G54SOD (Spring 2018)

Workshop 03

DES Conceptual Modelling Exercise + Data and Information

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Motivation

- Test your conceptual modelling skills
- Learn about data and information
- Test your knowledge about data gathering

DES Conceptual Modelling Exercise

DES Conceptual Modelling Exercise

- Case Study: Fast-Food Restaurant: (Robinson 2004)
  - A fast-food restaurant is experiencing problems with one of its branches in its network. Customers regularly complain about the length of time they have to queue at the service counters.
  - It is apparent that this is not the result of shortages in food, but a shortage of service personnel.

DES Conceptual Modelling Exercise

- Case Study: Fast-Food Restaurant
  - Objective(s)
  - Constraint(s)

DES Conceptual Modelling Exercise

- Case Study: Fast-Food Restaurant
  - Objective(s):
    - The number of service staff required during each period of the day to ensure that 95% of customers queue for less than 3 minutes for service.
  - Constraint(s):
    - Due to space constraints, a maximum of six service staff can be employed at any one time.

DES Conceptual Modelling Exercise

- Case Study: Fast-Food Restaurant
  - Objective(s):
    - The number of service staff required during each period of the day to ensure that 95% of customers queue for less than 3 minutes for service.
  - Constraint(s):
    - Due to space constraints, a maximum of six service staff can be employed at any one time.
  - Experimental factor(s)?
  - Response(s)?

DES Conceptual Modelling Exercise

- Case Study: Fast-Food Restaurant
  - Objective(s):
    - The number of service staff required during each period of the day to ensure that 95% of customers queue for less than 3 minutes for service.
  - Constraint(s):
    - Due to space constraints, a maximum of six service staff can be employed at any one time.
  - Experimental factor(s):
    - Staff roster
  - Response(s):
    - % of customers queuing for less than 3 minutes
    - Histogram of waiting time for each customer in the queue
    - Time series of mean queue size by hour
    - Staff utilisation

DES Conceptual Modelling Exercise

- Case Study: Fast-Food Restaurant

Model Scope	Detail	Decision	Justification
Customers		Include	Flow through service process
Staff	Service		
	Food preparation		
	Cleaning		
Queue at service counter			
Tables			
Kitchen			

Model Level of Detail	Detail	Decision	Comments (Details)
Customers	Inter-arrival time	Include	Distribution
	Size of order		
Service staff	Service time		
	Staff rosters		
	Absenteeism		
Queues	Queuing		
	Capacity		
	Queue behaviour	-	-
	- jockey, balk, leave		
	- join shortest queue		

