# High Performance Computing: Towards Better Performance Predictions and Experiments

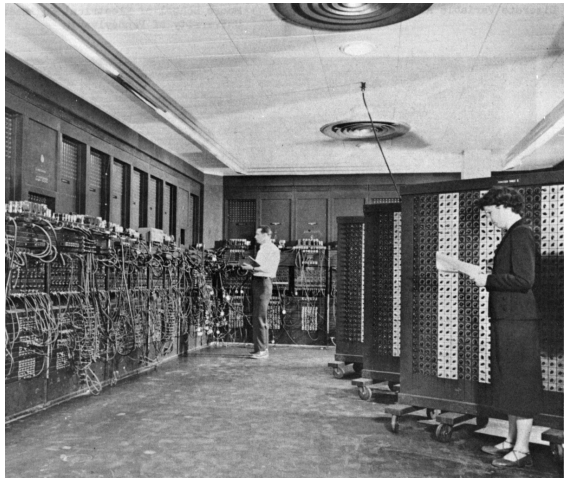
Tom Cornebize

2 June 2021, PhD defense



# No science without computing

Arithmomètre (1851)



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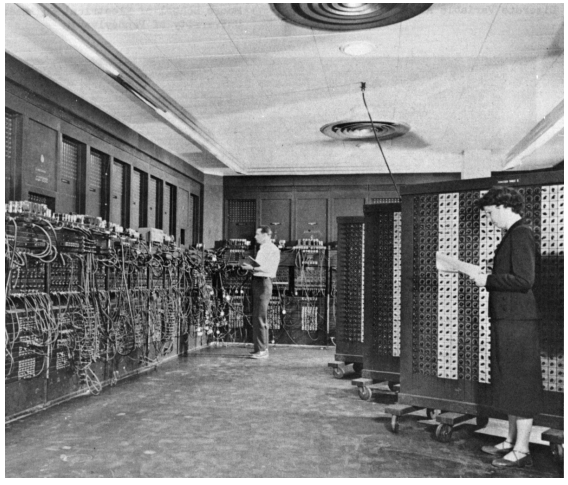

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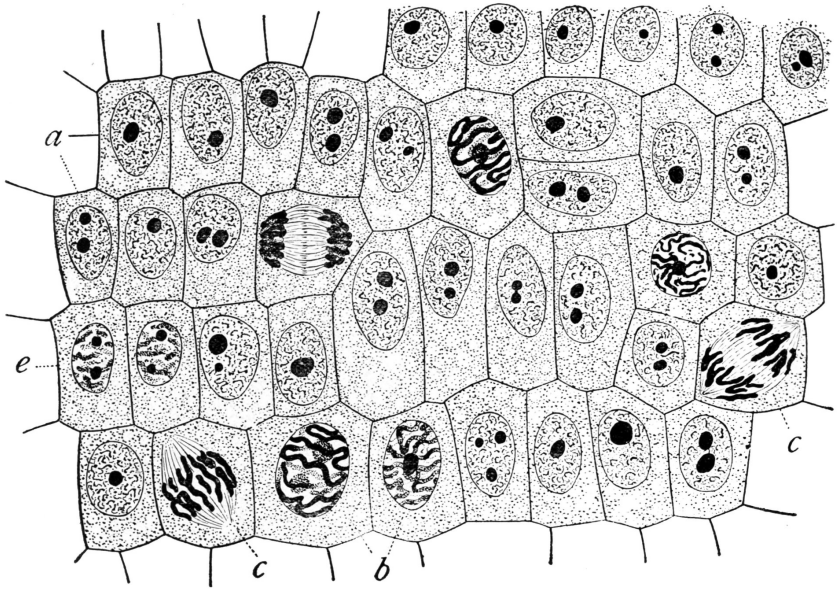
Last decades:

- Exponential performance improvements (e.g. sequencing an entire human genome costed $100,000,000 in 2001, $1000 now)
- At the price of complexity (both software and hardware)

