COMP1531

🎨 Design - Conceptual Modelling

Lecture 8.3

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In This Lecture

- **Why? 🤔**
  - A critical element of software design is to be able to translate complex system ideas into something high level and understandable
- **What? 📰**
  - Conceptual Model
  - State Diagrams

What Is A Model?

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Figure 1: Mathematical Model

$$\frac{dC}{dt} = \frac{s_c C}{1+(R_b+N_b+T_b+L_b)/b_{c\infty}} + \frac{k_{cp}}{v_m}(P-C) - (k_{crc}+k_{cnc}+k_{ctc}+k_{clc})C - \mu_c C$$

$$\frac{dP}{dt} = \frac{k_{cp}}{v_b}(C-P) - \mu_p P$$

$$\frac{dR_c}{dt} = \frac{s_{rc}R_c}{1+R_b/b_{r\infty}} + k_{crc}C - k_{rcm}R_c - \mu_{rc}R_c \qquad \frac{dR_m}{dt} = k_{rcm}R_c - \frac{k_{rmb}}{v_m}R_m - \mu_{rm}R_m$$

$$\frac{dN_c}{dt} = \frac{s_{nc}N_c}{1+N_b/b_{n\infty}} + k_{cnc}C - k_{ncm}N_c - \mu_{nc}N_c \qquad \frac{dN_m}{dt} = k_{ncm}R_c - \frac{k_{nmb}}{v_m}N_m - \mu_{nm}N_m$$

$$\frac{dT_c}{dt} = \frac{s_{tc}T_c}{1+T_b/b_{t\infty}} + k_{ctc}C - k_{tcm}T_c - \mu_{tc}T_c \qquad \frac{dT_c}{dt} = k_{tcm}T_c - \frac{k_{tmb}}{v_m}T_c - \mu_{tc}T_c$$

$$\frac{dL_c}{dt} = \frac{s_{lc}L_c}{1+L_b/b_{l\infty}} + k_{clc}C - k_{lcm}L_c - \mu_{lc}L_c \qquad \frac{dL_c}{dt} = k_{lcm}L_c - \frac{k_{lmb}}{v_m}L_c - \mu_{lc}L_c$$

$$\frac{dR_b}{dt} = \frac{k_{rmb}}{v_m}R_m - \mu_{rb}R_b \qquad \frac{dT_b}{dt} = \frac{k_{tmb}}{v_m}T_m - \mu_{tb}T_b$$

$$\frac{dN_b}{dt} = \frac{k_{nmb}}{v_m}N_m - \mu_{nb}N_b \qquad \frac{dL_b}{dt} = \frac{k_{lmb}}{v_m}L_m - \mu_{lb}L_b$$

What Is A Model?

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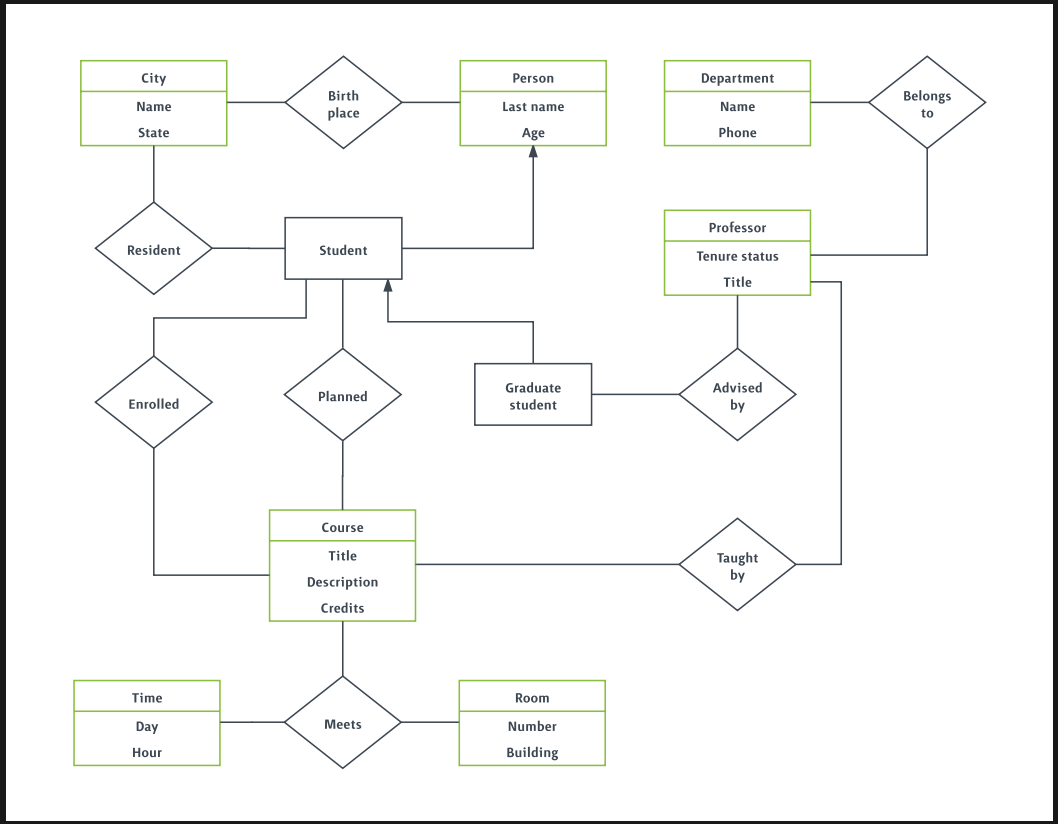

