The occam-π "Better Bar" Simulation

and how it all works

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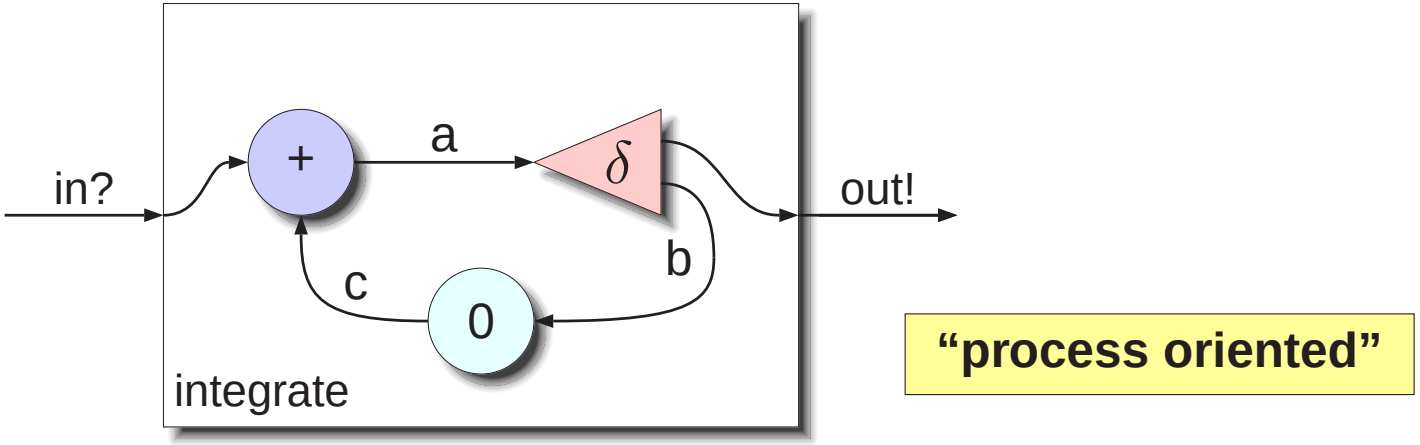
The Communicating Processes Paradigm

- Systems are built from layered networks of communicating parallel processes

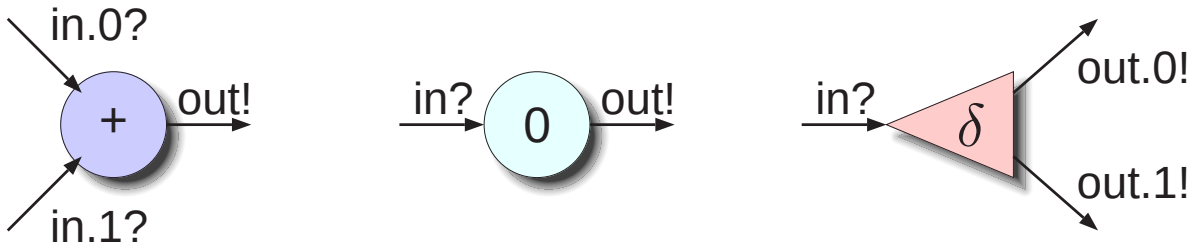


“process oriented”

- Synchronous point-to-point communication via ‘channels’
- The three sub-components here are ‘plus’, ‘prefix’ and ‘delta’
  - that could also be parallel process networks
- Implementation in occam-π; semantics from Hoare’s CSP and Milner’s π-calculus — mathematics

The Communicating Processes Paradigm

- Individual processes are completely isolated;
  - interacting with the environment only through channels visible in their interfaces



- The synchronous nature of channel communication means that different implementations may behave differently with respect to their environment.
- Formal methods (CSP) permit reasoning about these behaviours.

$$\text{DELTA} = in?x \rightarrow (out.0!x \;|||\; out.1!x) \;;\; \text{DELTA}$$

- See books by Tony Hoare and Bill Roscoe for more..