# Experimental study of computer performance




Similar to natural sciences

Complexity $\Rightarrow$ Variability and Opacity

$\Rightarrow$ No perfect model

$\Rightarrow$ Need for experiments

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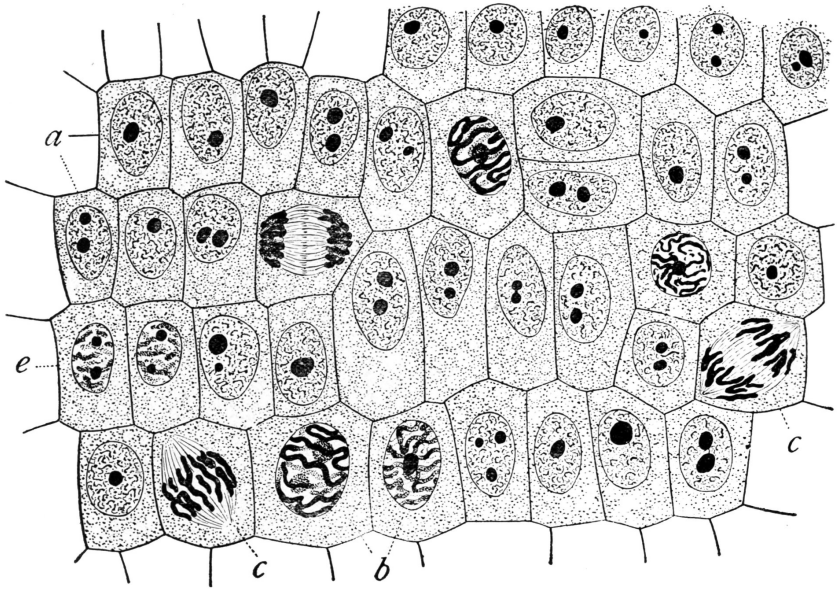


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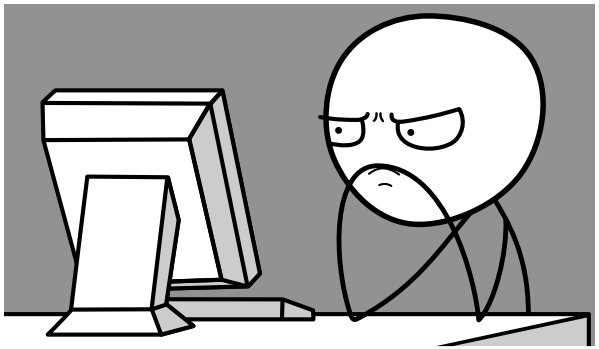
Experiments can be carried in reality or in simulation

# Context

**Typical Performance Evaluation Questions** (Given my application and a supercomputer)



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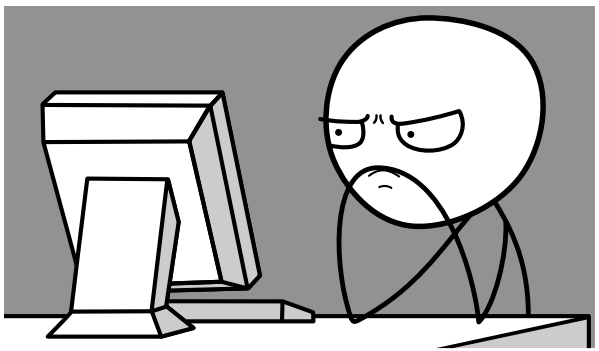

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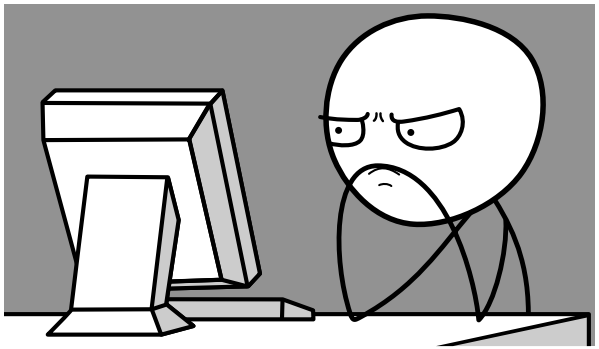

