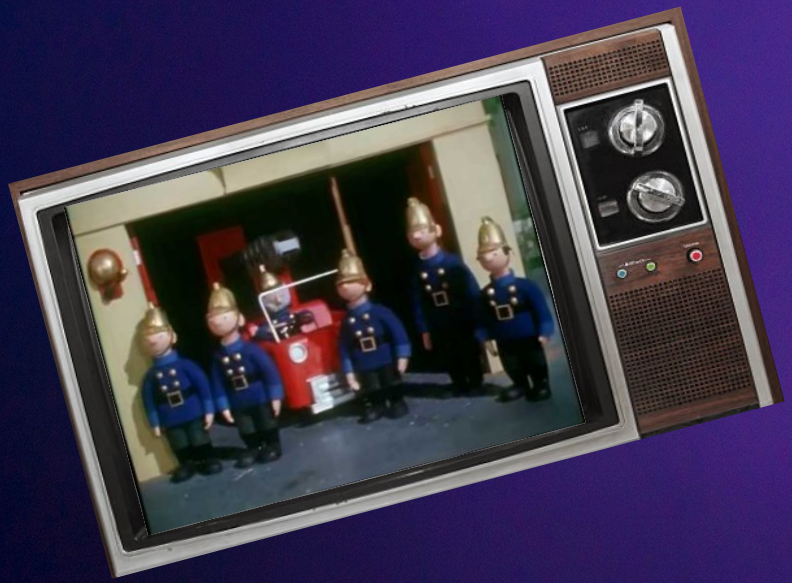

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HSMA 5 Open Day Mini Taster Lecture
A Taste of Discrete Event Simulation and Conceptual Modelling
Dr Daniel Chalk

"Queue, Queue, Barney McGrew"

HSMA 5

#hsma5isalive

What is Operational Research?

Applying modelling, simulation and analysis techniques to help **inform** decisions, and **improve decision making.**

“What If?” Analysis

Base Case Scenario
A model of the current system.
How are things running now?

We can use this to see how well the current system works, validate the model and identify bottlenecks.

- How long do you think a patient spends in the system now?
- Where are the bottlenecks?
- What does our capture of the current system tell us about where we may need to increase / reduce resources, or alter processes?

“What If” Analysis
Adapting the model to reflect potential future scenarios. How might things run if we were to change x, y and / or z?

We can use this to predict the impact of decisions, and help the decision maker to make an **informed evidence-based decision**.

- What is the predicted impact of x, y and z?
- How might things change if a, b and c were also implemented?

The Benefits of Modelling

- **Emulation :** A model is a version of reality that can be altered without risk or consequence

- **Speed :** Typically, models can be designed and built much more quickly than real world changes can be effected.

