Asynchronous, parallel computations for complex simulation tasks in ROOT

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ROOT Users' Workshop 2018

Introduction (1/2)

- Jochen Kerdels
  - Computer Scientist
  - Current position:

    PostDoc working for Prof. Gabriele Peters
    Chair of Human-Computer Interaction
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- Research Interests
  - Current focus: modeling of neural structures
  - Machine Learning $\leftrightarrow$ Neuroscience
  - Robotics
  - Philosophy of Mind

Introduction (2/2)

Computational modeling of neural structures

- entorhinal grid cells
- cortical columns

Focus on understanding the computational principles

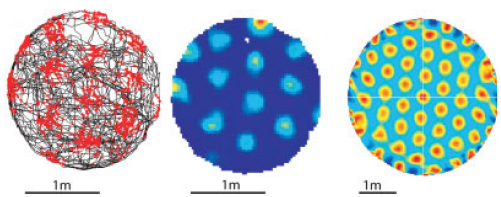


Figure from Moser et al. [2].

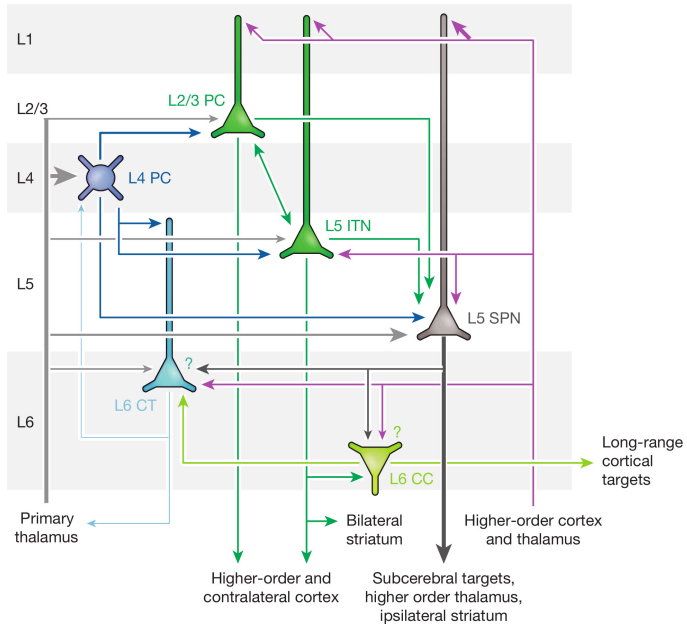


Figure from Harris and Mrsic-Flogel [1].

Simulation challenges

Large amounts of log & state data $\rightarrow$ ROOT

Neural structures in the brain are highly parallel and recurrent.

Synchronized, global time in a simulation leads to a bottleneck at each time step $\rightarrow$ Amdahl's law:

$$\lim_{r \to \infty} S(r) = \frac{1}{1 - p},$$

with p the fraction of the program that can be parallized.

