MiX99

Solving Large Mixed Model Equations

MTT

Trends in computing environments

Matti Taskinen, MTT

4.12.2014 MiX99 Workshop, Tuusula, Finland

Overview

- MiX99 has beed in development for about 15 years now.
- How MiX99 is going to look like after next 15 years?
  - Hardware
  - Software
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- Target hardware:
  - CPU: Intel/AMD 64-bit x86
  - Memory: 1-20 GB
  - Data storage:
    - (Spinning) hard drives
    - 100-200 MB/s speed
    - Space: 10-1000 gigabytes (limited partially by speed)
    - IOD (Iteration On Data) needs large memory or fast data storage
- Software:
  - Programming language: Fortran 90
  - Software libraries:
    - Home-made routines
    - Some use of BLAS/Linpack/Lapack/Eispack
  - Parallel computing:
    - Separate MPI version of the solver
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- CPU “speed” has been increasing steadily
- Intel/AMD x86 seem to have won the race as general purpose CPU
- CPU frequencies does not seem to be increasing
- Other optimizations still making CPUs faster
- Number of processing units (multi-core) is increasing
  - Commonly: 4-12 cores
- “Special purpose” processing units exploit parallelism:
  - GPU / Cell / Xeon Phi
  - Up to thousands of cores
  - Order of magnitude “faster” (theoretically)
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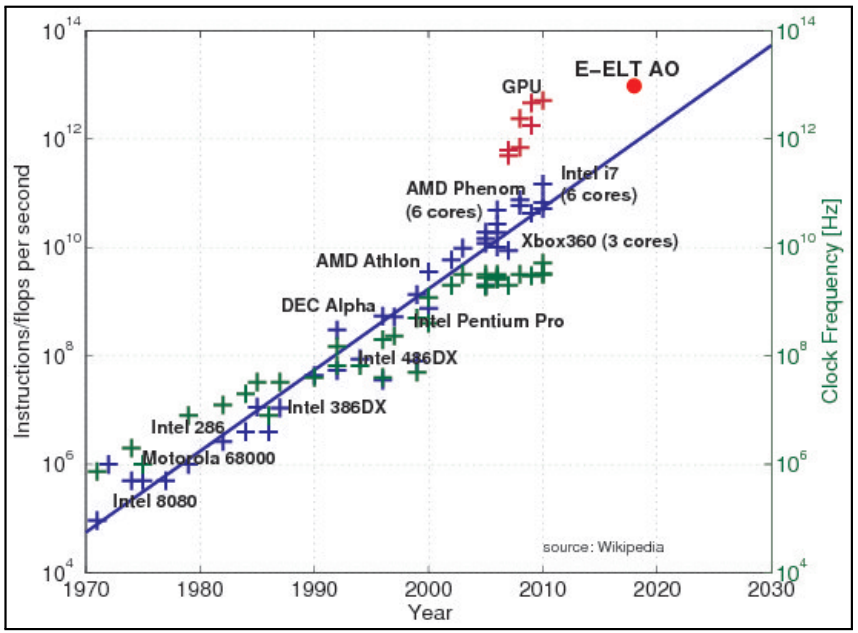

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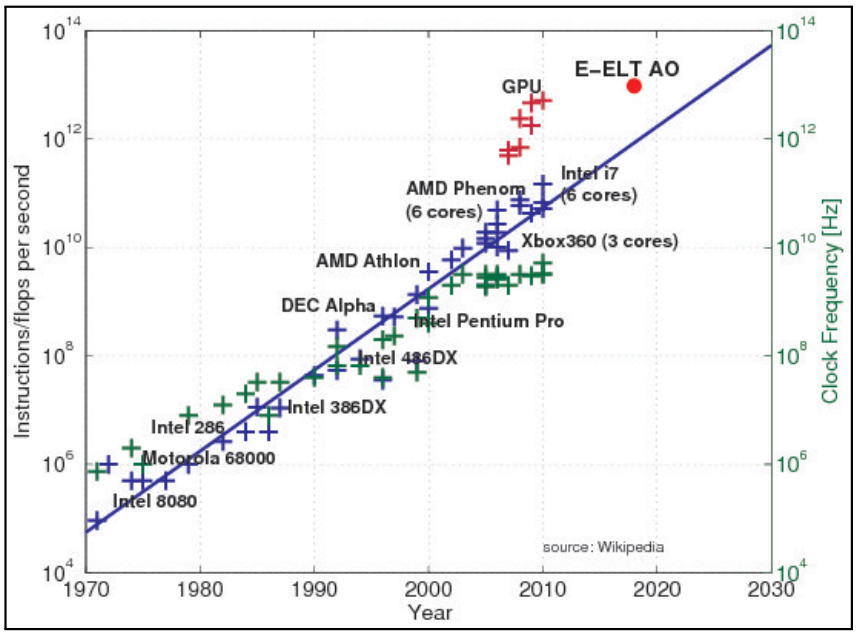