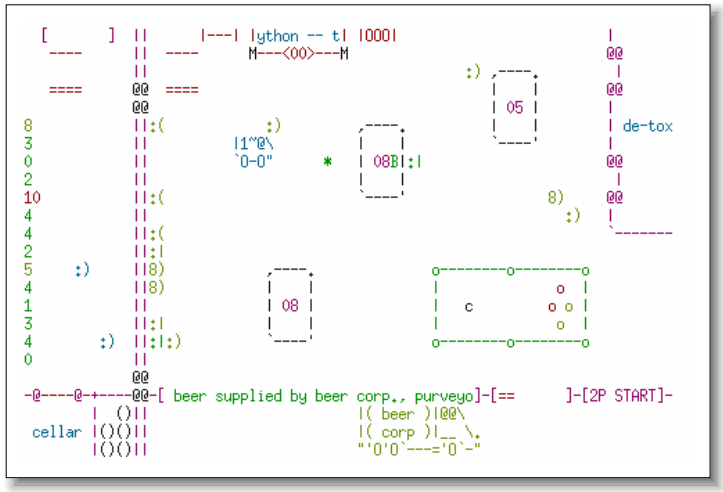
The occam-π Programming Language

- A highly concurrent programming language, derived from classical **occam**
  - can build systems containing millions of communicating parallel processes
  - context-switch time (to switch the CPU from one process to another) in the order of 50 nanoseconds (2.4 GHz P4)
  - mobile channel types, mobile processes, process priority, shared channels, extended synchronisations, dynamic process creation, ...
  - guaranteed freedom from aliasing and race-hazard error
- On-going development of the language and its applications at Kent
  - to educational ends, breaking the view that concurrency is hard and providing a robust software engineering methodology
  - building internet servers (e.g. the occam-π web-server)
  - building highly-concurrent and scalable operating-systems

`http://www.cs.kent.ac.uk/projects/ofa/kroc/`

The “Better Bar” Simulation

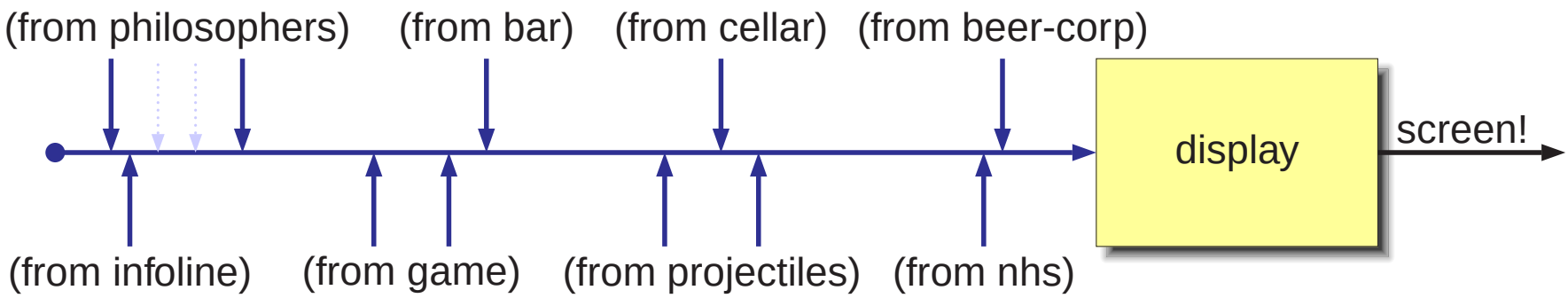
- Originally used to demonstrate fairness (or rather the lack of it – *starvation*)
  - when there are two or more people waiting to be served, whom does the bar-tender choose ?



- Implementation consists of around 100 parallel processes (some come and go)
  - uses a negligible amount of CPU – mostly waiting for timeouts
- Featuring: 14 drinking philosophers, 2 bar-tenders, beer-cellar and supplier, de-tox machine, ambulance service, juke-box, pool-table, teleporter and 2-player ‘shoot-em-up’ philosopher paintball

The “Better Bar” Simulation

- Most central component is the ‘display’ process:



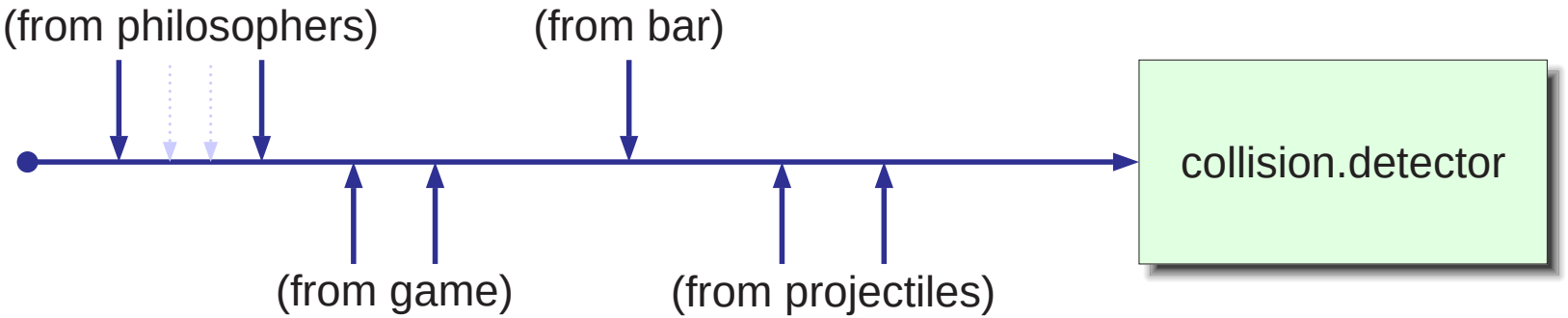
- Processes compete for access to the shared channel, sending *tagged-protocol* messages to draw on the screen:

```
CLAIM to.dpy!
  SEQ
    to.dpy ! colour; ANSI.FG.BLUE
    to.dpy ! string.x.y; 4; 1; "4 pints"
```

