GPU Computing with MATLAB

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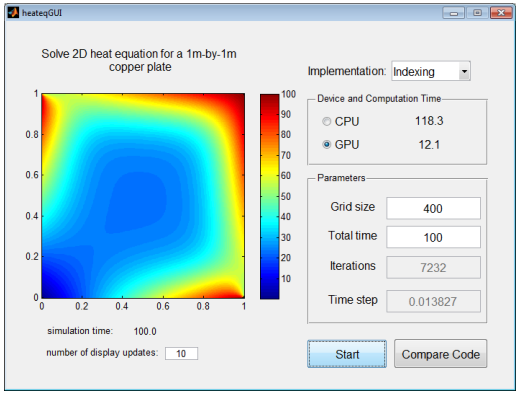
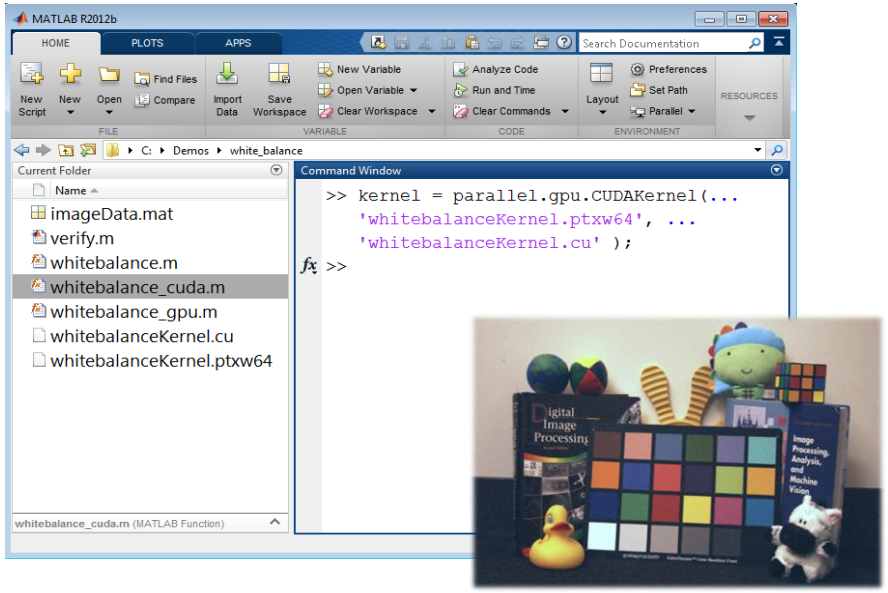
Why should you care?

- MATLAB Programmers
  - Acceleration MATLAB Code with GPUs
  - Minimal code changes

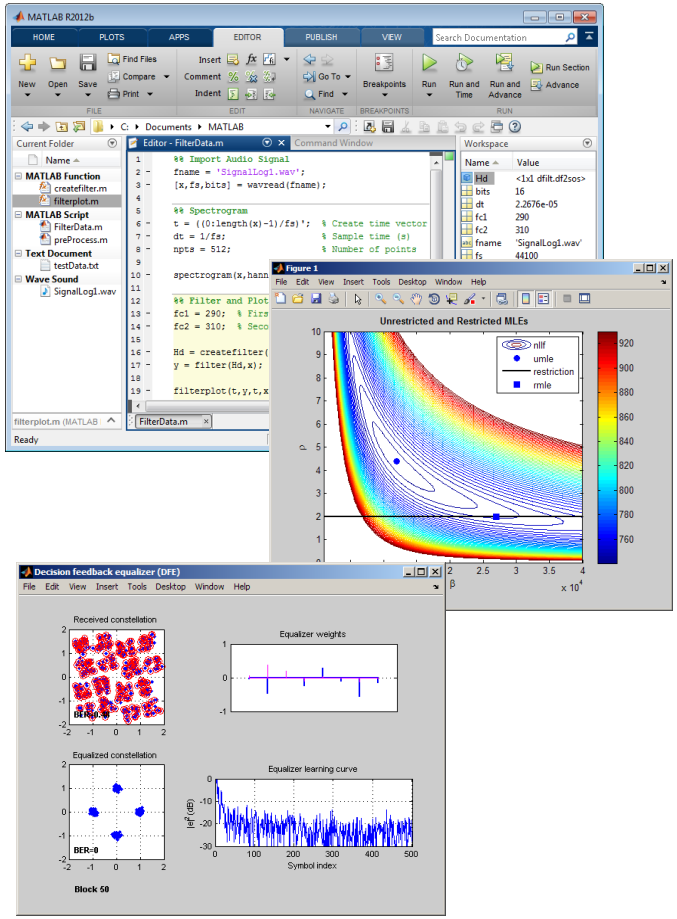


- CUDA Programmers
  - Prototype algorithms
  - Create test harnesses for your kernels
  - Quickly explore algorithm parameters
  - Analyze and visualize kernel results



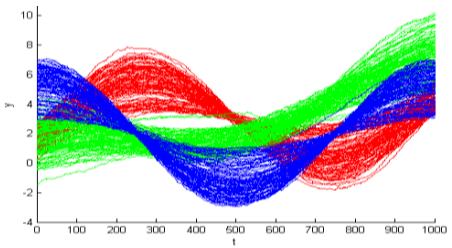
What is MATLAB?