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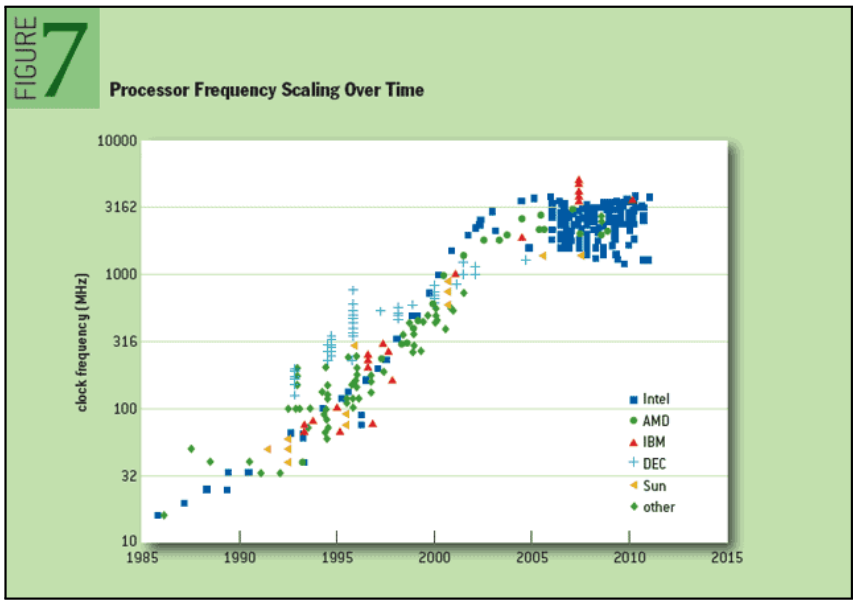

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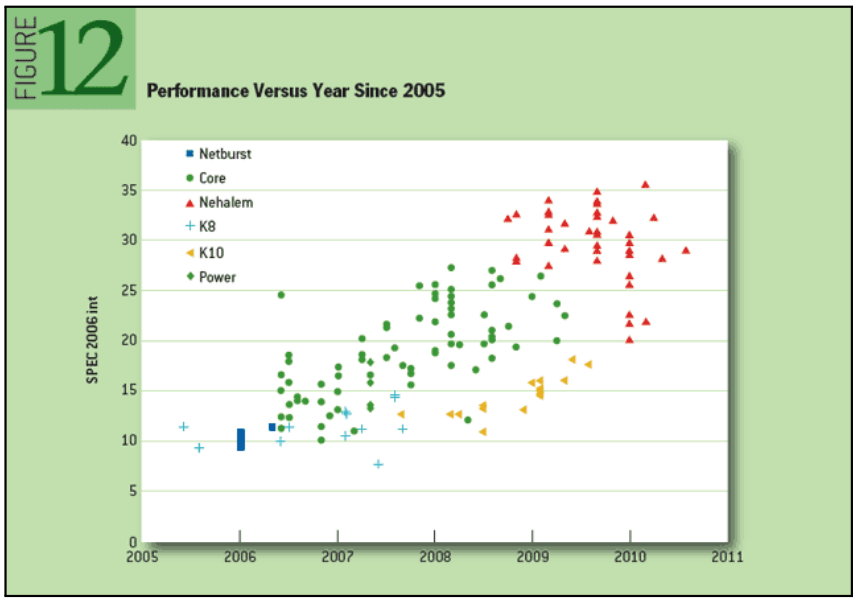

