

ALT 3

Modelling and Simulation

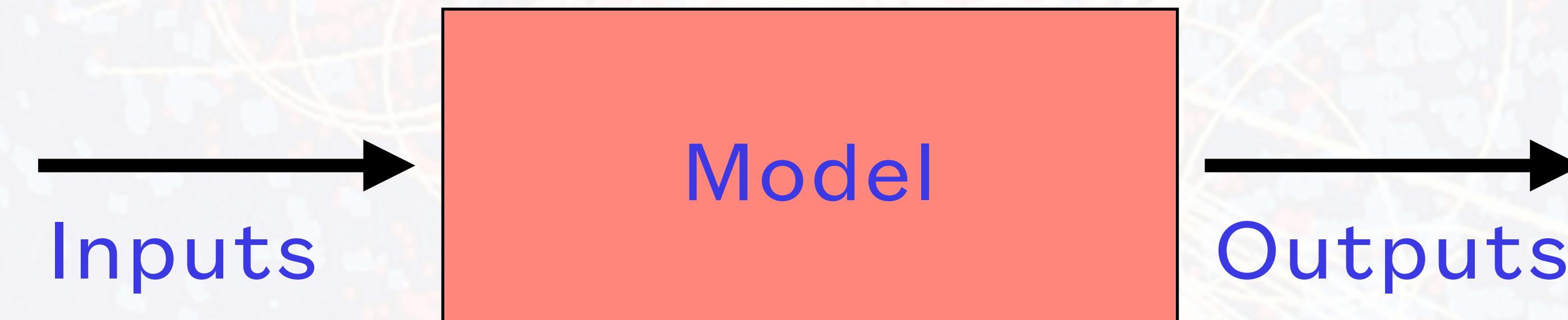


ALT 3 - Modelling and Simulation

Students learn about:	Students should be able to:
Modelling / Simulation	3.8 - Develop a model that will allow different scenarios to be tested
Abstraction	3.9 - Analyse and interpret the outcome of simulations both before and after modifications have been made
Algorithms	3 .10 - Explain the benefits of using agent-based modelling and how it can be used to demonstrate emergent behaviours

ALT 3 - Terminology

- Model - A block of code or a system that takes an input(s) and returns a set of outputs that allow the user make a prediction about a process.
- Scenarios - Conditions or situations that the model will run in.
- Simulation - The actual operation of a model to test different scenarios.



Real-world models



Where have you seen or heard of models and simulations being used lately?

- A model is used to simulate what is happening in a system or in a process.
- Using models allows us to repeat tests under different conditions and learn from ‘what if?’ Scenarios
- Models allow us to investigate dangerous situations safely and to make alterations and quickly see the outcomes.

What stage of the development process could you use models?

Build a simple model (p 264)

- As part of your ALT 3 you will have to design and create a model.
- Computational thinking is a key part of developing a meaningful model.

Can you recall the 4 pillars of computational thinking?

- Computational thinking involves four techniques or ‘pillars’.
 - Pattern matching - Identifying patterns.
 - Abstraction - Ignoring irrelevant details and identifying important details.
 - Decomposition - Breaking a complex task into smaller tasks.
 - Algorithms - Using a sequence of steps to solve a problem.

Build a simple model (p 264)

- Abstraction in particular is an important part of developing a working model.



Many modern heating systems use thermostats to control the heating in a home. The home owner will set a desired temperature using a controller and an embedded system will read inputs from temperature sensors in the home and decide whether to turn on or off the heating depending on the users initial desired temperature.

Your task is to build a basic model that will send an output of 1 or 0 to the controller to turn on/off the heating.

Using abstraction identify what needs to be included in the model.

Thermostat model (p 264)

- Our model is a basic model as there is only two possible outputs, 0 or 1.
- Recall in the software development process we must evaluate our software.

How could we evaluate our thermostat software?



- We can use a 'test data table' to evaluate our software and identify potential problems or bugs.

Actual temp	Target Temp	Expected Result	Actual Result	Passed Y/N
15	20			
15	15			
16	-16			
0	1			
100	-100			



Compound Interest Model (p 267)

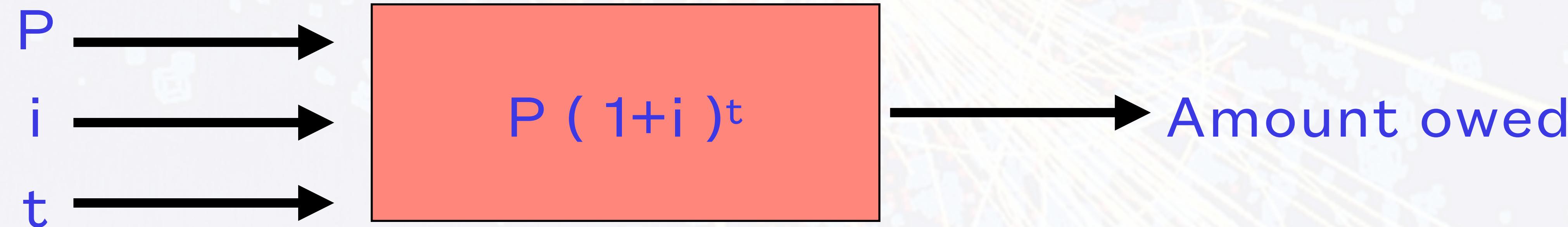
- Banks use a number of different models to identify if a customer is eligible for different financial packages such as loans and mortgages.

Compound interest formula = $P (1+i)^t$

P = initial amount borrowed (principal)

i = interest rate as a decimal value

t = term of the loan





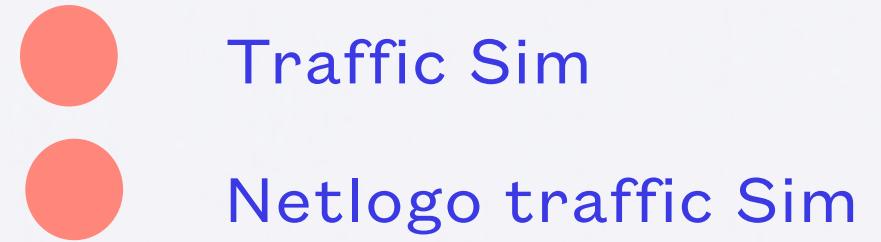
Agent Based Modelling

- Agent based models are computer models that attempt to capture the behaviour of individuals within an environment. Think of The Sims going about their life in the game.
- ABM's rely on simulating the actions and interactions of autonomous agents to investigate their effects on a system.
- In an ABM, agents and environments are clearly defined but interactions are allowed to freely occur to result in emergent behaviour.

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- ABM is used in a wide range of area's, particularly recently it has been used in the modelling of the Covid-19 pandemic.
 - Other areas include modelling customer behaviour, traffic ongestion, social networks financial market modelling, automated driving system validation

Explain the benefits of using agent-based modelling and how it can be used to demonstrate emergent behaviours

Agent Based Modelling benefits



- ABM can be used to describe complex environments by applying simple rules to each individuals behaviour.
- ABMs can allow us to make predictions of emergent behaviours or test scenarios before they happen.
- ABMs are a flexible, low cost and time saving approach.

Lets create a model for traffic flow:

Identify the environment e.g a town

Identify agents within the environment e.g cars

Identify simple rules for agents e.g cars go when lights are green