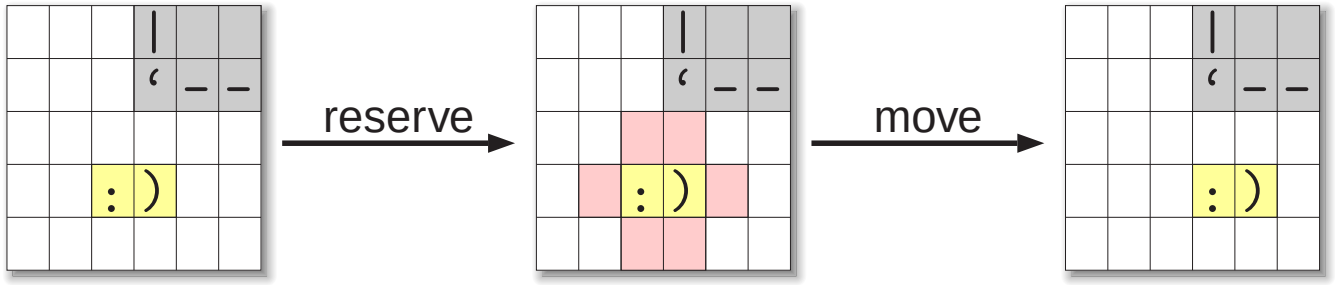
- Adding additional features is trivial :-)

The “Better Bar” Simulation

- Majority of the complexity lies in ensuring objects on the screen avoid each other
  - central ‘collision.detector’ process responsible for this:



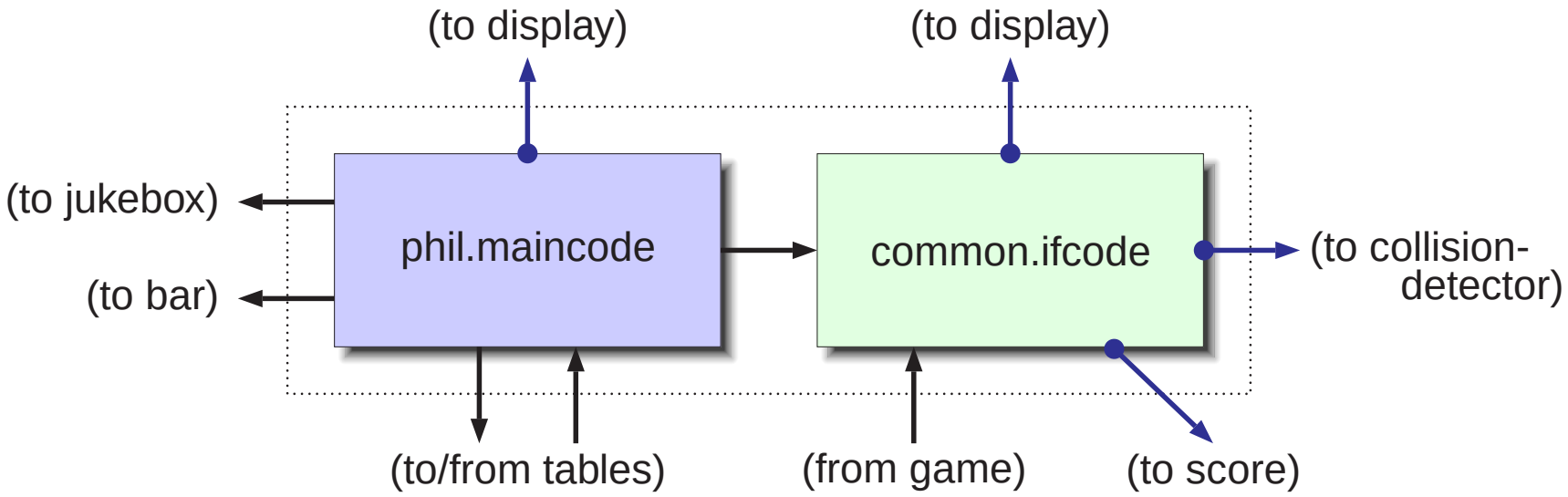
- ‘collision.detector’ maintains a representation of the screen, noting what is where:



