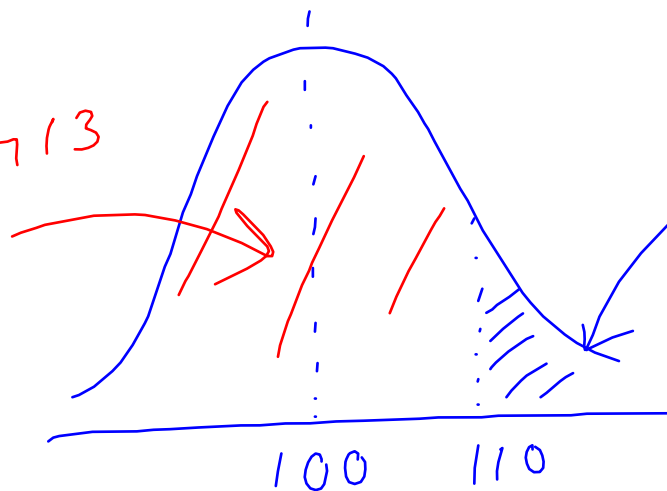


Sec 8.4

$X \rightarrow \mu = 100 \text{ mph}$   
 $\sigma = 10 \text{ mph}$   
Normal

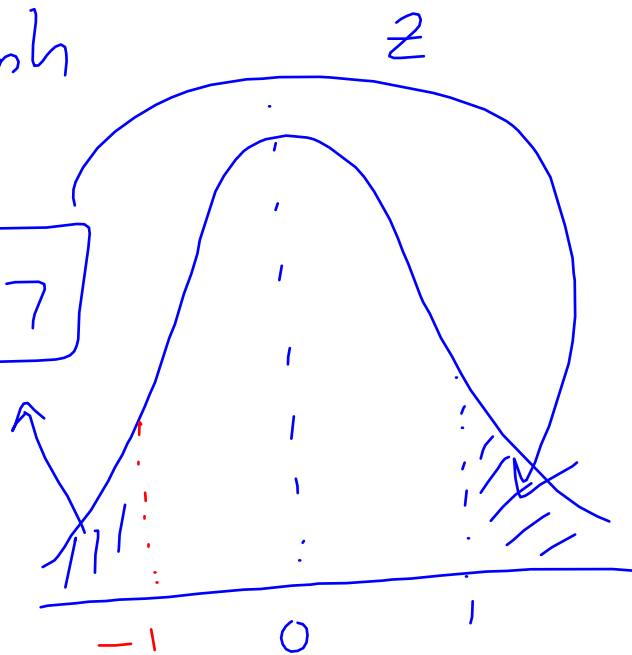
0.8413



=NORM.S.DIST(-1, TRUE)

=NORM.DIST(110, 100, 10, TRUE)

