Topics for Project in Math 1030

1. Investigating Water Usage (Ch 2, 3: estimation, unit conversion, making sense of large numbers, percents). How much water do you use daily? The total water use in the US is estimated at 408 billion gallons per day, which includes both fresh water and salt water, withdrawn for all uses. In this project we'll look at in-house water use and at water used for lawns.

In-House Water Use: First, discuss in your group how to estimate i) the average number of gallons that flow from faucets per minute in your house or apartment, and ii) the average number of minutes per day (use data from at least three days) that you use faucets in your house or apartment for purposes other than washing dishes, bathing/showering. Next, based on your group results, estimate the average number of gallons of water a person in the US draws daily from faucets in a house for purposes other than dishwashing, bathing/showering. According to the US Geological Survey, water drawn from faucets for purposes other than dishwashing, bathing/showering represents about 13.4% of the **total** in-house water used by a person daily. Using this information, estimate the average number of gallons of in-house water a person uses **each year** in the US. If this water were to fill a 13 foot high room with a square floor, what would the dimensions of the floor be? Report your findings in the form of an essay on per person water use in the US. Discuss your estimation methods, report both individual and group estimates made, and discuss the possible sources of error in your estimates.

Water Used for Lawns: The data below show the Salt Lake City Corporation water use records for one year for a family in Salt Lake City. The SLC Corporation uses one unit to represent 100 cubic feet of water. As you can see the number of units used increases from March through October when lawn watering activities are highest. Estimate the percentage of this family's water use that goes towards watering the lawn. Be sure to describe how you obtained your estimate. This family's lawn is 3200 square feet of Kentucky Bluegrass which requires about 30 inches of water per year. In both absolute and relative terms, compare the amount of water this lawn requires per year and the amount used by this family for lawn care per year.

Month											
1	2	3	4	5	6	7	8	9	10	11	12
Units Used											
6	7	7	13	35	50	56	54	30	7	6	7

Most lawns in Utah use Kentucky Bluegrass which requires a lot of water. Investigate what other varieties of grass might be used that would require less water per year and the percentage saving in water possible. Also investigate what water conservation practices should be followed in order to maintain a lawn without wasting water.
(Some useful sources are:
http://water.usgs.gov

http://www.deq.utah.gov
http://www.slcgov.com/waterconservation)

2. Planning for Retirement (Ch 4: compound interest; investment plans; percents) Many practical questions arise in dealing with one's finances. Pick a newspaper or magazine article published during the past year that discusses the savings patterns of Americans (provide the name of the newspaper/magazine and the date of the article). Examine the article in your group, summarizing the points made, and then do the following problem.

Suppose that Sarah, age 30, opens a bank account paying 1.85% annual interest compounded monthly. She plans to deposit $250 each month in the account. Assuming the interest is the same for the next 35 years, how much will Sarah's account be worth when she retires at age 65? Compare her accumulation to her total investment both in absolute and relative terms. Then, do the same analysis for Josh who is 20 and for Beth who is 40 (assuming that Josh and Beth will retire at 65 and will be saving until that age). Now, summarize and compare the investment results of these three people and discuss the implications for saving for retirement. Certainly saving from a younger age will accumulate more funds, but are there any other noteworthy results from your data? How would you compare the return on the investments made? Were there any connections between your calculations and the article you've read? (In doing your calculations you will find the formulas in Ch 4 very helpful.)

Now, determine how much you think you can afford to save per month and determine what kind of interest rate you could get at your bank. Depending on how old you are and when you want to retire, determine how much savings you could accumulate. Would it be possible to live on the interest from your accumulation when you retire? Estimating a 2.75% APY at that time, what would your annual interest, or your yearly income from your savings, amount to when you retire? Determine how much this yearly income would be in terms of today's dollar if you assume 2.5% annual inflation over the years till you retire. Suppose you merely wanted your interest from the account to supplement your retirement income (the more likely scenario) and to correspond to $30,000 today, how much should you plan to have in your savings account when you retire and what would you need to deposit each month to reach that goal? Most likely the interest from your savings will be only one of the sources of income you will have when you retire. What other methods of saving or sources of income are generally used to plan for retirement? Discuss some of these briefly and present their benefits and drawbacks. Check out some web sites on retirement issues (if you need more information). Finally summarize your findings and any conclusion(s) your group has made.