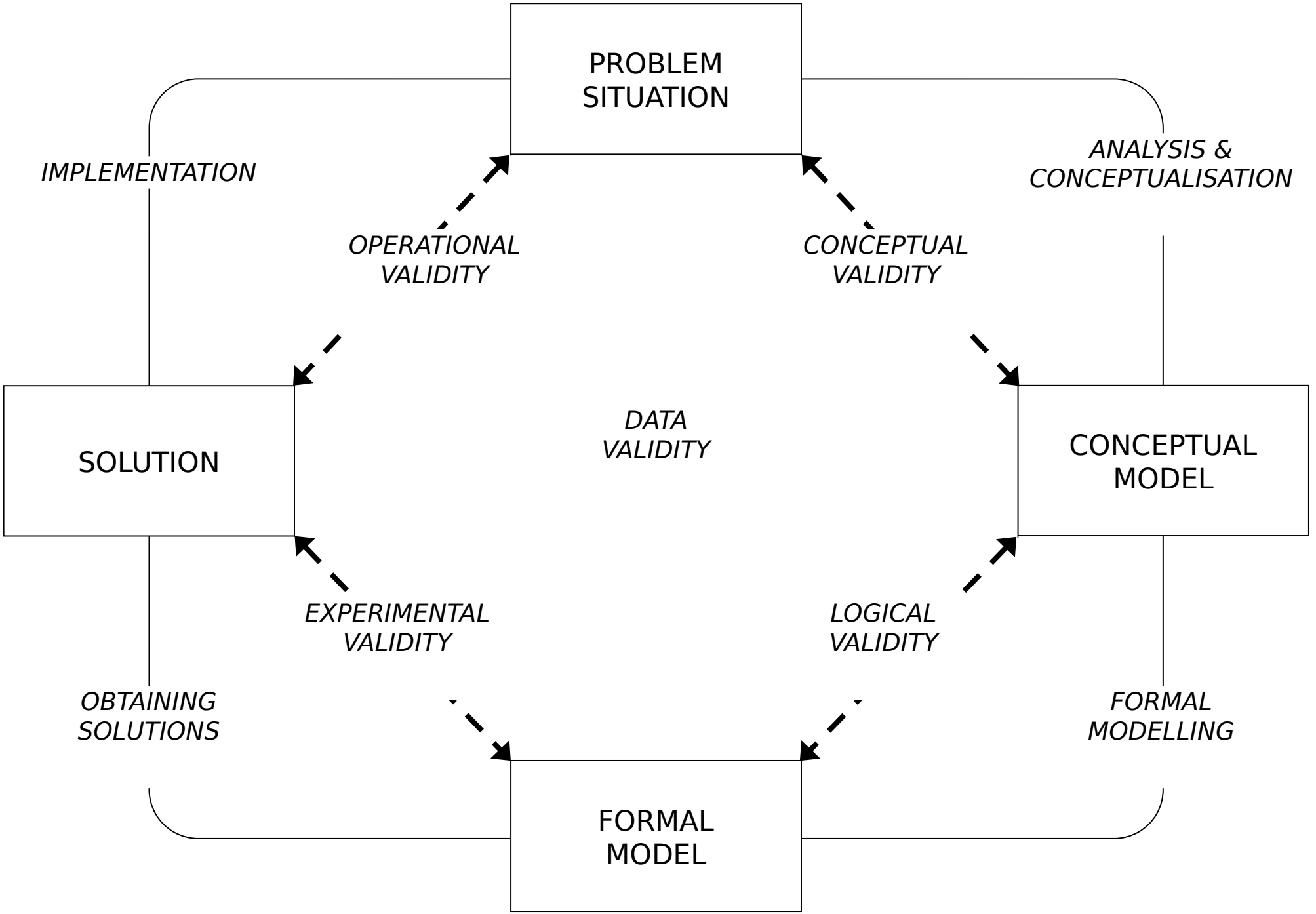
- **Communication :** A model can help people to communicate about a problem using a shared language and point of reference

