MIS775
Decision Modelling for Business Analytics

Unit Overview

TOPIC 1: Decision Modelling & Linear Programming (LP)

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Weekly Topics

Week	Module	Topics	Remarks
1	1. Deterministic decision models	Decision Modelling & Linear Programming (LP)	
2		Sensitivity Analysis & Linear Programming Applications	
3		Integer Linear Programming Models	
4		Non-Linear Programming Models	
5		Network Modelling	
6	2. Stochastic decision models	Decision Analysis: Making Decisions under Uncertainty	Assignment 1 is due
7		Building Stochastic Decision Models	
8		Simulation Modelling	
9		Quantitative Risk Analysis	
10		Applications of Simulation Modelling	
11		**Revision**	Assignment 2 is due

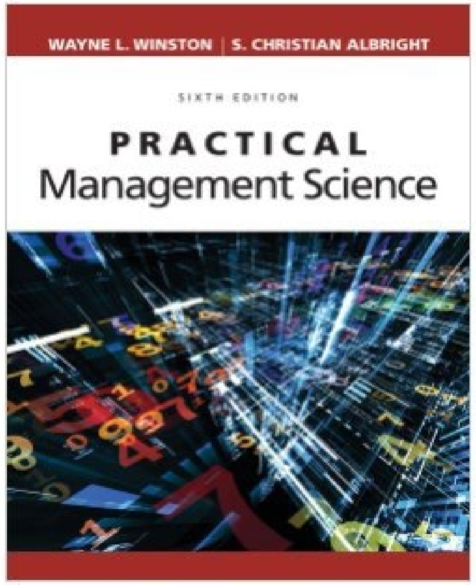
Teaching Team

Role	Name
Unit Chair	Dr Annista Wijayanayake
Lecturer	Dr Annista Wijayanayake
Tutors	Dr David Stewart Dr. Joerin Motavallian Dr. Rashid Mamadolimov Dr. Sajeewani Maddumage Dr. Ruwan Nagahawatte

Contact your tutor at the first instance, if you have any queries.

Email: **2025t1-mis775@deakin.edu.au**

Resources



Essential Reading Resources

Winston, & Albright. *Practical Management Science*, (Cengage, 6th edn., 2019)

(MIS775 Homepage > Announcements > Prescribed textbook - Use DISCOUNT code WOW10 to get 10% off the price of the text!)

Software

Microsoft Excel

Seek the IT support to install Microsoft Office for free via Office 365)

Prescribed Handbook

- **Practical management Science**

by Wayne L. Winston; S. Christian Albright (Publisher Cengage)

- **Spreadsheet modelling and decision analysis**

by Cliff T. Ragsdale (Publisher Cengage)

https://cengage.widen.net/s/trdnwfxccg/cengage-course-guide-decision-sciences

Unit Delivery

- **3 contact hours per week:**
  - 2-hour classes (Tuesday 4:00pm in HC 2.005) at Burwood covering key points of each topic
  - Weekly 1 hour computer lab seminar in Burwood for on-campus students
  - Weekly 1-hour computer lab seminar **for online students only**
    - ***Link to Lecture Recording:*** ***Go to Content > Online classroom and recordings >Panopto Video>select the relevant week Class recording***
  - **Cloud students are welcome to join face-to-face classes/seminars at anytime**

Online Seminar day and time

MIS775 Online Weekly Seminar

Day : Friday 6pm to 7pm (Commencing from 7th March Friday)

Meeting Link: Provided in the Clod Deakin Unit site

Link to Seminar Recording : Attend online seminar

Online classroom and recordings >Zoom meeting for weekly online Seminar

To watch the Lecture recordings and online seminar Recording :

Online classroom and recordings >Panopto -Lecture recordings and online seminar recordings> select the relevant recording according to the date

Link to Student Consultations- this consultation session is not recorded

Online classroom and recordings >Zoom meeting for weekly online Seminar> select the consultation

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Unit Communication Guidelines

- If you have any questions about the unit, please post them on the **Discussion Board**. Your query may be relevant to other students, and the response could benefit the entire class.

- If your question is not addressed on the Discussion Board, **please contact your Tutor as the first point of contact for any clarifications.**

- For **personal matters** that require discussion, please email us at

  2025t1-mis775@deakin.edu.au to arrange a suitable time.

Assessment

- **Assignment 1:** This requires students to understand one or more business scenarios, then build spreadsheet-based deterministic decision models, solve the models and interpret the output (**Individual Assignment - 20% weighting**)

- **Assignment 2:** This requires students to understand a complex business scenario and then build a spreadsheet-based stochastic decision model, and explore the solution (**Individual assignment - 30% weighting**)

- **End of Unit Assessment:** This is a summative assessment with a hurdle requirement and students must attain a mark of at least 50% in the final exam (**50% weighting**)

- Please check the unit guide and the unit schedule available on CloudDeakin for key dates

What Level of Maths is Required?

- While maths has a role to play in this unit, in the first module it is usually at the level of **basic algebra. Some statistical concepts** are also used – mean, variance and covariance

- In the second module **probability and statistics** have a more central role due to the nature of the problems being solved

- But keep in mind that this is **an application-oriented unit** - our main focus is on learning how to apply models to solve real-world business problems

Need support for Maths?
Reach out to Maths Mentors

Maths Mentors

Maths help for all Deakin students, for all Deakin units.

Drop-in online: Zoom, email

Week 1 – Week 12:	Monday to Friday, 10 am – 2 pm

Drop-in on campus:

Week 1 – Week 11:	Waurn Ponds JB2 and Burwood Library, Level 2 Tuesday and Wednesday, 11 am – 2 pm

www.deakin.edu.au/maths-mentors

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Deakin University CRICOS Provider Code: 00113B

Today’s Lecture

- Unit overview
- Introduction to Decision Modelling for Business Analytics

  - **TOPIC 1: Decision Modelling & Linear Programming (LP)**

Decision Modelling for Business Analytics

- **Decision Modelling for Business Analytics** is the process of using mathematical, statistical, and computational techniques to support data-driven decision-making in business contexts.

- It involves creating structured models that help organizations analyze complex problems, evaluate different scenarios, and optimize outcomes.

Key Aspects of Decision Modelling:

1. **Problem Formulation** – Identifying business problems and defining objectives.
2. **Data Collection & Analysis** – Gathering relevant data and identifying patterns.
3. **Model Development** – Using techniques such as:
   - **Optimization models** (e.g., linear programming, integer programming)
   - **Simulation models** (e.g., Monte Carlo simulation)
   - Predictive models (e.g., regression analysis, machine learning)
   - **Decision trees & risk analysis**
4. **Implementation & Monitoring** – Applying insights to business decisions and tracking performance.