3. Home Mortgage (Ch 4: compound interest, savings and loan formulas) In this project assume that you have a regular job, that you are planning to buy a house and that you want to investigate some of the financial aspects of buying a house and obtaining a mortgage. First, determine what criteria you desire in your house and then either contact a

realtor or use the internet to find out the approximate cost of such a house. Then decide how much you can afford as a down payment and what you will need to borrow.

Now, shop around for a mortgage, contacting at least two mortgage companies or banks, and find out: a) The APR for a 15 year loan, 20, 30 year loan, and for an adjustable rate mortgage; b) The total closing cost - you may want to get a truth and lending statement
c) Determine the cost of mortgage insurance - can you afford a large enough down payment to eliminate mortgage insurance.

With the above information, choose a mortgage company and calculate the following:
a) The monthly payment on each of the 15 year loan, 20 year loan and the 30 year loan. Be sure to show your calculations. Does this agree with what the lender quoted?
b) Next calculate the total cost of the 15 year loan, 20 year loan and the 30 year loan as well as how much you will pay in interest for each loan (in $ terms and % terms).
c) If you could afford to pay an extra $200 a month toward your principle, estimate by trial and error (or see your instructor for an easier method) how long would it take you to pay off your mortgage. How much would you save in interest over the length of the loan? Would you be better off in the long run if you invested this $200 a month in a mutual fund? Explain.

Now investigate the adjustable rate mortgage. What will your starting monthly payments be? What is the upper limit of the APR? How fast can it move to the upper limit and what would your monthly payments be if you did have to pay the upper limit on the APR? Check out the following web site and report any useful information you find here.
Finally, summarize your findings as you examine the circumstances under each option might be the most reasonable choice.

4. Financial Aspects of Buying a Car (Ch 4: compound interest, loans, amortization tables) You want to buy the "car of your dreams". Determine the price of the "car of your dreams" by going to a new car dealership or looking in the newspaper. Find out the tax and the license fees for the car. Let's assume that you cannot buy the car outright and will need a car loan. Contact at least two of the following: a bank, credit union, or other financial institution. Find out the rates for 3-year, 4-year, 5-year auto loans. Also find out what percentage down payment is required. State which financial institution you have chosen to use and why. Include all your calculations.

Now, calculate the amount of the loan you will need (selling price of the car minus the down payment) and use one of the formulas in Ch 4 of your text to calculate your monthly payment on the loan. Calculate the payments for: i) 3-year loan, ii) 4-year loan, iii) 5-year loan. Also, calculate the amount of money that you will need before you can take possession of the car (down payment, tax, license fees). Now write an amortization schedule for the **first year** of payments on the 3,4, and 5 year loans. You should include the following:

Payment No. Payment Amount Interest Paid Principal Repaid Balance

Then, calculate the total amount that you will pay for each of those auto loans over the three, four, or five year period.

Suppose that instead of buying the car, you decide to lease the car. What costs will you incur? Find the amount you would have to put down if you were to lease the above car for three years. Also find the monthly lease payment and figure the total amount you will pay over the life of the lease. Then compare the cost of having the car (excluding gas, maintenance, et cetera) for three years if you take out a lease for that time with the cost of the three-year loan. Remember that to make these situations comparable, you must take into consideration that at the end of the three year loan you will own the car as an asset, with the lease you will not own the car. Estimate what the car will be worth at the end of the three years and then find a way to use this information in making your comparison reasonable.

Estimate the number of miles you drive in a month. (Don't just guess, do some work to make the estimate really mean something.) Will you have to pay extra for your lease for high miles? If so, how much will that cost over the life of the lease? How would this affect the analysis you did comparing the cost of leasing the car and the cost of buying the car?

Finally, be sure to summarize your findings from your research and calculations in paragraph form as a report. Include in your discussion an analysis and commentary on the merits/drawbacks of the different loans and the lease.
Has this project been a valuable experience for you? Explain.

5. College Funds For Your Children (Ch 4: compound interest; investment plans; evaluating financial decisions and planning for future expenses) Putting a child through college is a huge expense. In this project you will explore the cost of college for your children and an investment strategy to cover the costs. If a member of your group has children and you want to investigate these issues for his or her family, then do so. Otherwise, I will supply you with a hypothetical family with two children to send to college. The first child will start college in 15 years. The second child will start college in 16 years. First, for each child, select a university you would like him or her to attend. Find the annual cost of room and board in a dormitory and tuition at each school. Assume that the inflation rate will be a constant 3% each year for the next 21 years, and assume that each child will attend college for five years. How much will tuition, room and board cost for each child, each year he or she is at college? Summarize your results in a table, including the total you will spend each year and the total cost for each child's education.