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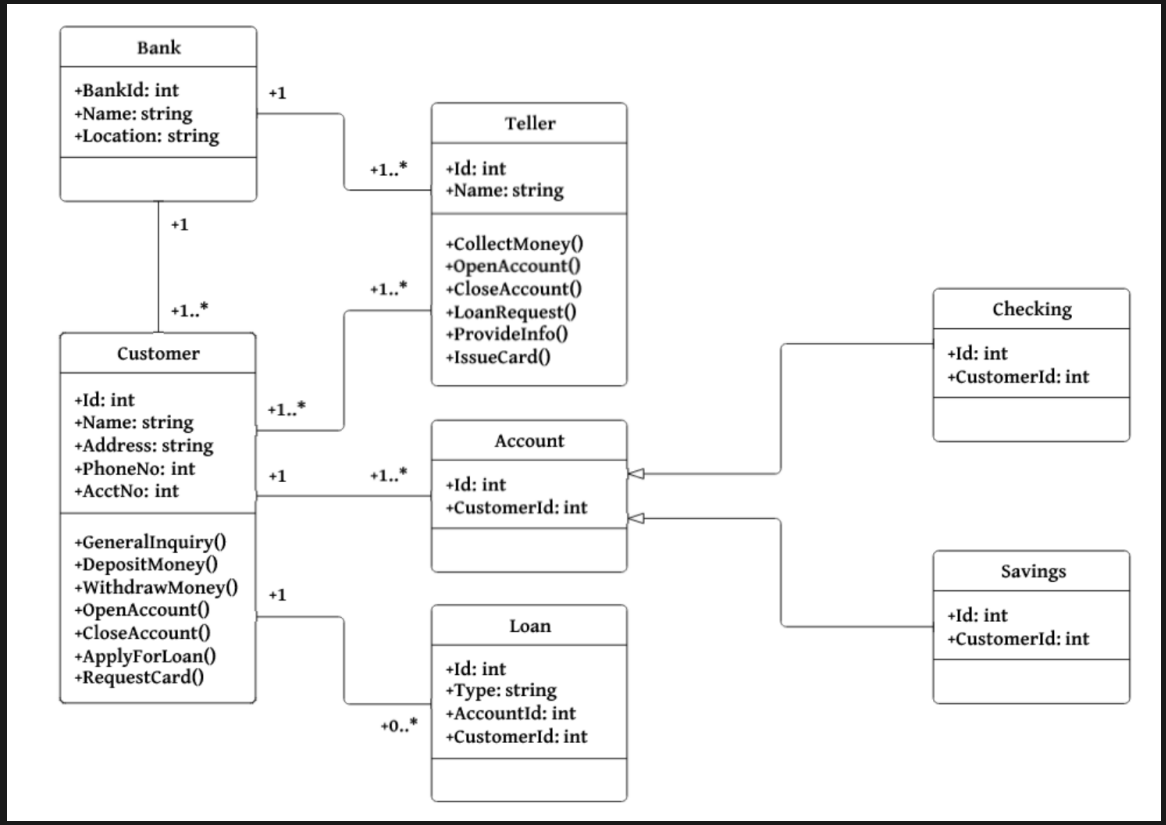

