Working With Graphs
Graphs In General:

A graph is a visual representation of the relationship between two or more variables.

We will deal with just two variables at a time.
Graphs In General:

1. **Independent variable**: This is the variable that influences the dependent variable. *(X variable)*

2. **Dependent variable**: Its value is determined by the independent variable. *(Y variable)*
3. We say that the dependent variable is a function of the independent variable:

\[ Y = f(X) \]
The Axis of a Graph:

Dependent Variable (Y-axis)

Independent Variable (X-axis)
**Direct Relationships:**

- A person's weight and height are often related.

- If we sample 1000 people and measure their weight and height we would probably find that as weight increases so does height.
Direct Relationships:

Height

Weight
Direct Relationships:

- There is a direct relationship between height and weight.

- Have a direct relationship when:

  \[
  \uparrow \text{indep. variable} \Rightarrow \text{dep. variable} \uparrow
  \]

  \[
  \downarrow \text{indep. variable} \Rightarrow \text{dep. variable} \downarrow
  \]
Inverse Relationships:

There is strong evidence indicating that as price rises for a specific commodity, the amount purchased decreases.
Inverse Relationships:

Price per Unit

Demand Curve

Quantity Purchase per Unit Time
Inverse Relationships:

- There is an inverse relationship between price per unit and the quantity purchased per unit of time.

- Have an inverse relationship when:

  1. indep. variable $\uparrow \Rightarrow \downarrow$ dep. variable
  2. indep. variable $\downarrow \Rightarrow \uparrow$ dep. variable
Complex Relationships:

- Evidence suggests that income from wages increases up to a certain age, and then decreases until death.
Here we have a complex relationship with a maximum. That maximum occurs at or near the age of retirement.
Complex Relationships:

- There is a direct relationship between wage income and age up to a certain point known as retirement,

- then an inverse relationship exists from retirement to the individuals expiration date.
Notice that the Y-axis has been changed to “income from all sources” which would include wages and investments etc. Would we want income from all sources to look like the graph above? I hope not.
Some of you might think that we would want income from all sources to look like the graph above. Constant income from the point of retirement until expiration. Constant income translates to a “fixed income.” Is that what we really want? What do you think will happen to your cost of living as the years go by? What have we observed happens to prices over time? Remember inflation? If our nominal income is constant over the years, then our real income will be decreasing as inflation erodes the value of our “fixed” nominal income. What will happen to our standard of living as time progresses with a “fixed” nominal income? It will most probably erode with the declining purchasing power of our constant (fixed) income.
Now the graph above looks more like what we would hope to see in our “golden years.” At the minimum, our income from all sources should increase at the rate of inflation in order to maintain the standard of living that we were accustomed to at our retirement party. So the slope of the linear segment of the graph should be at least equal to the inflation rate. The best way to assure that your standard of living will be maintained after you retire is to save and invest properly today. Another objective you may want to consider is to be debt free when you retire. Being debt free at retirement will certainly help enhance your standard of living if you did not save or invest enough when you were younger.
Social Security was NEVER intended to provide benefits sufficient to be the sole source of retirement income.

TRUE.
What we refer to as “social security” is really three different programs. There is a retirement program, a disability program and a medical insurance program that is referred to as medicare. There are also three different trust funds associated with these programs. The retirement program that was started in 1937 is officially known as the Old Age and Survivors Insurance Fund or OASI. The disability program was initiated in 1957 and is officially known as the Disability Insurance Fund or DI. The OASI tax rate for 2000 is 5.30% and the DI tax rate for 2000 is .90%. These two programs discussed collectively are termed as OASDI with a combined tax rate of 6.20% on the first $76,200 of wages.
What we call “medicare” was established in 1966 and is officially referred to as the Medicare Hospital Insurance Fund or HI. The tax on wages for medicare is 1.45% for the year 2000, and there is not wage limit associated with this tax.
Social Security Issues:

- Social Security covered 58 percent of the work force in 1940, covered over 90 percent in 1990.

- Over this 50 yr. period, REAL benefits have increased and coverage has been extended to spouses, widows, and dependents.
Social Security Issues:

- Today, elderly as a group have lower poverty rates than the general population, and about the same per capita income.
Social Security Issues:

- Greater than 90 percent of all persons 65 or older receive Social Security.
- On average, SS equals 38 percent of total income received by elderly households.
- For 25 percent of older households, SS equals 90 percent of family income.
Social Security Issues:

- For 15 percent of older households, SS equals 100 percent of family income.

- To maintain pre-retirement living standards, middle and upper income households must have additional income from employer pensions or private savings.
Historical Social Security Tax Rates:

- Before 1950, SS rate = 1.0 percent paid by both the employer and employee.
- This covered retirement only, no disability or Medicare.
- Maximum earnings taxed prior to 1950 = $3,000
- Maximum tax paid prior to 1950 = $30 per employee, $30 per employer
Historical Social Security Tax Rates:

- In 1970, the maximum retirement tax paid was $284.70. Matched by employer.

- In 1990, SS retirement tax rate = 5.60 percent, Maximum earnings taxed in 1991 = $51,300

- Maximum tax paid in 1991 = $2,872.80 per employee. Matched by employer
Historical Social Security Tax Rates:

- In 2000, SS retirement tax rate = 5.30 percent, Maximum earnings taxed in 2000 = $76,200

- Maximum tax paid in 2000 = $4,038.60 per employee. Matched by employer
Future of Social Security

- Funds in the SS trust fund will peak in 2030 at $12 trillion (no cash, all gov. bonds!)

- I will be 73 years old.

- You will be ? years old.
Future of Social Security

- After **2030**, these trust fund assets decrease rapidly, and will be equal to zero in **2046** at the current SS tax rates.