Introduction to Decision Analytics: Decision Models & Modelling

- A **model** is a simplified representation of reality, comprising essential features of the real world, that helps us solve real-life problems

*"In order to move into the model world, we abstract the essential features of the real world, leaving behind all the inessential detail and complexity"**

REAL WORLD
- Full of detail
- Complex
- Messy

Extract the essential features

ARTIFICIAL WORLD: MODEL
- Essential features only
- Simple
- Clear

Learnings from analysing models provide insights for addressing real world problems

*Quote from Management Science: The Art of Modelling with Spreadsheets by Powell and Baker, 2nd Edn, p. 9

Introduction to Decision Analytics: Decision Models & Modelling

- Decision analytics involves the use of **decision models to improve** managerial decision making
- It is a management science approach to decision making that has application across a broad range of domains, including finance, supply chain, production planning, resource allocation and distribution networks
- The key to this approach is to frame real-life business scenarios as concise mathematical models, from which spreadsheet models can be developed
- The benefit to the decision maker, who is typically not mathematically-minded, is that they can use a spreadsheet model to experiment with different decision alternatives and investigate the sensitivity of the outcomes to these changes

Optimisation

- Optimisation means finding ***the best solution*** from among the set of all *feasible solutions* (i.e. solutions that satisfy all constraints)

- There are two types of decision models which we seek to optimise:

  - **Deterministic decision models – these assume that all the information needed is available, with fixed and known values. (Module 1: Topics 1-5)**

  - **Stochastic decision models – these assume that the values of some important variables are unknown before a decision is made. (Module 2: Topics 6-10)**

  - The analytic techniques covered in this unit are prescriptive in that they identify the decision alternative that optimises (i.e. minimizes or maximizes) some objective that is subject to certain constraints

Module 1: Deterministic Optimisation

- A model is said to be deterministic if ***its behaviour is entirely predictable***
- These models assume that both the quantity to be optimised (the "objective function") and its constraints are known deterministically – i.e. there is no random variation associated with the various numbers
- The aim is to get optimal solutions through numerical computation
- There are three main types of deterministic optimisation:
  - **Linear programming**
  - **Integer linear programming**
  - **Non-linear programming**

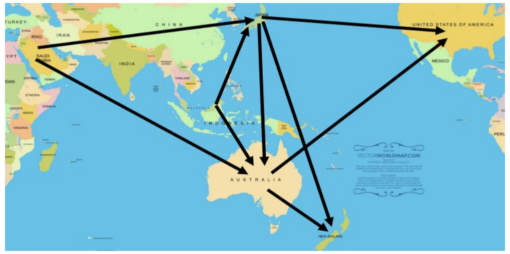
The term 'programming' has nothing to do with computer programming, but "choosing a course of action."

Applications

Capital Budgeting

Facility Location

Investment Portfolio Optimisation



Distribution system

Airline Scheduling Problem

Menu planning at restaurants

...and many, many more

TOPIC 1: Decision Modelling & Linear Programming (LP)

- LP decision models assume that all relevant inputs and parameters are known with certainty. In other words, these are deterministic models

- LP is a mathematical technique to find the best possible solution in allocating limited resources (energy, machines, money, personnel, space, time, etc.) to achieve maximum profit or minimum cost

- However, this technique is applicable only where the objective function and all constraints are linear

Learning Objectives

1. Define decision models and describe their importance
2. Recognise the two types of decision models
3. Understand the steps in the decision modelling process
4. Understand the properties (i.e. assumptions) of LP problems
5. Understand the range of possible optimisation outcomes
6. Understand the steps involved in developing an LP decision model
7. Use graphical procedures to solve LP problems with **two** decision variables
8. Understand how to set-up LP problems in a spreadsheet and solve them using Excel's Solver

Textbook reading: Chapter 1 (1.1-1.6), 2 (2.1-2.2), 3 (3.1-3.3, 3.5-3.7)

A Two-variable Product Mix Model*

A PC Tech company makes two models of computers – Basic & XP

- **They believe the most it can sell in a month is 600 Basics and 1200 XPs**
- **A Basic sells for $300, and an XP for $450**
- **The cost of component parts is $150 for a Basic and $225 for an XP**
- **There are at most 10,000 assembly hours and 3,000 hours of testing**
- **Each hour for assembling and testing costs $11 and $15 respectively**
- **Each Basic requires 5 hours of assembly and one hour of testing, whereas each XP requires 6 hours of assembly and two hours of testing**

The objective is to find the mix of computer models that **maximises profit**

Textbook pp 75-86

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Model formulation

- They believe the most it can sell in a month is 600 Basics and 1200 XPs
- A Basic sells for $300, and an XP for $450
- The cost of component parts is $150 for a Basic and $225 for an XP
- There are at most 10,000 assembly hours and 3,000 hours of testing
- Each hour for assembling and testing costs $11 and $15 respectively
- Each Basic requires 5 hours of assembly and one hour of testing, whereas each XP requires 6 hours of assembly and two hours of testing

	Hours of assembly per unit	Cost per hr of Assembly	Hours of Testing per unit	Cost per hr of Assembly	Demand	Cost ($)	Selling Price ($)
Basic (X1)	5	11	1	15	600	150	300
XP (X2)	6	11	2	15	1200	225	450
max Capacity	10000		3000				

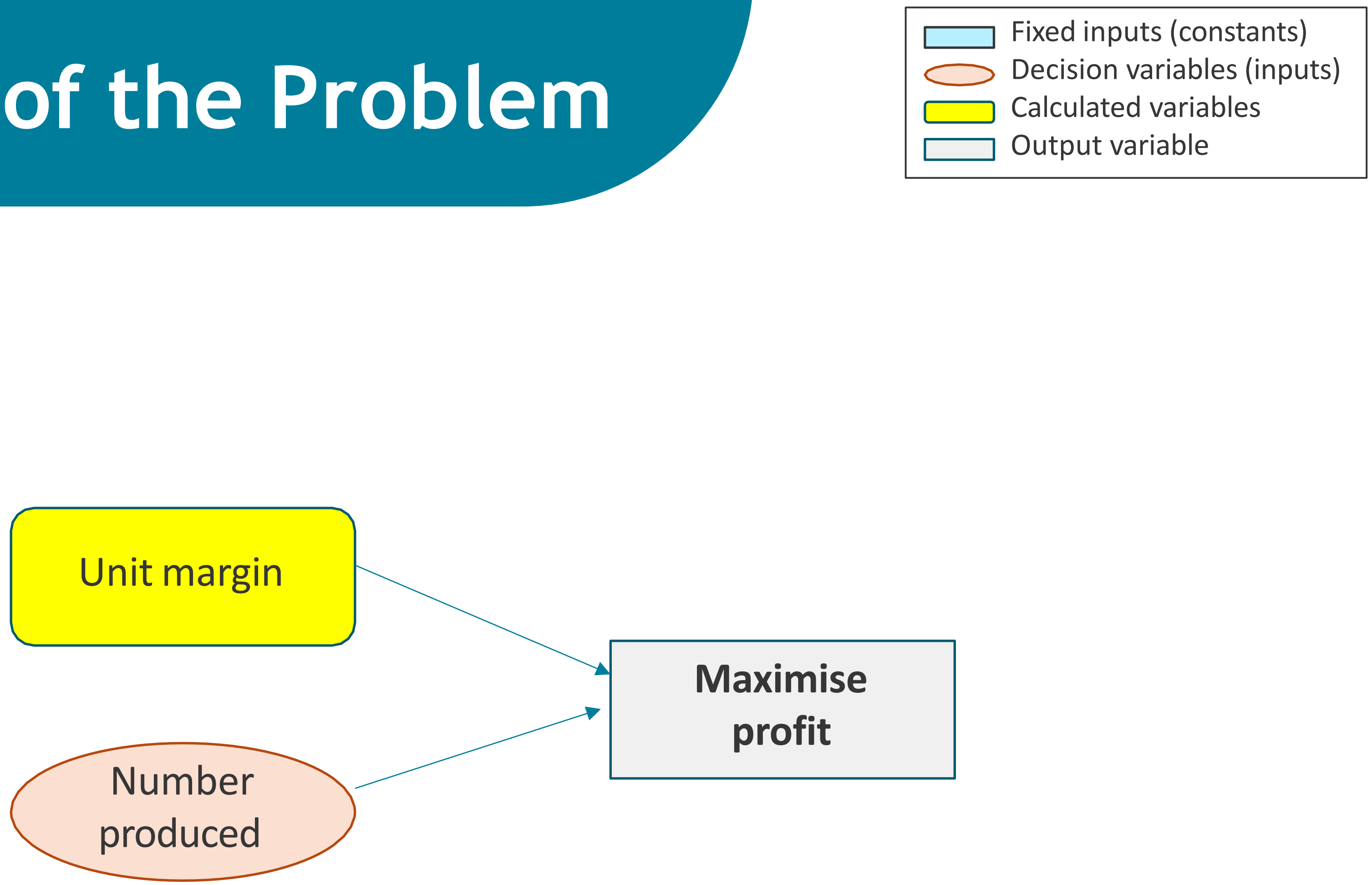
Basic (X1) net profit	300 - 150 -5*11 - 1*15 = 80
XP (X2) net profit	450 - 225 -6*11 -2*15 = 129