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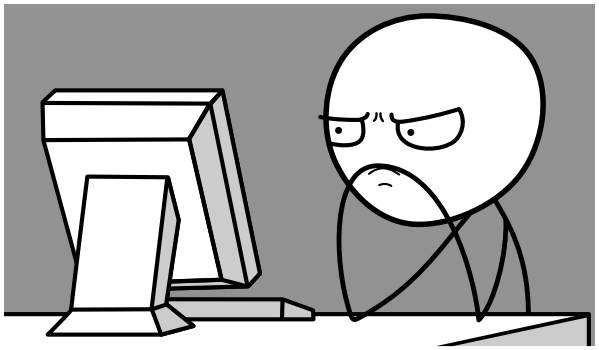

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**Holy Grail: Predictive Simulation on a “Laptop”**

Capture the **whole application** and **platform complexity**

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**Thesis contributions (towards this goal)**

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**Full reimplementation of MPI on top of SIMGRID**

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**Contribution**: Skip the expensive computations (mostly `dgemm`) and replace them by performance models

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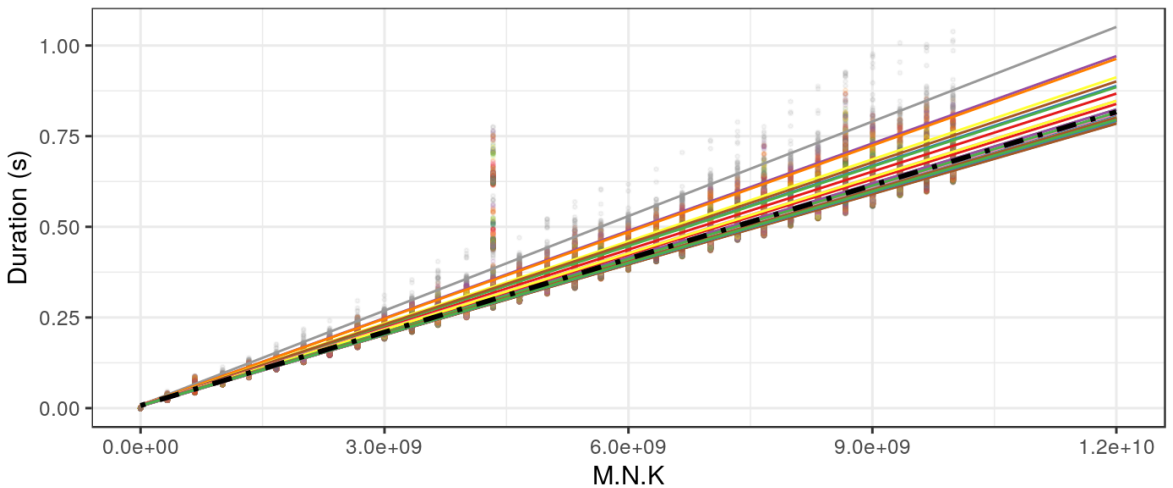
Different color $\Rightarrow$ different host



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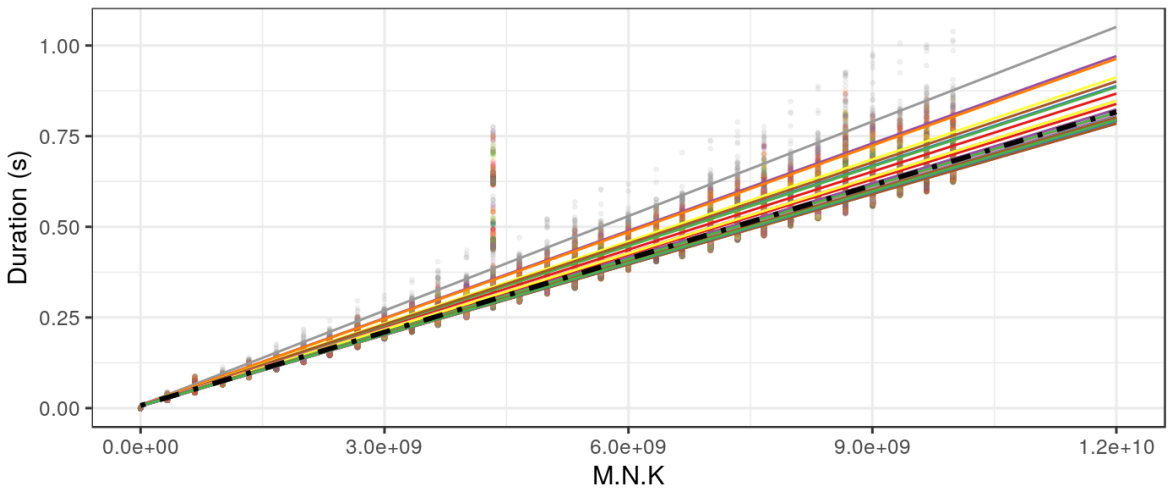