- **Systems Thinking :** The process of designing the model can help people to think about their systems

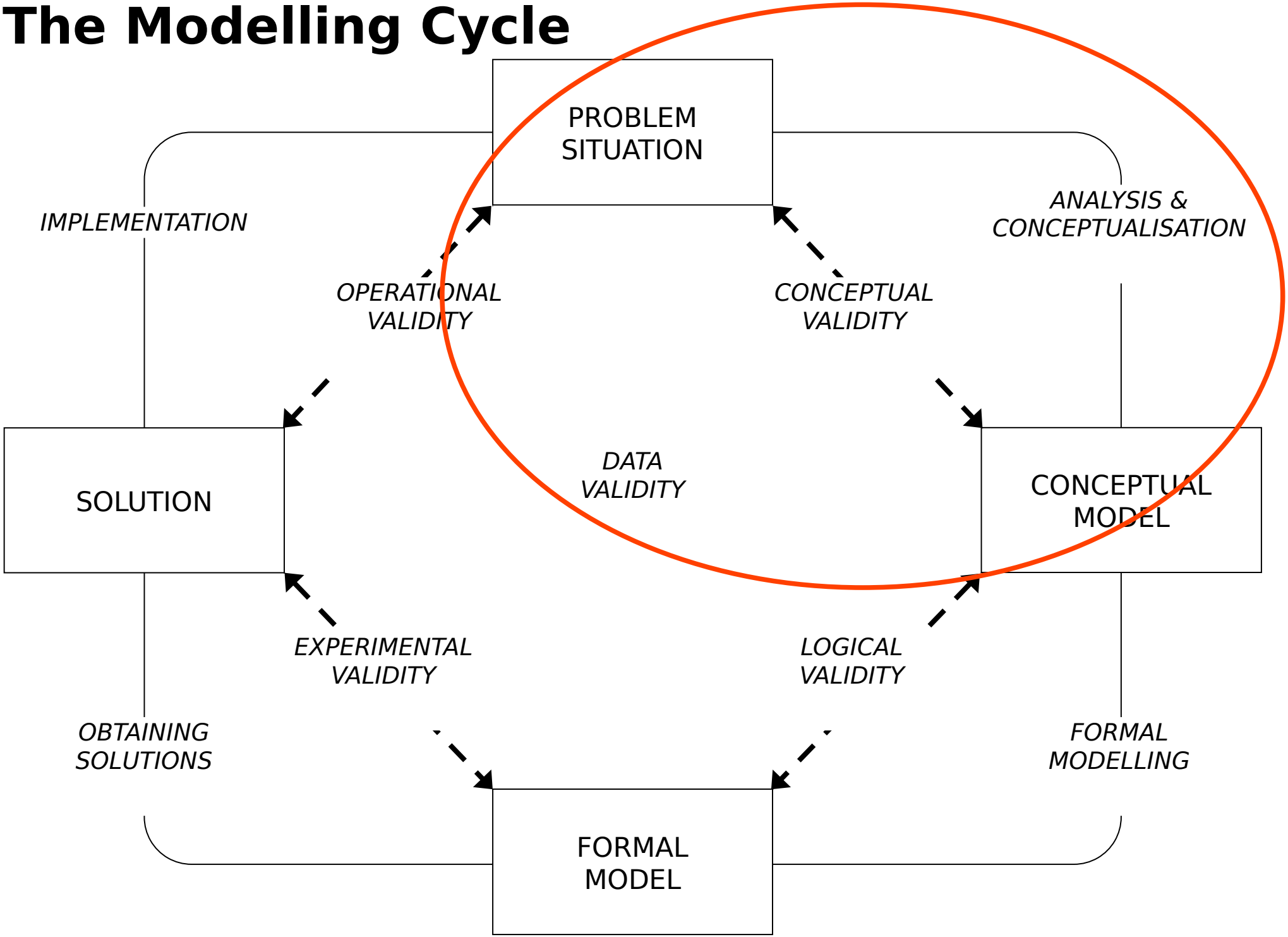
- **Objectivity :** A model can provide objective support for an argument