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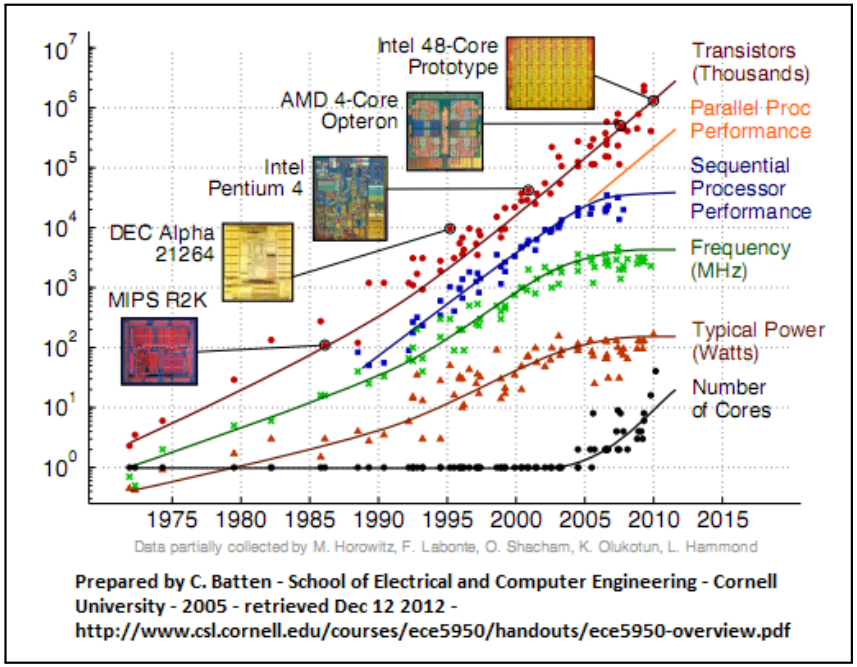

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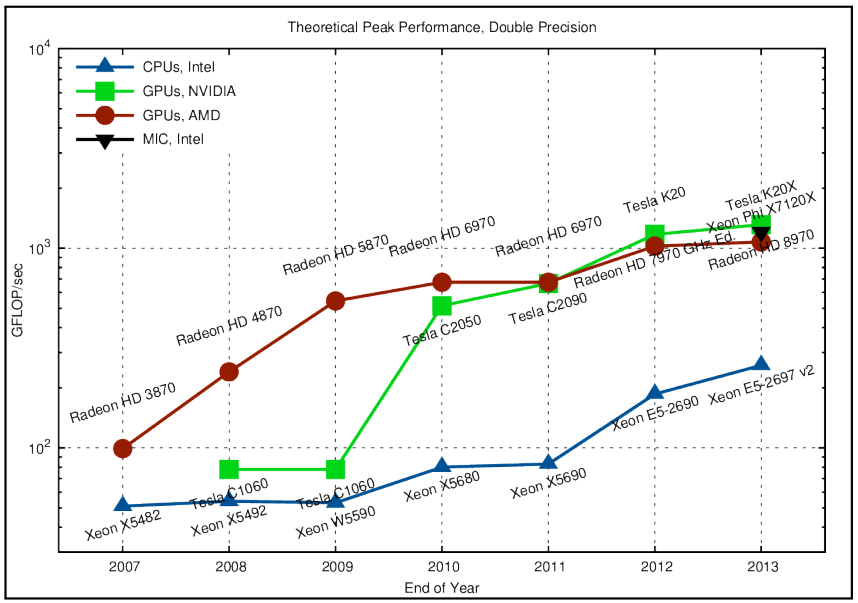

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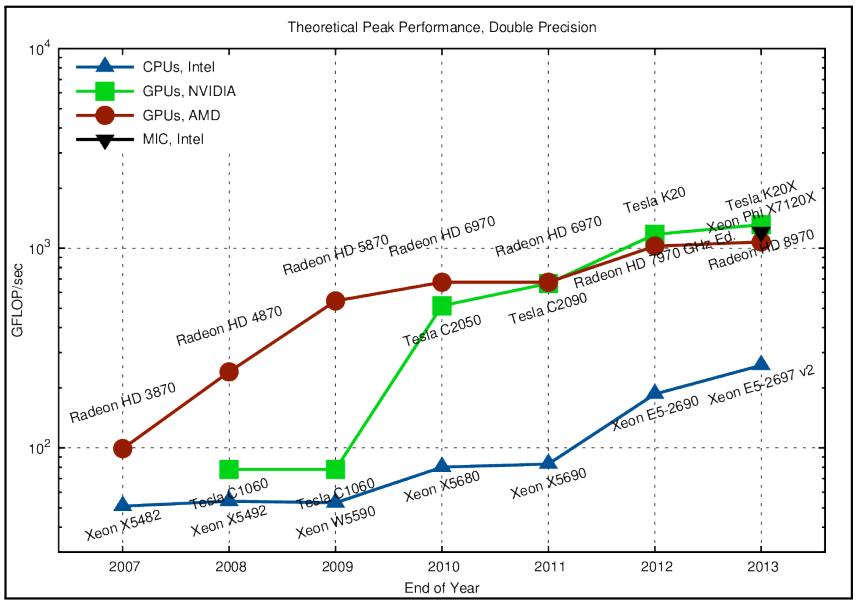