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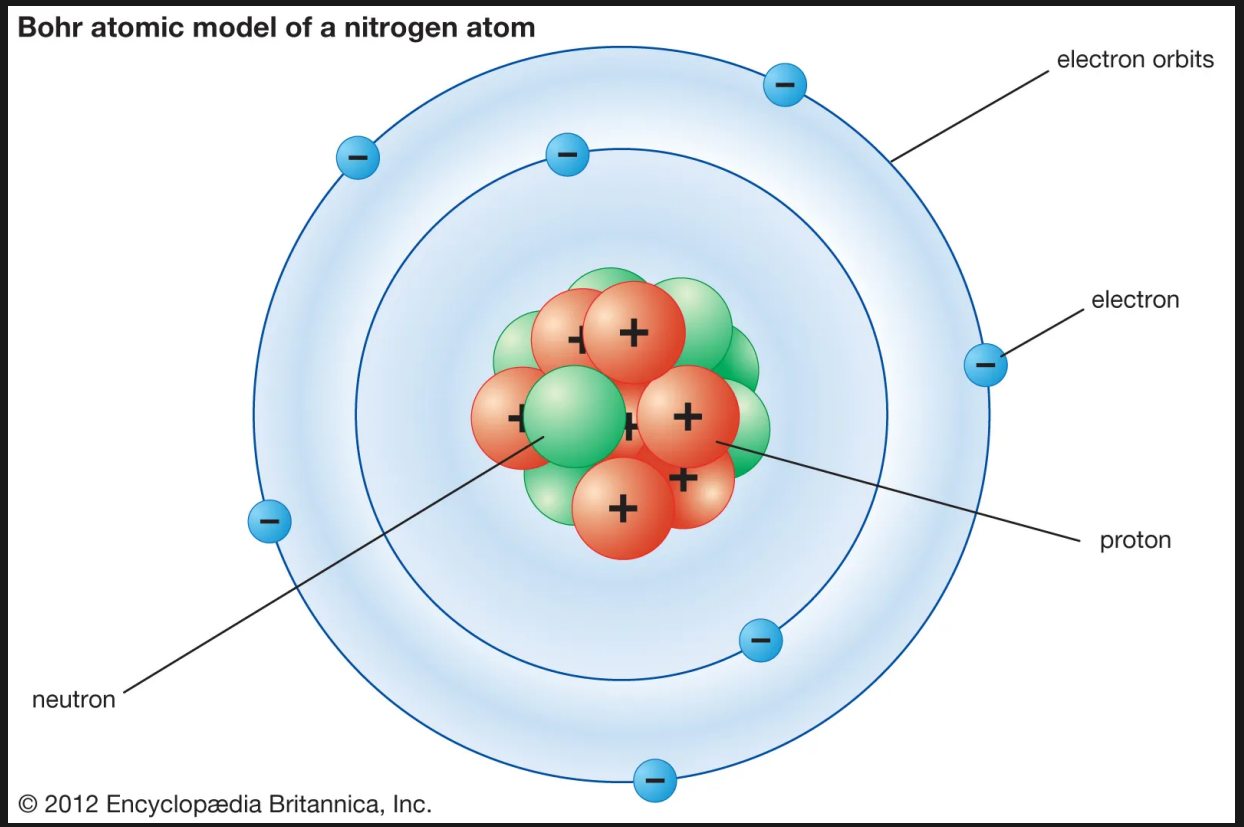

