Learning Objectives

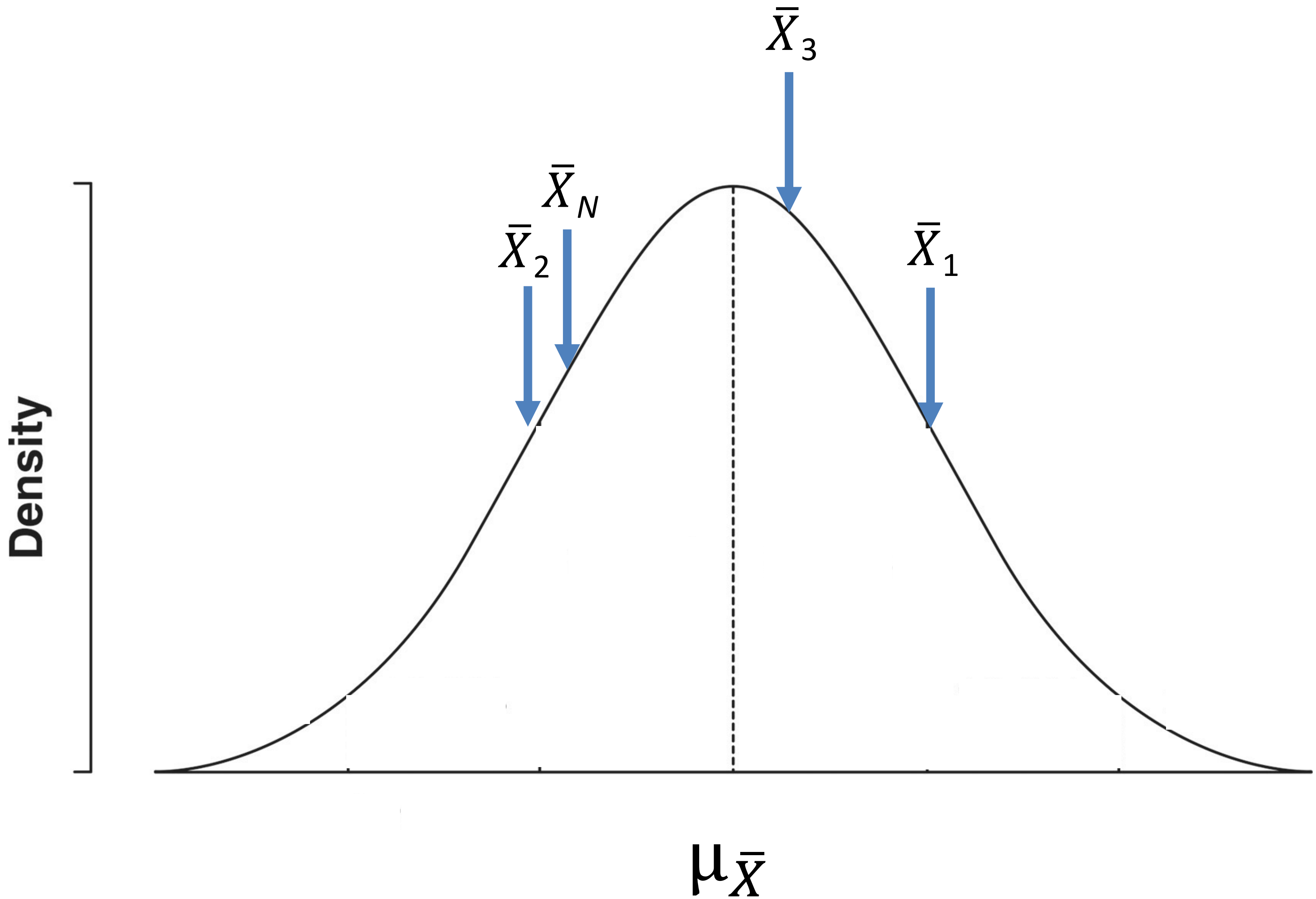
- **Describe** sampling distributions of means
- **Calculate** the *standard error of the mean*
- **Understand** *Central Limit Theorem*, and its effect on distributions
- **Conduct** *z*-tests (in 6 baby steps)

