How to speed up MATLAB

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Agenda

- Two coding tips to speed up MATLAB code

- Leveraging multiple cores with MATLAB

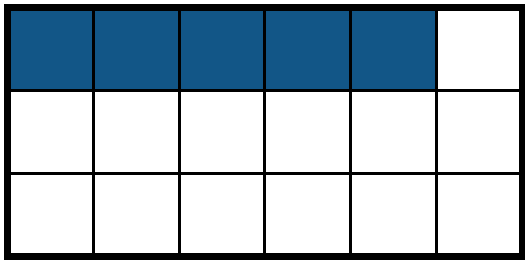
- MATLAB to C:
  - Generating C code from MATLAB
  - Integrate C functions in MATLAB

Two Coding Tips for Speeding Up MATLAB

- Pre-Allocation of Memory
- Vectorization

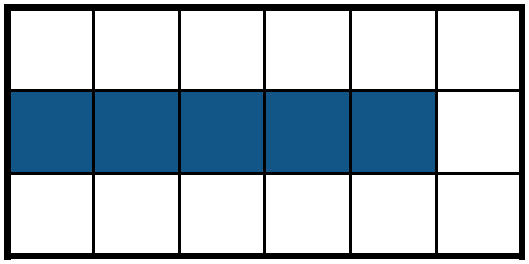
Pre-Allocation of Memory

```
for id = 1:10000
  a(id) = rand();
end
```



vs.

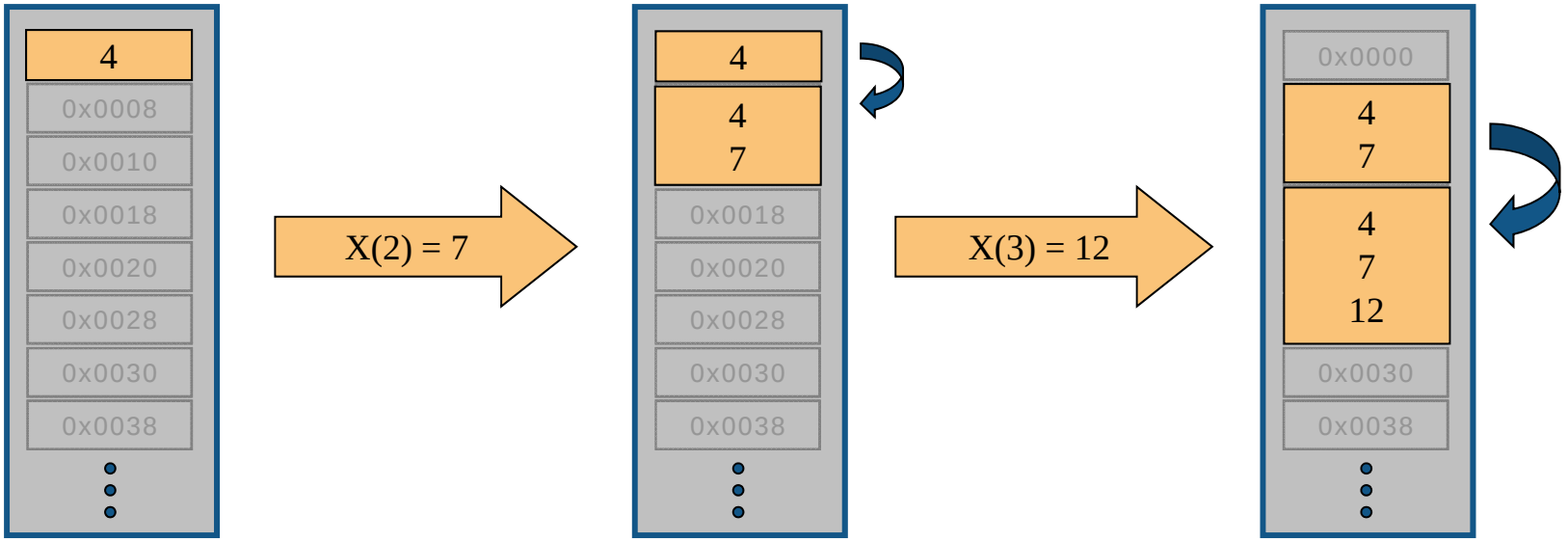
```
a = nan(1, 10000);
for id = 1:10000
  a(id) = rand();
end
```