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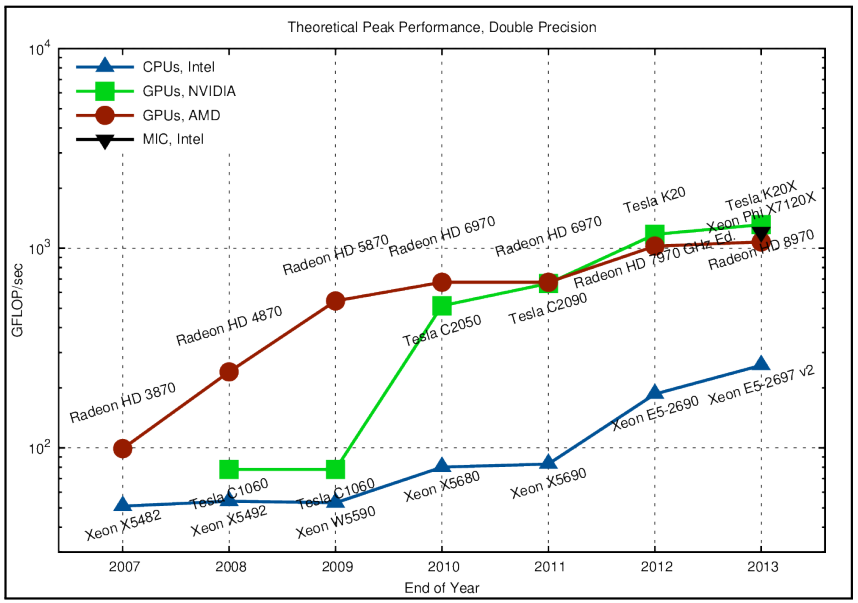

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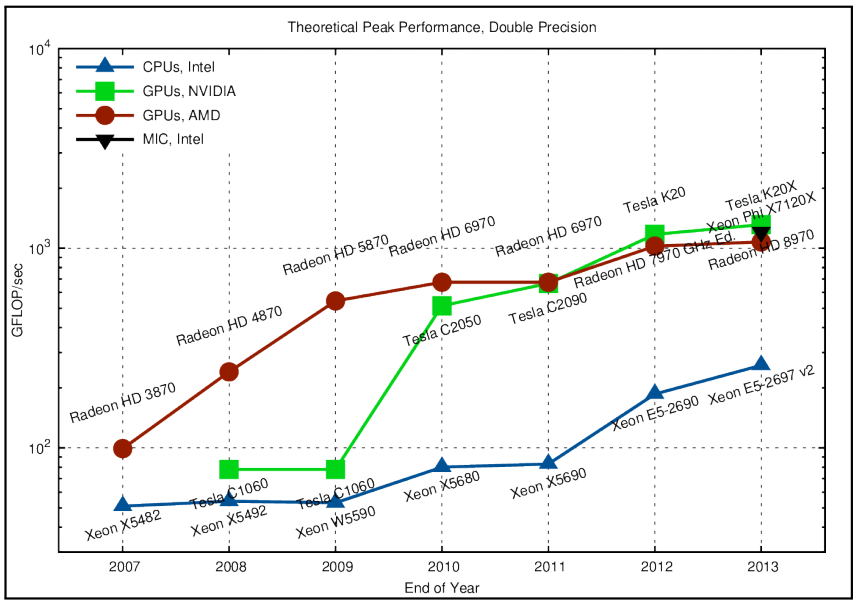