Building a Conceptual Model*

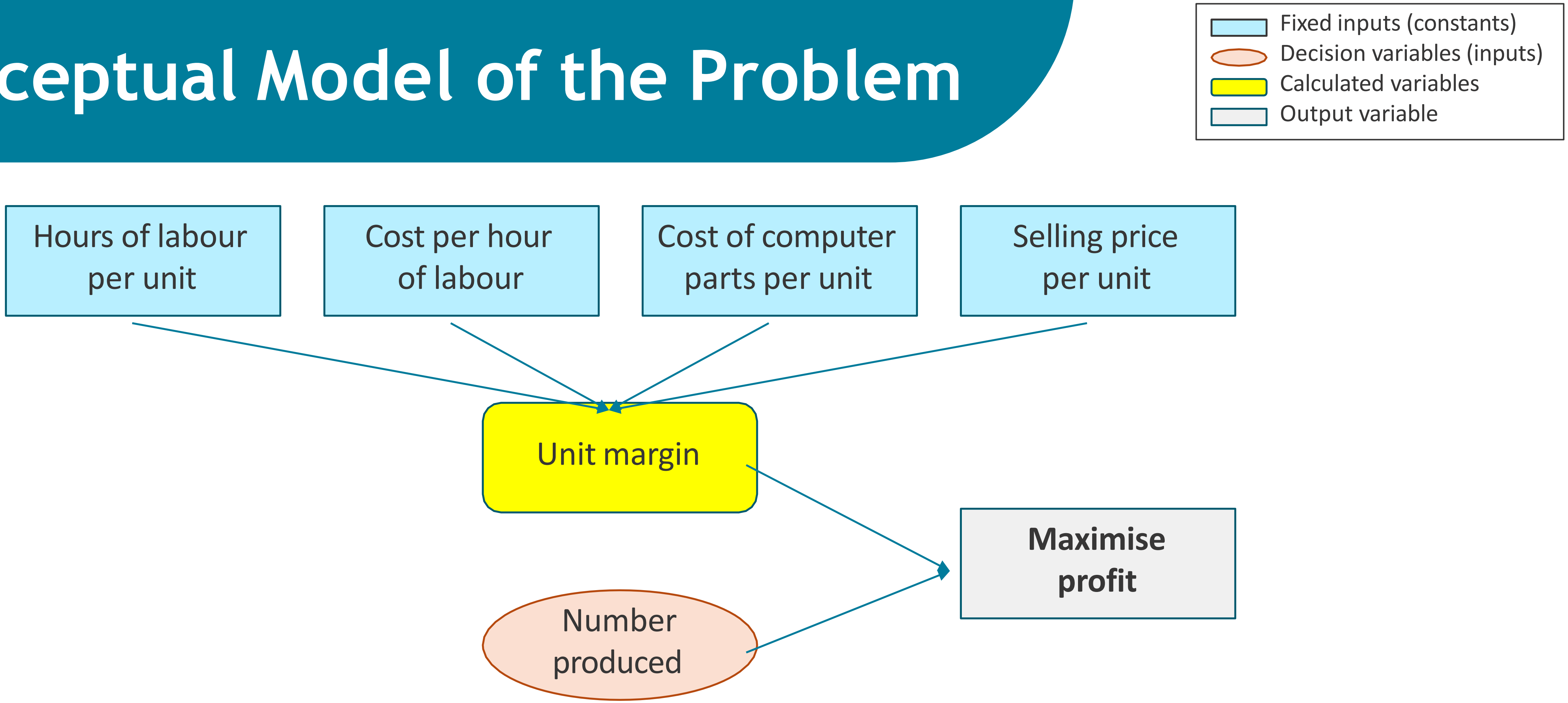
- A conceptual model is a visual aid for thinking conceptually about the problem
- Guidelines for building a conceptual model:
  1. Use a backward chain starting with the key output measure
  2. Identify the variables that directly determine the output measure
  3. Consider each of these variables in turn and repeat step 2,by asking"what do I need to calculate it?"
  4. Identify calculated variables,decision variables,constants (i.e.fixed values) and constraint inequalities (≤ or ≥ or =) as they arise
  5. Make sure that each variable appears only once in the diagram
  6. Make sure the connecting arrows are directed from'inputs' to'outputs'

*Adapted from Management Science:The Art of Modelling with Spreadsheets by Powell and Baker, 2nd Edn, p. 30

