

# MST 383/683

## Computational Assignment #1

Due Date: September 24, 2021

In this assignment you will use Mathematica to solve the following problems. You should print out and submit the output from your Mathematica file as part of this assignment.

- Recall that the Malthus model, logistic model, and constrained logistic model for population growth are given by the following differential equations:

(a)  $\dot{N} = rN$

(b)  $\dot{N} = rN \left(1 - \frac{N}{K}\right)$

(c)  $\dot{N} = \Lambda - \mu N$

Using the DSolve command in Mathematica with initial condition  $N(0) = N_0$  determine explicit solutions to all of differential equations. For example, if we wanted to solve the equation

$$\begin{aligned} y'(x) + y(x) &= a \sin(x) \\ y(0) &= y_0 \end{aligned}$$

we would use the following command

```
DSolve[{y'[x] + y[x] == a Sin[x], y[0] == 0}, y[x], x]
{{y[x] -> -1/2 a e^-x (-1 + e^x Cos[x] - e^x Sin[x])}}
```

- Using the command NonlinearModelFit in Mathematica, solve problem #3.1 on page 63 of the text. Your output should include a single plot with the data and the three models fit to the data in different colors (avoid using green). You should include a legend to differentiate the different models fit to the data. Sample code for fitting data is included below.

```
data = {{0, 1}, {1, 0}, {3, 2}, {5, 4}, {6, 4}, {7, 5}};
nlm1 = NonlinearModelFit[data, Log[a + b x^2], {a, b}, x];
nlm2 = NonlinearModelFit[data, r * Exp[b * x], {r, b}, x];
plot1 = Plot[{nlm1[x], nlm2[x]}, {x, 0, 7},
  PlotStyle -> {{Thick, Blue}, {Thick, Red}},
  PlotLegends -> Placed[{"Logarithmic Model", "Exponential Model"}, Above]];
plot2 = ListPlot[data, PlotStyle -> {Black}];
Show[plot1, plot2, AxesLabel -> {"x", "y"}, LabelStyle -> {Black, Large}]
```