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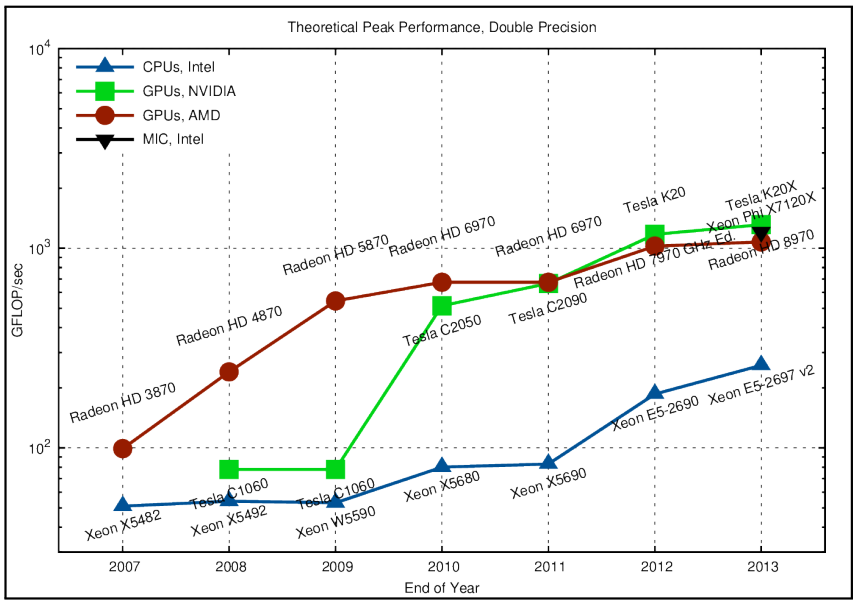

Hardware: Large memory or fast data storage

- For large genomic models very large matrices are needed to be stored in the memory or in the data storage
- Currently, up to 2 terabyte (CPU) memory possible:
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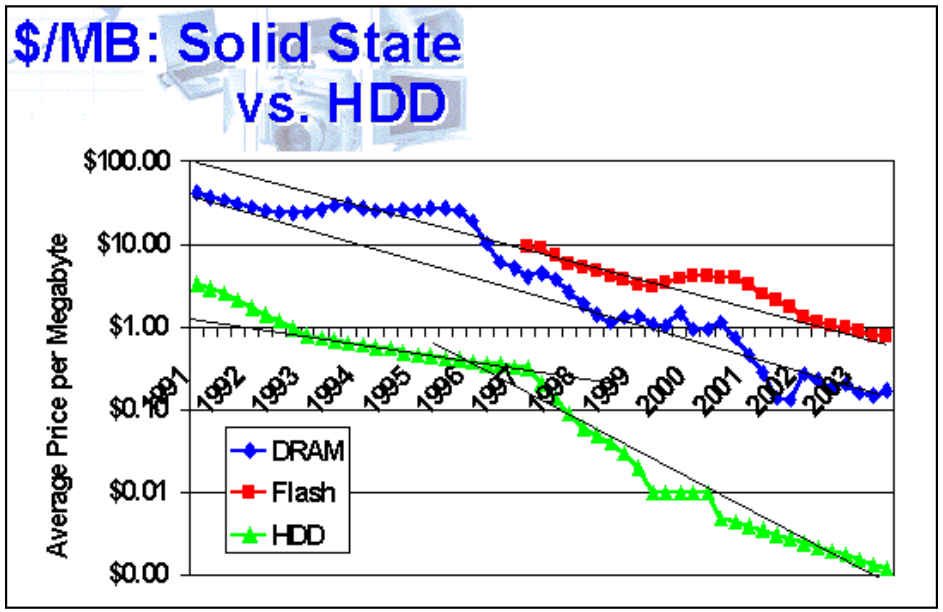

