UNIVERSITY HONORS PROGRAM

SENIOR PROJECT - APPROVAL

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PROJECT TITLE: A Quest for Knowledge: Mathematical Webquests for the High School Classroom

I have reviewed this completed senior honors thesis with this student and certify that it is a project commensurate with honors level undergraduate research in this field.

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Comments (Optional):

A Quest for Knowledge: Mathematical WebQuests for the High School Classroom

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Begin the Journey

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A Quest for Knowledge: Mathematical Webquests for the High School Classroom

Abstract

The objective of this project is to develop several WebQuests that can be implemented into the high school math classroom. The educational advantages of using these WebQuests in the classroom are multi-faceted. The quests offer real-world applications of mathematical concepts and provide a change of pace from regular classwork. Students gain experience with computers and the Internet, as well as with computer applications such as Microsoft Excel. WebQuests also offer students the opportunity to explore the given topic and to learn at their own pace. Cooperative learning and interdisciplinary study is also possible with some of the WebQuests.

Topics for the WebQuests include cryptography in conjunction with matrices, travel planning involving the estimation of expenses, analysis of the stock market through the graphing of data sets and the calculation of percent increase and percent decrease, and the use of the performance of different baseball players to make basic statistical calculations and to set up and evaluate equations involving unknown variables. The WebQuests are designed primarily for the Algebra I and Algebra II level of mathematics, and each quest incorporates at least one curriculum standard for a high school math course. Representing real-world applications using real numbers, collecting and representing data sets developed from the real world, modeling real-world phenomena using graphs, interpreting graphs that depict real-world phenomena, performing operations on algebraic expressions, and using matrices in real-world problem solving are among the many curriculum standards that are met through these WebQuests.

Introduction

A WebQuest is a web-based project whose completion requires students to acquire and

integrate new information. Most or all of the resources and references required for understanding and completing the project will be found on-line. In general, WebQuests usually contain the following sections:

1. an Introduction
2. a statement of the Task
3. a list of information Resources (usually links that students can follow to find more information)
4. a statement of the Process (the steps that need to be taken to complete the task)
5. a Conclusion (which wraps things up and reminds students what they have learned).

The WebQuest may also include Guidance and Evaluation sections. The Guidance section gives the students guidelines on how the teacher wants the information to be organized and submitted for grading. The Evaluation section outlines how the teacher plans to grade the project.

Purpose

There are two main reasons for making these WebQuests.

1. Access to computers and the internet in schools has increased over the years, and teachers are looking for ways to integrate technology into their classrooms. WebQuests are a way to do this. By creating the WebQuests, I hope to gain the practical experience of coming up with creative applications of math and the technical experience of creating webpages through which students can explore these applications.
2. As a teacher, it is my hope that students get the most out of their learning experience. Most students will not understand and remember the information that they "learn" in school if they are simply forced to memorize formulas and algorithms. It is my belief that students learn more by becoming involved in the learning process through hands-on activities. Students are also more willing to learn if they feel that the information they are being asked to learn is relevant. Thus, by creating and implementing projects involving real world applications, teachers are more likely to get students interested in learning. Also, by allowing students to explore the applications at their own pace, they have time to process and understand the math concepts behind the applications.

Contents

This project contains four WebQuests.

1. The Matrix

In this WebQuest, students look at a message encoded by a simple substitution code. The students break the code using the idea of letter frequency, combined with logical reasoning skills. For a copy of the cracked code, along with hints as to how to break the code, click here. After breaking the code, students are asked to look at a more secure way of encoding a message. This method involves matrix multiplication.

2. The Stock Market
   In this WebQuest, students are asked to choose three companies that they would like to observe. The students observe the daily performance of their chosen stocks for a two week period. The students then look at the yearly performance of their stocks for the past ten years. The students analyze the data by creating line graphs and calculating percent increase and decrease. By looking at their analysis, students determine in which stocks they would choose to invest their money.
3. Play Ball!!!!!
   In this WebQuests, students become the general manager of their favorite baseball team. They have offered bonuses to players who bat .300 or better for the season. The students estimate how many players will bat .300 or better and then calculate how many extra tickets must be sold to cover the cost of the bonuses.
4. Road Trip (A Map To Get You There)
   In this WebQuest, students get to plan the perfect senior trip. They plan everything: the destination, the lodging, the food, the activities, etc. The only catch is that they have to pay for the trip themselves. So, they have to plan the trip, estimate the cost, and then decide how much they are going to have to work in order to pay for the trip.

Notes to Teachers

For teachers in the state of Tennessee, here are the mathematics curriculum standards that may be covered by each of these WebQuests.

1. The Matrix
   - Using matrices in real-world problem solving (Estimation, Measurement, and Computation - Algebra I and Algebra II)
2. The Stock Market
   - Using real numbers to represent real-world applications (Number Sense and Number Theory - Algebra I)
   - Interpreting graphs that depict real-world phenomena (Patterns, Functions, and Algebraic Thinking - Algebra I and Algebra II)
   - Modeling real-world phenomena using functions and graphs (Patterns, Functions, and Algebraic Thinking - Algebra I and Algebra II)
   - Collecting, representing, and describing linear and nonlinear data sets developed from the real world (Statistics and Probability - Algebra I and Algebra II)
   - Choosing, constructing, and analyzing appropriate graphical representations for a data set (Statistics and Probability - Algebra I and Algebra II)

3. Play Ball!!!!!
   - Using estimation to make predictions and test reasonableness of results (Estimation, Measurement, and Computation - Algebra I)
   - Applying the concept of variable in solving equations (Patterns, Functions, and Algebraic Thinking - Algebra I)
4. Road Trip (A Map To Get You There)
   - Communicating the concepts and strategies being used in estimation, measurement, and computation (Estimation, Measurement, and Computation - Algebra I)
   - Solving problems in number theory, geometry, probability and statistics, and measurement and estimation using algebraic thinking and symbolism (Patterns, Functions, and Algebraic Thinking - Algebra I)

References

- General WebQuest Links
  - Building Blocks of a WebQuest: http://edweb.sdsu.edu/people/bdodge/webquest/buildingblocks.html
  - Matrix of Examples: http://webquest.sdsu.edu/matrix.html
  - Some Thoughts About WebQuests: http://edweb.sdsu.edu/courses/edtec596/about_webquests.html
  - The WebQuest Page: http://webquest.sdsu.edu/webquest.html
  - WebQuests: A Strategy for Scaffolding Higher Level Learning: http://webquest.sdsu.edu/necc98.htm