- High level language and development environment for:
  - Algorithm and application development
  - Data analysis
  - Mathematical modeling
  - GPU computing *
- Extensive math, engineering, and plotting functionality
- Add-on products for image and video processing, communications, signal processing, financial modeling, and more
- Over 1.3 million users worldwide



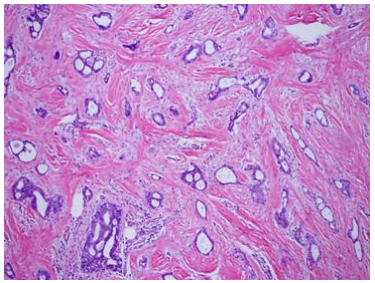
* Requires Parallel Computing Toolbox

Speed up MATLAB code with NVIDIA GPUs

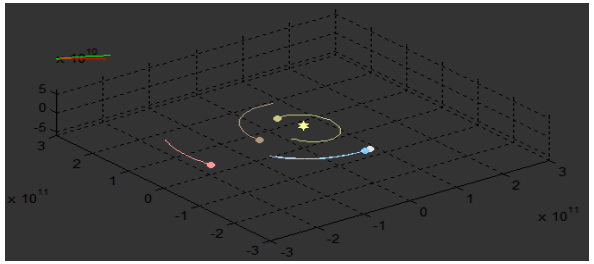


10x speedup *in data clustering via K-means clustering algorithm*

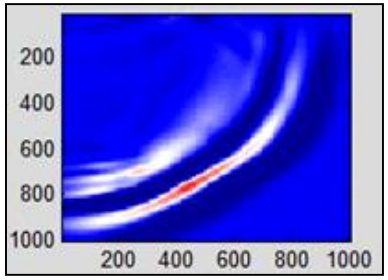
20x speedup *in wind tunnel acoustic data analysis (NASA Langley Research Center)*



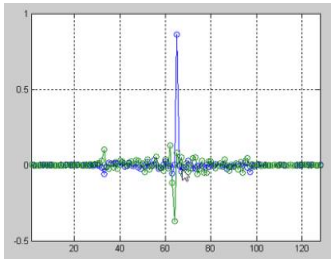
14x speedup *in template matching (part of cancer cell image analysis)*



17x speedup *in simulating the movement of 3072 celestial objects*



4x speedup *in wave equation solving (part of seismic data processing algorithm)*



4x speedup *in adaptive filtering (part of acoustic tracking algorithm)*

Demonstration: 2D wave equation

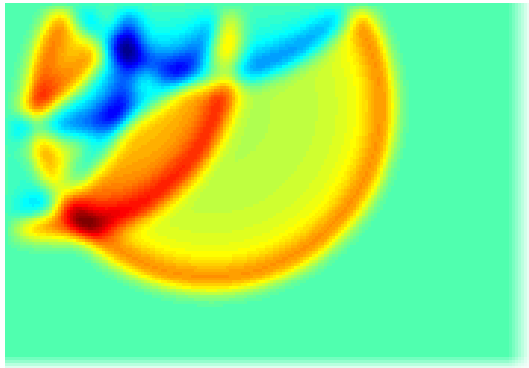
Goals

- Solve 2D wave equation in MATLAB
- Use GPU computing to speed-up algorithm

Damped wave equation

$$\frac{\partial^2 u}{\partial t^2} = r^2 \nabla^2 u - b\frac{du}{dt}$$

$$u_{t+1} = 2u_t - u_{t-1} + r^2 \nabla^2 u - b(u_t - u_{t-1})$$



Running MATLAB code on the GPU

- 200+ built-in MATLAB functions that are supported on the GPU
  - Random number generation
  - FFT
  - Matrix multiplications
  - Solvers
  - Convolutions
  - Min/max
  - SVD
  - Cholesky and LU factorization

