# Welcome!

The program will begin soon.

You will not hear audio until we begin.

# A LEAP IN SCIENTIFIC COMPUTING FOR RESERVOIR SIMULATION

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Webinars

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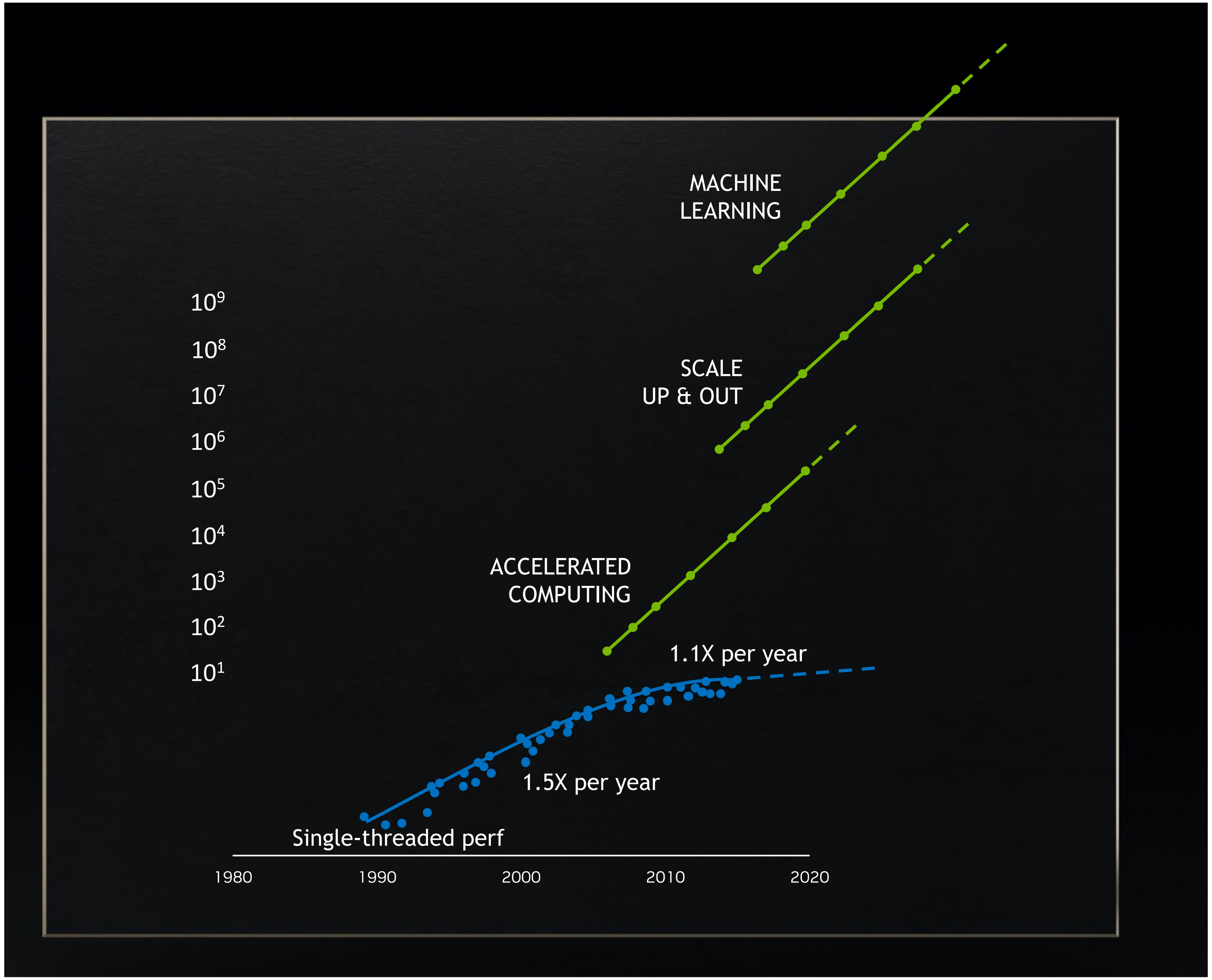
# A Leap in Scientific Computing for Reservoir Simulation

- Many current reservoir simulation solutions
  – Computationally, resource, and time expensive
- High performance computing solution
  – GPU-accelerated reservoir simulation
- Machine learning solutions
  – What's next for reservoir simulation?