- WebQuest 1: The Matrix Links
  - Another letter frequency page: http://home.ecn.ab.ca/~jsavard/crypto/pp0101.htm
  - All possible two-letter words, along with some common three- and four-letter words, common word endings, and patterns in punctuation: http://www.mindspring.com/~fmnshare/help.htm
  - Careers with RSA Security: http://www.rsasecurity.com/careers/index.asp
  - How cryptography is used today: http://www.rsasecurity.com/rsalabs/faq/1-4.html
  - Literary Cryptograms: http://books.mirror.org/litcrypt/index.html
  - The National Security Agency: http://www.nsa.gov/programs/employ/index.html
  - RSA Security Company: http://www.rsasecurity.com/company/corporate.html
  - Substitution Codes: http://home.ecn.ab.ca/~jsavard/crypto/ppen01.htm
  - Terminology: http://www.ssh.fi/tech/crypto/intro.html#terminology
  - The Oxford Dictionary's letter frequency chart: http://www.askoxford.com/asktheexperts/faq/aboutwords/frequency
  - Three different letter frequency charts: http://raphael.math.uic.edu/~jeremy/crypt/freq.html
  - What is Cryptography:

http://www.rsasecurity.com/solutions/developers/whitepapers/IntroToCrypto.pdf
  - "Where Mathematics Meets Computer Science:" http://math.usask.ca/document/netinfo/careers.html

- WebQuest 2: The Stock Market Links
  - Microsoft Excel formulas: http://www.barnard.edu/at/training/excel/expage5.html
  - Microsoft Excel line graphs: http://www.barnard.edu/at/training/excel/expage6.html
  - Stock symbols from Yahoo Finance: http://finance.yahoo.com/l
  - Yahoo Finance: http://finance.yahoo.com/.

- WebQuest 3: Play Ball!!!!! Links
  - Baseball Alamanac: http://www.baseball-almanac.com/stats.shtml
  - Baseball Reference: http://www.baseball-reference.com/
  - Baseball Reference Glossary: http://www.baseball-reference.com/about/bat_glossary.shtml
  - CBS-Sportsline: http://www.sportsline.com/u/baseball/mlbcom/stats/playerstats.htm
  - Major League Baseball: http://www.mlb.com
  - Major Leage Baseball Statistics: http://mlb.mlb.com/NASApp/mlb/mlb/baseball_basics/mlb_basics_stats_101.jsp

- WebQuest 4: Road Trip (A Map To Get You There) Links
  - Amtrak: http://www.amtrak.com/
  - Best Western: http://www.bestwestern.com/
  - Carnival: http://www.carnival.com/
  - Days Inn: http://www.daysinn.com/DaysInn/control/home
  - Disney Cruises: http://disneycruise.disney.go.com/disneycruiseline/index
  - Fuel Economy: http://www.fueleconomy.gov/feg/findacar.htm
  - Hilton: http://www.hilton.com/en/hi/index.jhtml
  - Holiday Inn: http://www.sixcontinentshotels.com/holiday-inn
  - Hyatt: http://www.hyatt.com/corporate/index.jhtml
  - Kampgrounds of America (KOA): http://www.koa.com/
  - Lodging.com: http://www.lodging.com/
  - MapQuest: http://www.mapquest.com
  - Marriott: http://www.marriott.com/
  - The National Park Service: http://www.nps.gov/
  - Norwegian Cruise Line: http://budgetcruiser.com/cruiselines/NCL/ncl.asp?referID=31115
  - Orbitz: http://www.orbitz.com
  - Reserve America: http://www.reserveamerica.com/
  - Royal Caribbean: http://www.royalcaribbean.com/asp/default.asp
  - Sheraton: http://www.starwood.com/sheraton/index.html
  - Travelocity: http://www.travelocity.com

- Travelodge: http://www.travelodge.com/Travelodge/control/home
- Yahoo search results for hotels: http://dir.yahoo.com/Business_and_Economy/Shopping_and_Services/Travel_an

The Matrix

Introduction

Have you ever wanted to send a secret message? Or wanted to crack the code of a secret message? How might you go about trying to crack a coded message? Are some methods of encoding a message more resistant to being broken than others? For the answers to these questions, continue reading.

Task

- Your first task is to decode or decrypt the following message, which will tell you what your task is for the remainder of the WebQuest.
- Encoded Task Message:
  QT LJP FKB KBFAQOS MIQV, MIBO LJP YBKB FCZB MJ CKBFN MIB DJAB.

  IJY IFKA YFV QM MJ ABDJAB MIQV EBVVFSB?

  IJY ZJOS AJ LJP MIQON QM YJPZA MFNB F HKJTBVVQJOFZ VHBDQFZQGQOS QO DKLHMJZJSL MJ ABDJAB MIB EBVVFSB?

  DFO LJP MIQON JT F EJKB VBDPKB YFL MJ BODJAB F EBVVFSB?

  MIB OBWM HFKM JT MIB YBCUPBVM TJDPVBV JO BODJAQOS F EBVVFSB PVQOS VJEBMIQOS DFZZBA MIB IQZZ DQHIBK.

  LJP YQZZ PVB F EJAQTQBA XBKVQJO JT MIB IQZZ DQHIBK MJ BODJAB LJPK JYO VBDKBM EBVVFSB.

  TJK MIB KBVM JT MIB QOVMKPDMQJOV, SJ MJ MIB YBC FAAKBVV FOA DIFOSB "1TKFEBMBEH.IMEZ" MJ "1IQZZDQHIBK.IMEZ".

Process

- Follow the links to find out more about cryptography and substitution codes.

- Assume that the encrypted message was obtained by using a simple substitution code. Think about how you might break the cipher. Follow the links on letter frequencies.

- Calculate the frequency of the letters in the Encrypted Task Message. Make a chart with the letter in the first column and the letter's frequency in the second column. Arrange the letters from the most frequent to the least frequent.