Effect of Not Preallocating Memory

```
>> x = 4
>> x(2) = 7
>> x(3) = 12
```

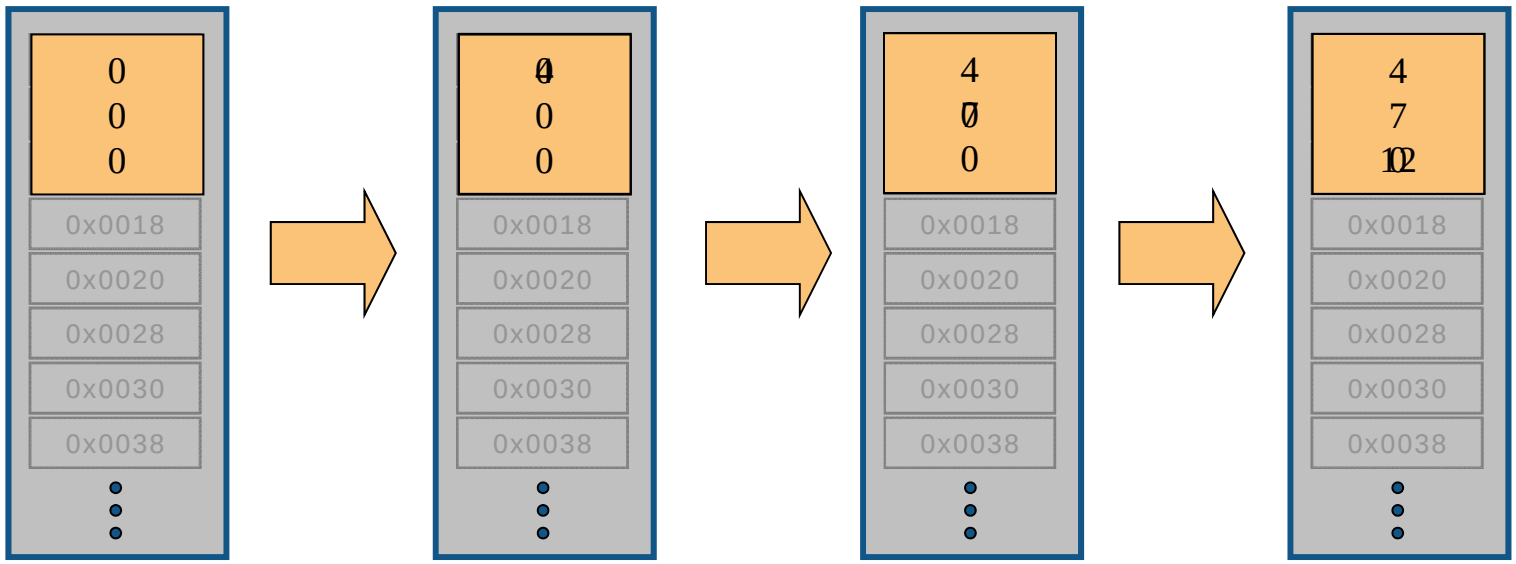
Resizing Arrays is Expensive



Benefit of Preallocation

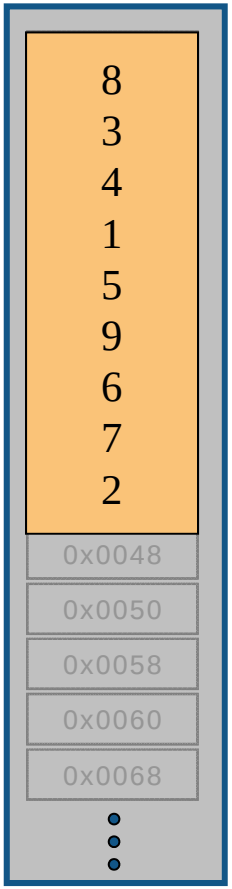
```
>> x = zeros(3,1)
>> x(1) = 4
>> x(2) = 7
>> x(3) = 12
```

Reduced Memory Operations



Data Storage of MATLAB Arrays

```
>> x = magic(3)
x =
     8     1     6
     3     5     7
     4     9     2
```



Column-Major Memory Storage

See the June 2007 article in “The MathWorks News and Notes”:
http://www.mathworks.com/company/newsletters/news_notes/june07/patterns.html