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- MiX99 is programmed with Fortran 90
- Fortran evolves:
  - F66, F77, F90, F95, F2003, F2008, F2015
  - Vectorization, parallel execution
  - Object oriented programming
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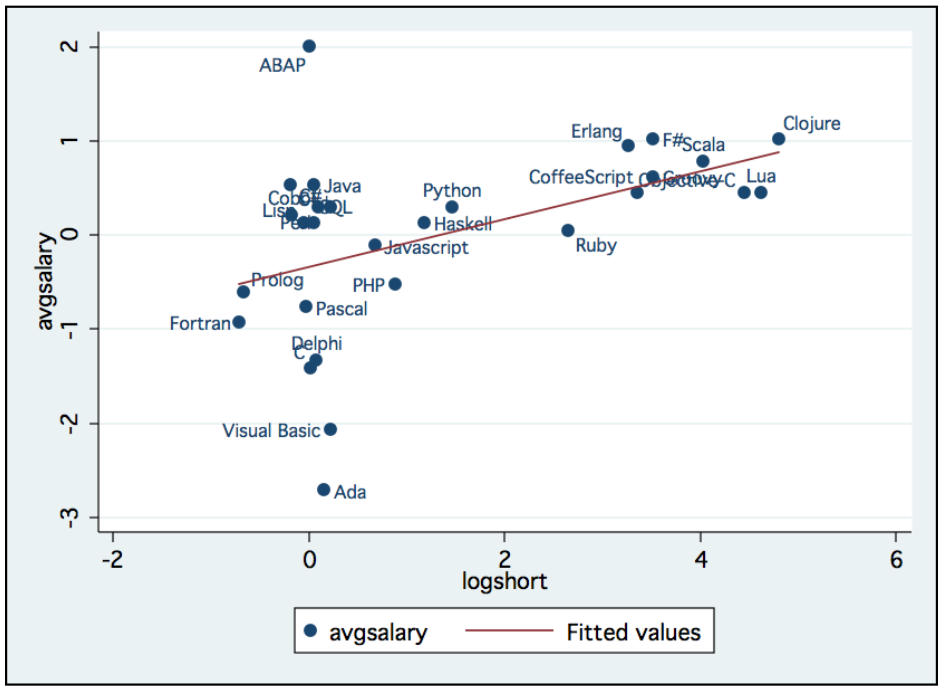

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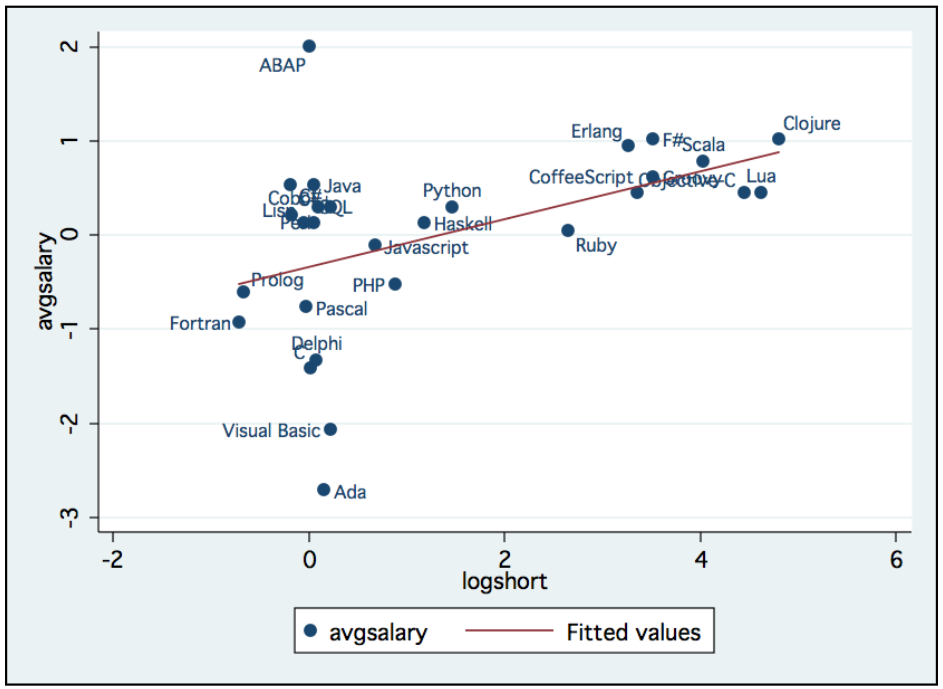