Next, we need to figure out how much to deposit each month in an investment plan to pay for everything. I will describe one investment strategy. You will have a child in school each year for a total of six years (with the hypothetical family). Contact at least one financial institution to find the APR for a savings account. Then open one savings account for each year you will have at least one child in college. Savings Account #1 will hold the money for the first year of college expenses, when only one child will be attending college. Savings Account #2 will hold the money for the second year of college

expenses, when both children will be attending college, and so on. You will have six savings accounts in all.

From your chart, you will know how much you will want in savings account #1 after 15 years. Compute the monthly payment required to reach this goal. Also from your chart, you know how much you will want in savings account #2 after 16 years. Compute the monthly payment required to reach this goal. Do this for each of the six savings accounts, then add the six different monthly payments together to find your total monthly payment. Discuss whether this will be a reasonable amount for you to invest each month. Finally, compute the total amount you will have invested and compare this to the total cost of your children's educations. Discuss the benefits and drawbacks of this investment plan. Can you think of a better plan?

6. Population Projections : (Ch.3, 8, 9: absolute and relative change, linear models, exponential model)

First, describe and compare linear and exponential growth in your own words. Then, give 3 examples of each type of growth explaining why it would be linear/exponential growth.

i) Do you think that the population in Utah has grown linearly or exponentially over the last 100 years? Please see the data bellow and make sure to use a graph and appropriate calculations of the absolute and relative changes over time to justify your answer.

Year:	Population of Utah:	Year:	Population of Utah:
1900	276,749	1960	890,627
1910	373,351	1970	1,059,273
1920	449,396	1980	1,461,037
1930	507,847	1990	1,722,850
1940	550,310	2000	2,233,169
1950	688,862	2003	2,351,467
		2006	2,550,063
		2009	2,784,572
		2010	2,763,885
		2012	2,855,287

The projection of Utah population for the year 2030 is 3,485,367. What does your graph show (make an estimate)?

ii) From the latest census data available, select the m-th largest city in USA, where $m = \frac{x}{4} + 7$, x represents the last two digits of you student identification number. (Please round m to the nearest whole number.) This is your city. For example, if your student ID number ends in 37, you should find the data for the 16th largest city in the United States. Using internet site(s), find and record the populations (using a table) for your city in 1910, 1920, 1930, 1940, 1950, 1960, 1970, 1980, 1990, 2000, 2010. Find the absolute and relative change in population during this period (decade to decade and overall). Can you see any big gap in your data? Can you explain any big changes (if that is the case)?

Plot you data on a graph. Develop (derive) linear equations that model the data. It could be based on two actual points (that fit the line the well), or you should come up with the

line that visually fits the data well. Draw your line on your graph and discuss the meaning of the slope of the model. Use the linear model (that you developed) to predict the population for 2013, 2015, 2025 and 2050?
Next, develop an exponential equation to model your population data, and sketch it on your graph. What does this model predict for the year 2013, 2015, 2025 and 2050? How do these values compare to the values you found using a linear model?
Find the estimated population for 2013 using U.S. Census web site and compare it to the value that your models predicted. Do the same for the year 2010, 2025 and 2050 (compare U.S. Census projection for those years with the prediction that you got using your model).
In your opinion, which graph/model would better represent the population of your city?

Note: Some useful sites: www.nationsonline.org/oneworld , www.census.gov.

7. Periodic Drug Doses: (Ch 8, 9: exponential models, half-life, working with logarithms) First, describe and compare linear and exponential growth in your own words. Then give examples of each type of growth that are drawn from the fields of study of the students in your group. Be sure to describe your examples clearly and state the area of study from which each example is drawn.