Two Coding Tips for Speeding Up MATLAB

- Pre-Allocation of Memory
- Vectorization

Vectorization

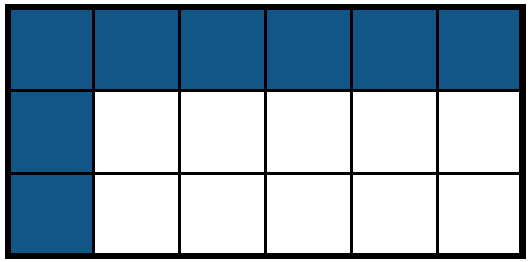
- MATLAB is a matrix (vector)-based language

  → *supports vectorized operations (faster in general)*

```
for id1 = 1:size(a,1)
  for id2 = 1:size(a,2)
    b(id1, id2) = a(id1, id2)^a(id1, id2);
  end
end
```

```
b = a.^a;
```

- Process in column blocks, rather than row blocks



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- Leveraging Parallel Computing with MATLAB
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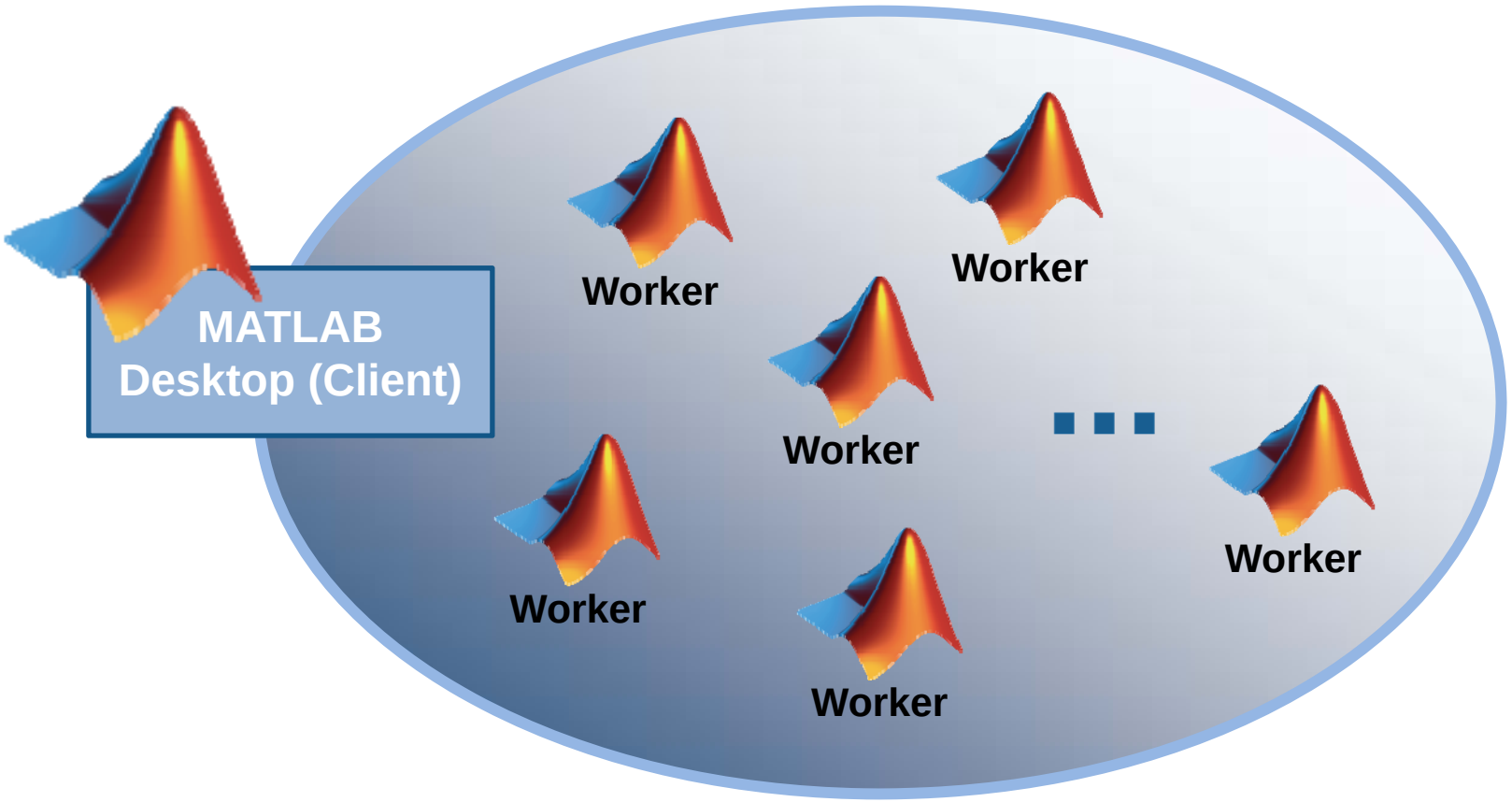
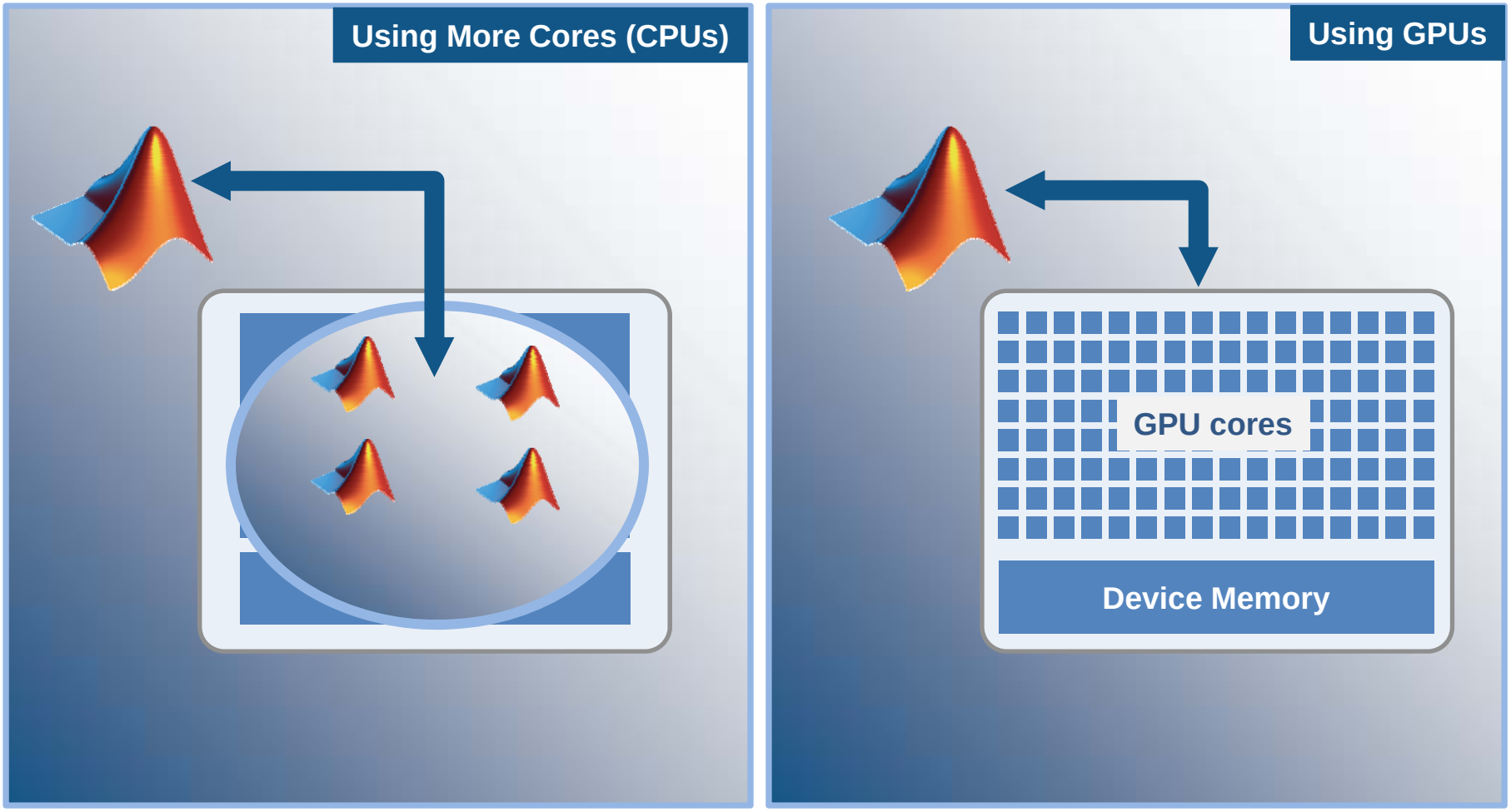
Going Beyond Serial MATLAB Applications