- Try to decode the message given in the Task by comparing the frequencies that you calculated with the frequency for the letters in the English language. Remember, the letter frequencies are just a guide. You may also have to use your logical reasoning skills to help break the code. For example, try to figure out the two-letter words, as there are a limited number of two-letter words in the English language. Also look at double letters and word endings (such as -ing and -ion). You also need to remember the context of the message. We are talking about codes and encoding and decoding messages, so you might want to look for some of those words in the message. If you get stuck, check out the hints page.

- Follow the instructions given in the Encoded Task Message.

Resources

- Here are some links about cryptography and substitution codes.
  - Terminology: http://www.ssh.fi/tech/crypto/intro.html#terminology
  - What is Cryptography: http://www.rsasecurity.com/solutions/developers/whitepapers/IntroToCrypto.pdf (Just read the section titled "What is Cryptography?".)
  - Substitution Codes: http://home.ecn.ab.ca/~jsavard/crypto/ppen01.htm

- Here are some links on letter frequencies.
  - Here is a chart from the Oxford Dictionary that tells how often letters in the English language occur as a percentage.
  - Here is a page that gives three different charts for the frequency of letters in the English language. If you multiply the frequencies given by 100, you will obtain the percentage of time that the letter occurs compared to other letters.
  - Here is another page that tells how often letters in the English language occur as a percentage.
  - Here is a page that lists all the possible two-letter words, along with some common three- and four-letter words, common word endings, and patterns in punctuation.

- Do you need a hint to help you decode the Encoded Task Message?

Conclusion

The idea of sending a coded message is not new, and people have been trying to break codes for as long as people have been sending coded messages. How did you use math to analyze and crack the Encoded Task Message? How did you use math to make a code that was harder to break?

If you are interested in careers in cryptology, check out the following links to find out more about how cryptography is used and what careers are available.

- Check out the first part of "Where Mathematics Meets Computer Science."
- What about working for The National Security Agency?
- Click here for information on how cryptography is used today (including cell phones and e-commerce).
- Here is some information on the RSA Security company and careers with RSA Security.

Did you enjoy cracking the Encoded Task Message? If so, check out the following page for fun with cryptograms.

Literary Crytograms

Hints

- Hint #1: For the four least frequent coded letters, the correct corresponding real letters can be found by looking at the Encyclopedia Britannica letter frequency chart.

- Hint #2: The coded letter that represents the real letter S appears 6.85% of the time.

- Hint #3: The coded letter that represents the real letter G appears 3.20% of the time.

- Hint #4: The coded letter that represents the real letter P appears 1.83% of the time.

The decode message should read:
"If you are reading this, then you were able to break the code. How hard was it to decode this message? How long do you think it would take a professional specializing in cryptology to decode the message? Can you think of a more secure way to encode a message? The next part of the WebQuest focuses on encoding a message using something called the hill cipher. You will use a

modified version of the hill cipher to encode your own secret message. For the rest of the go to the web address and change "1frametemp.html" to "1hillcipher.html".

Letter Chart

Coded Letter	# of Occurences	Frequency	Percentage
A	18	0.0410959	4.11%
B	62	0.1415525	14.16%
C	4	0.0091324	0.91%
D	18	0.0410959	4.11%
E	12	0.0273973	2.74%
F	27	0.0616438	6.16%
G	1	0.0022831	0.23%
H	8	0.0182648	1.83%
I	27	0.0616438	6.16%
J	42	0.0958904	9.59%
K	21	0.0479452	4.79%
L	9	0.0205479	2.05%
M	36	0.0821918	8.22%
N	4	0.0091324	0.91%
O	23	0.0525114	5.25%
P	13	0.0296804	2.97%
Q	28	0.0639269	6.39%
R	0	0	0.00%
S	14	0.0319635	3.20%
T	10	0.0228311	2.28%
U	1	0.0022831	0.23%
V	30	0.0684932	6.85%
W	1	0.0022831	0.23%
X	1	0.0022831	0.23%
Y	10	0.0228311	2.28%
Z	18	0.0410959	4.11%

Total	438	1	100.00%

Sorted Letter Chart

Coded Letter	# of Occurences	Frequency	Percentage
R	0	0	0.00%
G	1	0.0022831	0.23%
U	1	0.0022831	0.23%
W	1	0.0022831	0.23%
X	1	0.0022831	0.23%
C	4	0.0091324	0.91%
N	4	0.0091324	0.91%
H	8	0.0182648	1.83%
L	9	0.0205479	2.05%
T	10	0.0228311	2.28%
Y	10	0.0228311	2.28%
E	12	0.0273973	2.74%
P	13	0.0296804	2.97%
S	14	0.0319635	3.20%
A	18	0.0410959	4.11%
D	18	0.0410959	4.11%
Z	18	0.0410959	4.11%
K	21	0.0479452	4.79%
O	23	0.0525114	5.25%
F	27	0.0616438	6.16%
I	27	0.0616438	6.16%
Q	28	0.0639269	6.39%
V	30	0.0684932	6.85%
M	36	0.0821918	8.22%
J	42	0.0958904	9.59%
B	62	0.1415525	14.16%

How to obtain this chart:

1. Copy the original Letter Chart.
2. Highlight the entire chart, including the headers (letter, number of occurences, ect.)
3. Click on the Data menu.
4. Choose Sort.
5. Choose Sort by: # of occurences, ascending.

   (You can also sort by "frequency" or "percentage." Since the numbers in each row are all related, sorting the rows by "number of occurences," "frequency," and "percentage" will all give the same result.)

6. Click OK.

Here is an ordered list of the coded letters. It is arranged from least frequent to most frequent.

The list of coded letters is placed side by side with lists of letters ordered from least frequent to most frequent. The ordered lists of letters are taken from the web resources on the WebQuest.

