Exercises for Practical #4 - Advanced Topics

In this practical you will start to use some of the more advanced builtin MATLAB routines and plotting features.

1. Use MATLAB to randomly determine which of these questions you attempt first.

2. Compute both the integral and maximum of $f = \sin(x) + \sin(x^2)$ on the interval $[0, 10]$. Adjust the tolerances to convince yourself that you have computed the first 10 digits accurately.

   Locate also three of the roots of the same function f on $[0, 10]$.

3. (Tricky) For what values of a does $I(a) = \int_{-1}^{1} \left(\sin(x) + \sin(ax^2)\right) dx = 1$?

4. (Hard) Fit the data from `census` to a curve of the form

   $$c_1 + c_2 \exp(c_3 t)$$

   and predict when the population of the U.S. will reach 500 million.

5. Find the roots of

   $$P(x) = 50 + 610x - 290x^2 - 1625x^3 + 225x^4 + 1030x^5$$

   using first the `roots` command and then `fzero`.

6. Implement a bisection algorithm to find the roots of the polynomial above.

7. Integrate $y\sin(x) + x\cos(y)$ over $\pi \leq x \leq 2\pi, 0 \leq y \leq \pi$.

8. Compute the 10^{th} root of $J_0(x)$ – The 0^{th}-order 1^{st}-kind Bessel function (`besselj(0,x)`).

9. Solve the initial value problem $\frac{\mathrm{d}x}{\mathrm{d}t}(t) = tx(t)$, $x(0) = 1$ on the interval $t \in [0, 2]$ using `ode23` and `ode45`. Evaluate your solution at $t = 1$.

10. Solve the boundary value problem $y'' + y'(1 - y^2) = 0$, $y(0) = -1$, $y(1) = 1$ using `bvp4c` and `bvp5c`. Find where $y(x) = 0.5$.