COMPUTER ALLOCATION OF CAPACITY

John Lehoczky, a professor of statistics at Carnegie Mellon University, spoke last week to about 100 CMU graduates (and me) about computers and real time systems – data processing that is constantly taking into account new data as it is collected.

SUMMARY

- Computer processing sometimes requires allocation of limited resources – limited by weight and power, for example
- Computer calculation of a static problem with limitless time is different from calculation of a problem which is constantly changing, constantly adding new information
- A computer may needs to know what tasks are time sensitive, how to prioritize use of its time and capacity
- Driverless cars, electric cars and ride-sharing will transform society
- They will reduce deaths, legal claims and make old people more independent
- Programming driverless cars involves ethical questions

DETAILS

Computer processing has timing requirements. Certain problems require a quick response to new input. This involves lots of queuing theory – what information gets processed when? The service provider wants to respond quickly but not wastefully. Non-computer examples are staffing toll booths and call centers. The work capacity should be adequate to meet demand in a reasonable amount of time without letting it go unused. Decisions can be seen as hard deadlines – when failure to respond results in system crashes – and soft deadlines. The key is to distinguish between the two (and degrees of "crash" consequences) and to meet the hard deadlines.

Computers have weight and power constraints. For each pound of motherboard a computer needs four pounds of cooling and electrical capacity. So, assuming weight is a factor, a computer cannot have excess capacity. A computer can react very quickly if it has unlimited capacity.

Professor Lehoczky gave two examples of the queuing problem, a Mars rover and self-driving cars.

MARS ROVER – One of the Mars rovers was very important for NASA because if came shortly after a major failure. [I forget which one.] The initial success was trumpeted by NASA and the press as a (new) sign of NASA's competency. However, shortly after it landed and sent back pictures, its systems crashed repeatedly. The press turned against NASA. The problem was that multiple computer systems were running at the same time and got in the way of each other. This is the problem of queuing. A paper had been published about 10 years earlier with the solution, so the solution was clear. But the problem of overriding the operating system from earth was the problem.

NASA went to all its software vendors, including Wind River, now part of Intel. Wind River knew the problem and had included the needed protocol in the rover, but someone switched the protocol to "off" when the rover was launched. [My notes leave a gap here, but I think the story had a "happy ending" and the switch could be flipped to "on" from earth, thereby saving the mission.]

DRIVERLESS CARS

Driverless cars, electric cars and car-sharing will transform transportation. Aspects of these developments include: fewer accidents and traffic deaths (and reduced financial loss, legal actions, insurance costs), reduced commuting delays, greater productivity and renewed independence for older people (particularly important as much of the world's population ages).

Driverless features can be divided into 6 levels –

0 – no automation	1 – cruise control	2 – parallel parking, stopping and lane drifting
3 – drive itself some time	4 – drive itself mostly	5 – replace driver completely

Current problems include forward looking cameras which get blinded by the sun, legal liability – which varies from state to state, traffic signs and interconnectedness between signs and cars.

As with all new technology, there will be disruptions, particularly with truck drivers. Regulations are inevitable and they tend to limit innovation. What levels of real time support will Google and Uber provide car owners at what cost? Driverless cars are programmed to be very conservative. Pedestrians have figured this out and "play" with the cars at cross-walks, jumping out in front of cars to make them stop and start and ……

Separately, a friend of mine who works for Google in Berlin noted that the programming of these cars involves ethical judgments, particularly in situations involving accidents. Can the car distinguish between a dog and a child? Can it sacrifice the life of a pedestrian to save the driver?

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