Skills Needed for Applied Statistics

Last revised: January 9, 2022

Introduction

Students are often concerned about whether or not they have the mathematical skills needed to succeed in a course. The purpose of this document is to help identify some of those skills that you should already possess so that you can be successful in Math 113, Introduction to Applied Statistics.

If you find that you are weak in some of these areas, then get help. Visit the Math Enrichment Center or the Student Learning Center and let them know you need help reviewing arithmetic and algebra skills for statistics (if you just tell them you're in statistics, they may have trouble finding someone to help), or see the instructor.

Rounding

Here are some guidelines for rounding numbers.

- The instructions will often say to give your answers **accurate** to 1 or 2 decimal places. This is **not** the same thing as writing down the first 1 or 2 decimal places. If the answer is 0.1682315639 and it asks for 2 decimal place accuracy, an answer of 0.16 will be wrong. *In this course* you can round your answers in Canvas to the indicated number of decimal places or type extra decimal places and let the computer round for you. In this example, the answers of 0.17, 0.168, or 0.1682 would all be considered accurate to 2 decimal places.

- When rounding to a certain number of decimal places, use the next digit to determine whether to round up or not. If the next digit is a 5 or larger, then round your digit up. If the next digit is a 4 or lower, then leave your digit as it is.

- Always carry more decimal places through the intermediate steps than you plan to give in the final answer. If you want 2 decimals in the final answer then you should carry at least 3 (preferably more) places until you get to the final answer.

- A general rounding rule is to round the final answer to have one more decimal place than the original values. It is better to give more decimal places than needed than not enough.

- A general rounding rule for proportions is three decimal places, but I like four and if the problem comes out exactly with 6, it's better to go ahead and give all six.

- Don't be stingy. 2/3 is not 0.67, either put it in the calculator as 2/3 or 0.66666666 (a whole lot of sixes). Too few decimal places can cause rounding errors later.

- If a value cannot be displayed exactly, the calculator rounds the value when it displays it to you. 2/3 shows up as 0.6666666667, even though you know the 6 is supposed to repeat

forever. The calculator can't show repeating decimals and rounds the last digit shown.

Percent, Decimal, and Fraction forms

Much of the time, the information we receive will be given as a percentage. Percentages are easier for most people to comprehend because we use them in real life. But when we perform calculations, we work with decimals or fractions. Fractions are preferred in many cases, since they are exact, but decimals are easier for people to work with on a calculator. Regardless, we do not work with numbers in percent form; in fact, most calculators do not even have a percent key anymore. You will need to know how to convert between the different forms.

Percent means "per hundred" so you can think of the percent symbol as meaning "divided by 100." That is how you convert from a percent to a decimal, you simply divide by 100. A shortcut way of doing that is to move the decimal point two places to the left. To convert from a decimal to a percent involves multiplying by 100 or moving the decimal place two places to the right.

Fractions are easy to convert into decimals with a calculator. You just divide the number on top by the number on bottom. If the decimal repeats, you may put a line over the repeating part of the decimal. For example, the calculator says that 27/110 is 0.2454545455, but that last digit is a rounding issue, it is exactly $0.2\overline{45}$.

Completing Tables

Several of the statistical formulas involve performing calculations on a series of numbers. It is often convenient to arrange these problems in table form.

In this table the first two rows would be given and you would be asked to find the last two rows. The xp means multiply the x and p values together. The x^2p means to square the x value and then multiply it by the p value.

x	-3	-1	0	2	4	total
p	0.1	0.2	0.1	0.2	0.4	1.0
xp	-0.3	-0.2	0.0	0.4	1.6	1.5
x^2p	0.9	0.2	0.0	0.8	6.4	8.3

When you see formulas involving x, it usually means apply that formula to every value you have. For example, x – 2 would mean subtract two from every value, 3x means multiply every value by 3, 2(x + 7) means add 7 to every value and then multiply by 2, and x^2 means square every value.

Function Notation

In your algebra courses, you encountered function notation like f(x) = 3x + 2. We will introduce statistical functions in this course that will have names like mean(x) or SE($\bar{x}$) or p(x). It is important to realize that this is function notation and not a product. That is, SE($\bar{x}$) means the Standard Error of $\bar{x}$ not SE times $\bar{x}$. The SE($\bar{x}$) is to be treated as a single quantity in formulas.

Solving Equations

There is an algebra prerequisite for this course. You will need to know how to solve equations. In most cases, you will be able to substitute in the values and then solve, although you are certainly

welcome to solve and then substitute in the values. If you substitute and then solve, be careful about rounding too much in the intermediate steps.

These problems are of the type and difficulty that you'll need to solve in this course. In each case, round your answers to two decimal places. The answers are given at the right so you can see if you're doing them correctly.

Use the formula $z = \frac{x - \mu}{\sigma}$ to find the following.

1. Find z if x = 80, μ = 60, and σ = 15. z = 1.33
2. Find x if z = 1.96, μ = 18.4, and σ = 3.2. x = 24.67
3. Find σ if z = −2.05, x = 8.3, and μ = 10.4. σ = 1.02
4. Find μ if z = −1.28, x = 14.2, and σ = 5.6. μ = 21.37

Use the formula $t = \frac{b_1}{SE(b_1)}$ to find the following.

5. Find b_1 if t = −2.1 and $SE(b_1)$ = 1.6. b_1 = −3.36
6. Find $SE(b_1)$ if t = 4.6 and b_1 = 5.2. $SE(b_1)$ = 1.13

Combining Formulas

Sometimes it will be necessary to combine two or more formulas together to find a value. Be sure that you don't round the intermediate values too much when you're doing this or it can lead to wrong answers at the end.