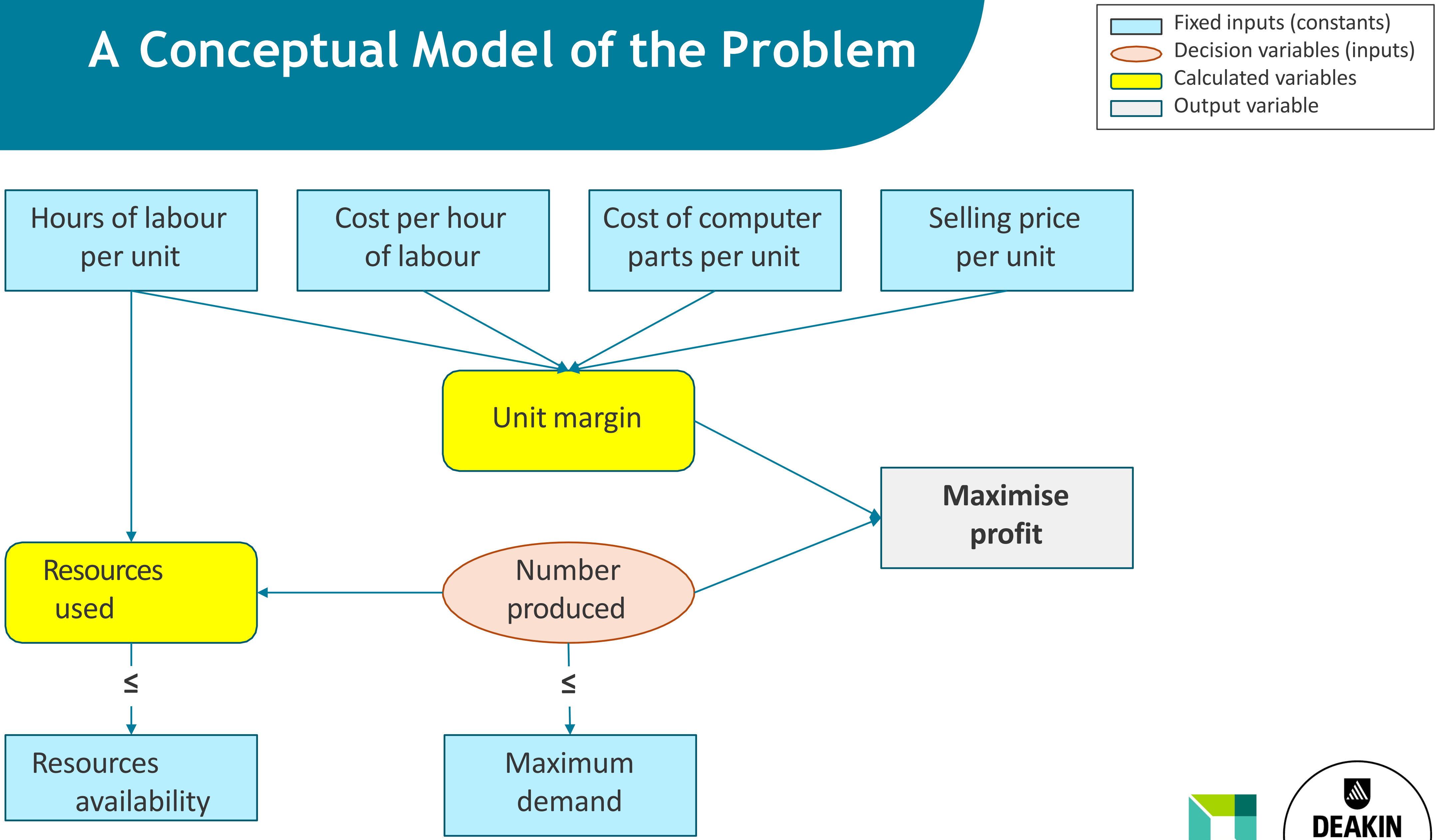
A Conceptual Model of the Problem



A Conceptual Model of the Problem



A Conceptual Model of the Problem



Steps of General Algebraic Form of an LP Model

1. • Define n decision variables: $X_1, X_2, \ldots, X_n$

2. • **MAX** OR (**MIN**) objective function: $c_1X_1 + c_2X_2 + \ldots + c_nX_n$

3. • Subject to:

$$a_{11}X_1 + a_{12}X_2 + \ldots + a_{1n}X_n \le (\ge)\ (=)\ b_1 \qquad \text{(constraint 1)}$$

$$a_{21}X_1 + a_{22}X_2 + \ldots + a_{2n}X_n \le (\ge)\ (=)\ b_2 \qquad \text{(constraint 2)}$$

$$\vdots \qquad \vdots \qquad \vdots$$

$$a_{m1}X_1 + a_{m2}X_2 + \ldots + a_{mn}X_n \le (\ge)\ (=)\ b_m \qquad \text{(constraint m)}$$

4. and $X_j \ge 0$ $(j = 1, 2, \ldots, n)$ **(UB or LB or non-negativity conditions)**

• The a_{ij}, b_i, c_j are assumed to be known constants $(i = 1, 2, \ldots, m;\ j = 1, 2, \ldots, n)$

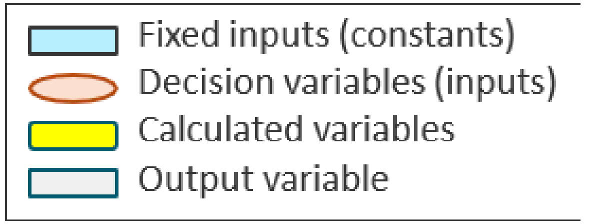
An Algebraic Model of the Problem

$300 – (5*11 + 1*15 + 150) =$ **\$80**

$450 – (6*11 + 2*15 + 225) =$ **\$129**

- Let X_1 and X_2 denote the number of Basics and XPs produced per month
- The objective is to *maximize total profit per month*. This requires the unit margins:

	Hours of assembly per unit	Cost per hour of assembly	Hours of testing per unit	Cost per hour of testing	Cost of parts per unit	Selling price per unit	Unit margin	Demand
Basic (X1)	5	\$11	1	\$15	\$150	\$300	\$80	\$600
XP (X2)	6	\$11	2	\$15	\$225	\$450	\$129	\$1,200
max Capacity	10000		3000					



X1 - # of basic products X2 - # of XP products

- **Maximise** profit (\$) = **$80X1 + 129X2$**

Subject to:

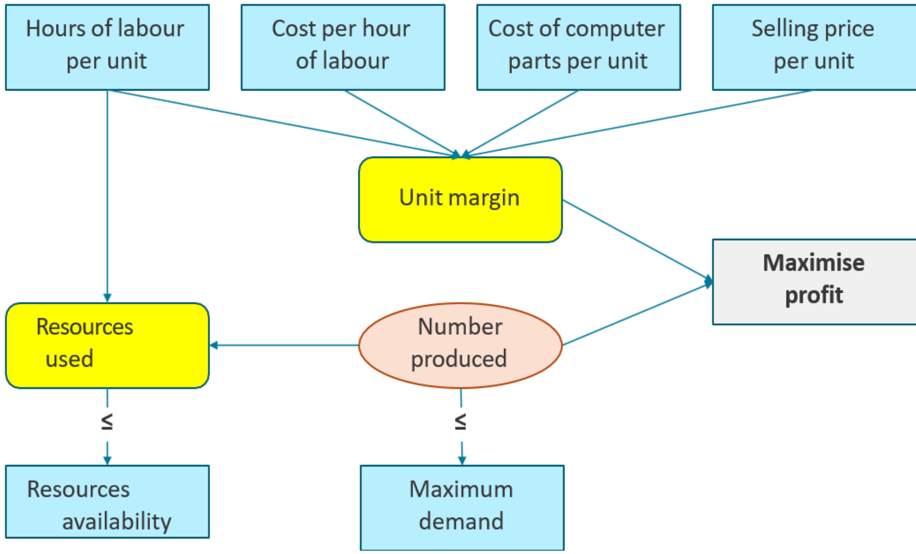
$5X1 + 6X2 \leq 10{,}000$ (assembly time constraint)

$X1 + 2X2 \leq 3{,}000$ (testing time constraint)

$X1 \leq 600$ (monthly demand for Basics)

$X2 \leq 1200$ (monthly demand for XPs)

$X1, X2 \geq 0$ (non-negativity conditions)



A Graphical Solution to the Problem

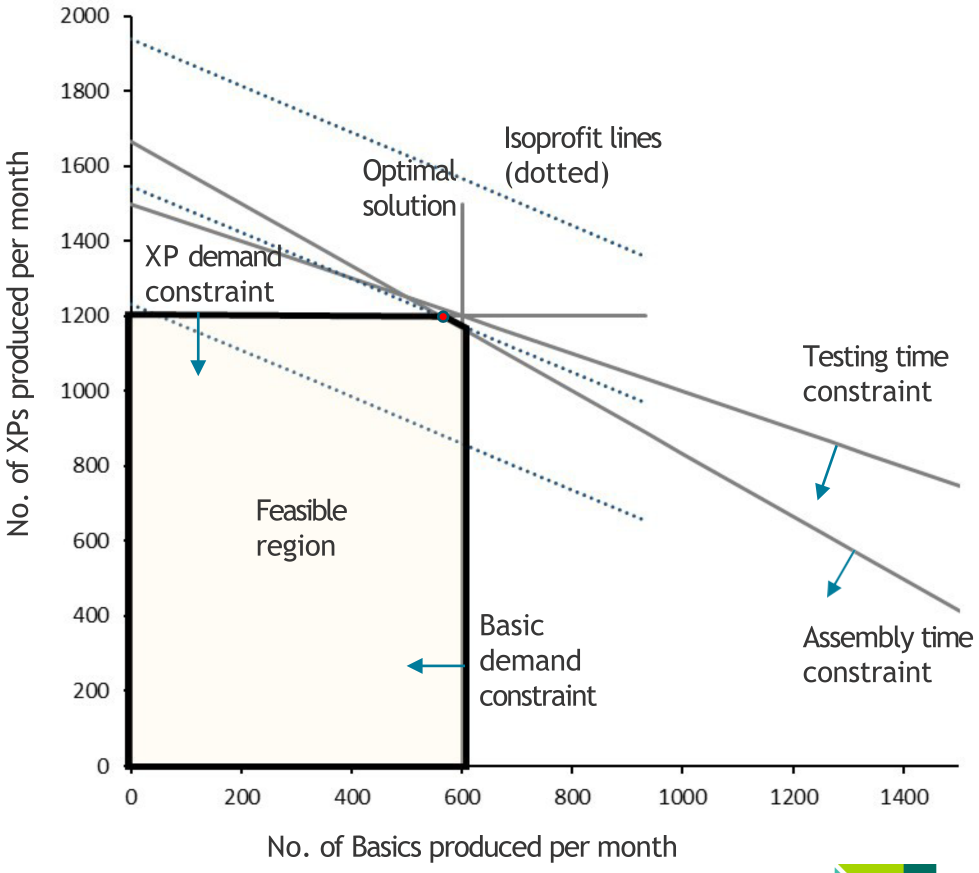
Maximise profit ($) = $80X1 + 129X2$

Subject to:
$5X1 + 6X2 \le 10{,}000$ (assembly time constraint)
$X1 + 2X2 \le 3{,}000$ (testing time constraint)
$X1 \le 600$ (monthly demand for Basics)
$X2 \le 1200$ (monthly demand for XPs)
$X1, X2 \ge 0$ (non-negativity conditions)