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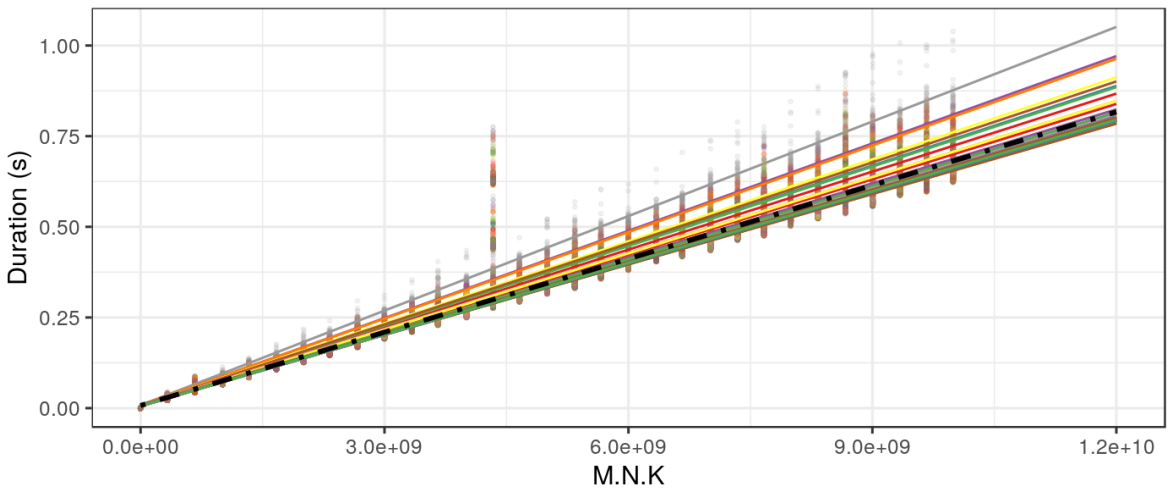

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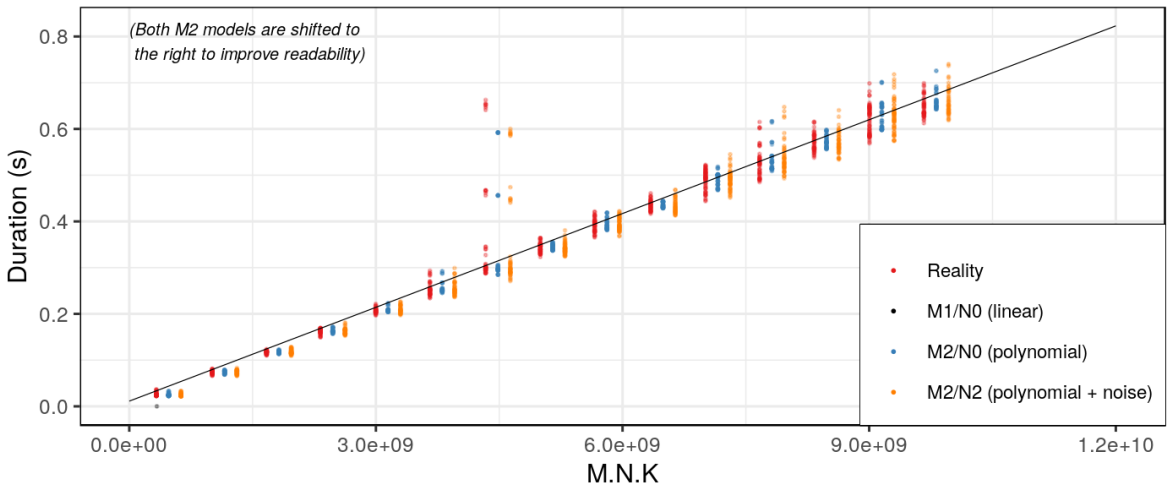
For a particular host



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Take-Away Message:

- Both spatial and temporal variability
- "Sophisticated" linear models are **excellent predictors** (for every function – `dtrsm`, `daxpy`, ...)