* assuming the model has been built objectively!

The Modelling Cycle



The Modelling Cycle



Objectives of the Model

- What are you trying to achieve / why are you building the model?

Problem Statement	"What if?" Question(s)	Deliverables	Organisational Impact
There are significant delays in referral to treatment	What if we reorganised the testing priority?	A report outlining the predicted results	More lives saved, targets met




Scope

- What are the boundaries of the system I need to model?

I need to model my ED

But many arrive by ambulance

So should I build a model of ambulance dispatch too?

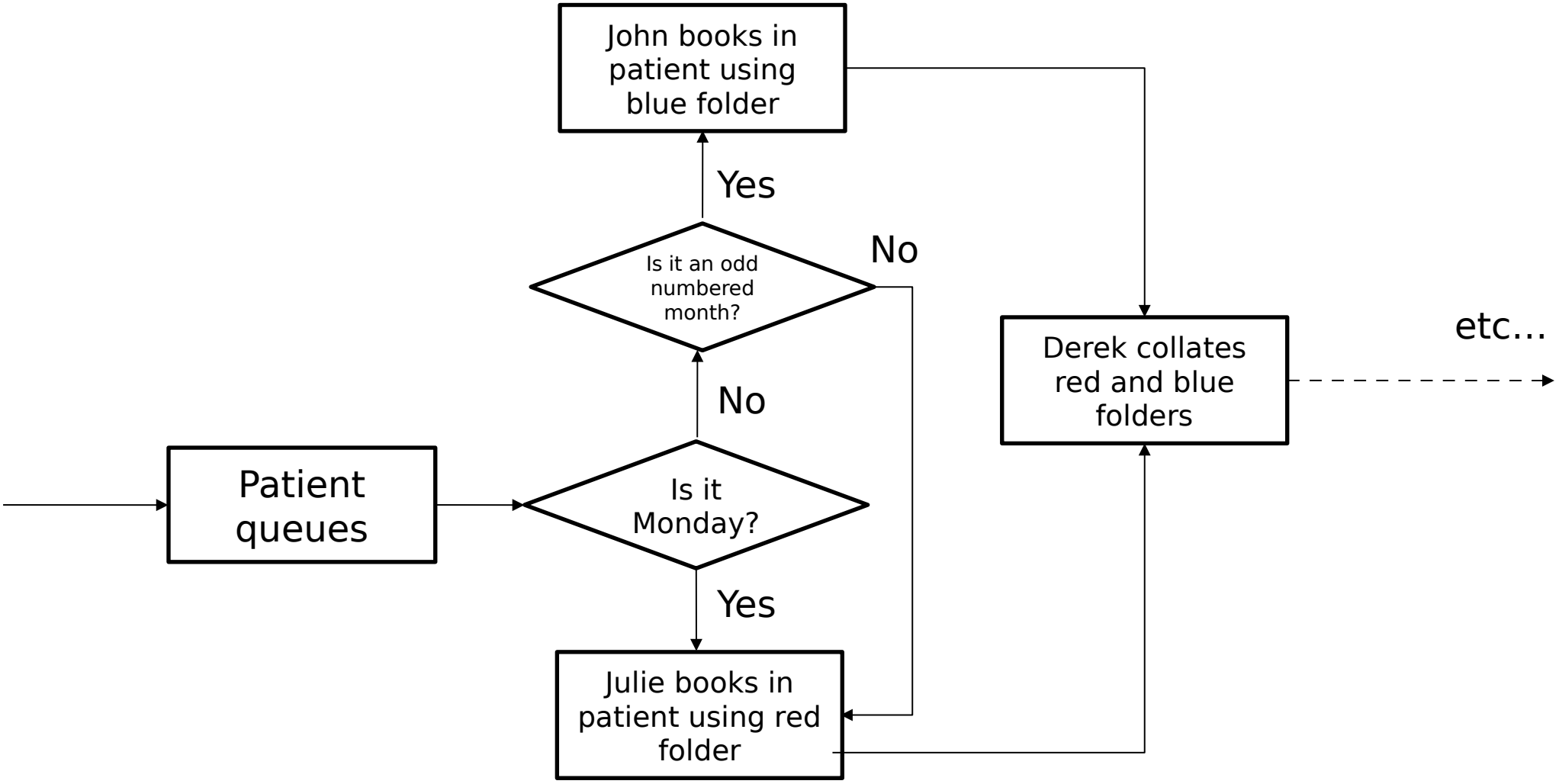
What's the minimum you can model to answer your question?

If I need to model other systems, how can I simplify their representation?

Level of Detail

- How much detail do I need to put into the model?

LOW-LEVEL



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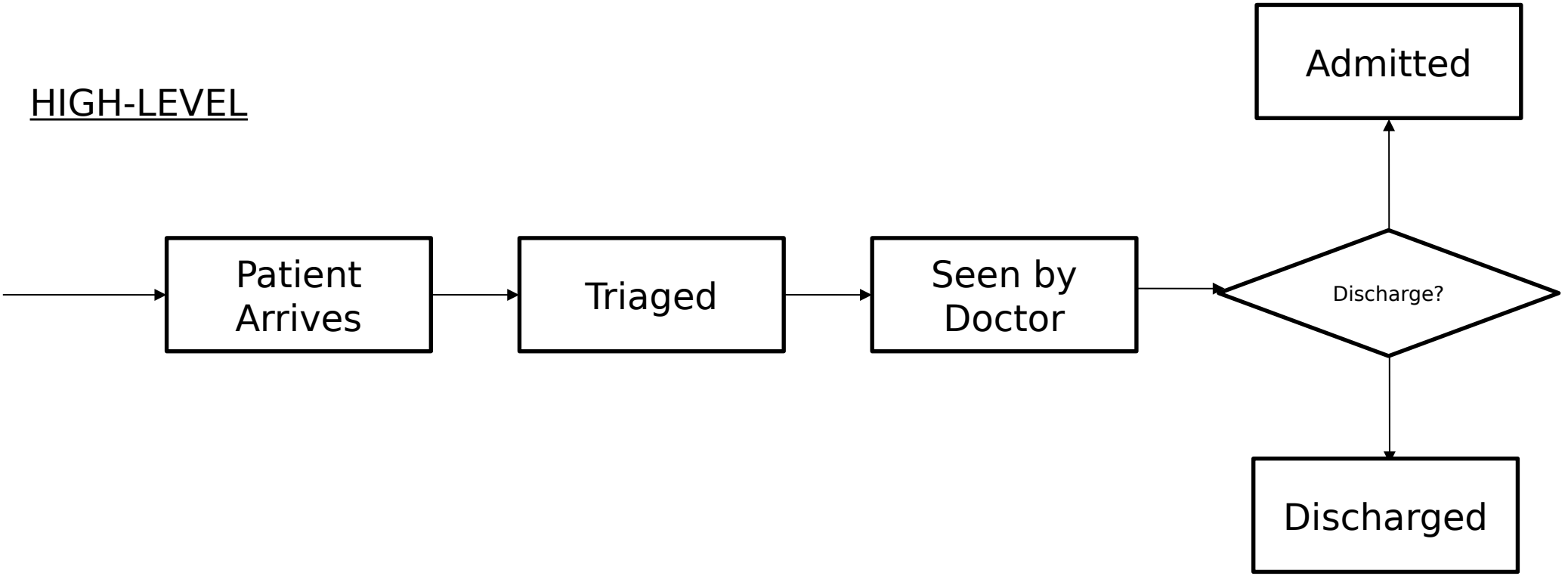