- Additional support in toolboxes

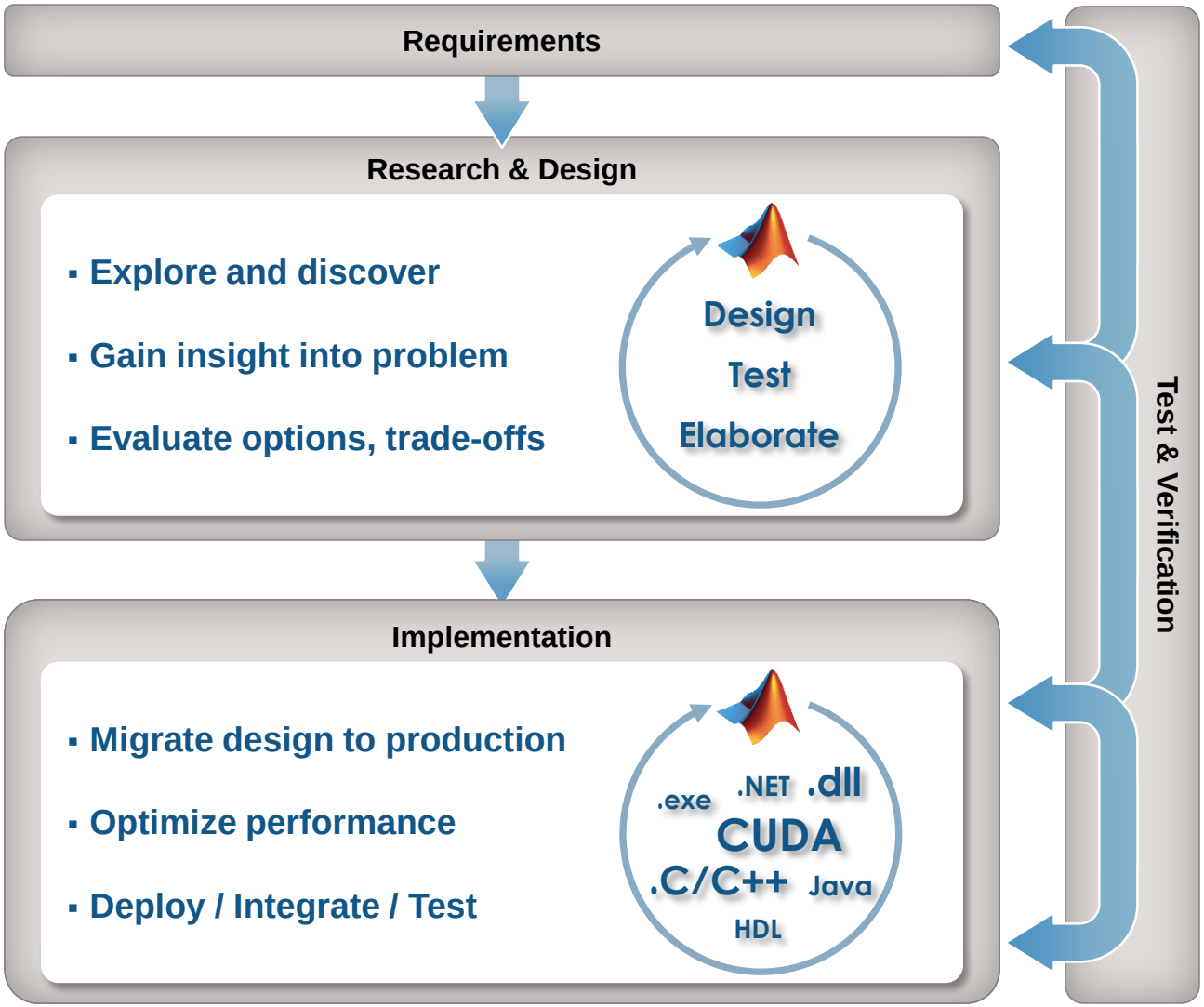
  Image Processing
  - Morphological filtering, 2-D filtering, …

  Communications
  - Turbo, LDPC, and Viterbi decoders, …

  Signal Processing
  - Cross correlation, FIR filtering, …

- Use `arrayfun` to execute custom functions on the GPU (more efficiently than doing each operation within function individually)