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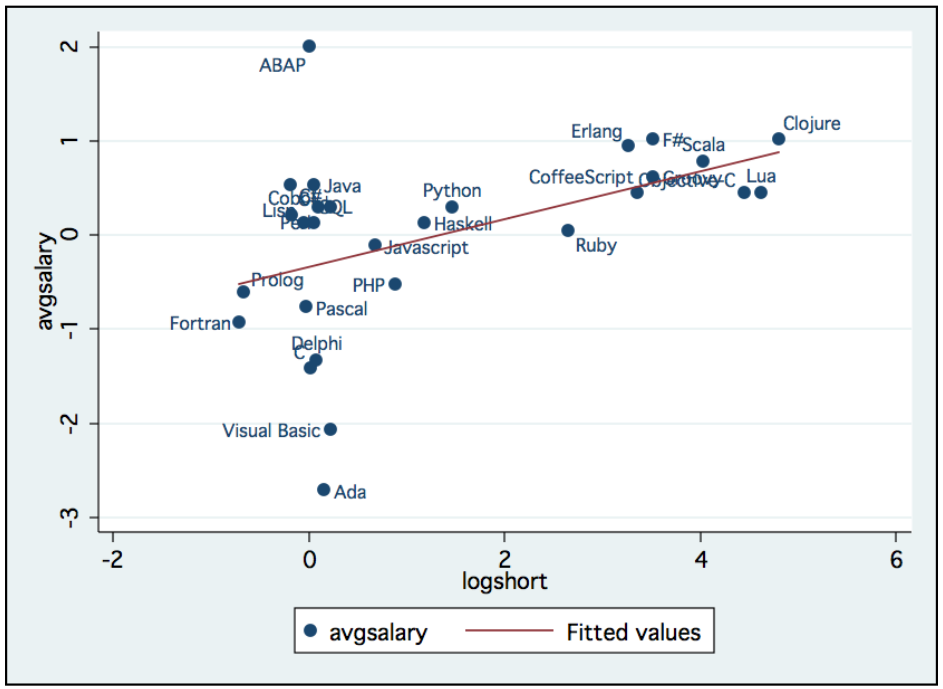

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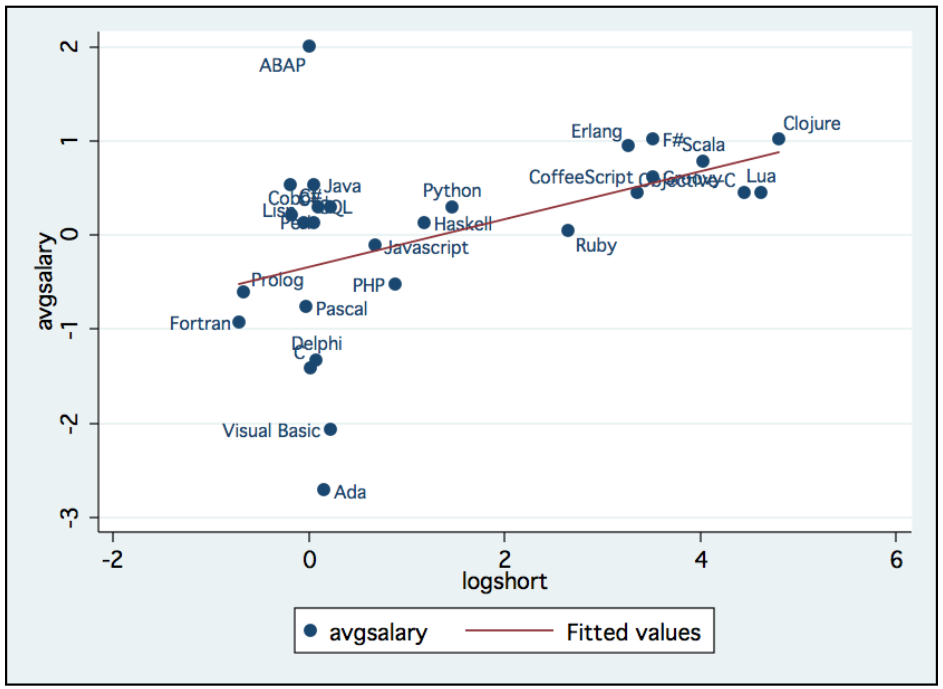