# Advances in High-Performance Computing and Machine Learning



# GPU-Accelerated Reservoir Simulation

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**Challenges of Traditional Reservoir Simulation**

- Time and computationally expensive
- Reduced workforce that is required to produce more results with fewer resources (time, people)

**Current Industry Solutions**

- Company A built reservoir simulation software on GPUs from the ground up
- Company B porting reservoir simulation software to be GPU-accelerated

**Performance Benchmarks**

- Company A: 11.2-million cell model with 9 components forecast for 20 years:
  - 30 minutes on 8 GPUs; 45 minutes on 4 GPUs
- Company B black oil:
  - 2.3-million cell model forecast for 30 years: 4.5x performance increase; 7.5x throughput with MPS; 5.7x throughput with MIG
  - 600-thousand cell model: 3.7x performance increase; 11x throughput with MPS; 9x throughput with MIG

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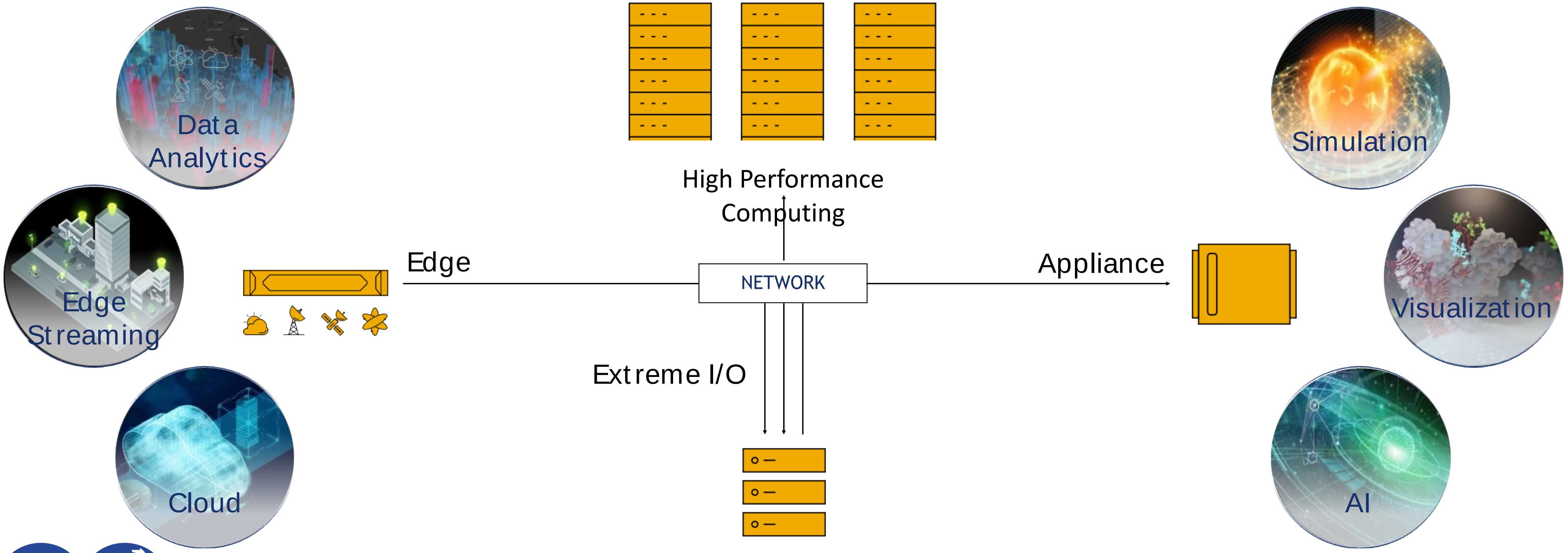
# GPU-Accelerated Reservoir Simulation

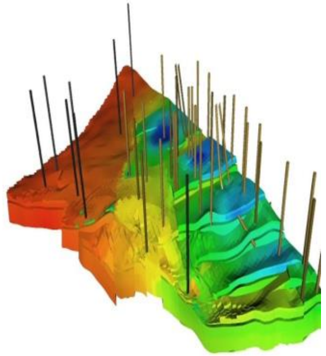
- Benefits
  - Significant acceleration
  - GPU technology allows for several users per GPU *or* ensemble modeling
- Challenges
  - Many solutions currently single GPU, user limited to memory of the GPU used
  - Multi-GPU solutions bring an additional layer of complexity when porting from CPU to GPU