Use the formulas $ME = t \times SE$ and $SE = \frac{s}{\sqrt{n}}$ to find the following.

7. Find ME if s = 4.7, n = 15, and t = 2.145.
   (a) First find $SE = \frac{4.7}{\sqrt{15}} \approx 1.21353478$
   (b) Now find $ME = 2.145 \times 1.21353478 \approx 2.603032107 \approx 2.60$
8. Find s if n = 24, t = 2.069, and ME = 5.61
   (a) First use $ME = t \times SE$ to find $SE = \frac{ME}{t} = \frac{5.61}{2.069} \approx 2.7114548$
   (b) Now use $SE = \frac{s}{\sqrt{n}}$ to find $s = SE \times \sqrt{n} = 2.7114548 \times \sqrt{24} \approx 13.28$

Finding the Equation of a Line

You will be need to know how to take a point and a slope and find the equation of a line.

Most of you will probably work with the slope-intercept form of a line, y = mx + b, where m is the

slope and b is the y-intercept. There are other forms of a line available, but this one is sufficient for our needs.

Example: Find the equation of the line passing through the point (3, 5) having a slope of 2.6.

The first step is to find the y-intercept by plugging the values we know into the equation. The x and y represent any point on the line, and (3, 5) is one of those. 5 = 2.6(3) + b.

Now solve that for the y-intercept to find b = −2.8. Finally, rewrite the equation, replacing the slope and y-intercept by their values. y = 2.6x − 2.8.

Know how to use your Calculator

This might sound like a no-brainer in a math class, but it's often the source of frustration and missed problems. Check the following on your calculator to make sure you know how to use it.

$2 + 3 \times 5$

The correct answer is 17. If you got 25, it's because your calculator doesn't understand order of operations or because you hit enter after the 3. If you're using your smartphone, you may need to turn it into landscape mode to get a scientific calculator with parentheses ( ). If you hit enter after the 3, stop! Get used to typing the entire expression into the calculator. It would look like `2+3*5`.

$\sqrt{16 + 9}$

The correct answer is 5 as the line in the square root is a grouping symbol. If you got 13, it's because you didn't put parentheses around the 16 + 9. It should look like `√(16+9)`, not `√16+9`.

r^2, where r = −0.5

The correct answer is 0.25. If you got −0.25, it's because you typed `-0.5^2` on the calculator and it knows that you're supposed to do exponents before multiplication by -1 to get the opposite. So it squared 0.5 to get 0.25 and then it took the opposite to get −0.25.

The correct way to do this would have been to enter `(-0.5)^2` or you could have realized that you get a positive when you square a negative and just put in `0.5^2`.

$b - m\bar{x}$, where b = 4.3, m = −3.1, and $\bar{x}$ = 9.6

The correct answer is 34.06. If you got −25.46 it's probably because your mind combined the subtraction in the problem and the negative sign in the slope m = −3.1 into a single item rather than subtracting a negative or adding a positive.

It should look like `4.3-(-3.1)*9.6` or you can simplify it yourself to get `4.3+3.1*9.6`.

$\sqrt{\frac{1-r^2}{n-2}}$, where r = −0.2 and n = 24

This becomes $\sqrt{\frac{1-(-0.2)^2}{24-2}} \approx 0.208893$. You can type it on the calculator as $\sqrt{((1-(-0.2)^2)/(24-2))}$. Squaring −0.2 and squaring 0.2 give the same number, so you could type $\sqrt{((1-0.2^2)/(24-2))}$.

If you got 0.217423, it's the same issue previously mentioned regarding r^2 when r = −0.5. What you found was $\sqrt{\frac{1--0.2^2}{24-2}} = \sqrt{\frac{1+0.2^2}{24-2}}$. You need to either put parentheses around the −0.2 to get $(-0.2)^2$ or do some mental math and drop the negative sign to get 0.2^2.

I would suggest two making two substitutions before you enter it into the calculator: $(-0.2)^2 = 0.2^2$ and 24 − 2 = 22. Then you would enter $\sqrt{\frac{1-0.2^2}{22}}$ or $\sqrt{((1-0.2^2)/22)}$

If you got 1.4i or `ERR:NONREAL ANS`, then you forgot to put the 24 − 2 on the denominator in parentheses. The division bar is a grouping symbol and you need to put parentheses around the numerator and around the denominator. What you found was $\sqrt{\frac{1-(-0.2)^2}{24}} - 2 = \sqrt{-1.96}$. The easier fix, though is to just do the mental math and write 22 instead of 24 − 2. Note that if you got 1.3988i, then you also experienced the problem with the $(-0.2)^2$.

Reading Comprehension

You need to be able to read, comprehend, and follow instructions. Do not jump straight to the problem without reading the instructions. Quizzes are graded using the computer and it's fairly unforgiving when people don't follow instructions. Students will miss the question because they didn't read the instructions that said "Give answers accurate to at least 3 decimal places."

Pay attention to what the problem is asking for. Consider this problem:

> There is a 20% chance someone is a Republican, a 30% chance they're a Democrat, and a 50% chance they're an Independent. In the following expression, how many people were Independents? $\frac{12!}{3!4!5!}(0.2)^3(0.5)^4(0.3)^5$.

Many students make the mistake of working out the problem to get 0.0336798. But the problem didn't ask for the probability, it asked for the *number* of Independents. The 0.5 is the probability of being an independent and the exponent on the 0.5 is 4, so the correct answer was 4.

This is an applied statistics course, which means that many of the problems we encounter will be given in story form, rather than what you see in this sheet. You need to be able to read through the problem, determine what is being asked for, what you know, and then apply the mathematical skills to find the values.