DES Conceptual Modelling Exercise

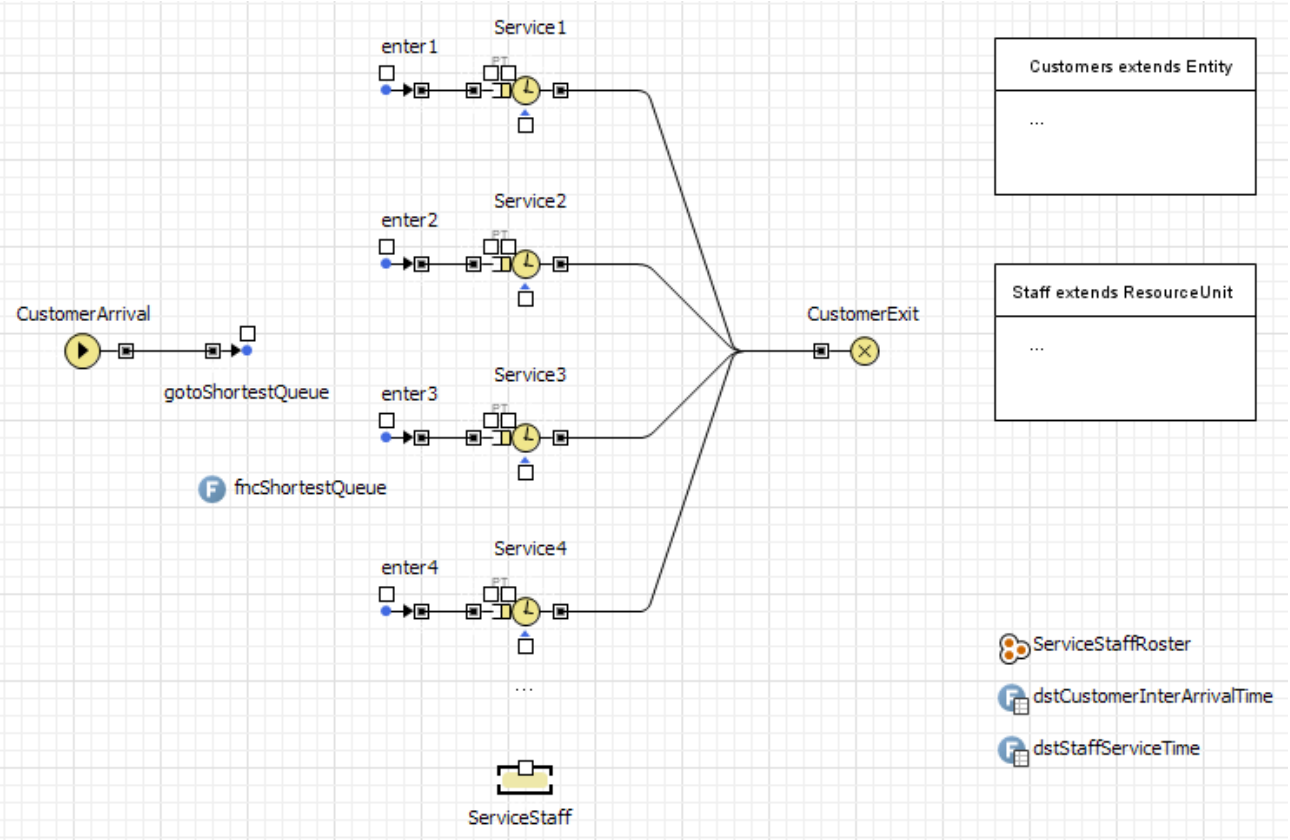
- Case Study: Fast-Food Restaurant

Model Scope	Detail	Decision	Justification
Customers		Include	Flow through service process
Staff	Service	Include	Required for response
	Food preparation	Exclude	Material shortage not significant
	Cleaning	Exclude	Not related to speed of service
Queue at service counter		Include	Required for response
Tables		Exclude	Not related to customers waiting
Kitchen		Exclude	Material shortage not significant

Model Level of Detail	Detail	Decision	Comments (Details)
Customers	Inter-arrival time	Include	Distribution
	Size of order	Exclude	Represented in service time
Service staff	Service time	Include	Distribution
	Staff rosters	Include	Experimental factor
	Absenteeism	Exclude	Could be represented in staff rosters
Queues	Queuing	Include	Required for responses
	Capacity	Exclude	Assumption: unlimited
	Queue behaviour	-	-
	- jockey, balk, leave	Exclude	Not well understood
	- join shortest queue	Include	Well understood

DES Conceptual Modelling Exercise

- Case Study: Fast-Food Restaurant



Data and Information

Introductory Remark

- In this lecture we will focus on DES Input Modelling
  - Robinson (2004) Chapter 2 and 7

- More about SD Input Modelling
  - Luna-Reyes and Andersen (2003)
- More about ABS Input Modelling
  - Janssen and Ostrom (2006)