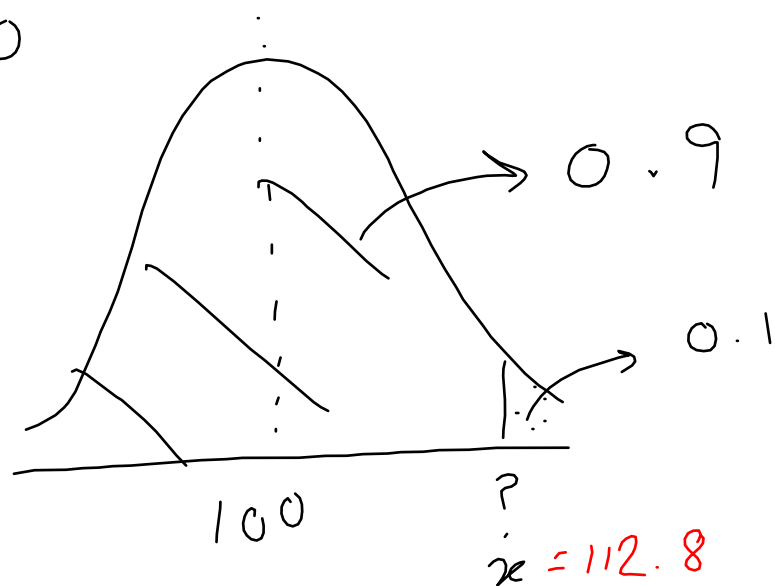
$$\frac{110 - 100}{10}$$



$$\mu = 100$$

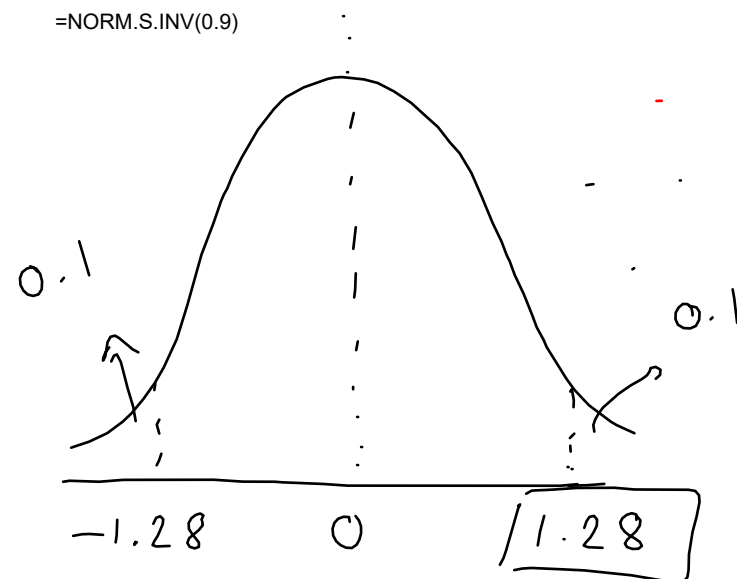
$$\sigma = 10$$

=NORM.INV(0.9, 100, 10)



$$\frac{x - 100}{10} = 1.28$$

=NORM.S.INV(0.9)



$$x - 100 = 12.8$$

$$x = 112.8$$

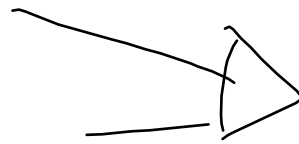
Sec 9.1

Random sample

Voluntary samples

Selected "

⇒ bias



non-random  
Samples

| <u>E stimator</u> | <u>Parameter</u> | <u>Estimate</u> |
|-------------------|------------------|-----------------|
| statistic / rule  |                  |                 |
| $\bar{x}$         | $\mu$            | $\bar{x} = 25$  |
| $\hat{p}$         | $p$              | $\hat{p} = 0.1$ |
| $s$               | $\sigma$         | $s = 10$        |

## Sec 9.2

Pop. param. of interest =  $\mu$

Say  $\mu = 100$   $\rightarrow$  avg. of  $X$   $\rightarrow$  std. dev. =  $\sigma$  (tennis serves)

$X \rightarrow$  speed of serves

Avg. of  $\bar{X} = 100$

expected value of  $\bar{X} = 100$

sample  
avg.  
of  
speed

$\bar{X}$

110

90

88.7

121.3

$\bar{X} \rightarrow$  unbiased estimator of  $\mu$

$$E(\bar{X}) = \mu$$

For any estimator if

expected value = true pop. value

$\Rightarrow$  estimator is unbiased

Variance of  $\bar{X}$

$\square$  :  $X$  values

84, 85, 92, 93, ...

Sample 1 :  $\square 60, 70, 83, \dots, 109$

$$\bar{X}_1 = 90 \quad \bar{x}_1 = 87$$

$\bar{X}$  values

Sample 2 :  $\square 90, 91, 97, 112, \dots, 140$   
93, 94, 88, 87, ...

$$\bar{X}_2 = 100 \quad \bar{x}_2 = 94$$

$$\text{var}(X) > \text{var}(\bar{X})$$

Sample 10 :  $\square 70, 72, \dots, 87, 97, 107$   
92, 88, 83, ...