- Constraints provide boundary lines of the feasible region
- The optimal solution is always at a corner point, giving us two ways to find the optimal solution

1. Move the dotted isoprofit lines (also known as *objective level curves*) down or left, until they just touch the feasible region

2. Calculate the value of the objective function at each corner point to find the one with maximum profit



Corner point	(0, 0)	(600, 0)	(600, 1167)	(560, 1200)	(0, 1200)
Profit	0	$48,000	$198,500	$199,600	$154,800

https://www.desmos.com/calculator/sulpmj5ksg

Graphical method

Maximise profit ($) = **80X1 + 129X2**

Subject to:

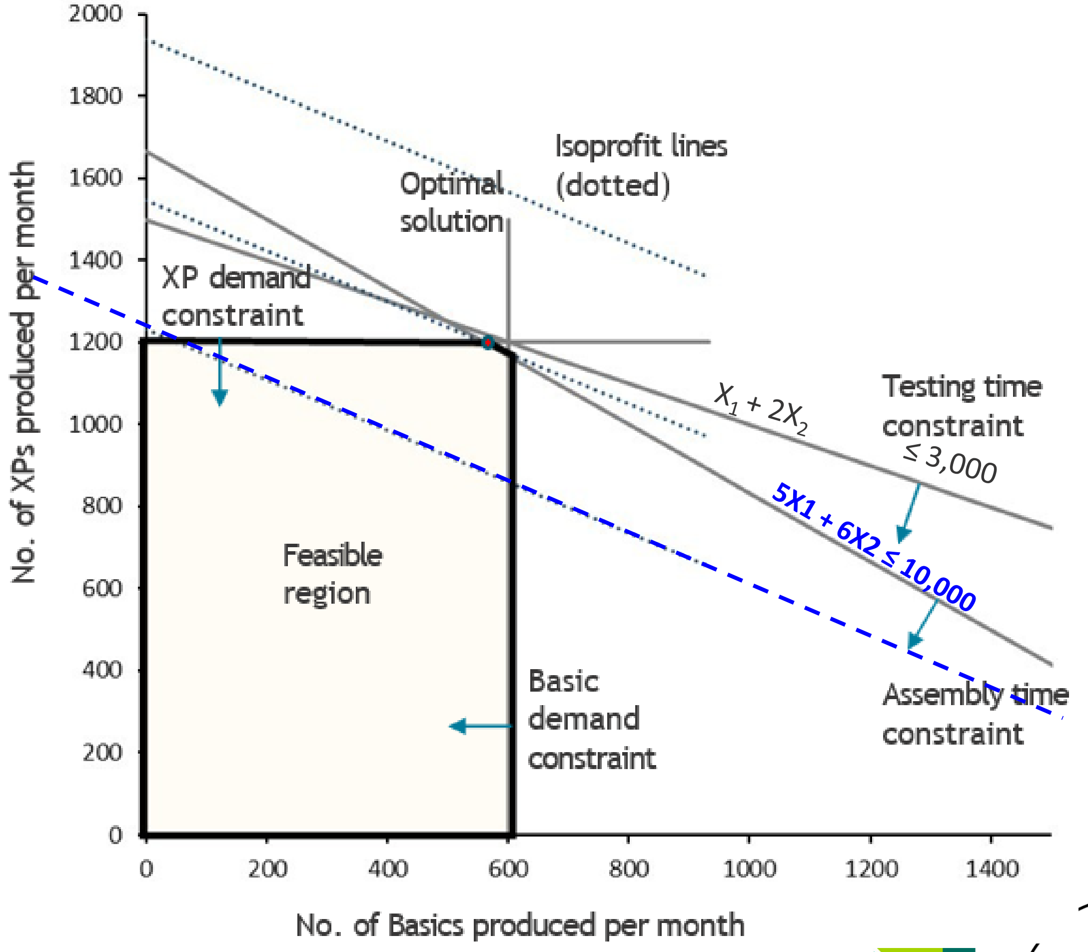
	5X1 + 6X2 ≤ 10,000	(assembly time constraint)
	X1 + 2X2 ≤ 3,000	(testing time constraint)
	X1 ≤ 600	(monthly demand for Basics)
	X2 ≤ 1200	(monthly demand for XPs)
	X1,X2 ≥ 0	(non-negativity conditions)

X1 = Basics and X2 = XPs produced

Maximise profit ($) = **80X1 + 129X2**

Subject to:

	5X1 + 6X2 ≤ 10,000	(assembly time constraint)
	X1 + 2X2 ≤ 3,00	(testing time constraint)
	X1 ≤ 600	(monthly demand for Basics)
	X2 ≤ 1200	(monthly demand for XPs)
	X1,X2 ≥ 0	(non-negativity conditions)



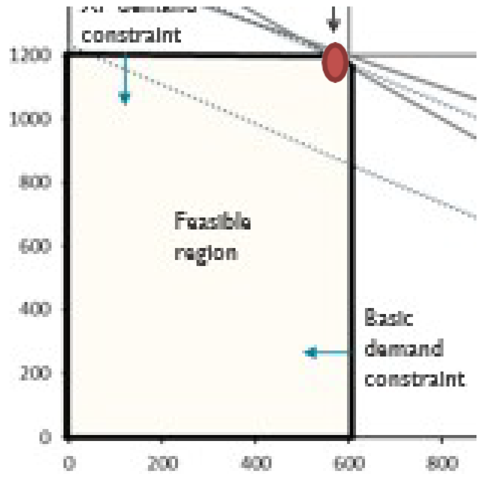
5X1 + 6X2 ≤ 10,000 (0,1666.7) (2000,0)

X1 + 2X2 ≤ 3,000 (0,1500) (3000,0)

80X1 + 129X2 = 80*129*10 = 103200 (0,800) (1290,0)

Optimal solution: X1=560, X2=1200

Some Terminology for Solutions



- A **feasible solution** is a solution that satisfies all constraints
- The **feasible region** is the set of all feasible solutions
- The **optimal solution** is the feasible solution that optimises the value of the objective function

Graphical method in LP- Supporting resources

Electronic graphical table: [*https://www.desmos.com/calculator*](https://www.desmos.com/calculator)

[*https://www.youtube.com/watch?v=o0vomTRCMrg*](https://www.youtube.com/watch?v=o0vomTRCMrg)

https://www.desmos.com/calculator/sulpmj5ksg

Additional resources: [***https://www.youtube.com/watch?v=0TD9EQcheZM***](https://www.youtube.com/watch?v=0TD9EQcheZM)

[***https://www.youtube.com/watch?v=pP0Qag694Go***](https://www.youtube.com/watch?v=pP0Qag694Go)

https://www.youtube.com/watch?v=K2ZQu2IYoDs

How to solve Linear Programming Problem with Equality (=) Constraint Graphically

[***https://www.youtube.com/watch?v=tG09UclkeY4***](https://www.youtube.com/watch?v=tG09UclkeY4)

An Important Generalisation

- What we observe in the simple case of only two decision variables carries over to an LP model with any number of decision variables:
  - Linear constraints always produce feasible regions that are a multidimensional version of a convex polygon, with all corner points (vertices) pointing outwards (like a triangle, for example)
  - The optimal value of the objective function of an LP model always occurs at a corner point of the feasible region
- Why is this generalisation important?