Coded Letter	Percent	Oxford Dic.	Percent	Britannica	Percent	~jsavard	Percent
R	0.00%	Q	0.20%	J	0%	Z	0.06%
G	0.23%	J	0.20%	Z	0%	Q	0.11%
U	0.23%	Z	0.27%	Q	0%	J	0.13%
W	0.23%	X	0.29%	X	1%	X	0.22%
X	0.23%	V	1.01%	K	1%	K	0.61%
C	0.91%	K	1.10%	V	1%	V	0.99%
N	0.91%	W	1.29%	W	1%	B	1.60%
H	1.83%	Y	1.78%	B	2%	Y	1.73%
L	2.05%	F	1.81%	U	2%	P	1.85%
T	2.28%	B	2.07%	G	3%	G	1.87%
Y	2.28%	G	2.47%	F	3%	W	2.06%
E	2.74%	H	3.00%	Y	3%	F	2.53%
P	2.97%	M	3.01%	M	3%	M	2.56%
S	3.20%	P	3.17%	P	3%	C	2.75%
A	4.11%	D	3.38%	D	4%	U	2.83%
D	4.11%	U	3.63%	L	4%	L	4.00%
Z	4.11%	C	4.54%	H	4%	D	4.07%
K	4.79%	L	5.49%	C	5%	R	5.97%
O	5.25%	S	5.74%	S	5%	H	6.00%
F	6.16%	N	6.65%	R	6%	S	6.36%
I	6.16%	T	6.95%	A	7%	I	6.92%
Q	6.39%	O	7.16%	O	7%	N	6.94%
V	6.85%	I	7.54%	N	7%	O	7.62%
M	8.22%	R	7.58%	T	8%	A	8.03%
J	9.59%	A	8.50%	I	9%	T	9.31%
B	14.16%	E	11.16%	E	10%	E	12.88%

Coded Letter	Real Letter

A	D
B	E
C	B
D	C
E	M
F	A
G	Z
H	P
I	H
J	O
K	R
L	Y
M	T
N	K
O	N
P	U
Q	I
R	J
S	G
T	F
U	Q
V	S
W	X
X	V
Y	W
Z	L

One way to break the code:

1. The coded letter B is the most common, so it probably correlates to E
2. QT, MJ, QM, AJ, QO, JT, JO, and SJ are the coded two letter words.
   ** M and J appear at the end and beginning of coded two letter words.
   ** Looking at the chart of two letter words given at http://www.mindspring.com/~fmnshare/help.htm, O, S, and T are the only letters that appear at the beginning and end of two letter words. So the coded letters M and J are probably O, S, or T.
   ** Since the coded letter J occurs in the most number of different two letter words and O has the most number of two letter words in which it appears at the end or the beginning of the word, it can be guessed that the coded letter J corresponds to O.
   ** The coded letter M appears 8.22% of the time. According to all three frequency charts, the is closer to T than to S. So it can be guessed that the coded letter M corresponds to T.
3. The three letter coded word "MIB" appears several times. Substituting our guesses so far, this corresponds to T_E. It can be guessed that this might be "THE," which means that the coded letter I would correspond to H.
4. Looking back at the two letter coded words, we have JT. We have guessed that a coded J corresponds to O. Looking at the chart of two letter words, it can be guessed that the coded T is probably either F, N, R, or X. X can be ruled out because it has a very low letter frequency (much lower than the coded T.)
   The coded T appears 2.28% of the time.
   This is closest to the frequency of the letter F, so it can be guessed that the coded T corresponds to F.
5. Now look at the coded two letter word QT. If coded T corresponds to F, then coded Q must be

either I or O. But coded J corresponds to O, so that leaves I to correspond to coded (You could also look at the fact that coded QT is _F and coded QM is _T. The only letter that fits in both spots is I.)

6. The coded letter F appears by itself, so it's either A or I. If coded Q is I, the coded F must be A.

7. We now have the coded word "MIBO" which corresponds to "THE_." This gives us the them, then, and they. The coded letter O occurs 5.25% of the time. In all three charts, this percentage is closer to N than to M or Y, so it can be guessed that the coded letter O corresponds to N.

8. We now have the coded word "MIQV" which corresponds to "THI_." This gives us the possibilities thin and this. But we have already assigned the coded letter O to the letter N. So this leaves us with S to correspond with the coded letter V.

9. We now have the coded word "MIQON" which corresponds to "THIN_." This gives us possibilities thing, think, and thins. The letter S corresponds to the coded letter V, so we are left with the possibilities of G and K. The coded letter N appears 0.91% of the time. This percentage is closer to the percentages of K than to those of G, so we can guess that the coded letter N corresponds to the letter K.

10. Now we have the coded word "OBWM" which corresponds to "NE_T." The coded letter W 0.23% of the time. The only letter that appears that often and makes sense is X, so we can guess that the coded letter W corresponds to X.

11. Now we have to coded word "TJK" which corresponds to "FO_." The possibilities are foe, fog, and fox. The letters E and X have already been used, so we are left with R and G. The coded letter K appears 4.79% of the time. Although the percentages for R and G are not extremely close to this, the percentage for R is closer than that of G, so we can guess that the coded letter K corresponds to the letter R.

12. We have the coded word "YBKB" which corresponds to "_ERE." The letter H is already been used. This leaves us with W to correspond to the coded letter Y.

13. We now have the coded word "HKJTBVVQJOFZ" which corresponds to "_ROFESSIONA_." The only letter that makes sense to correspond to the coded letter H is the letter P. And the only letter that makes sense to correspond to the coded letter Z is the letter L.

14. We now have the coded word "ZJOS" which corresponds to "LON_." The only words that make sense are lone and long, but E is already taken, so the only choice is for the coded letter S to correspond to G.

15. We are now left with the two letter coded word "AJ" corresponding to "_O." This could be do, go, no, so, or to. But G, N, S, and T are already taken. This leave the coded letter A to corresond with the letter D.

16. With the letters that are left, it can be guessed that "ABDJAB" is "DECODE," which makes the coded letter D correspond to the letter C. It can also be guessed that "EBVVFSB" is "MESSAGE," which makes the coded letter E correspond to the letter M.

17. With the letters that are left, it can be guessed that "VHBDQFZQGQOS" is "SPECIALIZING," which means that the coded letter G corresponds to the letter Z. Also the coded word "DKLHMJZJSL" is "CRYPTOGRAPHY," which means the coded letter L is the letter Y.

18. It can now be guessed that the coded letter P corresponds to the letter U.

19. We are left with the coded letters C, R, U, and X to correspond with the letters B, J, Q, and V. It is easy to see that the coded letter C must correspond to the letter B. The coded letter U must be the letter Q and the coded letter X must be the letter V, which leave the coded letter R to be the letter J.