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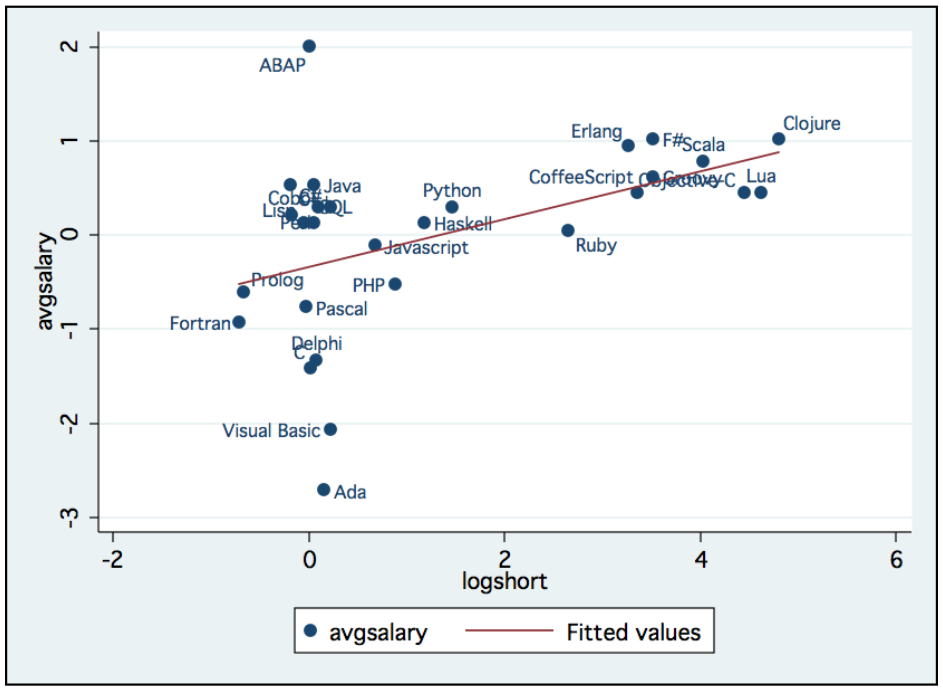

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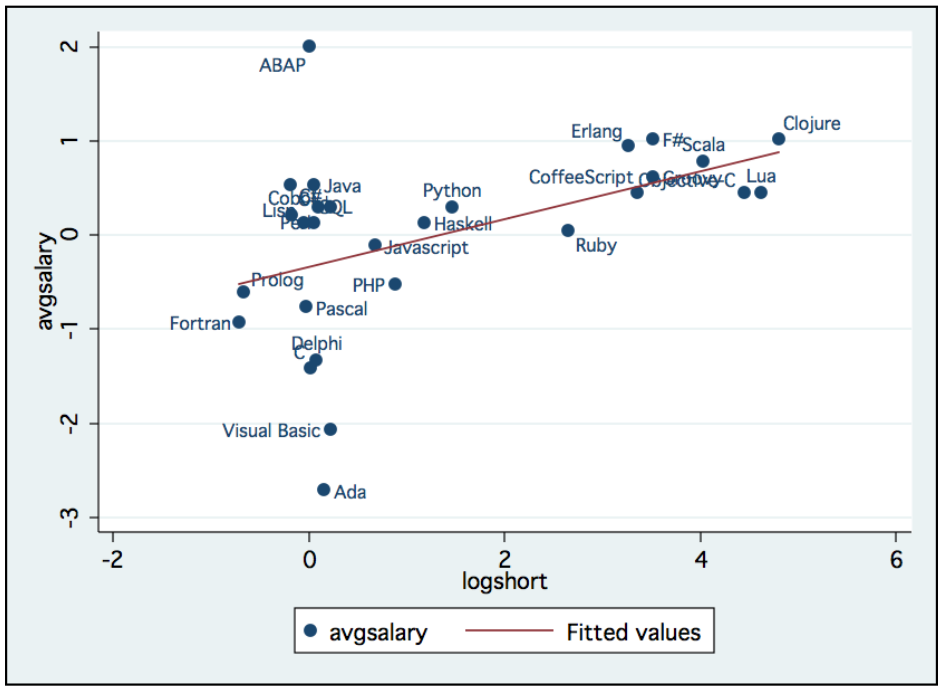

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  - MPI, Distributed memory model
- There are different levels of parallelism:
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User interface

- Command language:
  - MIX/CLIM
  - Embedded language: Lua/Python/...
- Embedding MiX99:
  - Octace/R
- Operating system
  - Linux/Windows/MacOS
  - Android
- Desktop/Mobile/Tablet
- Cloud computing
  - Grid computing
  - OpenStack
  - Docker