- Sprites have ‘buddy’ processes to help them move around

The “Better Bar” Simulation

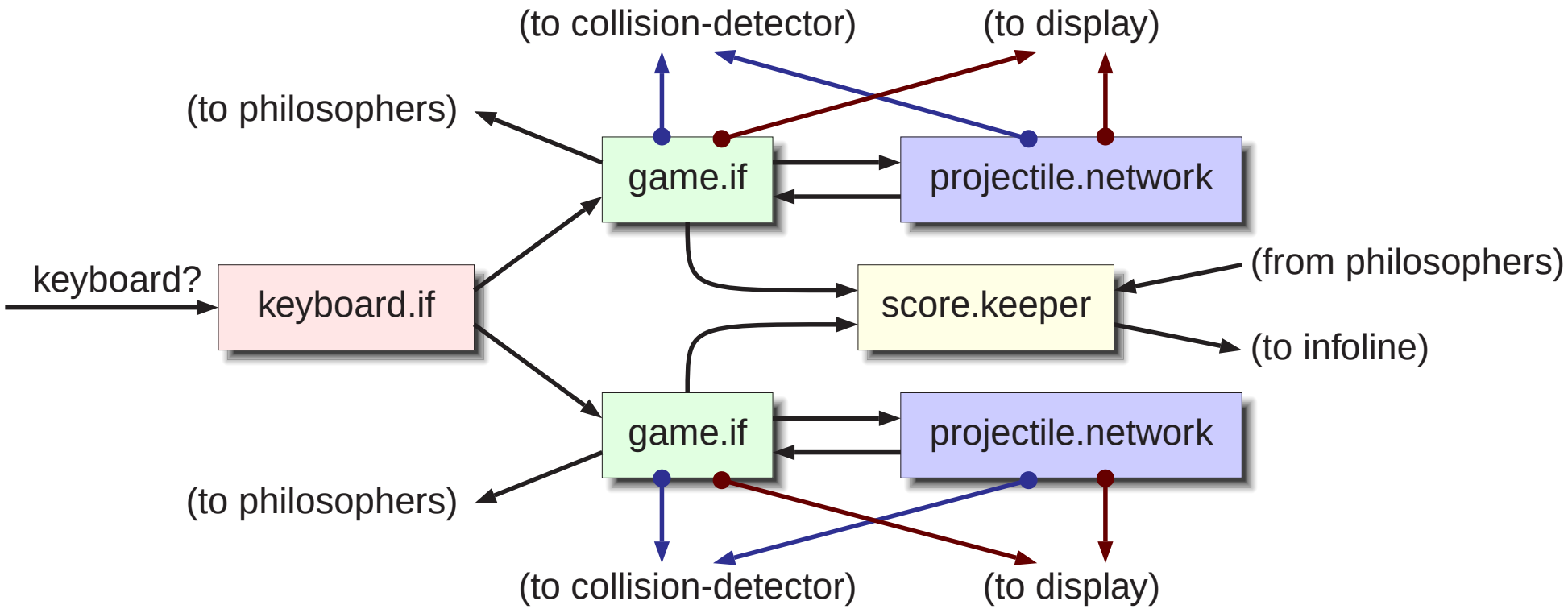
- ‘philosopher’ processes are wired up as follows:



- Moving around avoiding obstacles is handled by ‘common.ifcode’; ‘phil.maincode’ simply does: `out ! move.x.y; cx; cy; tx; ty`
- Being hit by paintballs is handled in ‘common.ifcode’
- Similar process networks used for the bar-tenders

The “Better Bar” Simulation

- Game processes represent the interactive portion:



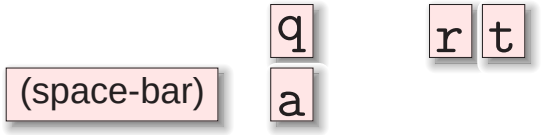
- A relatively complex process network — some care required in programming to prevent deadlock

The “Better Bar” Simulation

- Player 1 keys:

(dot or slash to fire, arrow keys to move)

- Player 2 keys:



(space-bar to fire, q,a = up,down, r,t = left,right)

- Use fire to start
  - objective is to shoot philosophers and turn them your colour (green or red)
  - game ends when nothing has been shot for a certain amount of time (shown at the bottom-right of the screen)

Acknowledgements

- Concurrency research sub-group:
  - Part of the Systems Research Group:

    `http://www.cs.kent.ac.uk/research/groups/sys/`
  - Academic staff:
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    - Adam Sampson, Joseph Sheridan
- More general information on communicating process architectures:

  `http://www.wotug.org/`