Amdahl's law

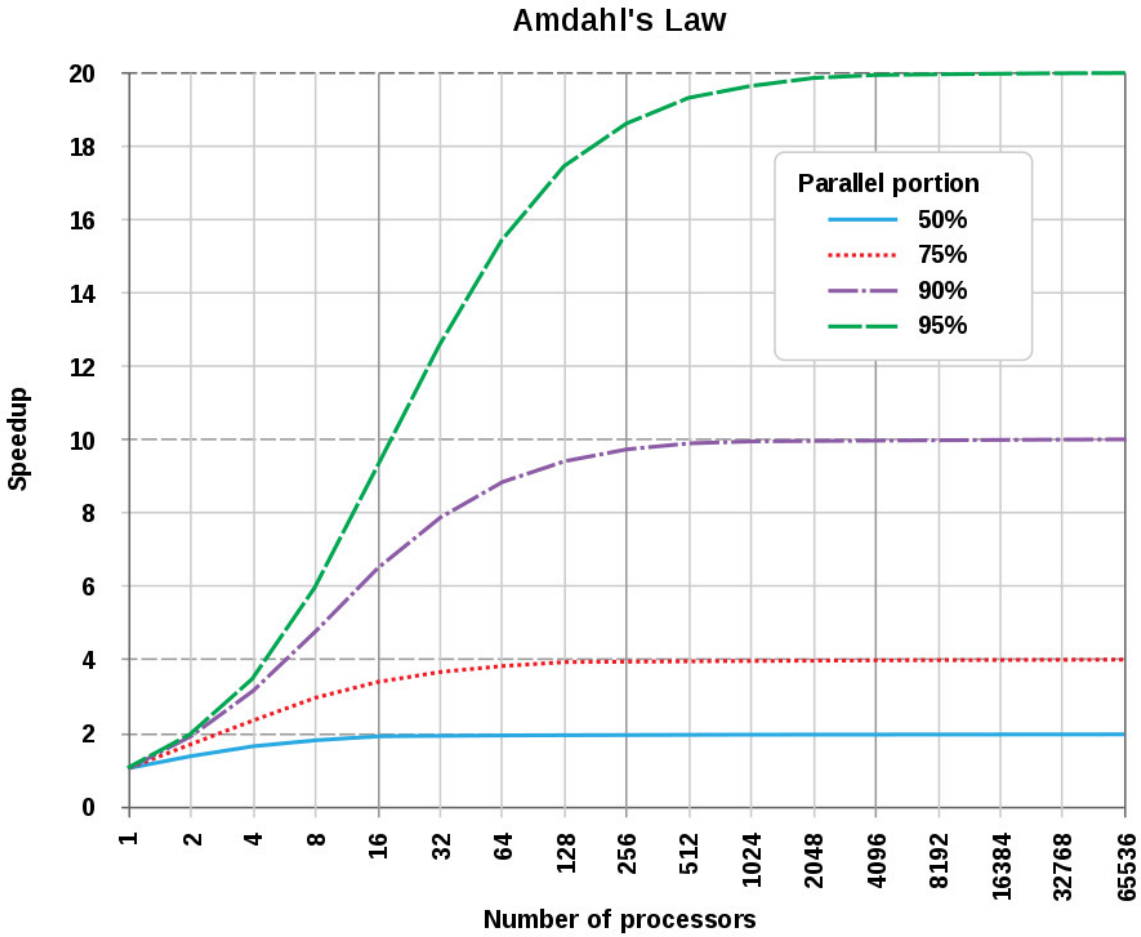
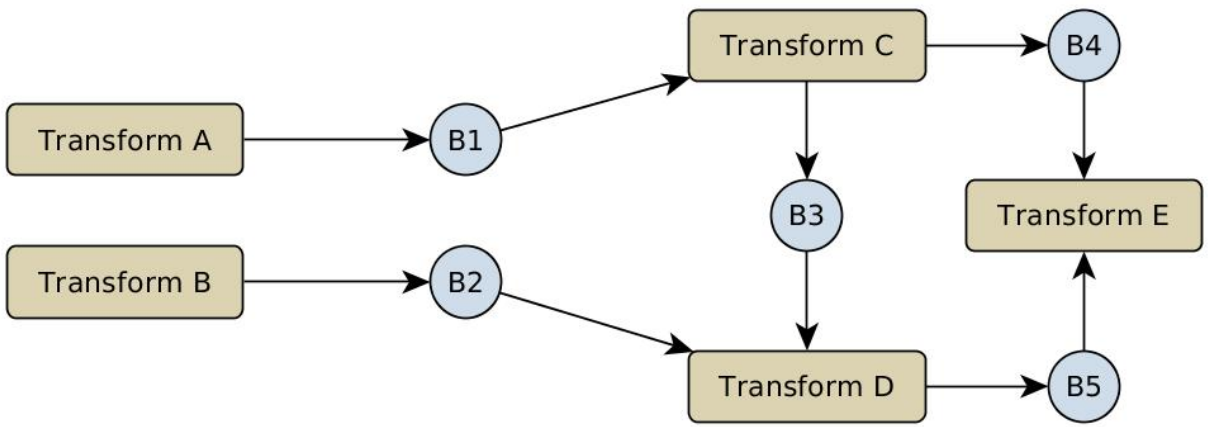


Figure by Daniels220 at English Wikipedia, CC BY-SA 3.0 .

Local Synchronization

Describing the simulation as **set of transforms** that communicate via **individual buffers**.



Properties

lock-free since a buffer is either read from or written to by only one transform at a time

self-timed, no global clock

the set of transforms and buffers can be modified during runtime

trade-offs:

- lock-freeness payed for by increased memory usage
- choice of transform granularity influences performance (caching!)
- lack of global time makes analysis more demanding

ROOT wish list

serialization of large memory structures (>2GB)

increased performance when storing many small objects
(current workaround: A streamable version of TBufferFile)

Thank you for your attention.

References I

[1] Kenneth D. Harris and Thomas D. Mrsic-Flogel.
Cortical connectivity and sensory coding.
Nature, 503:51, November 2013.

[2] Edvard I. Moser and May-Britt Moser.
A metric for space.
Hippocampus, 18(12):1142–1156, 2008.