$$\bar{X}_{10} = 92$$

$$\bar{x}_{10} = 92$$

serve speed  $X$

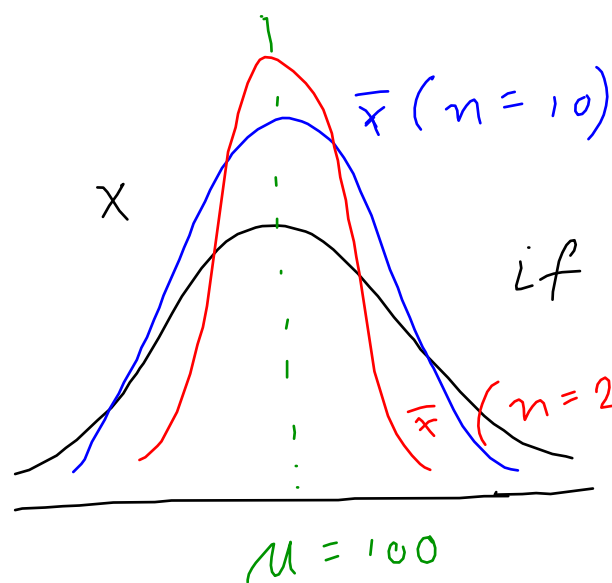
avg. =  $\mu = 100$

std. dev. =  $\sigma = 10$

avg. serve speed  $\bar{X}$

avg. =  $\mu = 100$

std. dev. =  $\frac{\sigma}{\sqrt{n}}$



if  $n = 100$

$$\frac{\sigma}{\sqrt{n}} = \frac{10}{10} = 1$$

$$= \frac{10}{\sqrt{n}}$$

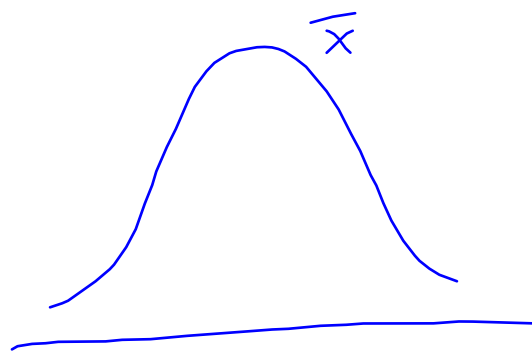
if  $n = 400$

$$\frac{\sigma}{\sqrt{n}} = \frac{10}{20} = 0.5$$

Distribution of  $\bar{X}$  ?

Central Limit Theorem

Normal provided  $n$  is large



if  $X$  is normal

then  $n$  can be small

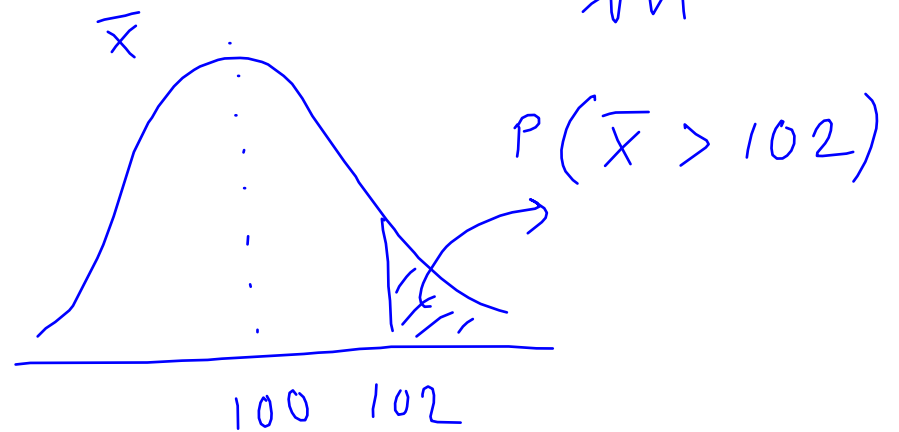
$$\bar{X} \sim N\left(\mu, \frac{\sigma}{\sqrt{n}}\right)$$

↓  
is distributed

normal  
avg. =  $\mu$   
std. dev. =  $\frac{\sigma}{\sqrt{n}}$

$$\sim N\left(100, \frac{10}{\sqrt{100}}\right)$$

$$\sim N(100, 1)$$



$$\frac{102 - 100}{10}$$

$$\frac{\bar{X} - \mu}{\sigma/\sqrt{n}} \sim N(0, 1)$$