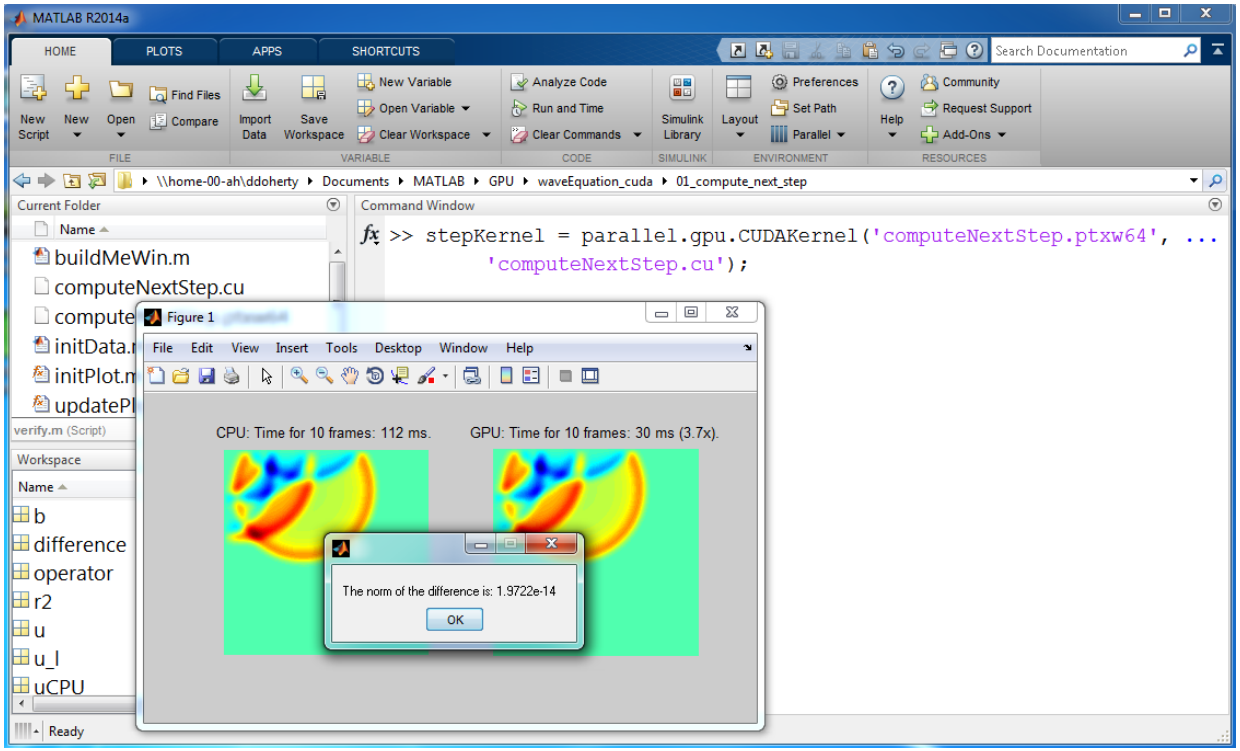
How can MATLAB support CUDA development?



Demonstration: 2D wave equation

Goals

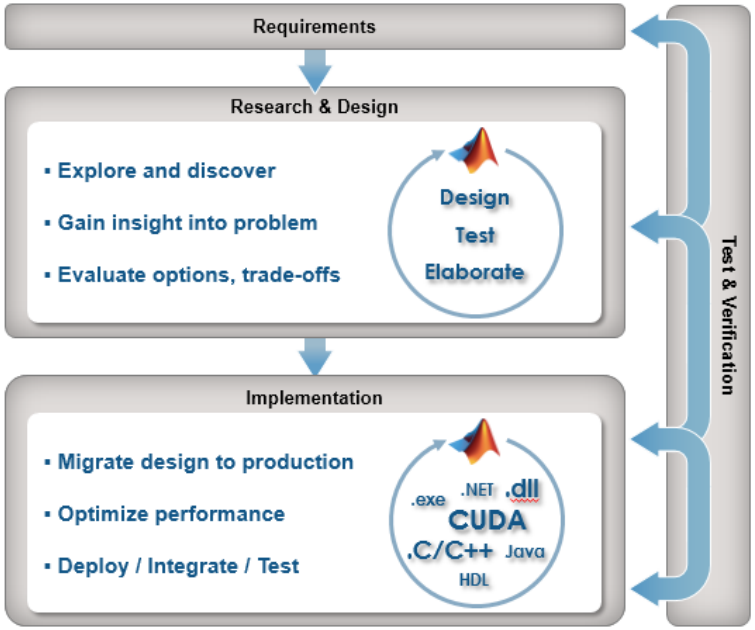
- Develop 2D wave equation solver in CUDA C/C++
- Use MATLAB to support CUDA development



Summary

- Develop GPU applications in MATLAB
  - Built-in GPU enabled functionality
  - `arrayfun` for element-wise operations
  - CUDA kernel integration
  - Leverage multiple GPUs

- Use MATLAB to support CUDA development
  - Prototype and explore algorithms
  - Create test harnesses for your kernels
  - Analyze and visualize kernel results



Next steps

- Learn more by visiting www.mathworks.com/gpu
- Try GPU computing with MATLAB on Amazon EC2
  - Email matlab-gpu-trial@mathworks.com if interested
- Thank you!

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Richard Heyns, CEO of brytlyt, UK

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