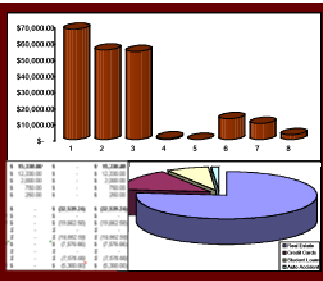


Week 1: Introduction to Quantitative Methods

- ✓ Quiz:
Define “Qualitative Analysis” and “Quantitative Analysis.”
- ✓ Quiz for next week:
Know how to use these functions in Excel: sum, average, min, max.
- ✓ Assignments due this week:
 - Biography: Thomas Bayes
- ✓ Assignments due next week:
 - Biography: W. Edwards Deming
 - **Note:** If you have a laptop with Excel (or another spreadsheet), I encourage you to bring it (and a power strip) to class next week.
 - If you need to refresh your basic Excel skills, do it this week. Plan on spending time each week working with your computer, or one of the computers on campus.
 - If you don't have Excel, you can do many of the same things with MS Works, Google Spreadsheets (free, but no graphs), the OpenOffice Spreadsheet, etc.
- ✓ Why do people get MBAs?
 - Get a better job and make more money? Be a more successful entrepreneur?
 - The reason you expect to make more money once you have an MBA is that we (students and employers) believe the MBA prepares you to analyze problems, communicate effectively, and make good decisions.
- ✓ How do we make decisions?
 - Quantitative Analysis versus Qualitative Analysis
 - What are some business problems that are best approached qualitatively?
 - What are some business problems that are best approached quantitatively?
 - Inventory
 - Accounting
 - Cash flow
 - Transportation
 - Queues



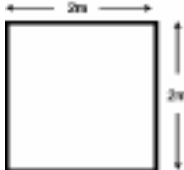
- In order to get a good answer, you need to understand what kind of question you are asking.
- Being a good manager doesn't mean you know everything. But one of the things that you do need to know is how to handle the things you know you don't know.
- We always want to minimize uncertainty, and quantitative analysis can help us do that. But in practice we generally can't afford to eliminate it. So we also need to know how to deal with the uncertainty that remains.

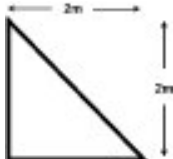
✓ Common Quantitative Approaches

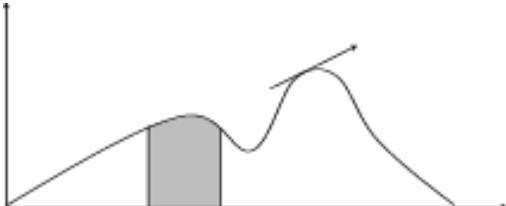
* Credit owed to Wikipedia for parts of many of these explanations

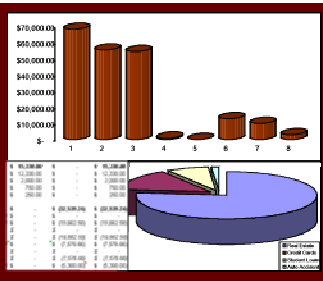
- Arithmetic
 - A branch of mathematics which records elementary properties of certain operations on numbers. $2 + 2 = \underline{\quad}$

- Algebra
 - A branch of mathematics in which the properties of operations on the real number system are recorded using symbols as "place holders" to denote constants and variables, and the rules governing mathematical expressions and equations involving these symbols are studied. $2 = x - 4$

- Geometry
 - Geometry (Greek γεωμετρία; geo = earth, metria = measure) arose as the field of knowledge dealing with spatial relationships. 

- Trigonometry
 - Trigonometry (from the Greek trigonon = three angles and metron = measure) is a branch of mathematics which deals with triangles. 