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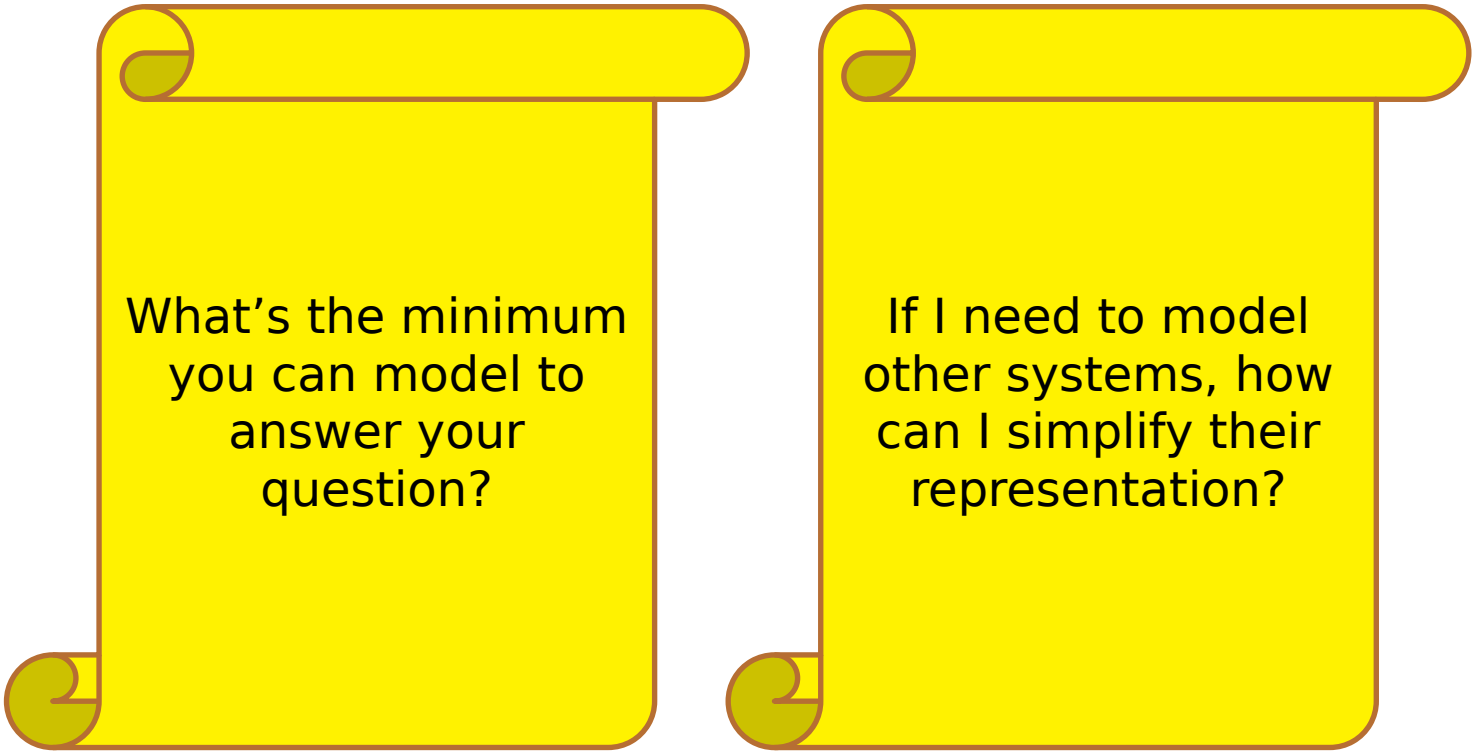


Assumptions and Simplifications

- Assumptions are things that we must assume because we don’t / can’t know their real world properties
  - We assume that the data we’ve got is representative
  - We assume there are no travel times within the clinic for staff or patients (or that they’re trivial)
- Simplifications are things from the real world that we choose to distil down to simpler elements because we anticipate that added complexity does not provide benefit
  - We simplify the triage process into the patient spending an amount of time with the nurse
  - We simplify such that there are no limits to the queuing time for the MIU

What is Discrete Event Simulation?

