Name: _____

Math 114 Final
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Instructions

- The exam is open book, open notes, open internet, open everything except texting your friends for answers.
- Turn in your course wrapup document. (Do that now so you don't forget at the end of the exam.)
- You can find this exam at `http://www.cs.umb.edu/~eb/114/final/finalf14.pdf`.
- Write your answers on the exam paper whenever that's possible. Use the reverse side for more space.
- If you use Excel, work in just one spreadsheet. Use separate tabs (worksheets) if you use it for separate problems. When you are done, email your spreadsheet to me at my gmail address

  `ebolker@gmail.com`

  with subject line

  `Math 114 final`

  Email a copy to yourself (or put your spreadsheet on your memory stick).
- Show all your work (other than arithmetic) write full sentences (even paragraphs sometimes). Support your opinions with quantitative reasons.
- Round answers to the right number of significant digits.
- Use the internet only when you don't have the data you need in the problem statement.
- Please use your common sense.

1. An Oct. 9 2014, Boston Metro headline read "Council OKs $20K raise for its members". The article said

> The Boston City Council approved a raise from $87,500 to $107,500 per year salary for its members (in other words they voted themselves a raise).

   (a) What percent increase in salary does this represent?

   (b) If the federal minimum wage of $7.25 per hour were increased by the same percentage, how much more per year would someone earn who worked full time at the minimum wage? (Be sure to explain your definition of "full-time".)

2. Dogfish (a kind of small shark) is one of the few fish that are still abundant in New England coastal waters. According to the Boston Globe (September 9, 2014), Maine fishermen caught a little more than 100,000 pounds of dogfish in 2013 at a total value of $17,945, barely a tenth the price per pound of haddock, and less than 7 percent of the price per pound of cod. The total value of the cod catch was $736,154, while for haddock it was $211,279.

   (a) What was the 2013 price per pound of dogfish?

   (b) What were the approximate prices per pound of haddock and of cod?

   (c) Estimate the size in pounds of both the haddock and cod catch in Maine in 2013.

3. On November 14, 2014 then Secretary of Defense Chuck Hagel (he has since resigned the post) announced "the Defense Department will boost spending on the nuclear forces by about 10 percent a year for the next five years. That would be a total increase of about $10 billion over the five years."

   (a) What percentage increase will five years at 10 percent per year amount to?

   (b) Use your answer to the previous question to estimate current Defense Department spending on nuclear forces.

   (c) Compare your answer to the amount the federal government spends subsidizing school lunches. (You can do that as a Fermi problem, or with information you find on the Internet. If you use the Internet, be sure to identify your sources and comment on their reliability.)

4. In October, Eric Betzig, Stefan W. Hell and William E. Moerner won the 2014 Nobel Prize in Chemistry for inventing a microscope using fluorescence to see such tiny things as the creation of synapses between brain cells. According to the Boston Globe:

> In 1873 Ernst Abbe [another German scientist] said that [microscopic] resolution could never be better than 0.2 micrometers, or around 500 times smaller than the width of a human hair.

(a) Use the data in this quote to estimate the width of a human hair. Choose the appropriate metric unit of length: meter, millimeter, micrometer, or nanometer.

(b) Use the web to confirm the accuracy of your estimate.

(c) The article went on to say that the fluorescent microscope now allows scientists to "peer into the nanoworld."

- Express the width of a human hair in nanometers.
- How much smaller than a human hair are the things scientists can now see?

5. The Excel file `CSMquotes.xlsx` contains data on the number of words in quotes used in our *Common Sense Mathematics* textbook.

   That file is available on the lab computers, and at `http://www.cs.umb.edu/~eb/114/final/CSMquotes.xlsx`.

   (a) Create a properly labeled histogram displaying this data. You may sketch the histogram on your exam paper or print out and attach to your exam one you drew using Excel.

   (b) Calculate the total number of quotes.

   (c) Estimate the total number of words in the quotes.

   (d) Estimate mode, median and mean quote sizes, and mark them on your histogram.

   (e) Explain why the mean is the largest of the three averages.

   (f) Estimate the total number of words in the text (you can use the online copy of the text in the lab if you wish).

   (g) Estimate the percentage of words in the text that are in quotes

6. On December 1, 2012 R. Alexander Bentley and Michael J. O'Brien wrote in *The New York Times* that

> [F]or the last 300 years, the number of words published annually grew exponentially by about 3 percent per year. From about 20 million words for 1700, the annual word count grew to several trillion for 2000.

   (a) Check the authors' arithmetic.

   (b) How long did it take for the 20 million word count of 1700 to double to 40 million words annually?

   (c) If the growth continues at the same rate how many words will be published in the year 3000?

   (d) How much confidence do you have in your prediction?

7. Suppose a lottery with 1,000,000 tickets has a first prize of $200,000, three second prizes of $60,000 each and 100 third prizes of $200 each.

   (a) What is the probability that a ticket wins the first prize?

   (b) What is the probability that a ticket wins some prize?

   (c) What is the fair price of a ticket?

   (d) How much should the state charge for a ticket if it needs 10% of the revenue for overhead and wants to make $500,000 profit?