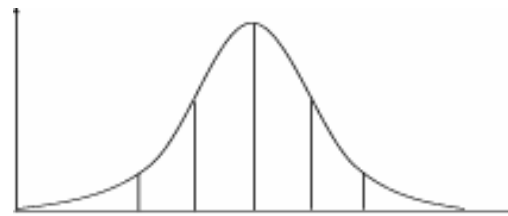
- Calculus
 - Two complementary disciplines comprise calculus, both of which rely on the concept of a limit. The first is 



differential calculus, which is concerned with the instantaneous, as opposed to average, rate of change of a quantity. This can be illustrated by the slope of a function's graph at a particular point. Velocity (speed) is the derivative of distance with regard to time. Acceleration is the derivative of velocity with regard to time. The second is integral calculus, which studies the accumulation of infinitely small quantities, summing to areas under a curve, linear distance traveled, or volume displaced. The integral of velocity is distance. The integral of acceleration is velocity.

○ Probability

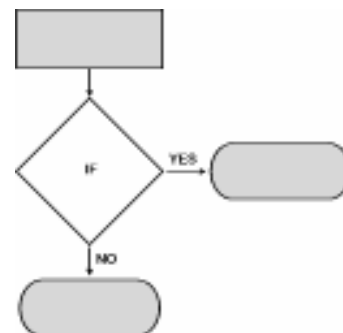
- Informally, “probable” is one of several words applied to uncertain events or knowledge, being closely related in



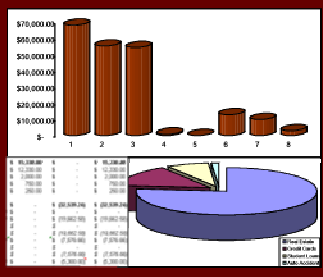
meaning to likely, risky, hazardous, and doubtful. Chance, odds, and bet are other words expressing similar notions. The theory of probability attempts to quantify the notion of probable. Probability always lies between 0 and 1. If probability is equal to 1 (100%) then that event is certain to happen and if the probability is 0 (0%) then that event will never occur. Gambling and gaming theory, chaos theory, and quantum theory all rely heavily on probabilities.

○ Logic

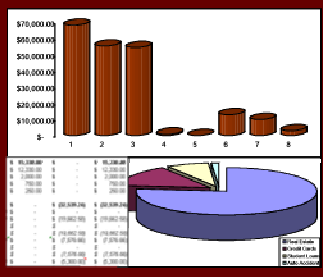
- Logic, from Classical Greek λόγος (logos), originally meaning the word, or what is spoken, (but coming to mean thought or reason) is the study of criteria for the evaluation of arguments, although the exact definition of logic is a matter of controversy among philosophers. The task of the logician is to advance an account



of valid and fallacious inference, to allow one to distinguish logical from flawed arguments. Traditionally, logic is studied as a branch of philosophy. Since the mid-nineteenth century



logic has also been commonly studied in mathematics and law. More recently logic has been applied to computer science. The parts that make up a computer chip are often called "logic gates."



✓ Scenario: Tasteful Coffee Shops

- We are a management team working for Tasteful Coffee Shops Corporation, a rapidly growing new company that operates coffee shops. Our business plan calls for opening one store per month. We are nine months into the plan, and our team has been assigned to open a new coffee shop in Rapid City, South Dakota. We understand that throughout this project we will need to use a variety of quantitative methods to make decisions. For example:

Arithmetic (and Statistics)

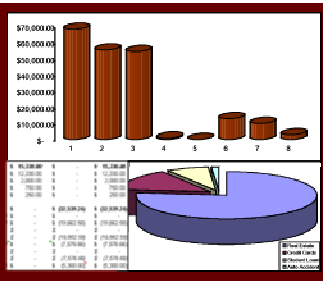
- We have been given a budget of \$625,000 for construction of a 5,000 square foot store. How much will our budget allow us to spend per square foot?
 $\$625,000 / 5,000 \text{ square feet} = \$125 \text{ per square foot.}$
- We have received three bids from different companies to do the construction. The bids were \$515,000, \$613,125, and \$653,125. How do these bids compare to our budget?
 - $\$515,000 / \$625,000 \times 100\% = 82.4\%$, so this bid is 17.6% under budget.
 - $\$613,125 / \$625,000 \times 100\% = 98.1\%$ so this bid is 1.9% under budget.
 - $\$653,125 / \$625,000 \times 100\% = 104.5\%$ so this bid is 4.5% over budget.