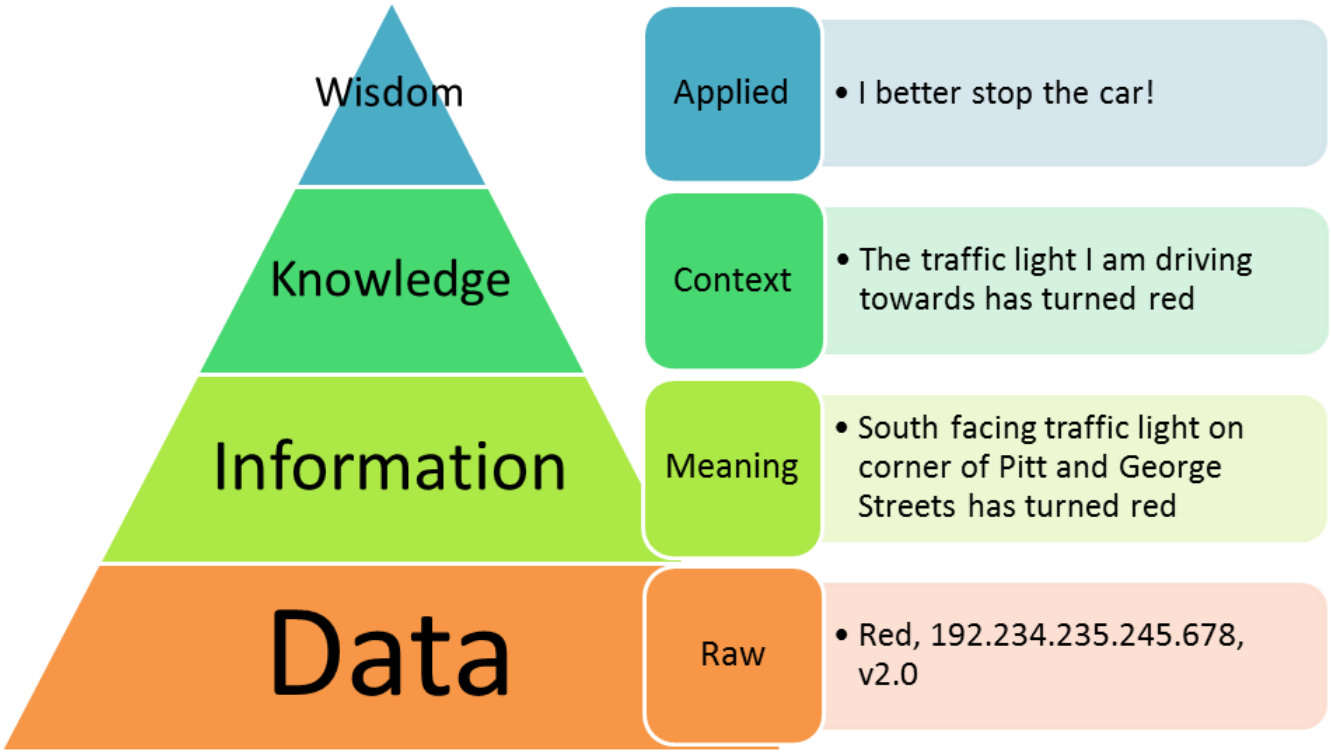
- Answers to the Top Ten Input Modeling Questions
  - Biller and Nelson (2002)

Data and Information

- Data vs. Information
  - Data
    - Quantitative: numeric data
      - e.g. cycle (service) times, breakdown frequencies, arrival patterns
    - Qualitative: non-numeric facts or believes
      - e.g. drawings of layouts, routing of automated guided vehicles, queuing behaviour
  - Information
    - Analysed data
      - e.g. standard time (cycle time including allowances for breaks, skill level and process inefficiency), fitted statistical distributions

Data and Information

- From Data to Wisdom [http://www.allthingy.com/data-information-knowledge-wisdom/]



Data and Information

- Data requirements:
  - ***Preliminary or contextual data:*** Required for understanding the problem situation and for conceptual modelling
    - e.g. basic layout, believes about the cause of the problem
  - ***Data for model realisation:*** Directly identified from conceptual model
    - Deterministic data that have known and unchanging values
      - e.g. number of servers
    - Stochastic data that vary in an uncontrolled way (not completely!)
      - e.g. cycle times, machine break down patterns, customer arrival patterns, descriptions of customer types, scheduling and processing rules
  - ***Data for model validation:*** Used to ensure that every part of the model and the model as a whole is representing the real world system with sufficient accuracy

Data and Information

- Case Study: Fast-Food Restaurant
  - ***Plot:*** A fast-food restaurant is experiencing problems with one of its branches in its network. Customers regularly complain about the length of time they have to queue at the service counters.
  - ***Objective:*** Identify the number of service staff required during each period of the day to ensure that 95% of customers queue for less than 3 minutes for service.
  - ***Constraint:*** Due to space constraints, a maximum of six service staff can be employed at any one time.

