Improving Matlab Performance

CS1114

http://www.cs.cornell.edu/courses/cs1114

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MATLAB and Speed

- MATLAB is an interpreted language
- Each instruction by the user takes time to decode into machine code
- Proper coding techniques can minimize this decode time and maximize program speed

Preallocation of arrays

- MATLAB allows growing arrays in loops, but this is inefficient

```
array1 = [];
array2 = [];
n = 1000 ;
for i=1:n
  array1 = [array1 5*i] ;
  array2(i) = 5*i ;
end
```


Preallocate, using correct data type

- For double array,

```
array1 = zeros(1,n);
```

- For another data type, like int8,

```
array1 = zeros(1,n, 'int8');
```

- Do not use

```
array1 = uint8(zeros(1,n));
```

- Avoid changing data type of a declared variable
- Instead, have different variable preallocated in correct type

Preallocation demonstrated

Optimizing Functions

- Functions with the same in input vs output arguments operate in-place
  - Standard function declaration:

```
function y = myfunc (x)
function [a b c] = myfunc (x)
```

  - In-place function declaration

```
function x = myfunc (x)
function [x b c] = myfunc (x)
```

- Best when only outputs are inputs
- Must call function with same input/output

In-Place Demonstration

Compiling functions

- MATLAB does contain a compiler, which turn MATLAB files into executables
- It allows you to run MATLAB programs on a computer without MATLAB
- In general, doing this will not make your code faster

Vectorization

- An example of for loop code

```
i = 0;
for t = 0:.01:10
  i = i + 1;
  y(i) = sin(t);
end
```

- Vectorized:

```
t = 0:.01:10;
y = sin(t);
```

- Most built-in functions accept arrays

Logical Indexing

- Allows simultaneously indexing all values of an array that meet certain logical criterion

- For example, to create an array B which contains all entries in A with value less than 2:

```
B = A(A < 2);
```

- This is one of the most powerful tools in MATLAB, but can be difficult to learn

Vectorization & Logical Indexing Examples

repmat and reshape

- What if we want to create a matrix whose columns are all of the (x,y) locations in an image?

```
img = rand(3,3);

% want to create the matrix
% [ 1 2 3 1 2 3 1 2 3;
%   1 1 1 2 2 2 3 3 3 ];
```

repmat and reshape

- What if we want to create a matrix whose columns are all of the (x,y) locations in an image? Could use a nested for loop:

```
[rows, cols] = size(img);
locs = zeros(2, rows * cols);
i = 1;
for y = 1:rows
  for x = 1:cols
    i = i + 1;
    locs(:,i) = [x y]';
  end
end
```

Very slow!

repmat and reshape

- Instead can use **repmat**
- Replicates a matrix

```
>> help repmat
 repmat Replicate and tile an array.
    B = repmat(A,M,N) creates a large matrix B
    consisting of an M-by-N tiling of copies of A.
    The size of B is [size(A,1)*M, size(A,2)*N].
```

repmat and reshape

- Instead can use **repmat**
- Replicates a matrix:

```
[rows, cols] = size(img);
colidxs = repmat([1:cols], 1, rows);
% getting the right y coordinates is trickier
rowidxs = reshape(repmat([1:rows], cols, 1), ...
                  1, rows * cols);
idxs = [ rows; cols ];
% vectorized matlab code can become hard to understand
```


repmat and reshape

- Not the only (or necessarily the fastest) way to solve this problem
- In Matlab, there are often many ways to solve the same problem
  - Some fast, some slow
  - Some easy to code, others extremely hard

Still not fast enough?

- Use a compiled language
- C/C++ are known for their speed
- C code can be compiled within MATLAB
- This will not be needed for your final projects

Questions?

- http://people.cs.ubc.ca/~murphyk/Software/matlabTutorial/html/speedup.html
- http://www.mathworks.com/help/matlab/matlab_prog/techniques-for-improving-performance.html
- http://blogs.mathworks.com/loren/2007/03/22/in-place-operations-on-data/