Algebra

- We have been reviewing data from a recent store construction in Billings, Montana. That store was 3,500 square feet, and it was built for \$289,000. How much would it have cost to build that store if it had been 5,000 square feet instead?

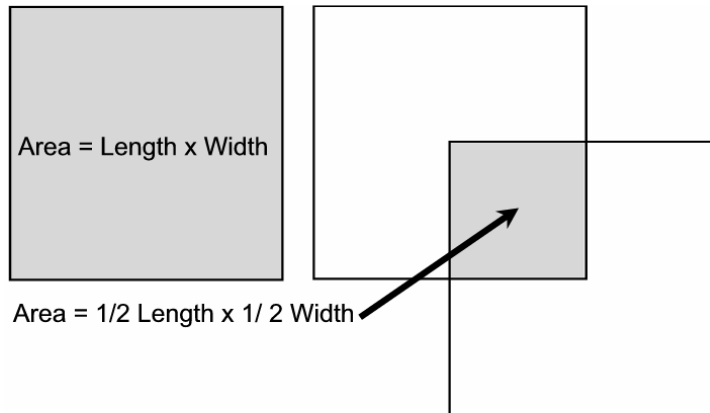
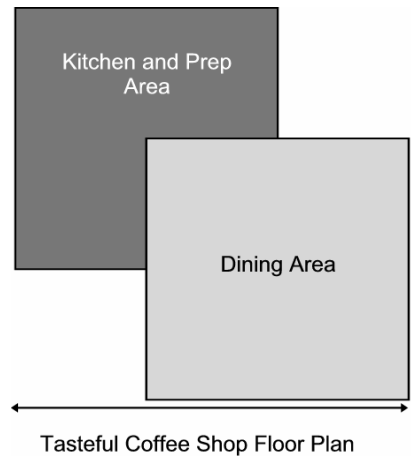
$$\frac{\$289,000}{3,500 \text{ sq. ft.}} = \frac{x}{5,000 \text{ sq. ft.}}$$

$$x = \$412,857$$



Geometry

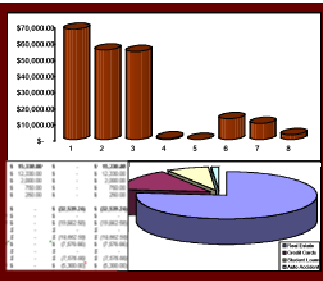
- We are evaluating sites for our new store, which must conform to the unique floor plan which is a trademark of our company. What are the minimum dimensions for any site in order to allow a 5,000 square foot store to be built?



$$\text{Store Area} = 2 \times (\text{Length} \times \text{Width}) - (1/2 \text{ Length} \times 1/2 \text{ Width})$$

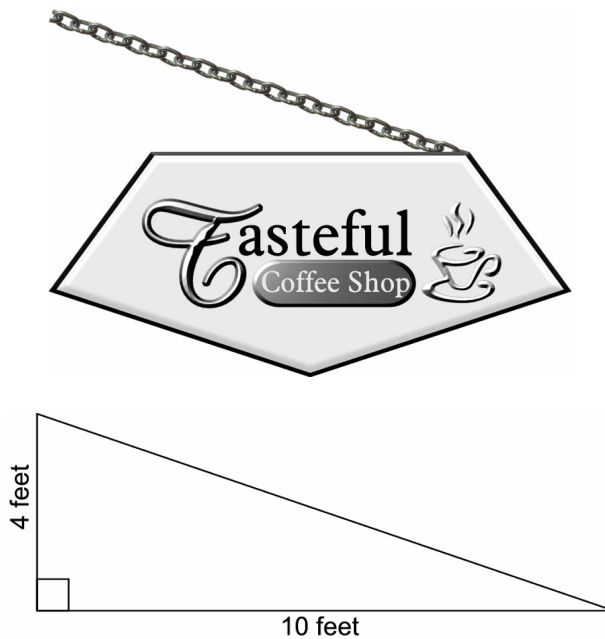
$$\begin{aligned} \text{Length} &= \text{Width} \\ \text{Store Area} &= 2 \times \text{Length}^2 - 1/4 \text{ Length}^2 \\ \text{Store Area} &= 7/4 \times \text{Length}^2 \\ 5000 &= 7/4 \times \text{Length}^2 \\ (4/7 \times 5000)^{1/2} &= \text{Length} \\ \text{Length} &= 53.45 \text{ feet} \end{aligned}$$