- In **2046**, I probably will be in a state of mind such that I won't care!

- You will be ? years old.
Future of Social Security

- As the population of our country continues to age, the ratio of (workers/beneficiaries) will decrease.

- The W/B ratio is expected to remain stable between 1989 and 2010 but will then decrease.
## Future of Social Security

<table>
<thead>
<tr>
<th>Year</th>
<th>W/B</th>
<th>&quot;Baby Boomers&quot; start</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>3.5</td>
<td>hitting 65 in 2010</td>
</tr>
<tr>
<td>2020</td>
<td>2.7</td>
<td></td>
</tr>
<tr>
<td>&gt; 2020</td>
<td>2.1</td>
<td></td>
</tr>
</tbody>
</table>
Future of Social Security

- Building up the trust fund **NOW** will reduce the expected tax burden on future workers (**YOU**) by making Baby Boomers (**ME**) pay higher taxes to partially finance their own retirement benefits.
Constructing A Graph

We start with a horizontal number line:
Constructing A Graph

1. The points on the line divide the line into segments.
2. All the line segments are equally spaced.
3. Numbers associated with the points increase in value from left to right.
4. Use a distance, so many points, to represent a quantity.
Constructing A Graph
Add a Vertical Number Line:

1. Construct a vertical number line.
2. Points divide the line into equal segments.
3. Numbers associated with points increase in value from the bottom to top.
4. The scale can be different from the horizontal number line.
Add a Vertical Number Line:
To Make A Graph:

1. The vertical and horizontal number lines must intersect at each others zero point.
2. They must be perpendicular.
To Make A Graph:

The vertical and horizontal number lines should look like the illustration below:
Now that we have combined the horizontal and vertical number line, they have become coordinate axes. The horizontal number line is referred to as the X-axis, and the vertical number line is referred to as the Y-axis. We can now reference a point on a graph with two numbers or coordinates. When referencing a point on a graph, we always call out the x-coordinate first, and then the y-coordinate. For example (x,y) references the coordinate of some point.

Let us go to the firing range and sight in a rifle.
Above you see a “target” that will be used to sight in or “zero” a rifle. You see a vertical and horizontal axis. Each square grid you see represents a square that is one inch by one inch. The black square in the middle of the target is where the y and x axis intersect each other. Graphically, their intersection point is called the origin and has the coordinates (0,0). Thus the term “zero” the rifle. Three shots are made and printed on the paper target. The three shots constitute a “group.” Find the center of the three shot group and you have located the point of impact. What are the coordinates of the center of this three shot group? If you answered (3,2), you are correct. You have also told the person firing the rifle that there point of impact was three inches to the right of zero, and two inches above zero. The person firing the rifle now knows how to correct the aiming device to bring the firearm to “zero”
Moving the aiming device three inches to the left and two inches down will bring the point of impact to the coordinates, (0,0). The rifle is now sighted in to be “on” at the current yardage. Guess what? We have been graphing! We identified two points on a piece of graph paper (the target). Some of you have been “graphing” since you were pretty young, and before you may have been formally introduced to this concept in school.
Yes, this is graphing too! Whether the “crosshairs” illustrated above are superimposed by a firearm or a camera, we are using them to locate a central point of aim to take a beautiful picture or harvest many delicious meals to share with family, friends, acquaintances, and even the disadvantaged through the Hunters for the Hungry Program.
What’s this? Just a “time out” for a moment to enjoy the beauty of mother nature.
To Make A Graph:

4. With a graph, you need two numbers to specify a single point

OR

When you see a point on a graph, you know that point represents two numbers!
Axis defined:

- The vertical number line is reserved for the **Dependent** variable and is referred to as the **Y AXIS**.

- The horizontal number line is referred to as the **X AXIS** and is reserved for the **Independent** variable.
The origin and points on the graph

- The point of intersection of the two number lines is referred to as the ORIGIN.
What are the coordinates for Point A? If you said (2,3) you have got the hang of this.
The origin and points on the graph

- Every point on a graph represents a pair of observations of \( x \) and \( y \).

\[(x, y)\]

- In this class, \( y \) will often represent price and \( x \) will often represent quantity.
1. Slope = change in Y values / change in X values

   = \( \frac{y_1 - y_0}{x_1 - x_0} \)

   = RISE / RUN
Any two points can be used to determine a straight line. The slope of a straight line is constant. Therefore, any two points on a straight line can be used to calculate the slope of a straight line. Above, you see two points on a straight line identified. Point (2,8) and point (3,6). You see two asterisks next to point (2,8). The two asterisks indicate the point that I have chosen to represent “home plate.” When we hit the ball in baseball or softball, we always run FROM home plate TO first base. That is the rules! The slope is defined to be the change in y divided by the change in x. Point (2,8) is home plate, so its “generic” coordinate becomes \((x_0, y_0)\). Point (3,6) is first base, so its “generic” coordinate becomes \((x_1, y_1)\).

The slope = \((y_1 - y_0) / (x_1 - x_0)\) = \((6-8) / (3-2)\) = \(-2 / 1\) = \(-2\)

If your head spinning, then try to remember the following: We always run from home plate to first base. Home plate is designated as 0, and first base is designated as 1.

Slope = (y I am going TO - y I am coming FROM) divided by (x I am going TO - x I am coming FROM).
The Slope

2. As $X$ goes from $2$ to $3$, $Y$ goes from $8$ to $6$.

3. $\Delta Y = \text{RISE} = (\text{TO} - \text{FROM}) = 6 - 8 = -2$

   $\Delta X = \text{RUN} = (\text{TO} - \text{FROM}) = 3 - 2 = 1$
Now try the class exercise in your notebook to graph a straight line and calculate the slope.