MISG 2019 Graduate Modelling Camp

On-line auctions

J. W. Sanders

AIMS South Africa

Contents

1. The problem

The importance of on-line commerce (and government).

Can we design an **on-line auction** to incorporate interesting features whilst maintaining required behaviour?

Early attempts: `eBay` and `Gumtree`.

Privacy? Accountability?
Distribution?
Using Data Analytics to benefit from market data?

2. Characteristics

What characterises a typical MISG problem?

How this problem is similar; and different.

What is required: a *design*; its correctness and efficiency.

What is not required: an *implementation*, tested by cases.

The maths is *pure*, *discrete* and perhaps unfamiliar.

3. Steps

1. Survey types of auction, in order to appreciate the range of potential behaviours/protocols.
   Examples: English, Dutch, Sealed-bid, Vickrey.
2. Consider the features and functionality desired of an on-line auction, including those not possible in a standard auction. Avoid undesirable features where possible.
   Privacy? Accountability? Collusion between bidders?
   Can Data Analytics be used to improve the profile of sales?
3. Design a system which incorporates the desired features.
4. Finally prove the chosen auction design behaves as desired.

Concerns

1. Modelling: how to *abstract* (deciding what is 'observable').

2. What *new* possibilities does *on-line* offer?

3. What features does *distribution* require?

4. Exploiting *data analytics*?

4. Design . . .

What are the *requirements* of an on-line auction?

Treat it as a black box to describe its behaviour, not its construction. Decide and express *what* it does, ignoring the mechanism which decides *how*. Our system is *specified* by its

- functionality

  (how do bids work?)

- extra features

  (privacy, anonymity, authentifiability, Data Analytics, . . .) .

. . . techniques

- Distinguishing between centralised and distributed designs.
  Invariant properties.
- Describing an interactive design.
  Modularity.
  Information flow by shared variables or message passing.
- Accessing (big) data security.
  Public key encryption. Digital signatures.
- Mathematical notation.
  Z formalism.

Example: bidding

For simplicity assume: a standard English auction with a single item for sale, a reserve price, and increasing bids.

Bid

$$\Delta State(\ldots currentbidder, currentbid, \ldots)$$
$$bidder? : \mathbb{U}$$
$$bid? : \mathbb{R}$$

$$bid? > currentbid$$
$$currentbid' = bid?$$
$$currentbidder' = bidder?$$

The *invariant* of *State* ensures *bids* are increasing.

5. References

1. Chapter 9, Auctions, in
   Networks, Crowds and Markets: Reasoning about a Highly Connected World.
   D. Easley and J. Kleinberg. CUP, 2010.
   www.cs.cornell.edu/home/kleinber/networks-book/

2. *Mathematical Underpinning of Analytics: Theory and Applications.*
   P. Grindrod, OUP, 2015.
   resituatq.firebaseapp.co/aa588/.../0198725094.pdf

3. *The Z Notation: A Reference Manual.*
   J. M. Spivey, Prentice-Hall, 2001.
   onlinebooks.library.upenn.edu/webbin/book/lookupid?key=olbp69629