Properties (Assumptions) of Linear Models

Proportionality

- Each term in the objective function and constraints is comprised of a decision variable with a constant coefficient (e.g. $3X_1, 0.5X_2, -X_3$)

Additivity

- The terms in the objective function and in the constraints are only ever added. There are no interactions between decision variables (e.g. terms such as $2X_1X_2$)

Divisibility (Continuity)

- Decision variables can take any value within a given feasible range. Fractional part of a solution can often be interpreted as work-in-process to be finished in the next production period

Certainty

- All model coefficients are assumed to be known. In the real world there is always uncertainty but we often assume complete certainty and then take small variations into account with sensitivity analysis (refer Topic 2)

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Range of Optimisation Outcomes

Unique optimal solution

- There is exactly one solution (i.e. one set of values of the decision variables) that will optimise (i.e. maximise or minimise) the value of the objective function

Alternative (multiple) optimal solutions

- There are multiple solutions with the same optimal objective function value. This can happen when the objective function is parallel to one of the constraints

Unbounded solution

- The value of the objective function can be increased or decreased without bound (i.e. go towards $\pm\infty$). This can happen if you forget to include a constraint in the model

Infeasibility

- No feasible solution exists. This can happen when a constraint has the wrong inequality (e.g. you used $\leq$ when it should have been $\geq$ or vice versa). Or it might mean you need to rethink some constraints

A Spreadsheet Model for the Product Mix Problem

Maximise profit (\$) = $80X_1 + 129X_2$

C23 =SUMPRODUCT(C17:D17,C21:D21)

	A	B	C	D	E	F	G
15		**DECISION VARIABLES**					
16			**Basic**	**XP**			
17		No. to produce	0	0			
18							
19		**OBJECTIVE FUNCTION**					
20			**Basic**	**XP**			
21		Unit margin	\$80	\$129			
22							
23		Total monthly profit	\$0				
24							
25		**CONSTRAINTS**					
26					**LHS**		**RHS**
27			**Basic**	**XP**	**Used**		**Available**
28		Assembly time	5	6	0	≤	10000
29		Testing time	1	2	0	≤	3000
30		Market demand for Basics	1	0	0	≤	600
31		Market demand for XPs	0	1	0	≤	1200

Reserve separate cells, C17:D17 for each decision variable, initially set to zero. Objective cell, C23 contains a formula for calculating the value of the objective function

Yellow cells contain coefficients of the objective function, and the LHS and RHS of each constraint

Cells headed 'LHS Used' have SUMPRODUCT formulas for finding the LHS value of each constraint

$5X_1 + 6X_2 \leq 10{,}000$ (assembly time constraint)

$X_1 + 2X_2 \leq 3{,}000$ (testing time constraint)

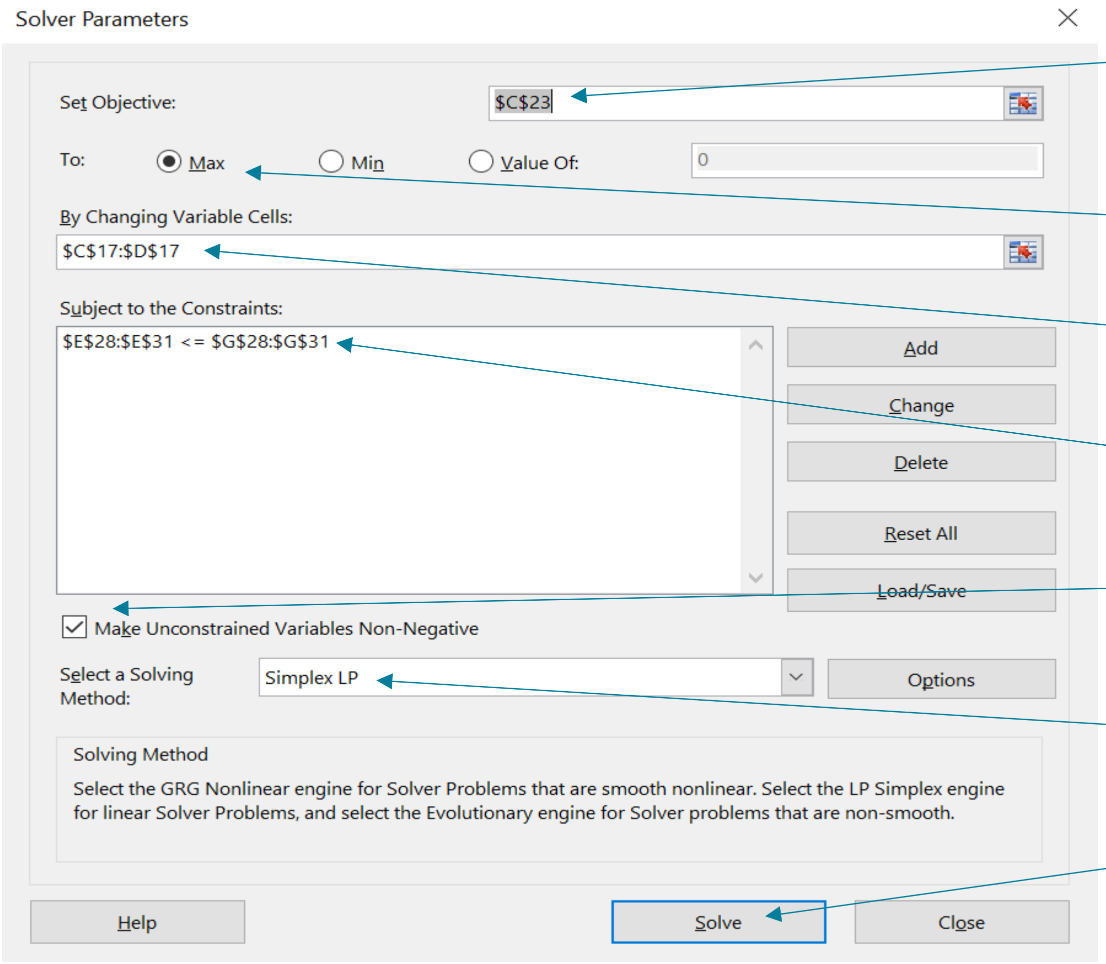
$X_1 \leq 600$ (monthly demand for Basics)

$X_2 \leq 1200$ (monthly demand for XPs)

$X_1, X_2 \geq 0$ (non-negativity conditions)

Using Solver

Open Excel Solver under Data tab.
If missing select Solver Add-in from File > Options > Adds-In



Objective cell reference

Set optimisation to Max or Min

Enter decision variable cell reference

Add constraints

Tick box for non-negative decision variables

Choose Simplex LP as solving method

Then click 'Solve'

Optimal Solution to the Problem

C23 =SUMPRODUCT(C17:D17,C21:D21)

	A	B	C	D	E	F	G
15		**DECISION VARIABLES**					
16			**Basic**	**XP**			
17		No. to produce	560	1200			
18							
19		**OBJECTIVE FUNCTION**					
20			**Basic**	**XP**			
21		Unit margin	$80	$129			
22							
23		Total monthly profit	$199,600				
24							
25		**CONSTRAINTS**					
26					**LHS**		**RHS**
27			**Basic**	**XP**	**Used**		**Available**
28		Assembly time	5	6	10000	≤	10000
29		Testing time	1	2	2960	≤	3000
30		Market demand for Basics	1	0	560	≤	600
31		Market demand for XPs	0	1	1200	≤	1200

The optimal solution is displayed in the green decision variable cells

The objective cell (C23) gives the optimal value of the objective function

A Larger Product Mix Model*

This time PCTech must decide how many of **8 models** to assemble and test, when there are **two lines for testing**. Computers can be tested on either line.