The Hill Cipher

So, you managed to break the Encoded Task Message. Congratulations! You are now ready for the next part of the assignment.

In this part of the assignment, you will create a message and encode it using a modified Hill Cipher. When using this method, you assign the nubmers 1 through 29 to the space, the comma, the period, and each of the 26 letters. Notice that so far this is just a simple substitution code. In order to complete the hill cipher process, you will have to place the numbers that correspond to your message into a 2-by-whatever matrix. You will then create a 2x2 encoding matrix, which you will multiply by your message matrix to get the encoded matrix. To decode the message, the encoded matrix must be multiplied by the inverse of the encoding matrix and then then numbers will have to be converted back to letters.

Here's what you need to do:

1. Come up with a short message that you would like to encode. It does not have to be any longer than a sentence, but you can make it as long as you would like.
2. Decide how you how you want to assign the letters, the period, the comma, and the space to the numbers 1-29. Make a chart showing the conversion (for example, make a chart with two columns; put the letter or symbol in the first column and the corresponding number in the second column).
3. Change your letter message to a number message using your chart.
4. Let "M" be your Message Matrix. M should be a 2-by-whatever matrix. Fill M column by column, from top to bottom. Put the first two numbers or your message in the first column. Your first number should go in the row 1, column 1 spot. Your second number should go in the row 2, column 1 spot. If there is an empty space in the last spot of the matrix, fill it with a space.

   For example, if I wanted to encode "Laura" and L=12, A=1, U=21, R=18, and space=0, my Message Matrix "M" would look like this:

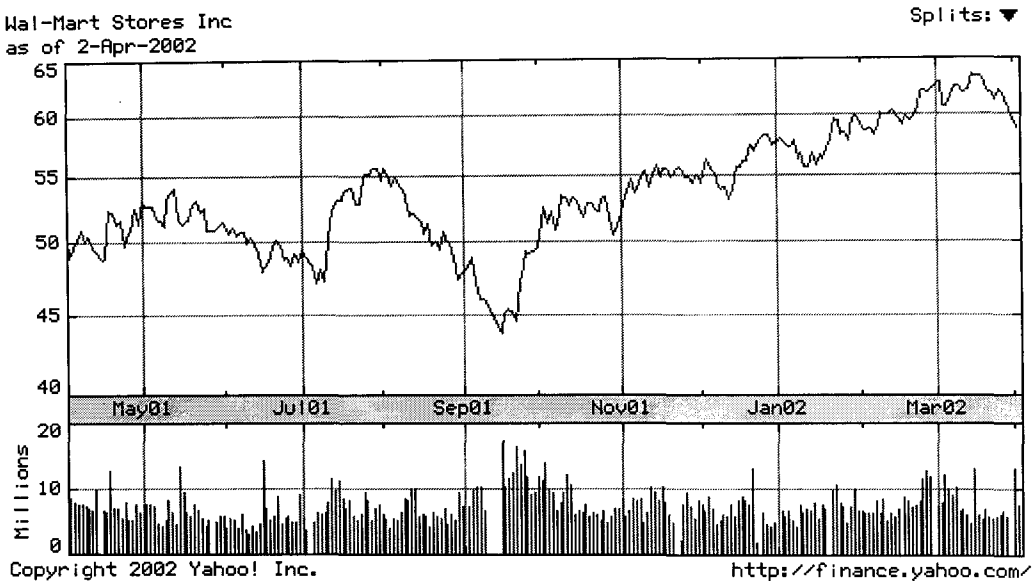
   M=
   [12 21 1
   1 18 0]
5. Let "E" be your Encoding Matrix. E should be a 2x2 matrix. E also needs to be invertible because you want the inverse of E to be the decoding matrix.
   ***** Remember, for a 2x2 matrix to be invertible, ad-bc cannot be equal to zero.
   ***** Also, so that you do not have to deal with a bunch of messy fractions, you might want to make sure that ad-bc=1.
6. Let "N" be your New Encoded Message.
   N=E*M
   ***** Remember, when multiplying matrices, order matters.

7. Let "D" be your Decoding Matrix. Find D. Calculate D*N. You should get M.
   D*N = (E inverse)*(E*M) = M
8. You're finished! Now you just need to turn in your work.

You will need to turn in the following:

- the work that you did to decode the Encoded Task Message (frequency charts, etc.),
- the decoded Task Message,
- the personal message that you created to encode using the modified hill cipher,
- a chart showing the alphabet to numbers conversion that you used,
- your message matrix (M),
- your encoding matrix (E),
- a copy of your encoded message (N), and
- your decoding matrix (D).

The Stock Market



(Images taken from http://finance.yahoo.com/.)

Introduction

Do you like money? Do you like making money? Then you're in the right place. Through this project, you will learn how to find the performance of stocks and and how to look at this information to decide how to best invest your money.

Task

Choose three companies and observe their daily performance in the stock market over a two week period. For the same three companies, find the yearly stock market performance over the past 10 years. Then analyze the performance of the stocks and determine how you would choose to invest your money.

Process

- Choose three companies whose stock prices you would like to observe, and look up the

symbol used to represent each company. When choosing a company, think of your interests. Do you like cars, sports, clothing, or computers? Then you might want to choose companies that deal with those areas.

- Look up the daily adjusted closing price of your chosen stocks for the past two weeks.
- For each company, make a table of data (using Microsoft Excel) that includes the date and the corresponding adjusted closing stock price for the two week period.
- For each company, make a line graph of the stock market data. The graph for one company must be done by hand. The rest may be done using Microsoft Excel. Let your x value be the day, and let the y value be the price of the stock. This should give you a visual idea of what is happening with the stock prices of the company from day to day.
- Calculate the daily percent increase or percent decrease in stock price for each company. Once again, the values for one company must be done by hand. The rest may be computed in Microsoft Excel.
- Using the same three companies, look up the yearly adjusted closing price for the past 10 years. As before, create a data table, make a line graph, and calculate the percent increase or percent decrease in the stock price for each company from year to year. All of this may be done in Microsoft Excel.
- Using the information that you have compiled, decide how you would want to invest your money. Do you plan to invest your money for a short period of time or do you plan to invest over a long period of time? Do you plan to invest all of your money in one stock or do you plan to invest in more than one stock? Make sure that you justify your decision by using your analysis of the stock prices over the two week period and over the ten year period.