Samples of Sample Means

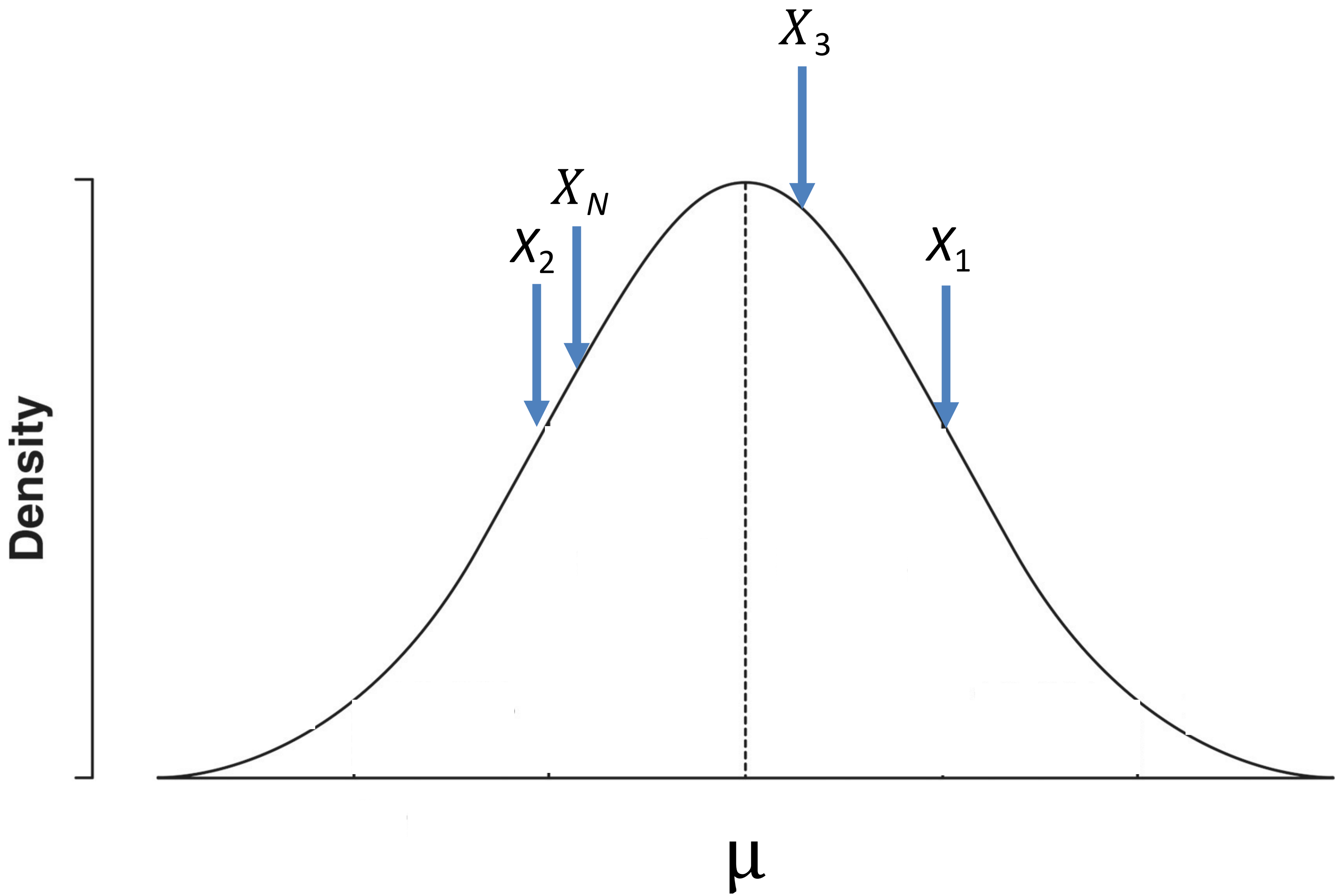
- Imagine drawing 30 samples of 4 student exam scores from our class
  - Sample 1: 63, 70, 72, 98
  - Sample 2: 59, 65, 71, 74
  - Sample *N*: 60, 66, 72, 73