Property Dimensions Must be 1.5 x 53.45 on each side or 80.18 feet on each side.

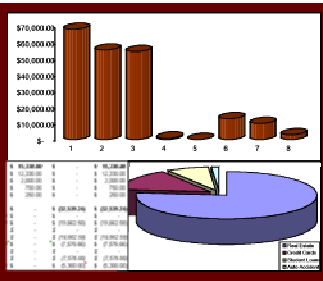


Trigonometry

- Our Tasteful Coffee Shop sign has arrived, but local sign codes will require it to be attached to the building by a heavy chain. We have found a suitable chain, but it is too long and we need to have a machinist cut it to the proper length for the sign to be level. The anchor point on the sign will be 10 feet from the wall, and we want to attach the other end of the chain to the building at a point 4 feet above the top of the sign. How long do we need the chain to be?

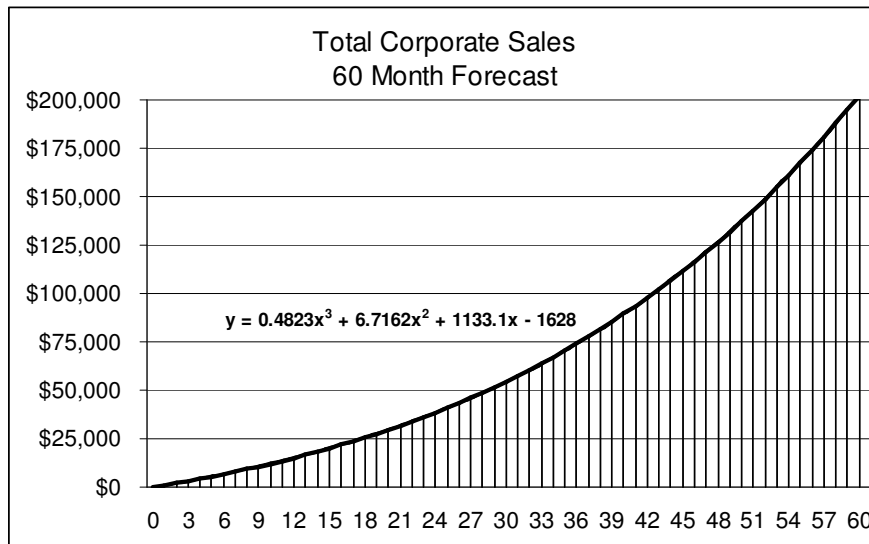


- Visual inspection shows that the chain will actually form the hypotenuse of a right triangle, with one side running from the anchor point on the sign to the wall (10 feet), and the other from the anchor point on the wall down the building (4 feet).
- The Pythagorean Theorem tells us that the sum of the squares of the sides of a right triangle equals the square of the hypotenuse. $10 * 10 + 4 * 4 = 116$. The square root of 116 is 10.77. So we need about 10.8 feet of chain.