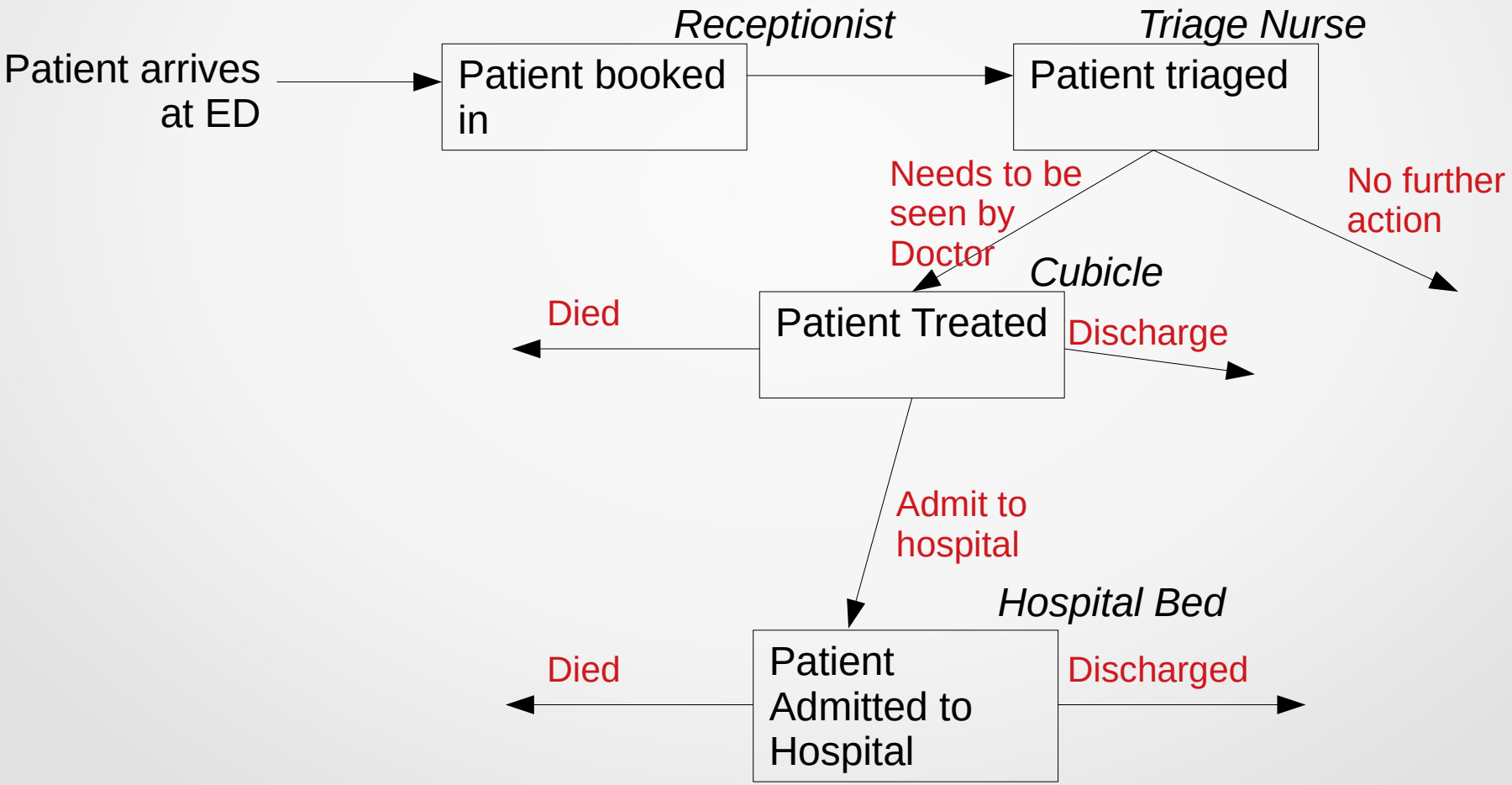
Discrete Event Simulation (DES) is a way of modelling pathways, or more specifically, *queuing problems*.