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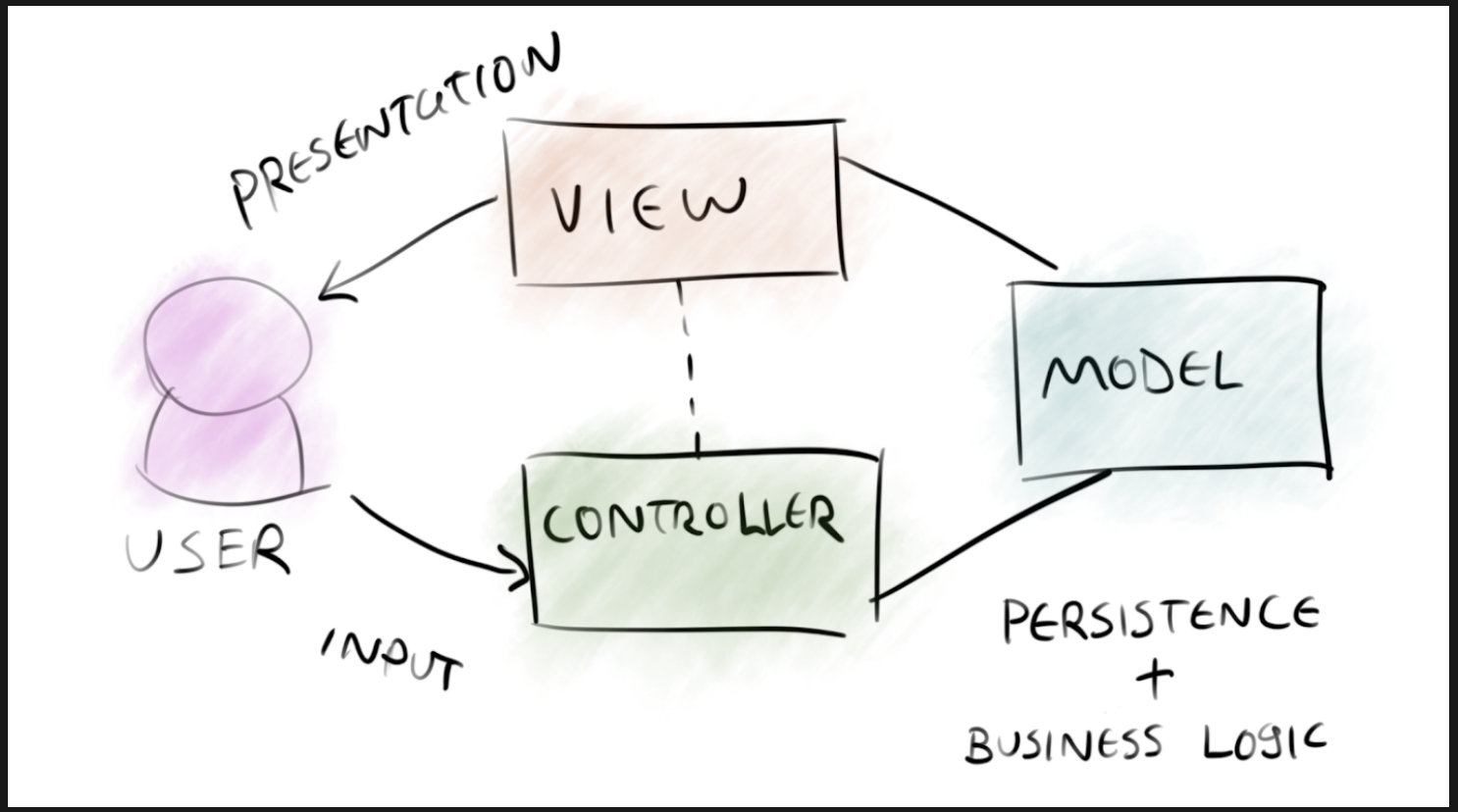

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What Is A Model?

A **model** is a simplified representation to assist in understanding something more complex.

This covers everything from mathematics through to model aeroplanes.

🤯 Conceptual Modelling

A **conceptual model** is a type of model that captures a system in a conceptual way rather than a physical way.

They tend to be **diagramatic** or **visual**.

🤯 Conceptual Modelling

Examples include:

- **Mathematical models**
- **Data models**: To model databases
- **Domain models**: To model components of a software system
- **State transition models**: To model how a program operates at different stages

🤯 Conceptual Modelling

Generally conceptual models in software will be one of two types:

- Structural – Emphasise the static structure of the system. Examples include:
  - UML class diagrams (object oriented programming)
  - ER diagrams (database design)
- Behavioural - Emphasise the dynamic behaviour. Examples include:
  - State diagrams (state machines)
  - Use case diagram (user flows)

We will discuss some of these, and explore **state diagrams** in detail.

🛠️ What Are Models Used For?

- To predict future states of affairs.
- Understand the current state of affairs.
- Determine the past state of affairs.
- To convey the fundamental principles and basic functionality of systems - i.e. help communicate