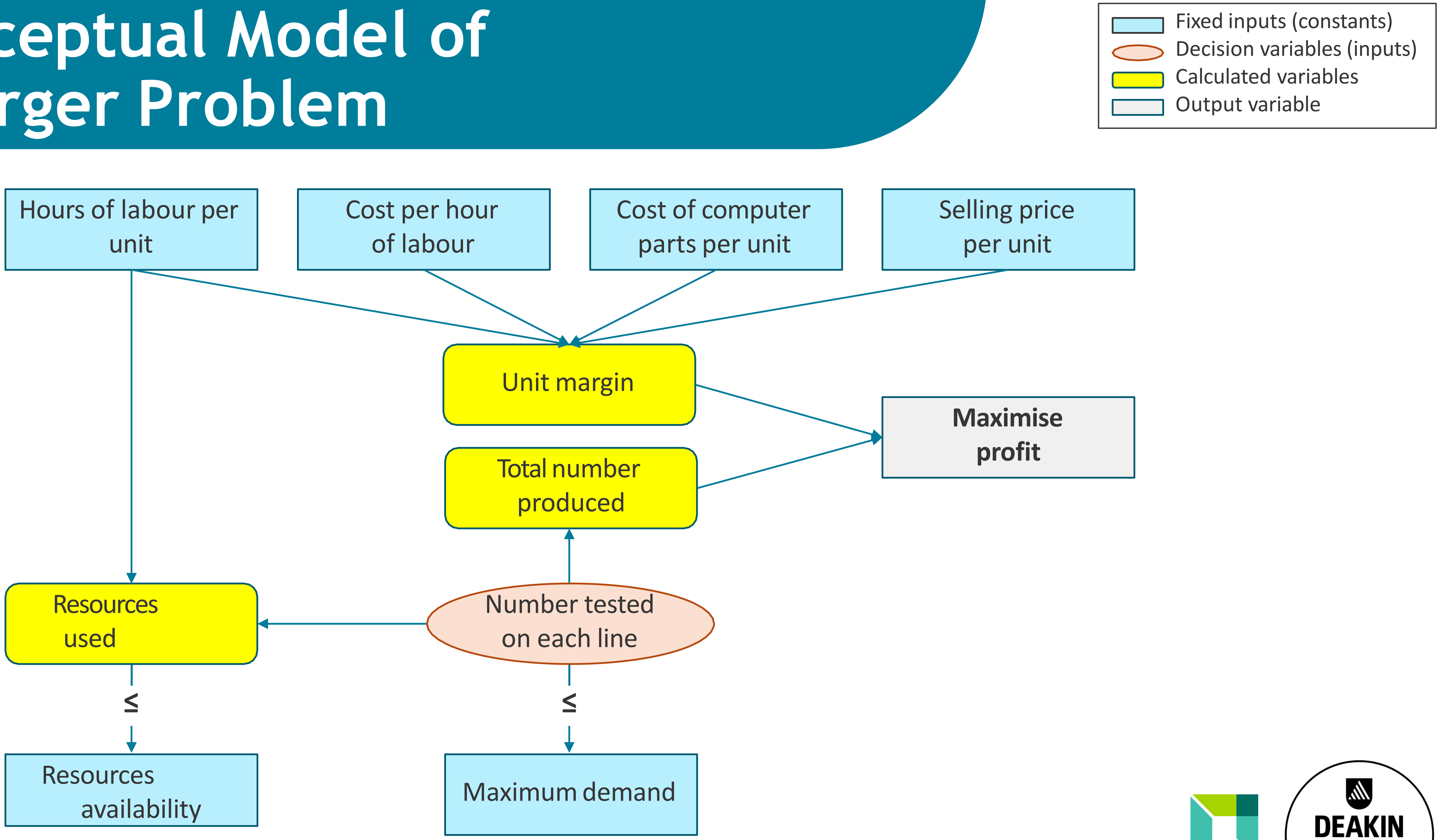
The objective is unchanged - find the mix of computer models that maximises profit

We solve this in our lab session, but it is worth noting that the main complicating factor here is that we now have 16 decision variables - the number of each type of model to test on each line

Let X_j and Y_j denote the number of model j computers tested on lines 1 and 2 respectively ($j = 1, 2, .., 8$)

Textbook pp 103-107

A Conceptual Model of the Larger Problem

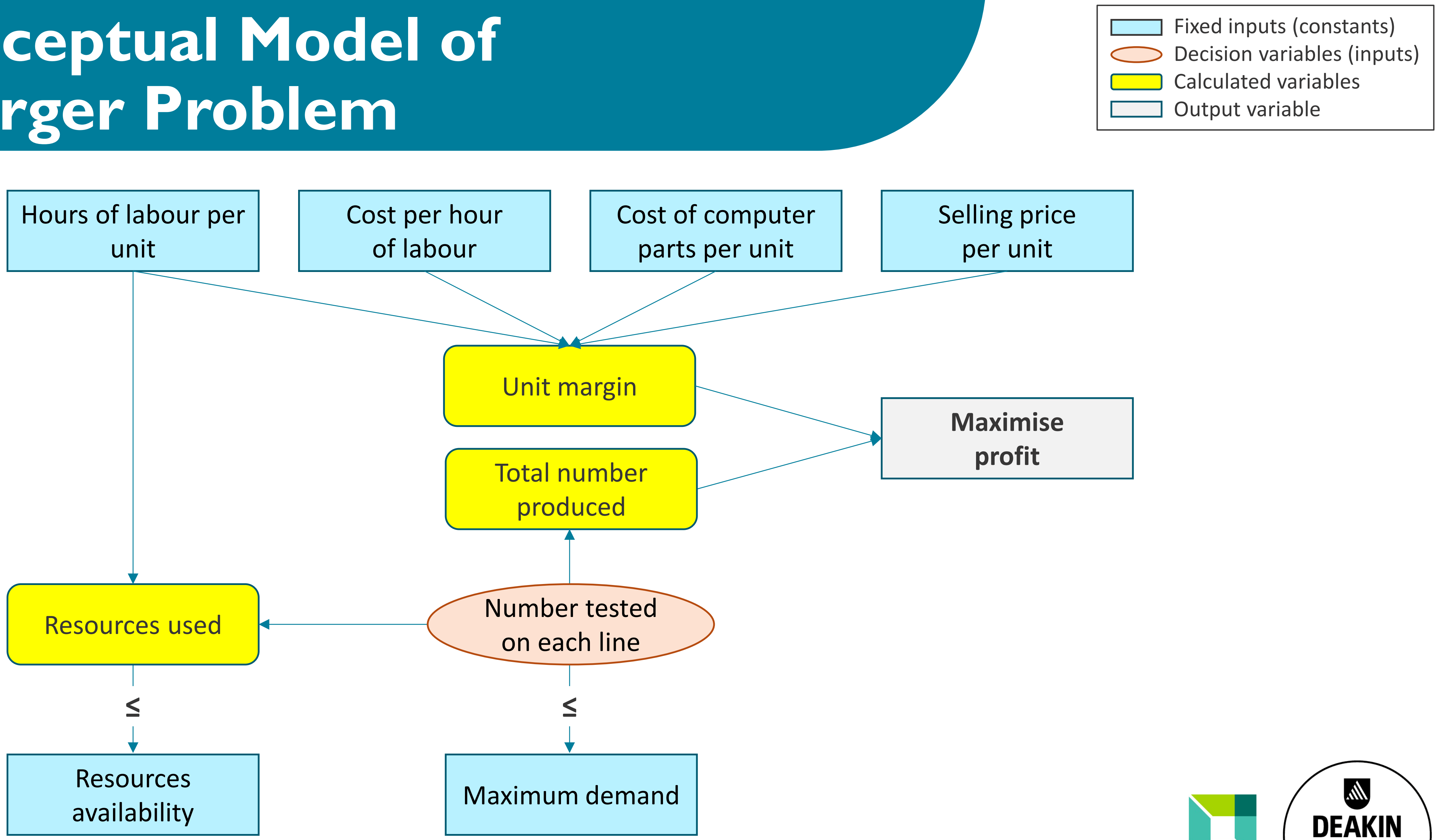


Do We Need the Algebraic Model?