In a DES, *entities* flow through (and queue for) *discrete sequential processes* that use *resources*.

DES is typically used to model processes and pathways. For example, what happens to patients when they arrive at the Emergency Department.

Therefore, DES is useful for asking “what if?” questions about process / pathway changes.

An Example


Patient arrives at ED
Receptionist
Patient booked in
Triage Nurse
Patient triaged
Needs to be seen by Doctor
No further action
Cubicle
Patient Treated
Died
Discharge
Admit to hospital
Hospital Bed
Patient Admitted to Hospital
Died
Discharged

Components of Discrete Event Simulation

Entities are the things flowing through the sequential processes in the model (e.g. patients, telephone calls, blood test results)

Generators are the way in which entities enter the model and come into being (e.g. brought in by paramedics, self-presenting at the ED)

Inter-arrival Times specify the time between entities being generated (arriving in the model)

Components of Discrete Event Simulation

Activities / Servers represent the activities that happen to entities (e.g. triage, treatment, ward admission)

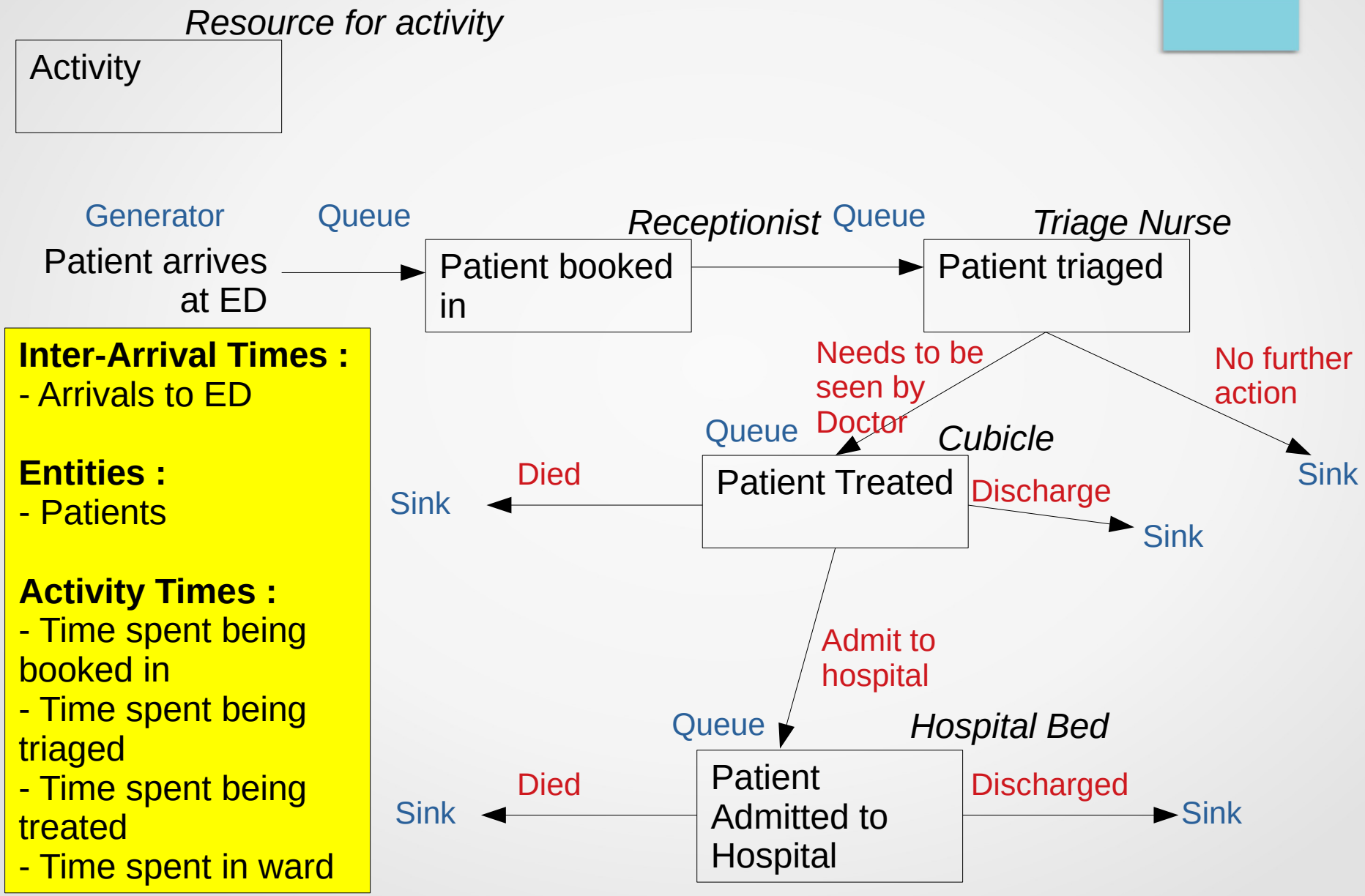
Activity / Server Time represents the amount of time it takes for an activity to happen to an entity.