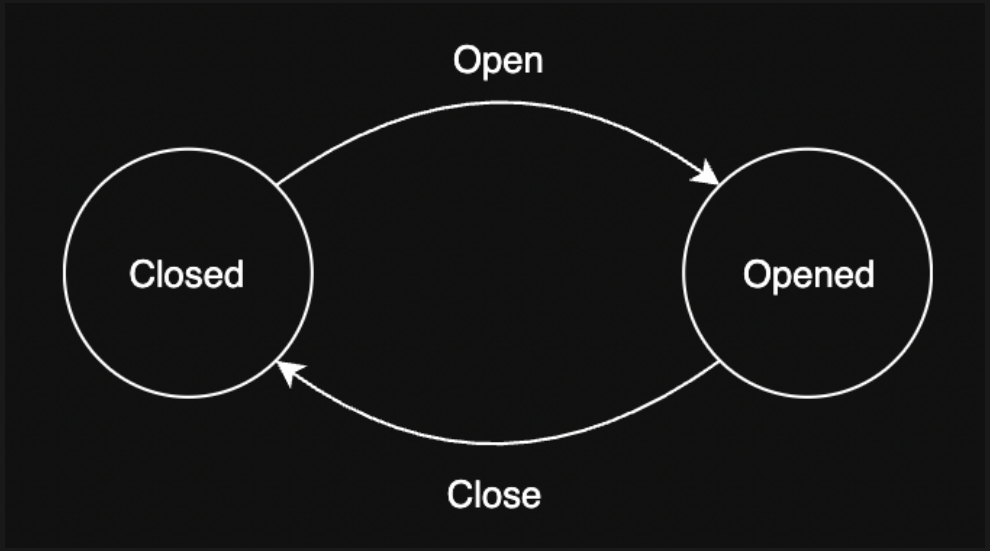
 Communicating Models

- Four fundamental objectives of communicating with a conceptual model:
  - Enhance an individual's understanding of the representative system
  - Facilitate efficient conveyance of system details between stakeholders
  - Provide a point of reference for system designers to extract system specifications
  - Document the system for future reference and provide a means for collaboration

Kung and Solvberg (1986)

👨‍🎨 State Diagrams

- A diagrammatic representation of a state.
- Simple example: a door
- Some variation in notation, though typically: states are circles, transitions are labelled arrows connecting them



🤖 State Machines

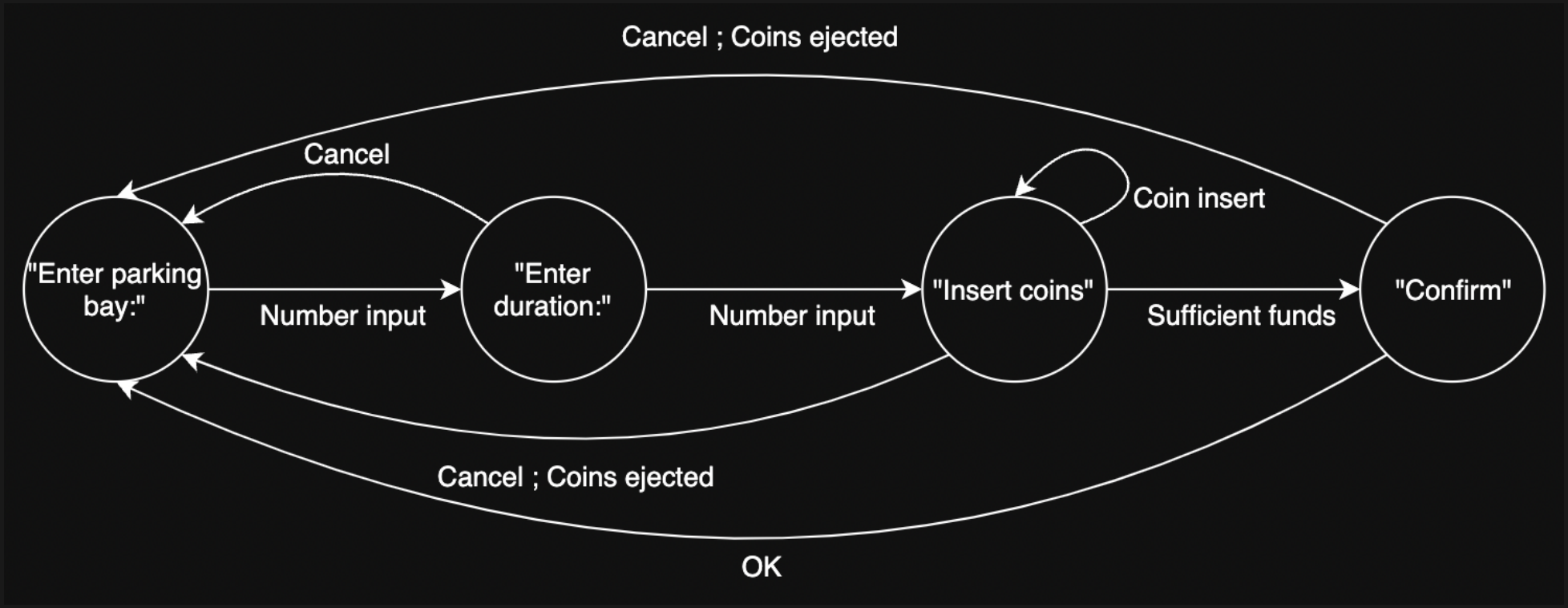
State diagrams are used to describe **state machines**.