# Hybrid AI-HPC for Scientific Computing



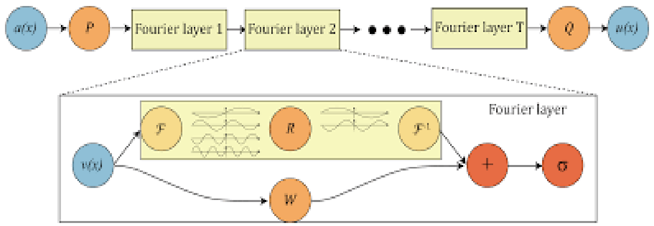
# Reservoir Simulation with AI

Obtain few *N* data points from finite volume solver



1

*FNO* (Fourier Neural operators)




Build surrogate model with *PINO* (FNO + Physics)

2

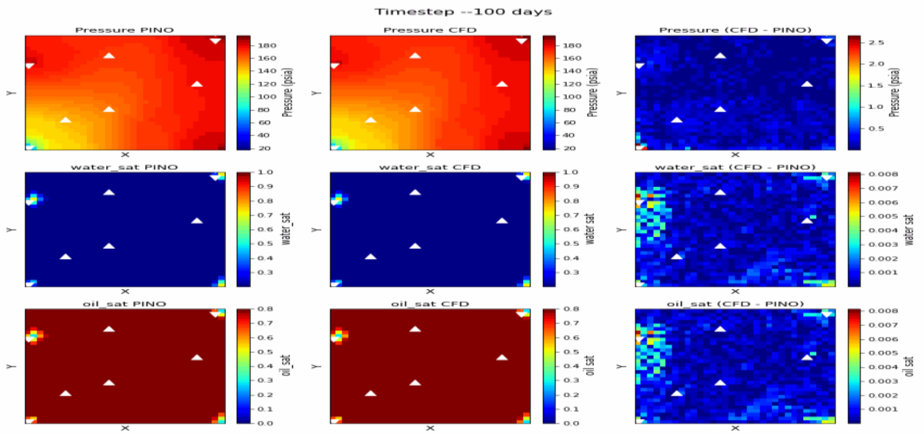
Physics

$$\varphi \frac{\partial S_\ell}{\partial t} = \nabla.(-K \frac{k_{r\ell}}{\mu_\ell}[\nabla p_\ell - \rho_\ell \hat{g} \nabla z]) + f_\ell \text{.... Eqn.(2)}$$

$\varphi$ = effective porosity, $S_\ell$ = phase saturation for water ($w$) and oil ($o$), $K$ = absolute permeability, $k_{r\ell}$ = phase relative permeability and a function of the phase saturation, $\rho_\ell$ = phase density, $\mu_\ell$ = phase viscosity, $\hat{g}\nabla z$ = acceleration due to gravity. $f_\ell$ = source and sink terms representing the phase production and injection. The equation is closed by adding auxiliary equations for capillary pressure between oil and water ($p_{cow} = p_o - p_w$) and ($S_o + S_w = 1$).

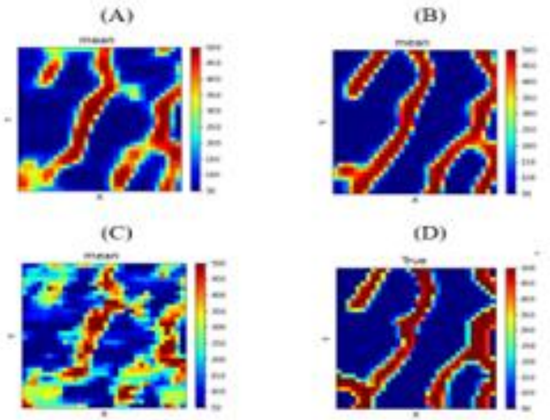
3

*PINO* surrogate for solving the forward problem




4

Use *PINO* surrogate forward model in an inverse problem workflow



# Reservoir Simulation AI

- Benefits
  – Additional acceleration compared to HPC results
- Challenges
  – Understanding and proper application of AI models
  – Still in R&D phase, not commercially available