Introduction to `fmincon`

Matlab's Optimization Toolbox

Matlab's Optimization Toolbox provides a variety of capabilties:

- solving linear and quadratic optimization problems;
- nonlinear least-squares (data-fitting);
- mixed-integer linear optimization problems;
- nonlinear unconstrained optimization;
- nonlinear constrained optimization, and;
- gradient-free optimization methods.

`fmincon`: basic usage

Using `fmincon` on linearly-constrained problems (like project 1), would look like the following:

```
1      [x,fval] = fmincon(fun,x0,A,b)
```

where the inputs are

- **`fun`:** function to be minimized
- **`x0`:** initial guess for the minimizer
- **`A`:** matrix in linear inequality $Ax \leq b$
- **`b`:** vector in linear inequality $Ax \leq b$

`fmincon`: basic usage (cont.)

The outputs are

`x`: estimated local minimizer

`fval`: value of function at x

`fmincon` Documentation

`fmincon` can do a lot more, and it is highly recommended that you read its documentation

- documentation is available under `Help` → `Product Help` or on the web
- Warning: check your version of Matlab by typing »`version` at the command line, because the web documentation may not apply to your version (for example, I am using R2012a, for which the `fmincon` documentation has changed slightly).
- If in doubt, use the documentation installed on your machine under Help.

Example

Use `fmincon` to solve

$$\min_x f(x) = (1 - x_1)^2 + 100(x_2 - x_1^2)^2$$

$$\text{s.t.} \quad x_2 \leq 2.$$

$$Ax \leq b$$

- Bonus: use the complex-step method to provide the gradient to fmincon

$$\underbrace{\begin{bmatrix} 0 & 1 \end{bmatrix}}_{A} \underbrace{\begin{bmatrix} x_1 \\ x_2 \end{bmatrix}}_{x} \leq \underbrace{\begin{bmatrix} 2 \end{bmatrix}}_{b}$$