- Normally we would produce the algebraic model, but there are two reasons why on this occasion we skip this step

1. It is time-consuming and tedious to write down expressions with 16 decision variables
2. In this case we don't need it as we already have a prototype spreadsheet model which can be easily extended to accommodate two testing lines

A Conceptual Model of the Larger Problem



Do We Need the Algebraic Model?

- Normally we would produce the algebraic model, but there are two reasons why on this occasion we skip this step

1. **It is time-consuming and tedious to write down expressions with 16 decision variables**
2. **In this case we don't need it as we already have a prototype spreadsheet model which can be easily extended to accommodate two testing lines**

INPUTS PER UNIT	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Cost ($)	Hours available
Hours of assembly	4	5	5	5	5.5	5.5	5.5	6	11	20,000
Hours of testing, line 1	1.5	2	2	2	2.5	2.5	2.5	3	19	5000
Hours of testing, line 2	2	2.5	2.5	2.5	3	3	3.5	3.5	17	6000
Cost of parts	$150	$225	$225	$225	$250	$250	$250	$300		
Selling price	$350	$450	$460	$470	$500	$525	$530	$600		
Maximum Demand	1500	1250	1250	1250	1000	1000	1000	800		

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Unit margin, line 1	$127.5	$132.0	$142.0	$152.0	$142.0	$167.0	$172.0	$177.0
Unit margin, line 2	$122.0	$127.5	$137.5	$147.5	$138.5	$163.5	$160.0	$174.5

Net profit of model 1 in line 1 =350 -150 -4*11 -1.5*19 = 127.5

Net profit of model 1 in line 2 =350 -150 -4*11 -2*17 = 122

INPUTS PER UNIT	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Cost ($)	Hours available
Hours of assembly	4	5	5	5	5.5	5.5	5.5	6	11	20,000
Hours of testing, line 1	1.5	2	2	2	2.5	2.5	2.5	3	19	5000
Hours of testing, line 2	2	2.5	2.5	2.5	3	3	3.5	3.5	17	6000
Cost of parts	$150	$225	$225	$225	$250	$250	$250	$300		
Selling price	$350	$450	$460	$470	$500	$525	$530	$600		
Maximum Demand	1500	1250	1250	1250	1000	1000	1000	800		

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Unit margin, line 1	$127.5	$132.0	$142.0	$152.0	$142.0	$167.0	$172.0	$177.0
Unit margin, line 2	$122.0	$127.5	$137.5	$147.5	$138.5	$163.5	$160.0	$174.5

Let X1 ,X2 ... X8 denote the number of products of Model 1...8 produced in Line 1 per month

Y1 ,Y2 ... Y8 denote the number of products of Model 1...8 produced in Line 2 per month

Maximise profit ($) : **127.5 X1+132 X2+ 142 X3……**

122 Y1+127.5 Y2+………… + 174.5 Y8

Subject to: 4X1 + 4Y1 +5 X2 + 5Y2 + ……+ 6X8 + 6Y8 ≤ **20,000** (assembly time constraint)

1.5X1 + 2X2+ …… +3X8 ≤ **5,000** (testing time constraint line 1)

2Y1 +2.5Y2+ …… +3.5Y8 ≤ **6,000** (testing time constraint line 2)

X1+Y1 ≤ **1500** (monthly demand for model 1)

X2+Y2 ≤ **1250**(monthly demand for model 2)

……..

……

X8+Y8 ≤ **800** (monthly demand for model 8)

X_1, $X_{2.....}$X8, Y1.....Y8 ≥ 0 (non-negativity conditions)

Larger Product Mix Problem - Optimal Solution

	A	B	C	D	E	F	G	H	I	J	K	L	M
17		**DECISION VARIABLES**											
18			**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**			
19		No. to produce on line 1	1500	0	0	125	0	0	1000	0			
20		No. to produce on line 2	0	0	0	475	0	1000	0	0			
21													
22		**OBJECTIVE FUNCTION**											
23			**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**			
24		Unit margin, line 1	$128	$132	$142	$152	$142	$167	$172	$177			
25		Unit margin, line 2	$122	$128	$138	$148	$139	$164	$160	$175			
26													
27		Total monthly profit	$615,813										
28													
29		**CONSTRAINTS**											
30											**LHS**		**RHS**
31			**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**	**Used**		**Available**
32		Assembly time	4	5	5	5	5.5	5.5	5.5	6	20000	≤	20000
33		Testing time line 1	1.5	2	2	2	2.5	2.5	2.5	3	5000	≤	5000
34		Testing time line 2	2	2.5	2.5	2.5	3	3	3.5	3.5	4187.5	≤	6000
35		Market demand for model 1	1	0	0	0	0	0	0	0	1500	≤	1500
36		Market demand for model 2	0	1	0	0	0	0	0	0	0	≤	1250
37		Market demand for model 3	0	0	1	0	0	0	0	0	0	≤	1250
38		Market demand for model 4	0	0	0	1	0	0	0	0	600	≤	1250
39		Market demand for model 5	0	0	0	0	1	0	0	0	0	≤	1000
40		Market demand for model 6	0	0	0	0	0	1	0	0	1000	≤	1000
41		Market demand for model 7	0	0	0	0	0	0	1	0	1000	≤	1000
42		Market demand for model 8	0	0	0	0	0	0	0	1	0	≤	800

Decision Modelling Process - Steps

- Regardless of the size and complexity of the optimisation problem, the decision modelling process requires a systematic approach

Model development

- This is where you will put most of your effort. You need to conceptualise the problem, formulate an algebraic model, and turn it into a spreadsheet model

Model optimisation

- This is where you tell Excel's Solver to find the optimal solution by applying the Simplex algorithm

Sensitivity analysis

- You then explore 'what-if' questions regarding the model's input values
- This will be discussed in detail next week

Summary

- We developed an understanding of deterministic decision models and their importance to managerial decision-making
- We learnt about the structure of an LP model and the steps for finding an optimal solution
- We learnt of an important generalisation concerning corner points of the feasible region for LP models,which reduces the search for an optimal solution
- We also learnt that the decision modelling process requires a systematic approach

Learning Objectives

1. Define decision models and describe their importance
2. Recognise the two types of decision models
3. Understand the steps in the decision modelling process
4. Understand the properties (i.e. assumptions) of LP problems
5. Understand the range of possible optimisation outcomes
6. Understand the steps involved in developing an LP decision model
7. Use graphical procedures to solve LP problems with **two** decision variables
8. Understand how to set-up LP problems in a spreadsheet and solve them using Excel's Solver

Textbook reading: Chapter 1 (1.1-1.6), 2 (2.1-2.2), 3 (3.1-3.3, 3.5-3.7)

Next Class

Topic 2: Sensitivity Analysis & Linear Programming Applications

- **How to perform sensitivity analysis for LP models**
- **Broaden our understanding of the range of applications**