Resources

- Here is an example of a data table with the daily stock information for Wal-Mart for a 2 week period. The daily percent increase or decrease has been calculated, and a graph of the daily adjusted closing prices has been made.
- Here is where you can find the symbols for the companies that you choose. If you don't have any companies in mind, you might try some of the following:
    - Wal-Mart (WMT)
    - Honda (HMC)
    - Nike (NKE)
    - American Eagle (AEOS)
    - Gap (GPS)

- Dell (DELL)

- This is Yahoo's finance page. You can use this page to search for the price of your company's stock.
  1. Place the symbol for your company in the box at the top of the page where it says, "enter symbol," and then press the "get" button.
  2. You should reach a page that gives the information for the most recent trade of your stock. Under this information, there should be a link for the "historical prices." Click on this link.
  3. Choose the starting and ending dates that you want. The ending date should be the current date. The starting date should be either two weeks earlier or ten years earlier (depending on which part of the project you are working on). Choose the correct increment of time (daily if you want the daily closing prices for the past two weeks or monthly if you want the monthly closing prices for the past ten years). Click the "get data" button.
  4. The information that you want, the adjusted closing price, should be in the far right column of the information that is displayed.

- Here is some information on how to insert formulas into Microsoft Excel. A generic formula may be created to calculate percent increase/decrease. The formula may then be cut and pasted to find all the necessary percentages. The Help menu in Excel can also be used to find information about creating and using formulas.

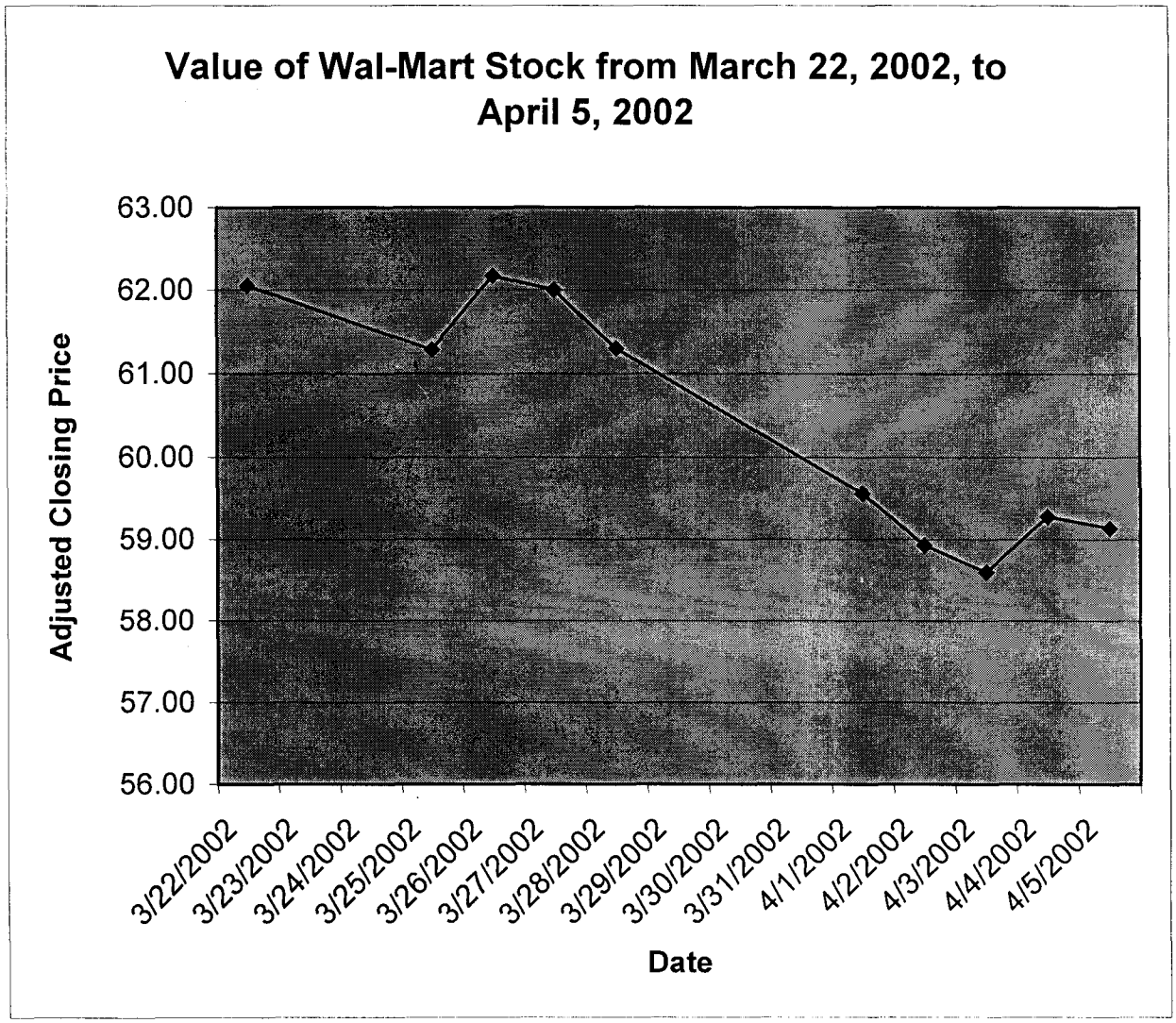
- Here is some information on how to create a line graph. The Help menu in Excel can also be used to find information on creating and formatting formulas.

Conclusion

Through this WebQuest, you were able to analyze the performance of stocks in order to make an educated guess as to which stock(s) would be the best investment(s). Think about the methods that you used for analysis (the graphs of the stock performance and the charts of the percent increase/decrease). How did the information obtained from these methods aid in your investment decision? How did using Microsoft Excel aid in the feasibility of completing the project in a timely manner?

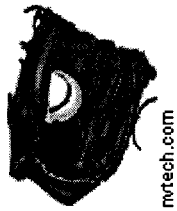
Value of Wal-Mart Stock
From March 22, 2002 to April 5, 2002

Day	Date	Adjusted Closing Price	Percent Increase/Decrease
1	3/22/2002	62.05	
2	3/25/2002	61.28	-1.24%
3	3/26/2002	62.17	1.45%
4	3/27/2002	62.00	-0.27%
5	3/28/2002	61.30	-1.13%
6	4/1/2002	59.56	-2.84%
7	4/2/2002	58.93	-1.06%
8	4/3/2002	58.60	-0.56%
9	4/4/2002	59.28	1.16%
10	4/5/2002	59.14	-0.24%



Play Ball!!!!!