State machines (i.e. software) are made up of a finite number of states.

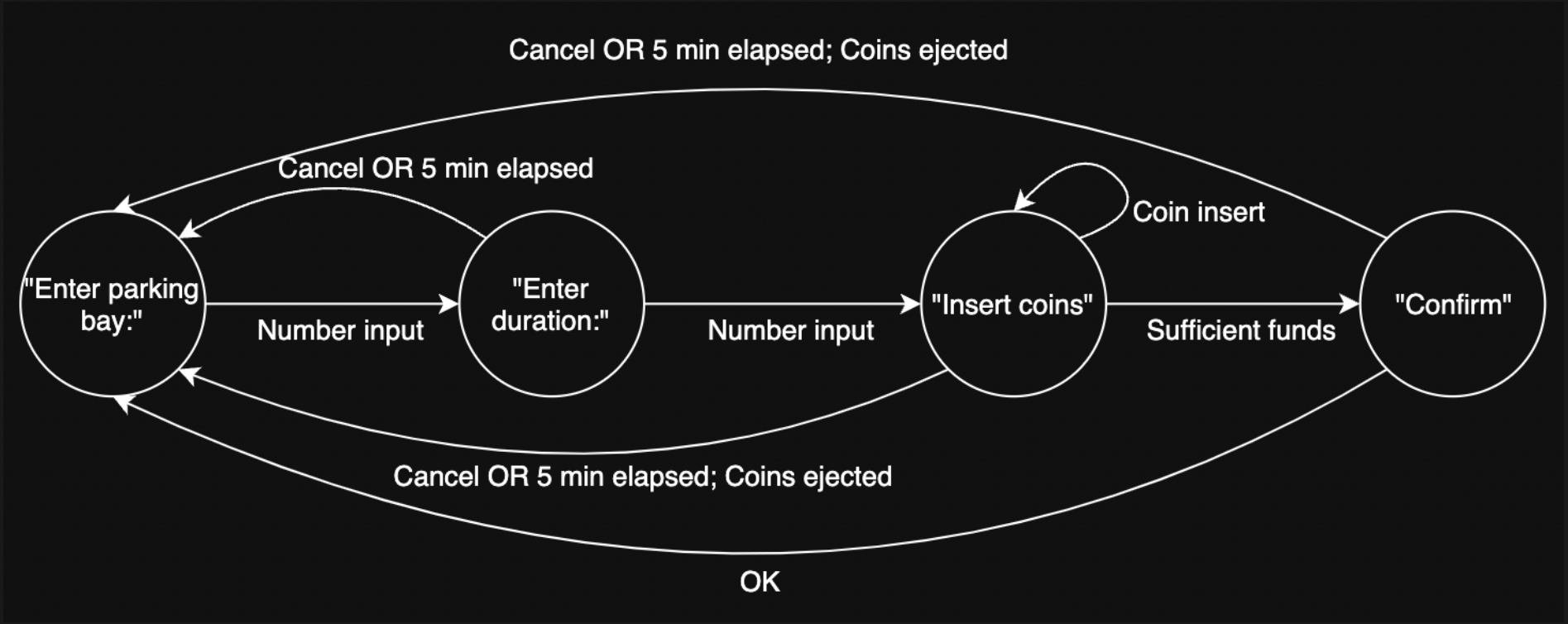
The machine (i.e. software) can be transitioned from one state to another through an action

- For example:
  - UIs with different screens
  - Network protocols
  - Conversational interfaces

🚗 Parking Meter Example



🚗 Parking Meter Example



Quick Activity

Can we model the opal card system as a state machine?

🌞 For Fun: A Complex Conceptual Model

- In 2015 a UNSW student wrote a conceptual model "Gallium" based off of previous research to represent the energy usage of a solar car as it drove from Darwin to Adelaide
- The model was written in python and modeled the physical system of the vehicle and it's energy consumption over a fixed distance in response to a dynamic environmental and physical characteristics

The model calculated the energy usage across a number of fixed-distance intervals (e.g. a 200 metre stretch of road) over a 3000km journey across Australia.

🌞 For Fun: Should We Build A State Machine??

Can we build a state machine for the opal system?

🦻 Feedback

Or go to the form here.