- Sample means would be different each time we collected a new sample…

Sampling Distribution of Sample Means

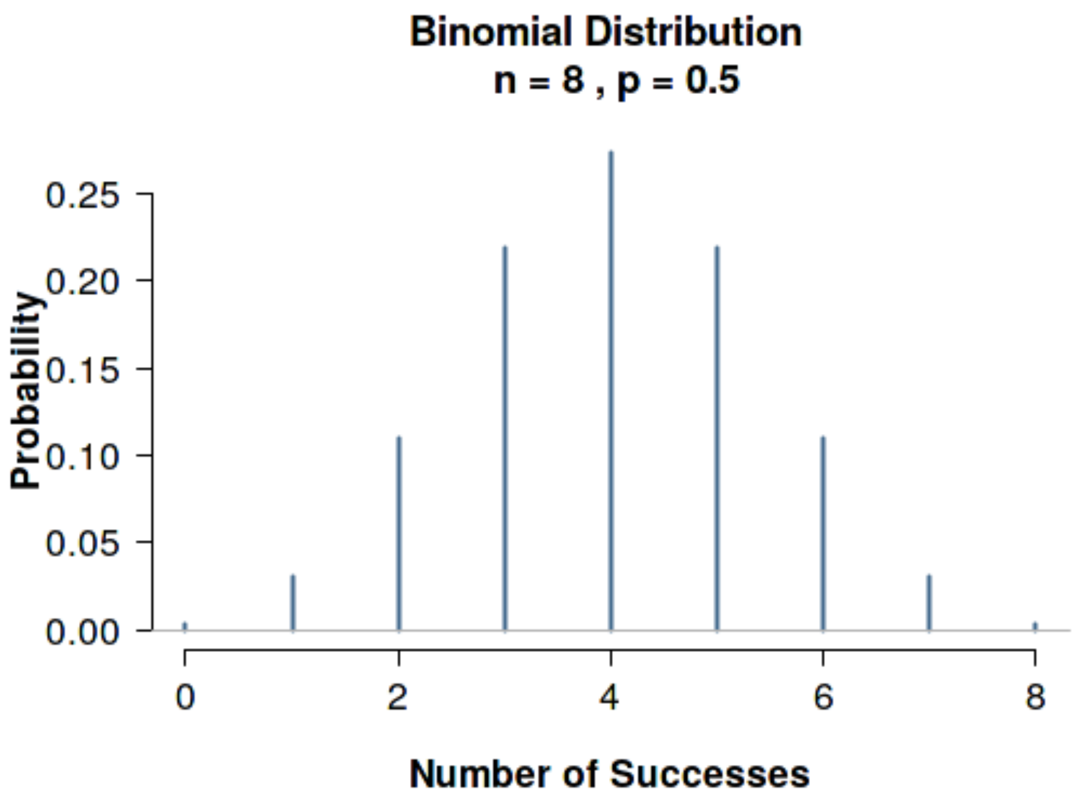


Sampling Distribution of Sample Scores



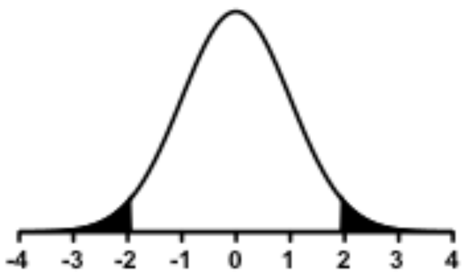
(we've already been doing this…)

- Not with means, but with proportions
  - If H_0 is true, then distribution is:

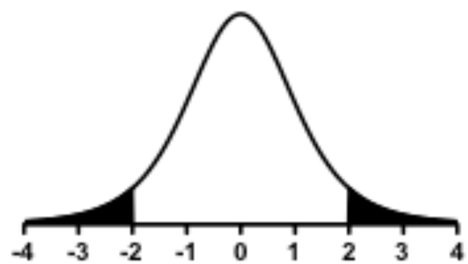


Other Random Distributions

- Distribution shape varies depending on the <u>scale</u> of IV/DV & research design
  - R



z



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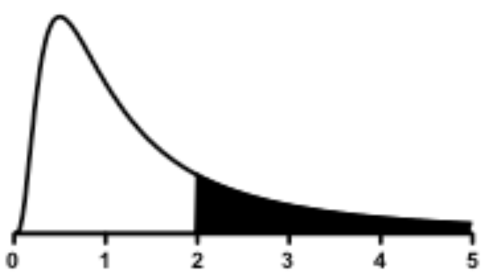