"Statistics are the lifeblood of baseball. In no other sport are so many available and studied so assiduously by participants and fans. Much of the game's appeal, as a conversation piece, lies in the opportunity the fan gets to back up opinions and arguments with convincing figures, and it is entirely possible that more American boys have mastered long division by dealing with batting averages than in any other way."
~~ Leonard Koppert in A Thinking Mans Guide to Baseball (1967)~~



(Images taken from http://www.coolclips.com/.)

Introduction

"Take me out to the ball game,
Take me out to the crowd.
Buy me some peanuts and Cracker Jacks,
I don't care if I ever get back,
'Cause it's root, root, root for the home team,
If they don't win it's a shame.
For it's one, two, three strikes, you're out,
At the old ball game."

You've become the general manager of your favorite baseball team. As an extra incentive for

your players, you've offered a $40,000 bonus for any player who bats .300 or better this season. However, you have to make sure that you'll have enough money for the bonuses. But how will you know how many bonuses you're going to have to pay, and where are you going to get the money?

Task

Your job is to pick your favorite baseball team and to try to estimate how many players will bat .300 or better this season. From this, you can estimate how much money you will need for bonuses. Then, assuming that you plan to obtain the extra money from increased ticket sales, you need to decide how many extra tickets must be sold in order to pay for the batting bonuses.

Process

- If you do not know how to calculate a batting average or if you do not understand all of the terminology, following the appropriate links for more information.
- Choose the baseball team for whom you want to be the general manager.
- Create a spreadsheet with all of your players' names on it. You will input all necessary statistical data into this spreadsheet.
- Look up the current hitting statistics for each of your team members. Look at their batting averages so far for the season. Also, note how many at bats and how many hits each player has had so far.
- Look up the last year's hitting statistics for each of your team members. In addition to the batting average, note how many at bats each of your players had.
- Assume that each player gets the same number of at bats this season as he did last season. Calculate how many more hits each player needs in order to reach the goal of a .300 batting average.
- Looking at each player's batting average from last season and his performance so far this season, estimate how many players you think will obtain a .300 batting average by the end of this season. From this, determine how much money you are going to need in order to pay the hitting bonuses.
- Check on the ticket prices for your home ballpark.
- Now it is time to figure out how many extra tickets you need to sell to cover the cost of the bonuses.
  (Hint: You can set up and solve an equation involving variables to answer each of these questions.)
  (Remember, you cannot sell a fraction of a ticket, so if you calculate a fraction of a ticket, round up.)
  1. Calculate how many tickets would have to be sold in each price range if the amount of ticket sales is only increased for one ticket price range.
     For example, if you estimate that two players will bat .300 for the season, you would be paying $80,000 in bonuses. Assume that your ballpark sells $60, $40,

$20, and $10 tickets. To cover the cost of the bonuses, you will need to sell 1334 extra $60 tickets, 2000 extra $40 tickets, 4000 extra $20 tickets, OR 8000 extra $10 tickets.

2. Now calculate how many tickets need to be sold in each price range if the number of ticket sales is to be increased evenly for each ticket price range. Using our numbers from the previous example, you would need to sell 616 $60, tickets, 616 $40 tickets, 616 $20 tickets, AND 616 $10 tickets.
3. Let us now assume that there are more general admission and upper deck seats available than front row box seats. We also assume that people are more likely to purchase the cheaper seats because of financial reasons. For these reasons, let us assume that we will sell more cheap seats than expensive seats. In fact, let us assume that we sell twice as many extra second most expensive tickets as we do the most expensive tickets. We sell three times as many extra third most expensive tickets as we do the most expensive tickets. We sell four times as many extra fourth most expensive tickets as we do the most expensive tickets, etc.
   For example, using the ticket prices from the previous examples, we would need to sell, 334 extra $60 tickets, 668 extra $40 tickets, 1002 extra $20 tickets, AND 1336 extra $10 tickets.