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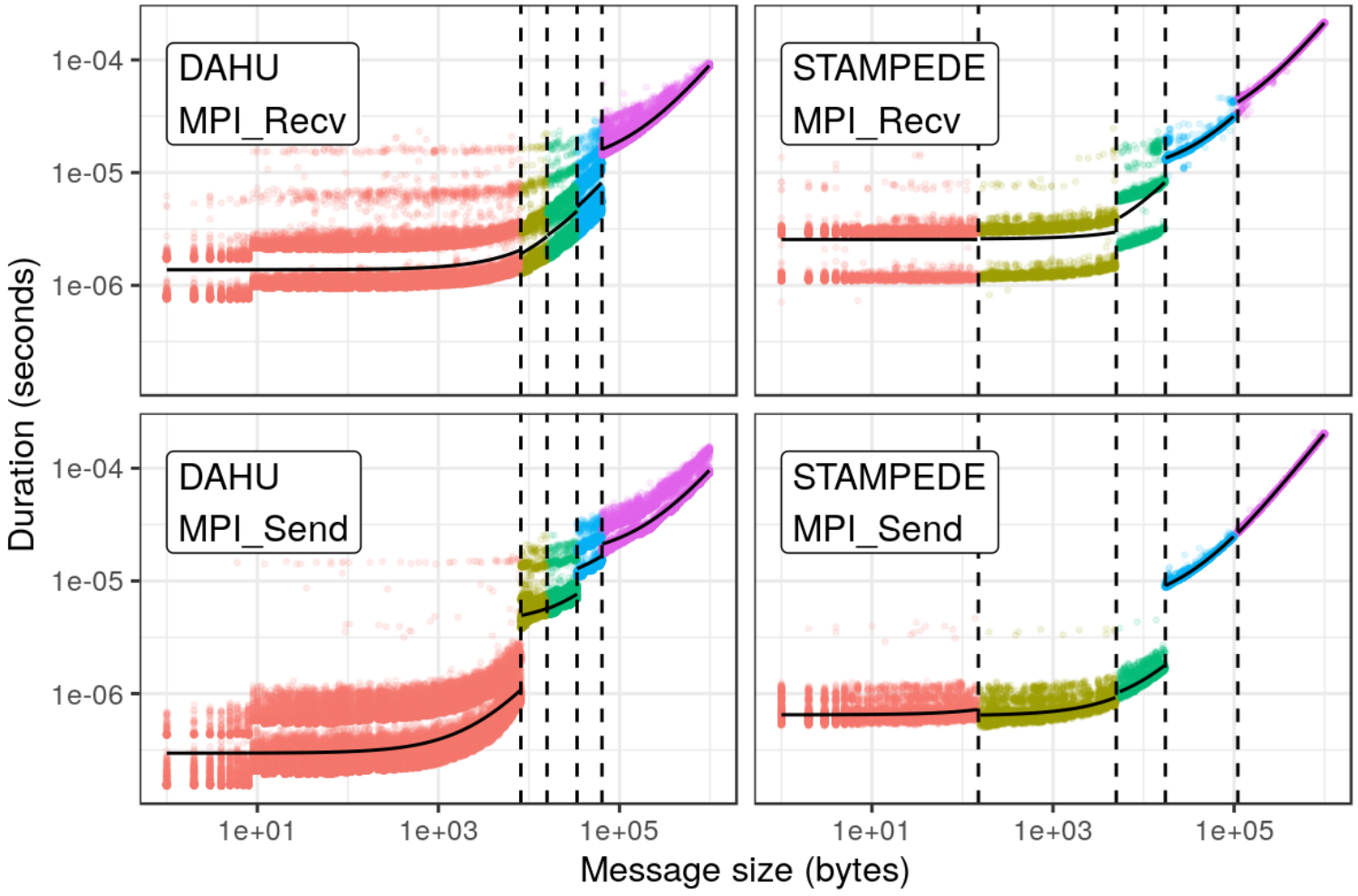

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**Take-Away Message**:

- For small messages, the **variability can be huge**
- **Piece-wise mixture** of **linear** regressions