Now consider the following situation. It is common to take a drug (such as aspirin, ibuprofen, antibiotic) repeatedly at a fixed time interval. Suppose that an antibiotic has a half-life of 12 hours and that an initial dose of 200 milligrams is given followed by a 100 milligrams dose taken every 8 hours. First describe the amount of antibiotic left in the bloodstream that remains from the initial dose t hours after the initial dose is taken as a function of t. Eight hours after the initial dose, a second dose is taken. How much of the drug is in the bloodstream now when you combine both the remains of the initial dose and the second dose? Sixteen hours after the initial dose is given a third dose will be taken. Combining the remains of first two doses with this third dose, how much of the drug is now in the bloodstream? Continuing in the same way, determine the amount of antibiotic in the bloodstream just after the follow-up dose is taken at 24 hours, 32 hours, 40 hours, 48 hours, . . ., 80 hours and display your results in a table. Then illustrate your results with a graph of the amount of antibiotic in the bloodstream for the first 80 hours after the initial dose is taken. Looking at your table and your graph, and assuming the dose continues as above, determine whether the amount of the drug in the bloodstream tends to increase, decrease, or does not change over time. If you decide that it increases or decreases, does it approach a limiting value over time and if so, can you estimate what that might be? Justify your answers to these questions in a quantitative way. If possible (ask your instructor for some help), write down an equation that will describe the amount of drug in the bloodstream 8n hours after the first dose in terms of n. Your equation will involve expressions of the form $(1/2)^{(8/12)n}$. Now, carry out the same investigation assuming that the initial dose is 400 milligrams. Do you notice anything interesting when you compare the graphs for your two initial doses? Next, suppose that instead of having the dose continue indefinitely, the last dose takes place 120 hours (5 days) after the first dose. How long will it take for the amount of drug remaining in the bloodstream to be less than 10 milligrams?

Consult a pharmacist (or read the fine print on the information sheet enclosed with many medicines) to find the half-live of a common drug other than ibuprofen. Create a model for the metabolism of that drug using the above procedure with the initial dose equal to the recommended dose and the time interval for each dose equal to that recommended on the package. Make a table and a graph that shows the amount of the drug in the bloodstream when each dose is taken over a three-day period. Summarize your results for this drug in a paragraph.

8. A Growing Income Gap? (Ch 8, 9: developing and analyzing a linear model; interpreting slope; absolute and relative change) In recent years there have been increased concerns that the gulf between income groups in the United States has widened. Do some research to find two articles published in newspapers or magazines during the last five years that address these issues. Summarize the main points in the articles.
The data below represents the mean income (in dollars) over the years 1990 to 2011 for the three groups: all US households, the top 20% of US households, and the top 5% of US households.

		Mean Income	
Year	All US Households	Top 20% of US households	Top 5% of US households
1990	37,403	87,137	138,756
1991	37,922	88,130	137,532
1992	38,840	91,110	144,608
1993	41,428	101,253	173,784
1994	43,133	105,945	183,044
1995	44,938	109,411	188,828
1996	47,123	115,514	201,220
1997	49,692	122,764	215,436
1998	51,855	127,529	222,283
1999	54,737	135,401	235,392
2000	57,135	141,620	250,146
2001	58,208	145,970	260,464
2002	57,852	143,743	251,010
2003	59,067	147,078	253,239
2004	60,466	151,438	263,896
2005	63,344	159,583	281,155
2006	66,570	168,170	297,405
2007	67,609	167,971	287,191
2008	68,424	171,067	294,709
2009	67,976	170,844	295,388
2010	67,392	169,391	287,201
2011	69,677	178,020	311,444

Present the above data on a scatter plot using different symbols to represent the three groups. Determine the line of best fit for each group (without using a computer) and interpret the slopes of the three lines in the practical terms of the problem. Use your

graph to consider the question, "Is the income gap widening in the US?" In your analysis be sure to take into consideration that when we examine income, we generally think in terms of percent change and that while a $10/hr raise for each of two people earning $20/hr and $50/hr respectively is the same amount of increase in dollars, the first person gets a 50% raise while the second person gets only a 20% raise.

The data reported above has not been adjusted for inflation. Since $1 in 2011 does not have the same purchasing power as $1 in 1990, a real comparison of income should take the purchasing power of the dollar in a given year into consideration. The Consumer Price Index is often used to adjust for effects of inflation. Use the inflation calculator on the Bureau of Labor Statistics web site, http://www.bls.gov/data/inflation_calculator.htm to determine the purchasing power of $1.00 in 1990 in terms of 2011 dollars. Do this for each year from 1990 through 2011 and report your results. Then, using these factors rewrite the above table in "inflation adjusted income" or, more precisely, in 2011 dollars. Now do the same analysis on the inflation adjusted data that you did on the data above. Explain the effect of adjusting for inflation on your conclusions above. Finally, relate your own analyses and calculations to the information in the articles you have read and summarize your group's conclusions about an income gap in the United States.
www.census.gov has a lot of articles and tables that can be helpful.