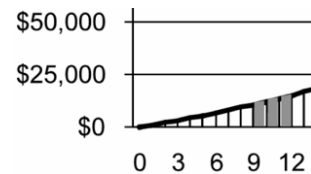


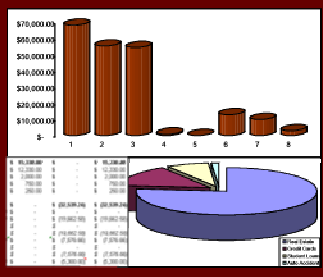
Calculus

- Our team needs to answer two questions based on the 60 month sales forecast from the corporate business plan. First, what is our total projected sales from the third quarter of the first year? Second, what is the total sales growth rate at the beginning of the second year?



- We used the trend line feature in Excel to fit a third-order polynomial trend line to the projection, and it fit quite nicely. The equation is displayed on the graph.
- We can answer the first question using an integral. First integrate the equation, and then evaluate for the interval from month 10 to month 12. We project a little over \$40,000 in sales for the quarter.
- We can answer the second question by using a derivative. First take the derivative of the equation, and then evaluate at the beginning of month 13. Total sales are projected to be growing at a rate of about \$1,550 per month (which is about 10% per month) as of month 13.





Statistics (Probability)

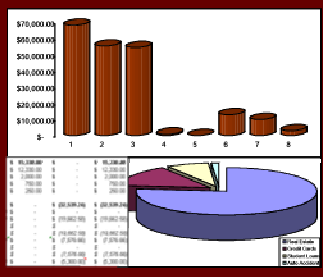
- We have already opened nine stores this year. Each time we open a new store we project first month sales, and later we compare our projection to the actual values. The chart below shows how close our projections were to the actual first month sales for each of our new stores.

First Month New Store Sales

Store	Above (Below) Projected Sales
1	1.4%
2	2.9%
3	8.4%
4	-3.0%
5	4.3%
6	-1.9%
7	-12.3%
8	3.2%
9	0.1%

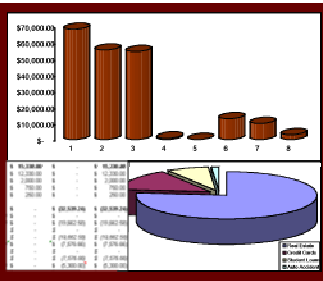
- For our store in Rapid City we have projected sales of \$1,080 for the first month. Based on our demonstrated capabilities to predict the future, what is the probability that our projection is either high or low?

	Events	Probability	Probability
Number Above	6	0.667	66.7%
Number Below	3	0.333	33.3%



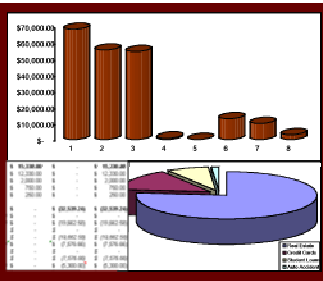
Logic

- We have established a tight construction timeline that must be followed in order to ensure that our store is able to open on schedule. The electrical wiring will take four days. Our prime contractor has just notified us that the electrical contractor cannot begin work until two weeks after the day called for in our timeline. What impact is this likely to have on the project, and what actions should we take?
- If we extend the timeline to accommodate the electrical contractor then the project will be delayed by two weeks. But the schedule changes could create conflicts for the other contractors and the building inspectors, thereby creating other delays.
- If we hire a different electrical contractor on such short notice we may have to pay more money, and we may end up with a lower quality service.
- If we rearrange the timeline we may be able to have the electrical work done later without affecting the overall length of the project. But changing the flow could lead to unanticipated problems which could add cost and time to the project.



- ✓ Breakdown of some MBA terminology that is used in the course objectives:
 - Bayesian Decision Theory
 - Fancy name for using probabilities to make decisions.
 - Programming Algorithms
 - Fancy name for describing real-world stuff using mathematical language.
 - Deterministic Models
 - Fancy name for a model that ignores randomness (chaos). In a deterministic model, if you follow the same procedure each time then you'll produce identical output. Most real world problems are actually stochastic, meaning that they are at least partly non-deterministic.
 - Queuing Models
 - Fancy name for some equations that help you manage delays and backlog in a system.
 - Many MBA programs describe this course as "Operations Research."
- ✓ General Quantitative Approach:
 - Define the problem
 - Develop a model
 - Acquire data
 - Develop a solution
 - Test the solution
 - Analyze the results and perform sensitivity analysis
 - Implement the results





✓ Example: How do you find the breakeven point for a product?