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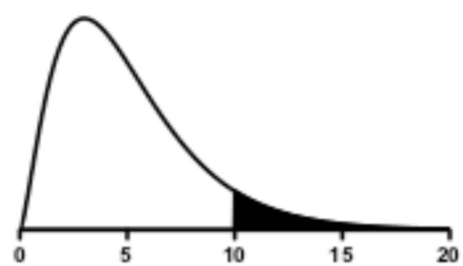
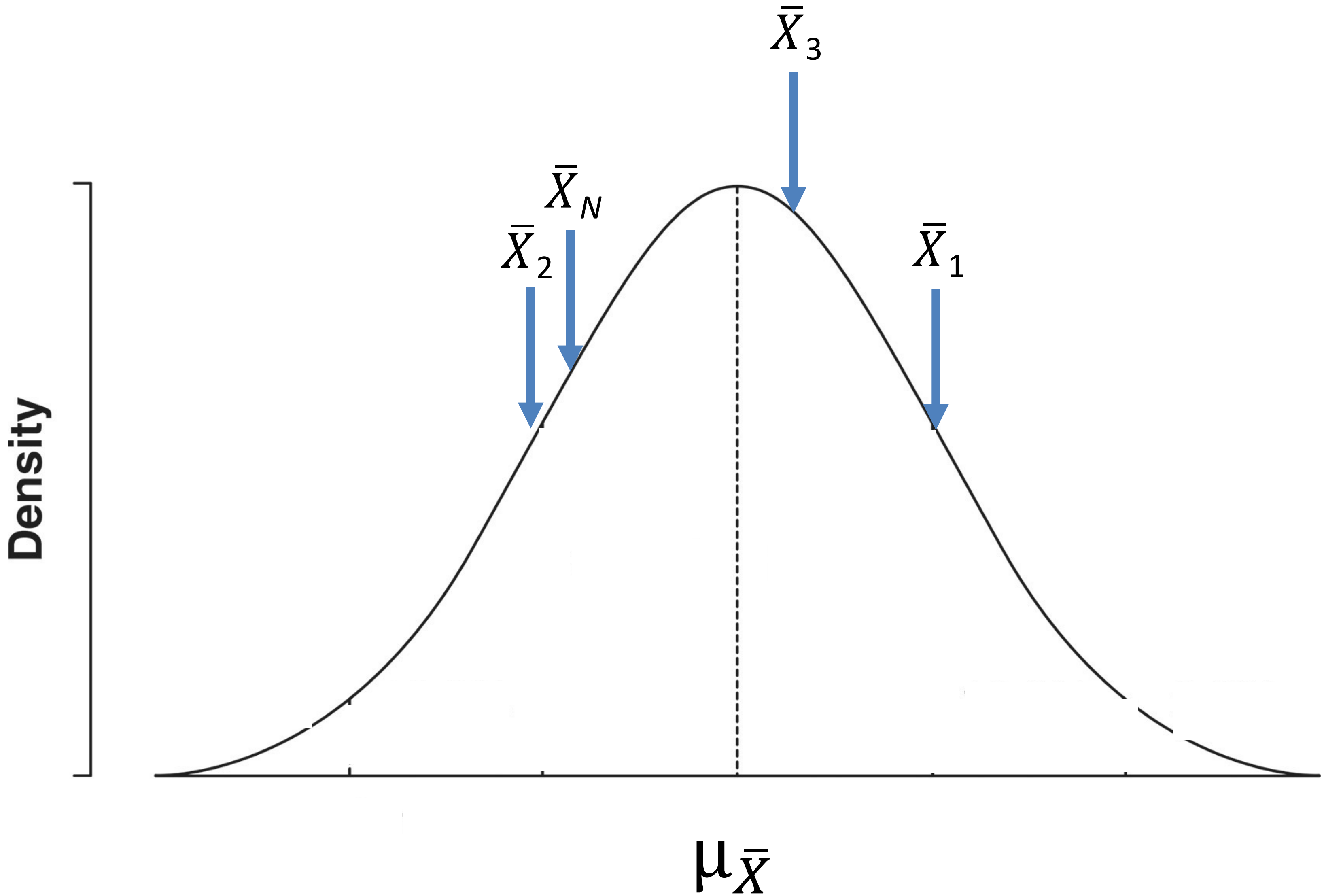


χ^2

Sampling Distribution of Sample Means

<u>If H_0 is true</u>, then distribution is:



Sampling Distribution of Sample Means

- Mean of the distribution (of sample means) is the same as population mean (mean of all cases)

$$\boxed{\mu_{\bar{X}} = \mu}$$

- Standard deviation of distribution (of sample means) is equal to the population standard deviation, divided by square root of *N*

$$\boxed{\sigma_{\bar{X}} = \frac{\sigma}{\sqrt{N}}}$$

Standard Error

- *Standard Error of the Mean* is the average (mean) difference between $\bar{X}$'s and μ

$$\boxed{\sigma_{\bar{X}} = \frac{\sigma}{\sqrt{N}}}$$

- Each sample mean is an estimate of μ
  - As σ decreases, $\sigma_{\bar{X}}$ decreases
  - As *N* increases, $\sigma_{\bar{X}}$ decreases
  - Sampling distribution narrows, $\sigma_{\bar{X}}$ decreases

Central Limit Theorem

- No matter what the distribution of individual observations (X_1, X_2…X_N) looks like…
  - As N increases, sampling distribution of means approaches the ***normal distribution*** (***z***)
  - Where N is the size of the <u>sample</u>

- Knowing the size of <u>our</u> sample tells us…
  - How 'normal' the distribution will look under H_0
  - How close our $\bar{X}$ will be, on average, to μ

Comparing distributions of scores to distributions of means

	Raw Score Distribution (Parent Population)	Sampling Distribution of the Mean
Each observation	X	$\overline{X}$
Mean	μ	$\mu_{\overline{X}} = \mu$
Standard Deviation	σ	$\sigma_{\overline{X}} = \dfrac{\sigma}{\sqrt{N}}$
Shape	Normal, skewed, rectangular, bimodal, etc…	Approximately normal (as N increases)