Resources

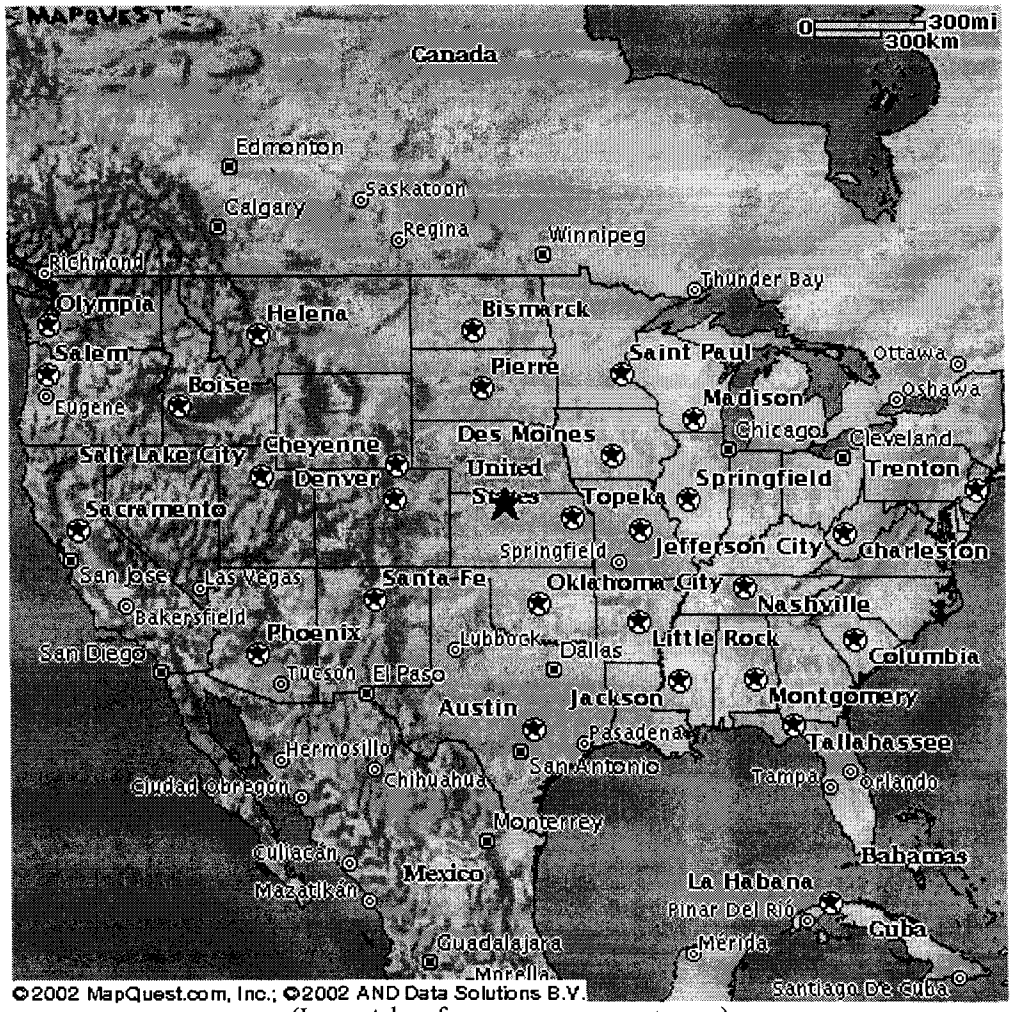
- If necessary, check out the Glossary of Abbreviations.
- Here is a good explanation of how to calculate a batting average.
- Here is another explanation of calculating batting averages.
- Check out CBS-Sportsline to find your team's hitting statistics for the current season. Find your team, and click on "hitting."
- Go to Baseball-Reference.com to look up last season's batting averages. To get to your statistics, click on your team name, then click on "batting register," and then click on last year.
- From the official Major League Baseball homepage, you can find the ticket prices for your ballpark. From the main page, choose your team from the pull-down box in the upper left corner. Next, click on the field name near top of page. From here you can click on "seating and pricing" in the upper left corner.

Conclusion

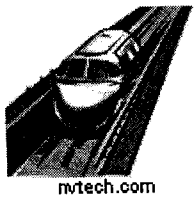
How did you use math to estimate how much money you were going to have to pay your players in bonuses? How did you use math to decide how many extra tickets needed to be sold in order to cover the cost of the bonuses?

Background provide by Backgrounds Etc.

Road Trip (A Map To Get You There)



(Image taken from www.mapquest.com.)



(Images taken from http://www.coolclips.com/.)

Introduction

It's the beginning of your senior year, and you're on top of the world. Your parents have just given you permission to go on a senior trip after graduation... but there's one catch. You have to pay for the trip yourself. So, how much is it going to cost? And how are you going to earn the money for the trip? To find the answers and to plan your dream vacation, follow this WebQuest!

Task

Your job is to plan the perfect senior trip. That means everything: the destination, the lodging, the food, the activities, etc. You have two options. The first option is to decide how much you are willing to work so that you know how much money you can spend. Then you can plan a trip that fits your budget. The second option is to plan your trip and calculate the cost. Then you can figure out how much you have to work in order to pay for the trip.

Process

- There are a few restrictions in terms of your budget.
  - Your parents want you to keep your grades up, so you are not allowed to work more than 15 hours per week (except during vacation time).
  - Assume that you have (at most) 33 weeks of school during which you can work and 3 weeks during Christmas break that you can work. This is the maximum number of weeks that you can work. You may choose to work fewer weeks if you would like.
  - Assume that you are only making minimum wage ($5.15/hour).
  - The government takes 20% of your earnings for taxes (which means that you only get to keep 80% of the money you earn).

- Now it's time to plan your trip.
  - Decide how many people will be traveling with you. This can affect your transportation and lodging arrangements. Also, when calculating individual expenses for things such as transportation and logding, you will need to know how many people are in your group, so that you can divide the shared costs

evenly.
  - Decide how long you want your trip to be, and choose a destination.
  - Decide on your mode of travel (plane, train, automobile, cruise, etc.).
  - Calculate the cost of round trip travel (individual ticket prices or the total cost of gas divided by the number of people in your travel group).
  - Choose your lodging arrangements, and determine the cost per person for the length of your stay.
  - Decide how much money you want to budget for food. Will you have a kitchen where you can cook? Or will you be dining out?
  - Decide how much money you want to spend on entertainment (amusement parks, clubs, movies/plays/performances/concerts, museums, etc.) and souvenirs (shirts, picutres, etc.).
  - Decide if and how much money you want to bring along as "emergency" cash.

- Estimate your expenses. Create a spreadsheet that details your expenses for the trip. Include any calculations that you made to reach your projected costs. Your spreadsheet should include (but is not limited to):
  - Transportation expenses
  - Lodging expenses
  - Food expenses
  - Entertainment expenses
  - Emergency expenses
  - Total cost of the trip

- Now it's time to finance your trip. Using your estimated cost of the trip, decide how many hours a week and how many weeks you need to work in order to pay for the trip.

- Turn in a brief description of your trip along with your spreadsheet of expenses and your work plans.

Resources

- General travel planning websites (good for finding airline ticket prices, lodging, cruises, etc.).
  - Travelocity
  - Orbitz

- Transportation
  - Amtrak
  - Find the mileage for your trip and get driving directions from MapQuest.
  - Find out what kind of gas milage your car gets. (Using the total distance of your trip and the gas mileage of your car, you can find out how much gas you will need for the trip.)

- Lodging
  - Cruises:
    - Carnival
    - Disney Cruises
    - Royal Caribbean
    - Norwegian Cruise Line
  - Campgrounds:
    - Kampgrounds of America (KOA)
    - Reserve America
    - The National Park Service
  - Hotels:
    - Lodging.com: A good place to search for any hotel at a given location.
    - Yahoo search results for hotels : A good place to go if you want to search for a specific chain of hotels.
    - Best Western
    - Days Inn
    - Hilton
    - Holiday Inn
    - Hyatt
    - Marriott
    - Sheraton
    - Travelodge

Conclusion

Now you have the perfect senior trip all planned. How did you use math in planning your trip? How did you use math to decide how to finance your trip?