We'll need to define these variables:

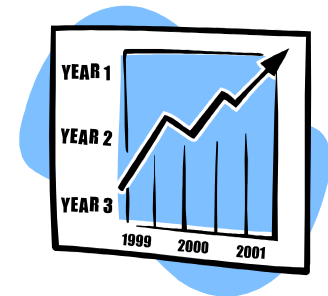
- P = Price
- Q = Quantity sold
- F = Fixed cost
- V = Variable cost per unit
- R = Revenue

The mathematical statement, algorithm, program, or model looks like this:

$$(P \times Q) - F - (V \times Q) = R$$

But at the breakeven point, $R = 0$

$$(P \times Q) - F - (V \times Q) = 0$$

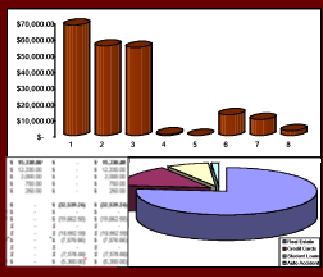


Using some algebra we can simplify this:

$$\begin{aligned} (P \times Q) - F &= (V \times Q) \\ -F &= (V \times Q) - (P \times Q) \\ -F &= (V - P) \times Q \\ F &= (P - V) \times Q \\ F / Q &= (P - V) \\ 1 / Q &= (P - V) / F \\ Q &= F / (P - V) \end{aligned}$$

In other words, the simplified form of this model tells us that the breakeven quantity is found by dividing the fixed costs by the price minus the variable cost.

Setting up the model to describe the problem requires some thoughtful analysis and a bit of algebra. But once the model is built, solving the problem becomes trivial. Now we know exactly what data we need. To find the breakeven point (Q) the only data you need are the fixed costs (F), the price (P), and the variable costs (V). Our next steps are to collect the data, test the model, assess the results, and – if necessary – perform a sensitivity analysis.

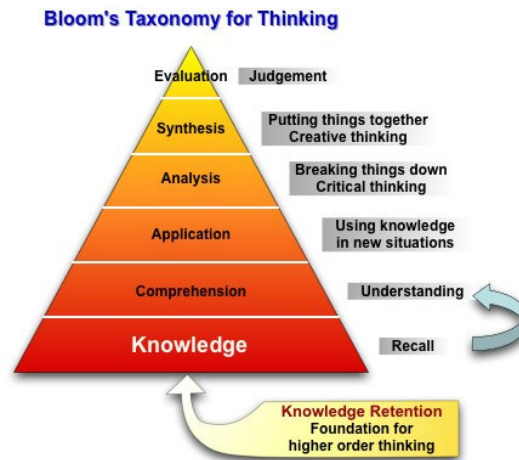


✓ Summary

- This course can help you hone your skills in understanding quantitative problems, developing models to describe them, and using common tools (math and computers) to identify solutions. Dr. Griffin describes it as a ladder...
- A similar approach was developed by Dr. Benjamin Bloom, and it is called Bloom's Taxonomy.



- If you knew all of this stuff before you enrolled then this class would not be a good use of your time. If you don't know all of this stuff, and you allow yourself to have a negative attitude toward math or computers, or if you doubt your own abilities, then you are undermining your own potential.



- "Argue for your limitations and sure enough, they're yours." *Richard Bach*
- My job is to help you move further up Griffin's ladder, and Bloom's Taxonomy. The worst case scenario would be if 11 weeks from now you don't know anything more than you know today. But if things go well then you'll practice some important skills and learn some new stuff that most other people don't know, and you'll be able justify the extra money that you expect to earn as an MBA. To get there you need to spend a bit of time reading about, talking about, and practicing this stuff. In return for you providing me with evidence of the work you've done, I'll provide you with a grade for the course.