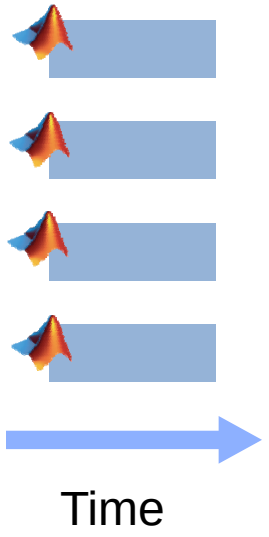


Performance Gain with More Hardware



Independent Tasks or Iterations

- Ideal problem for parallel computing
- No dependencies or communications between tasks
- Examples: parameter sweeps, Monte Carlo simulations



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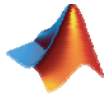
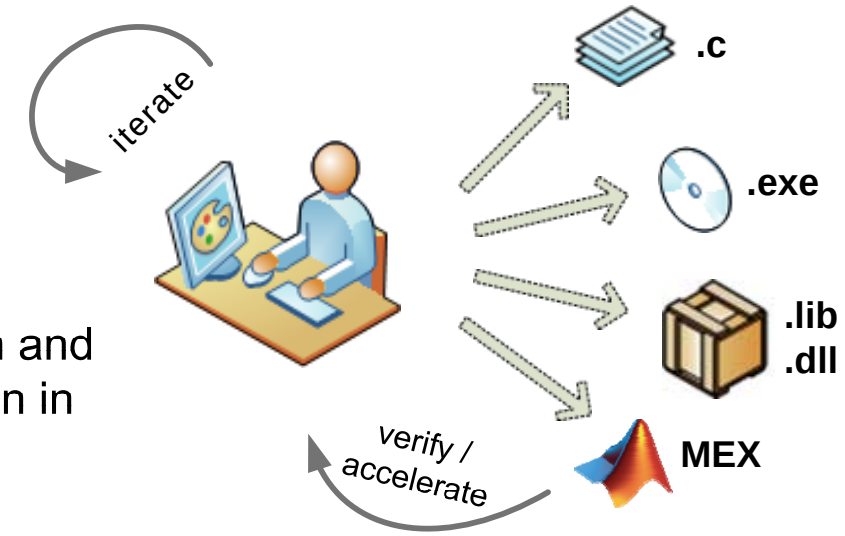
Why Engineers Translate MATLAB to C Today

 .c	**Implement** C code on processors or hand off to software engineers
 .lib .dll	**Integrate** MATLAB algorithms with existing C environment using source code and static/dynamic libraries
 .exe	**Prototype** MATLAB algorithms on desktops as standalone executables
 MEX	**Accelerate** user-written MATLAB algorithms

Automatic Translation of MATLAB to C

Algorithm Design and Code Generation in MATLAB

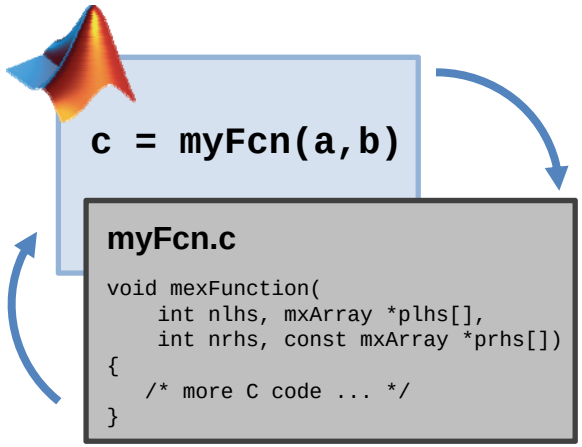


With MATLAB Coder, design engineers can:

- Maintain one design in MATLAB
- Design faster and get to C quickly
- Test more systematically and frequently
- Spend more time improving algorithms in MATLAB

Acceleration using MEX (MATLAB Executable)

- Call C or Fortran code directly from MATLAB
  - Integrate existing code using MEX API
  - Auto-generate C-based MEX files from MATLAB code using MATLAB Coder



- Speed-up factor will vary
  - May see speedup for state-based for-loops
  - May not see a speedup when MATLAB code is
    - Using multithreaded computations
    - Using optimized libraries (BLAS, FFTW, etc.)

Questions?