

## Finding Probabilities and Percentiles Under a Normal Distribution

- Many ways to compute probabilities and percentiles under the normal distribution
- 'Old school' way involves tables which are only ever used in an educational setting
- We will focus on using technology, which is what you will do in practice
  - There are many technologies we could use
  - My favorite is a simple online calculator, since these are easy to access
  - I will also show you how to use a graphing calculator, if you have one, Excel, and SAS
- Use of some technology will be necessary for the quizzes and examples in class
- On exams you will not have technology available, so you will not need to calculate probabilities or percentiles under the normal distribution
  - Instead, you will communicate understanding through a well-labeled picture

## Technology Options for Finding Probabilities

- Online calculators
  - E.g. [stattrek.com/online-calculator/normal.aspx](http://stattrek.com/online-calculator/normal.aspx)
  - Fill in: Value of  $y$  (or  $z$ ) you are interested in, Mean, & Standard deviation
  - Click "Calculate" and computer will provide the Cumulative probability (e.g. area below the entered value of  $y$ )
- Graphing calculator (e.g. TI-83 or 84)
  - Function: `normalcdf(`
  - Syntax: `normalcdf(LB, UB, mean, std_dev)`
- Software, e.g.
  - SAS: `DATA temp; prob_y = cdf('normal',UB,mean,std_dev); PROC PRINT; var prob_y; run;`
  - Excel: `=norm.dist(UB, mean, std_dev, TRUE)`

**Example:** Scores on a math test follow a normal distribution with a mean of 430 and a standard deviation 40. Janice scored 480; what percent of students scored below her?

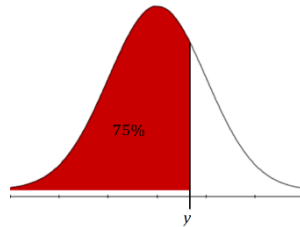
- Online calculator:

Standard score (z)	<input type="text" value="480"/>		Normal random variable (x)	<input type="text" value="480"/>
Cumulative probability $P(Z \leq z)$	<input type="text"/>	⇒	Calculate	⇒ Cumulative probability: $P(X \leq 480)$
Mean	<input type="text" value="430"/>			<input type="text" value="430"/>
Standard deviation	<input type="text" value="40"/>			<input type="text" value="40"/>

- Graphing calc: `normalcdf(-1000,480,430,40)`
- SAS: `DATA temp; prob_y = cdf('normal', 480, 430, 40); PROC PRINT; var prob_y; run;`
- Excel; in a cell enter: `=norm.dist(480,430,40,TRUE)`
- From each of these:  $P(Y < 480) = 0.8944$

## Technology Options for Finding Percentiles

- **Percentile** = value of variable that divides the distribution so that a specified percentage is below that value
  - Ex: 75<sup>th</sup> percentile is value of  $Y$  such that 75% of area is less than  $y$  (recall: this is the 3<sup>rd</sup> quartile!)



- Basic options for calculating percentiles are the same, but what you are inputting/solving for is different
- Online calculators
  - E.g. [stattrek.com/online-calculator/normal.aspx](http://stattrek.com/online-calculator/normal.aspx)
  - Fill in Cumulative probability, Mean, & Standard deviation
  - Click “Calculate”; computer provides value of  $y$  that is the appropriate percentile
- Graphing calculator (e.g. TI-83 or 84)
  - Function: `invNorm(`
  - Syntax: `invNorm(proportion to left, mean, std_dev)`
- Software, e.g.
  - SAS uses  $N(0,1)$  so it returns a z-score! Need to solve z-score formula for  $y$ :  
`DATA temp; z=probit(proportion); y = (z*std_dev) + mean;`  
`PROC PRINT; var y; run;`
  - Excel: `=norm.inv(proportion, mean, std_dev)`

**Example:** The principal of a high school wants give an award to students who score in the top 10% of the standardized mathematics test [recall: scores  $\sim N(430,40)$ ]. What raw score has the top 10% above it?

• Online calculator:

Standard score (z)	<input type="text"/>		Normal random variable (x)	<input type="text" value="481.262"/>
Cumulative probability $P(Z \leq z)$	<input type="text" value="0.9"/>	$\Rightarrow$	<input type="button" value="Calculate"/>	$\Rightarrow$ Cumulative probability: $P(X \leq 481.262)$
Mean	<input type="text" value="430"/>			<input type="text" value="430"/>
Standard deviation	<input type="text" value="40"/>			<input type="text" value="40"/>

- Graphing calc: `invNorm(0.9, 430, 40)`
- SAS: `DATA temp;`  
`z = probit(proportion);`  
`y = (z*std_dev) + mean;`  
`PROC PRINT;`  
`var y;`  
`run;`
- Excel; in a cell enter: `=norm.inv(0.9, 430, 40)`
- From each of these: 90<sup>th</sup> percentile = 481.26