Who Uses Parallel Computing?

**Optimizing JIT Steel Manufacturing Schedule**
Cut simulation time from 1 hour to 5 minutes

**Flight Test Data Analysis**
16x Faster

**Heart Transplant Studies**
3-4 weeks reduced to 5 days

**Mobile Communications Technology**
Simulation time reduced from weeks to hours, 5x more scenarios

**Hedge Fund Portfolio Management**
Simulation time reduced from 6 hours to 1.2 hours
Demo: Getting Data from a Web API
Demo: Getting Data from a Web API using `parfor`
Demo: Getting Data from a Web API using `parfeval`

Download the photos and display them

```matlab
for idx = 1:numPhotos
    futures(idx) = parfeval(@getPhotoFromFlickrPhotoInfo, 2, ...
        appKey, photoInfo(idx)), %HashTag
end

% Then use fetchNext to retrieve results and then display them. If the %
% overall time to download is too long, then we can cancel any pending
% futures.
numPlotsAcross = 0;
[figHandle, axesHandles] = createFigure(numPhotos, numPlotsAcross);
figure(figHandle);
overallTimeLimit = 100; % seconds

t = tic;
numCompleted = 0;
while numCompleted < numPhotos
    if toc(t) > overallTimeLimit
        % We have exceeded our time budget!
disp('Time limit expired!');
        % Cancelling the futures stops execution of any running
        % futures, but has no effect on already-completed futures.
cancel(futures);
        break;
    end
end
```
Going Parallel: Multicore

MATLAB client

Multicore Desktop

MATLAB workers
Going Parallel: Clusters

Computer Cluster

MATLAB client
Going Parallel: Cloud

MATLAB client

Cloud Cluster
Going Parallel: GPUs

MATLAB client

NVIDIA GPUs

GPU Cores

Device Memory
Explicit Parallelism: Independent Tasks or Iterations

parfor, parfeval, jobs and tasks

- Examples: parameter sweeps, Monte Carlo simulations
- No dependencies or communications between tasks
Speed-up using NVIDIA GPUs

- Ideal Problems
  - Massively Parallel and/or Vectorized operations
  - Computationally Intensive
  - Algorithm consists of supported functions

- 300+ GPU-enabled MATLAB functions

- Additional GPU-enabled Toolboxes
  - Neural Networks
  - Image Processing
  - Communications
  - Signal Processing

Learn More
Too Much Data for One Machine?
Use Distributed Memory

MATLAB client

Using More Computers (RAM)

RAM

RAM
Distributed Arrays

- Distributed Arrays hold data remotely on workers running on a cluster
- Manipulate directly from client MATLAB (desktop)
- 200+ MATLAB functions overloaded for distributed arrays
Too Much Data for Your Cluster?

Use Datastore

Datastore access data stored in HDFS from MATLAB

Hadoop
Too Much Data for Your Cluster?

Use **Datastore**, **MapReduce** and **tall**

MATLAB Distributed Computing Server

Hadoop

Datastore

HDFS

Node

Data

Map

Reduce

map.m

reduce.m
Offload and Scale Computations with `batch`
Going Parallel: Other MATLAB® Toolboxes
Enable parallel computing support by setting a flag or preference

- **Image Processing**
  Batch Image Processor, Block Processing, GPU-enabled functions

- **Statistics and Machine Learning**
  Resampling Methods, k-Means clustering, GPU-enabled functions

- **Neural Networks**
  Deep Learning, Neural Network training and simulation

- **Signal Processing and Communications**
  GPU-enabled FFT filtering, cross correlation, BER

- **Computer Vision**
  Parallel-enabled functions in bag-of-words workflow

- **Optimization**
  Parallel estimation of gradients

Other Parallel-enabled Toolboxes
Going Parallel: Simulink®
Enable parallel computing support by setting a flag or preference

Simulink Design Optimization
Response optimization, sensitivity analysis, parameter estimation

Simulink Control Design
Frequency response estimation

Communication Systems Toolbox
GPU-based System objects for Simulation Acceleration

Simulink/Embedded Coder
Generating and building code

Other Parallel-enabled Toolboxes
Why use Parallel Computing Toolbox?

- Reduce computation time by
  - Using more cores
  - Accessing Graphical Processing Units

- Overcome memory limitations by
  - Distributing data to available hardware
  - Using `datastore` and `mapreduce`

- Offload computations to a cluster and
  - Free up your desktop
  - Access better computer hardware