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Developing and maintaining software on future heterogeneous machines

Workshop on Software Challenges of Extreme Heterogeneity, NIST, 2020

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Develop? Maintain? Do we even know how to run software?

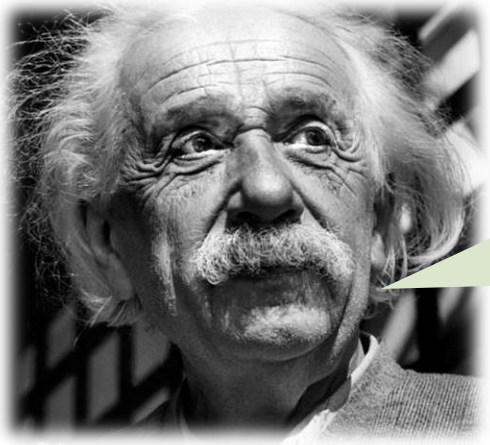
- **A huge community gave up years ago!**
  - The problem was simply reasonable software version and library management
  - -> too hard, solve it by throwing resources (memory, bandwidth at it …)
  - Opposite of efficiency!

- **And now we go heterogeneous!?**
  - Brave new world – if you have k classes of machines … … multiply the management complexity by k!

Back on topic: Dataflow to the rescue

- **Performance-centric computing is really a data management challenge!**

- **Heterogeneity is only needed to achieve performance**
  - So, we represent programs with their data movement as first-class citizen



Wait, what!? I could not care less!

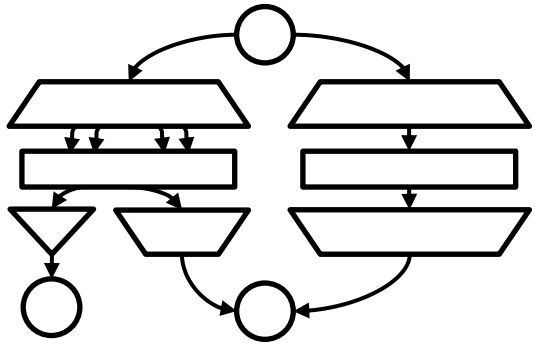
$$E = mc^2 \quad - \quad H|\Psi\rangle = E|\Psi\rangle$$

Productive dataflow programming

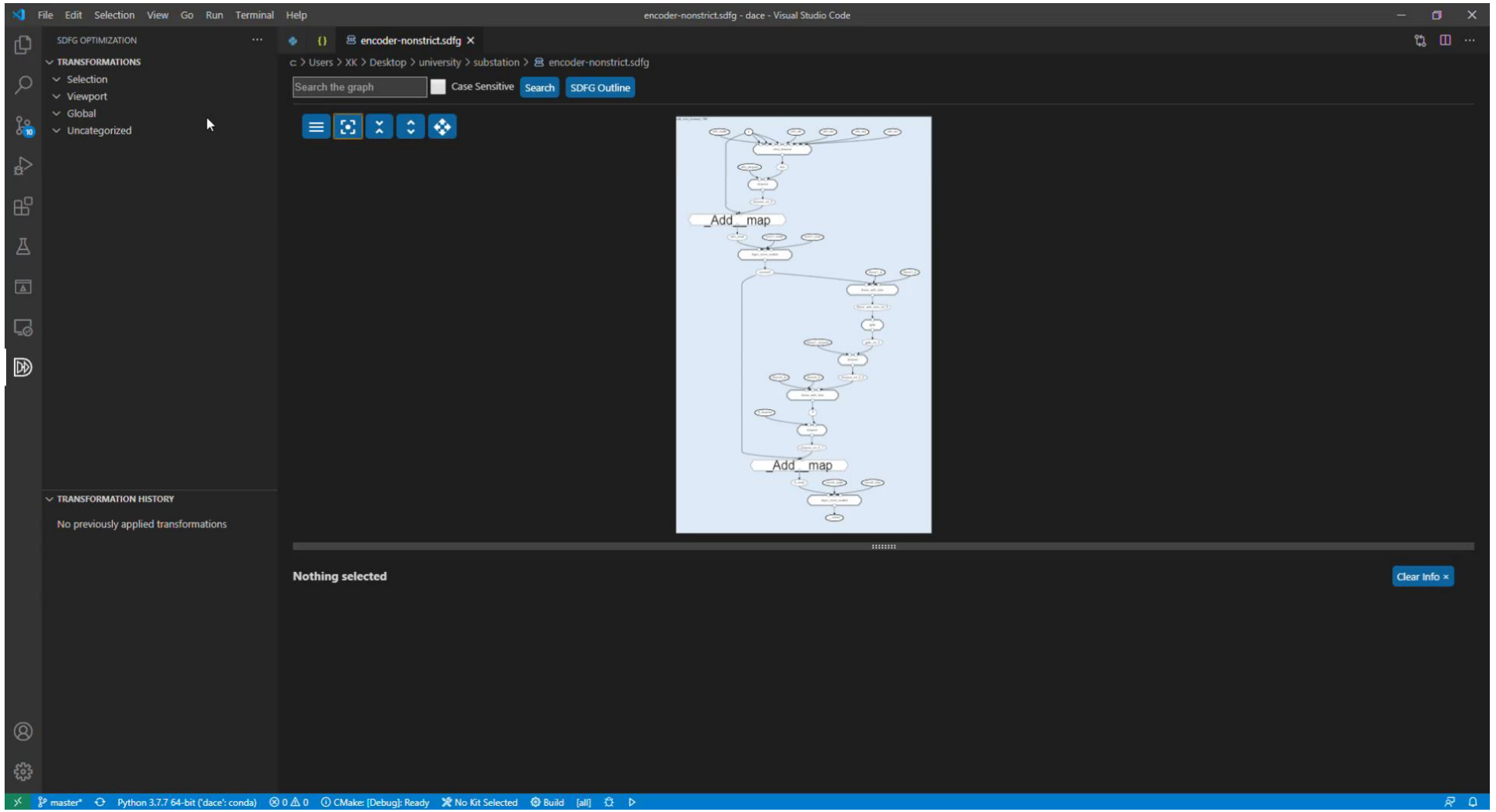
- **Python as DSL between scientist/user and performance engineer**
  - And as productivity factor for performance engineering!
  - Cf.

- **We embrace this model and generalize it to a wider community**
  - Let's make scientific computing productive (again?)

  - Key idea: parametric (dataflow) graphs as program representation
    Generate C/C++ code as backend or RTL (CPU, GPU, FPGA, …)



Data Movement is All you Need – seriously!



https://arxiv.org/abs/2007.00072

Battle-tested on large-scale heterogeneous systems

- `pip install dace`

- **Gordon Bell Award 2019**
  - Quantum Nano Transport simulation

    Design of future micro-processors

- **Now working on large-scale:**
  - AI (transformers)
  - Climate (COSMO, icon, fv3)
  - Green's functions solvers
  - … your project?

http://spcl.inf.ethz.ch/DAPP