Data and Information

- Case Study: Fast-Food Restaurant
  - Data Requirements
    - Preliminary or contextual data:
      - Believes about the cause of the problem
      - Service standard requirements
      - Space restrictions
    - Data for model realisation:
      - Customer arrival rates (distribution)
      - Staff service times (distribution)
      - Staff rosters (table)
    - Data for model validation:
      - Proportion of customers queuing for less than 3 minutes
      - Waiting time for each customer
      - Staff utilisation

Data and Information

- Obtaining data
  - Data needs to be ***sufficiently accurate*** and ***in the right format*** for the simulation model (more later)
  - Three categories of data:
    - Category A: ***Available***
      - Data is known or has been collected before
    - Category B: ***Not available*** but ***collectable***
      - Putting a data collection exercise in place by either getting people or electronic systems to monitor the operations
    - Category C: ***Not available*** and ***not collectable***
      - Often occurs because the real world system does not yet exist or due to time limitation to collect meaningful data

Data and Information

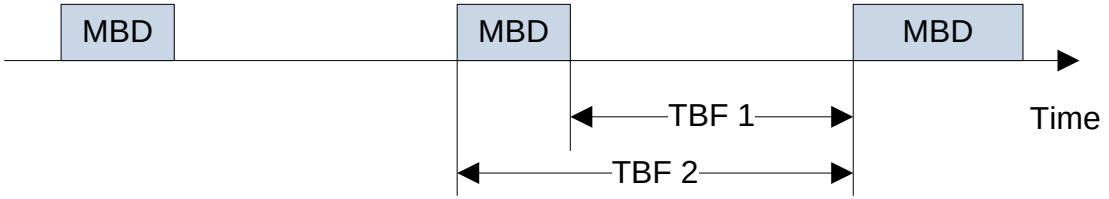
- Dealing with unobtainable Category C data
  - Estimate data
    - Use data from similar system for your estimates; using standard times; discuss with stakeholders; intelligent guess
  - Treat data as experimental factors
    - Instead of asking what the data are it is asked what do the data need to be (can only be applied when there is some control over the data in question)
  - Revise the conceptual model
  - Change the modelling objectives
  - Abandon the simulation study

Data and Information

- Dealing with unobtainable Category C data (cont.)
  - Validity and credibility issues
    - Estimates need to be clearly identified in an assumption list
    - Sensitivity analysis should be performed on these data
    - Data might become available as project progresses

Data

- Data format
  - Information is often not in the right format for the simulation
    - e.g. time study data are aggregated to determine standard times for activities; in simulation the individual elements (e.g. breaks and process inefficiencies) are modelled separately
  - Important to know how the input data is interpreted by the simulation software



MBD = machine breakdown
TBF = time between failures

Small Group Activity

- You are hired by a furniture production company to optimise their sofa production line (this is a predominantly manual assembly line). For this task you are planning to use simulation.
  - What kind of data should you gather for your simulation model? Provide two examples for each data category (A; B; C) and briefly state which category the data belongs to (and why) and how you could gather the data

Small Group Activity

- Some examples
  - ***Factory layout plan (category A)***: Updated whenever there are changes to the factory layout (e.g. position of production facilities); plans are usually available even if the factory does not exist yet
  - ***Productivity data (category A)***: Usually collected hourly and displayed somewhere in the factory to motivate staff (using electronic counters); if the factory exist historic data should be available

Small Group Activity

- Some examples
  - ***Cycle times (category B)***: time it takes to work on one sofa; collect data by using event loggers that record when a sofa arrives and when it leaves a work station; then you have to analyse the collected data
  - ***Machine breakdowns (category B)***: Can be measured when the maintenance crew has to get out to repair a machine; they could use a log that shows the start and end time of fixing the machine (one can then calculate the mean time between failures)

Small Group Activity

- Some examples
  - ***Future order arrivals (category C)***: Real system does not exist yet; one could use historic data (although this might not reflect the future; also there might not be any historic data available) or make this an experimental variable to test if the system can cope with various arrival rates
  - ***Poor data on machine failure (category C)***: Real system does not exist yet or does not exist for long enough to collect reliable breakdown data; try to collect data from a factory that uses the machine for a similar purpose or use the manufacturer guidelines

Questions / Comments

References

- Biller B and Nelson BL (2002). Answers to the Top Ten Input Modeling Questions. In: Proceedings of the 2002 Winter Simulation Conference, San Diego, California, USA
- Janssen MA and Ostrom E (2006). Empirically based, agent-based models. Ecology and Society 11(2): 37
- Luna-Reyes LF and Andersen DL (2003). Collecting and Analyzing Qualitative Data for System Dynamics: Methods and Models. System Dynamics Review 19(4) pp.271–296
- Robinson S (2004). Simulation: The Practice of Model Development and Use. John Wiley & Sons: Chichester, UK