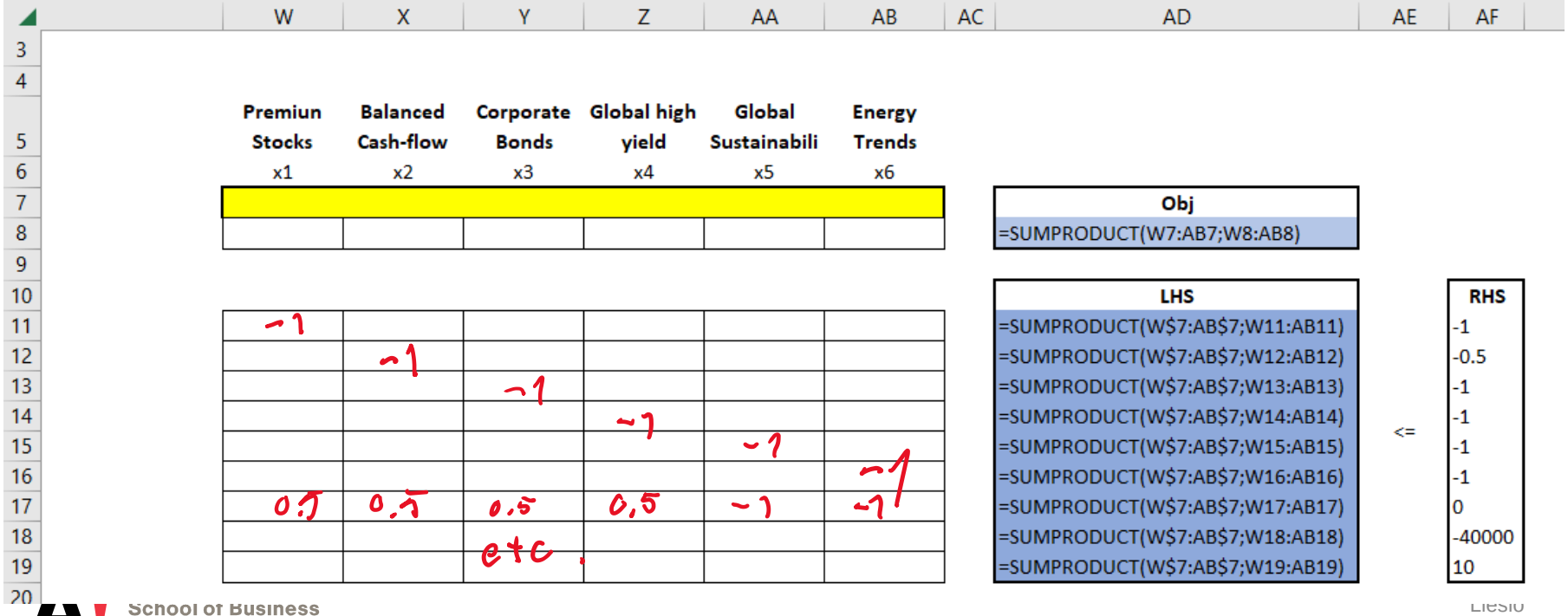
Table 1	3 year expected rate of return	Investment limit (Meuros)	TIS (points/ Meuros)
Premiun Stocks	15 %	1	3486
Balanced Cash-flow	12 %	0.5	-734
Corporate Bonds	13 %	1	2678
Global high yield	19 %	1	435
Global Sustainability	13 %	1	5623
Energy Trends	15 %	1	3454

To ensure appropriate diversification the board has placed the following constraints on the portfolio: (i) minimum investment limits for each investment type (see Table 1), and (ii) the total amount invested in Global Sustainability and Energy Trends has to be at least 50% of the total amount invested into the other funds.

Fundstar has a strong focus on corporate social responsibility. Thus, the investments should be made so that the Total Impact Score (TIS) of the investment portfolio is at least 40000 points. The TIS for each fund in shown in Table 1. TIS measures the impacts that the companies in each fund have on the surrounding world in areas of environment, health, society and knowledge. The analytics tools used to estimate the TIS scores utilize an extensive literature review based on natural language processing to analyze the products and services of each company whose stocks are included in the fund.

Exam: An illustrative example question (2/3)

TASK: Fill in the missing non-zero values to the white cells.



	W	X	Y	Z	AA	AB
5	Premiun Stocks	Balanced Cash-flow	Corporate Bonds	Global high yield	Global Sustainabili	Energy Trends
6	x1	x2	x3	x4	x5	x6
7						
8						
11	-1					
12		-1				
13			-1			
14				-1		
15					-1	
16						-1
17	0.5	0.5	0.5	0.5	-1	-1
18			etc.			
19						

Obj
=SUMPRODUCT(W7:AB7;W8:AB8)

LHS		RHS
=SUMPRODUCT(W$7:AB$7;W11:AB11)	<=	-1
=SUMPRODUCT(W$7:AB$7;W12:AB12)	<=	-0.5
=SUMPRODUCT(W$7:AB$7;W13:AB13)	<=	-1
=SUMPRODUCT(W$7:AB$7;W14:AB14)	<=	-1
=SUMPRODUCT(W$7:AB$7;W15:AB15)	<=	-1
=SUMPRODUCT(W$7:AB$7;W16:AB16)	<=	-1
=SUMPRODUCT(W$7:AB$7;W17:AB17)	<=	0
=SUMPRODUCT(W$7:AB$7;W18:AB18)	<=	-40000
=SUMPRODUCT(W$7:AB$7;W19:AB19)	<=	10

Exam: An illustrative example question (3/3)

TASK: Fill in the missing left-hand-sides of the constraints of the LP model.

$$\max 1.15x_1 + 1.12x_2 + 1.13x_3 + 1.19x_4 + 1.13x_5 + 1.15x_6$$

1	$-x_1$	≤	-1
2	$-x_2$	≤	-0.5
3	$-x_3$	≤	-1
4	$-x_4$	≤	-1
5	$-x_5$	≤	-1
6	$-x_6$	≤	-1
7	$0{,}5x_1 + 0{,}5x_2 + 0{,}5x_3 + 0.5x_4 - x_5 - x_6$	≤	0
8		≤	-40000
9	etc.	≤	10

Please give course feedback, earns +1 course point!

The has been sent to your @aalto.fi e-mail address