Resources are required for activities to take place and may be shared between activities (e.g. nurse, doctor, receptionist, bed)

Queues are where entities are held until an activity has capacity and the required resources to begin.

Sinks are how entities leave the model.

An Example



Inter-Arrival Times :
- Arrivals to ED

Entities :
- Patients

Activity Times :
- Time spent being booked in
- Time spent being triaged
- Time spent being treated
- Time spent in ward

Reneging, Balking and Jockeying

Not all queues run “as planned”. We may wish to model behaviours where entities stop waiting, switch queues, or never join the queue in the first place.

Reneging refers to an entity removing themselves from a queue after a certain amount of time has elapsed.

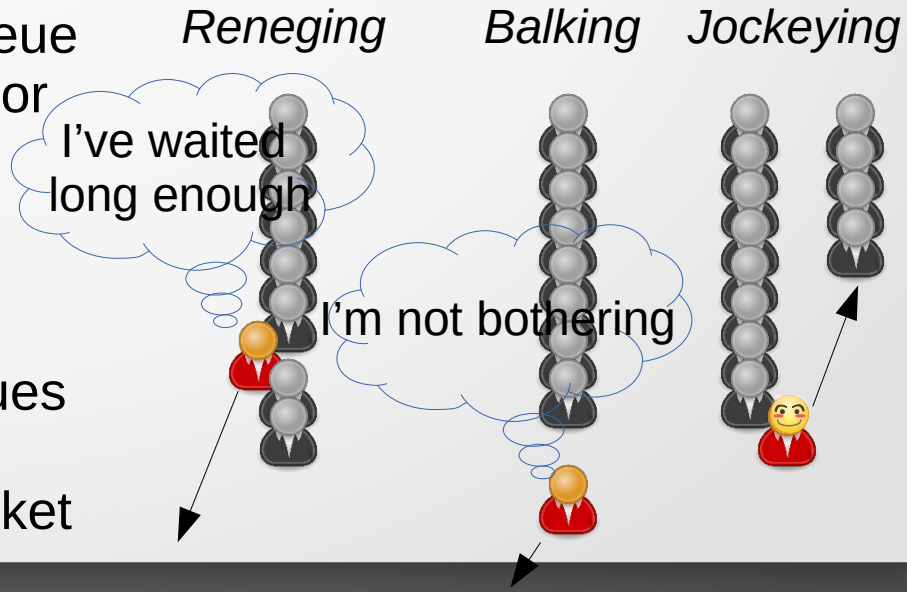
- e.g person not willing to wait any longer
- e.g test sample no longer being viable

Balking refers to an entity not entering a queue in the first place because of the length and / or capacity of the queue.

- e.g person seeing long queue
- e.g no capacity in waiting room

Jockeying refers to an entity switching queues in the hope of reducing queuing time.

- e.g switching till queues at the supermarket



Group Exercise

You will now be split into groups in breakout rooms. In your groups, I want you to :

- come up with some ideas of queuing systems in the real world. These might be work-related but they don't have to be – think about other queuing systems you encounter in the wider world too
- select one of these systems, and come up with one or more "what if?" questions you might want a model of that system to address
- draw up a design for a Discrete Event Simulation of your chosen system that you would build to answer your "what if?" questions. Consider the scope and level of detail of your model design. Your model design should include :
    - a drawing of the generators, processes, flows, queues, resources and sinks that you would model
    - a list of the inter-arrival times, entities and activity times that would be captured by your model

You have **35 minutes**. At the end of the exercise, your group may be asked to present what you came up with, so please ensure that your group nominates someone to do this.