

## MATH 3361 EXAM 1

### 1. THE RULES

- (1) Do not work with other students.
- (2) You may not consult any outside source, including other professors.
- (3) All work must be turned in, including code and writeups. Submit work via email. Make sure that your name is in the file name that you send me.
- (4) **DUE: Friday, Oct 13, noon.** Late exams will incur penalties.
- (5) Answer all questions completely. All parts of all questions are mandatory.

### 2. THE QUESTIONS

Questions 1 and 2 refer to the data set posted on blackboard.

- (1) In 1970, the bald eagle was placed on the Endangered species list, as populations crashed due to the widespread use of DDT. Between 1980 and 2000, annual population counts were made in the states where bald eagles are native. The bald eagle was downgraded in 2000 and delisted, as populations were recovering. These data are in the sheet entitled Q1 in the dataset. Perform the following analysis.
  - (a) Does the data appear to have any outliers? How could that outlier be explained?
  - (b) Use a transformation of the data to model the trend in population over time. Predict the number of bald eagle breeding pairs that will inhabit the US in 2030. Are there limits to the predictive power of your model? What are they?
  - (c) Construct a cubic spline model of the data to interpolate the population of breeding pairs for the missing years between 1963 and 2007. What does your model say that the number of breeding pairs was in 1970?
- (2) The US Census performs an Annual Community Survey that captures various characteristics of American life. The data on the sheet entitled Q2 represent the relationship between number of workers in American metropolitan areas and average commute time for those workers. Perform the following analysis.
  - (a) Determine a model that describes the relationship between population size and average commute time. Use your model

to predict the commute time for a city with 2,000,000 workers.

- (b) The New York and Chicago metro areas have extensive public transit systems. Remove those two data points and build a new model. What does your new model say that the commute time should be for a city of 9,700,000 workers? What can you say about the effect of public transit in large metropolitan areas?
- (3) Use Monte Carlo methods to estimate the following integral:

$$\int_1^n 2e^{1-t^2} dt,$$

for  $n = 1, n = 100, n = 1000$ . What is

$$\int_1^\infty 2e^{1-t^2} dt?$$