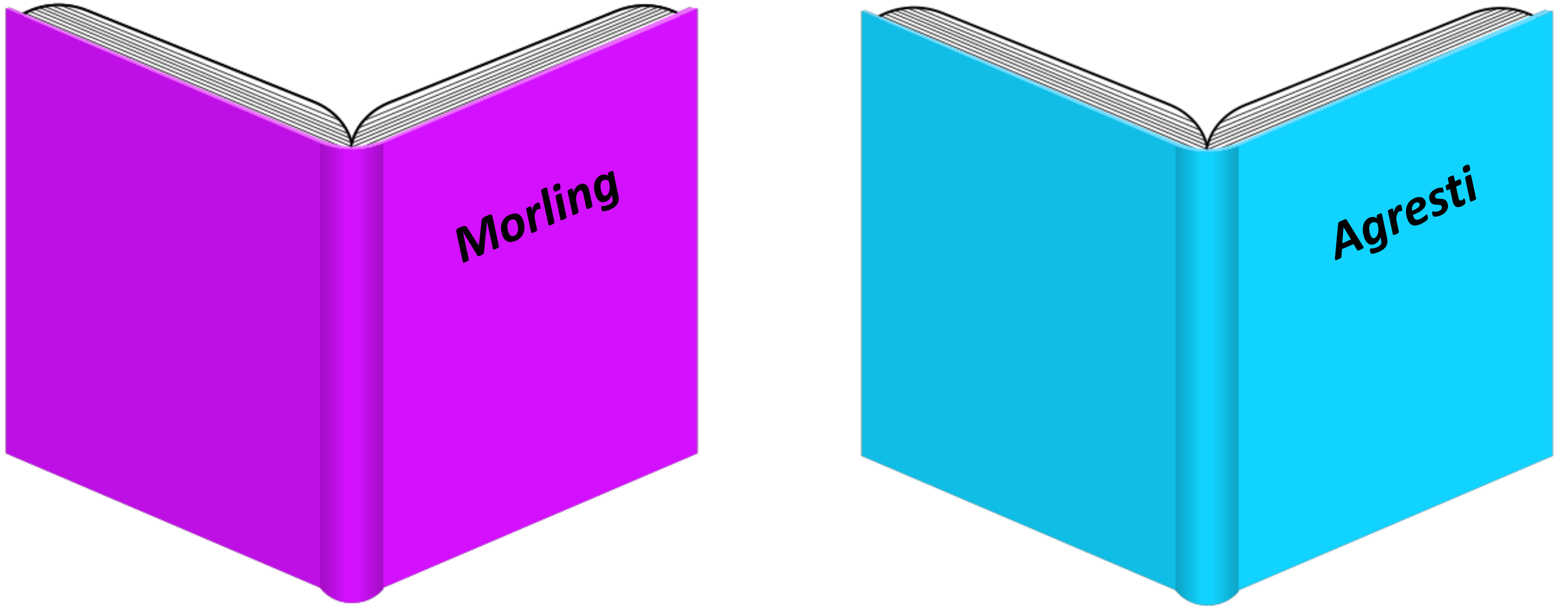


Research Methods and Statistics

Lecture 11: Confidence Intervals I

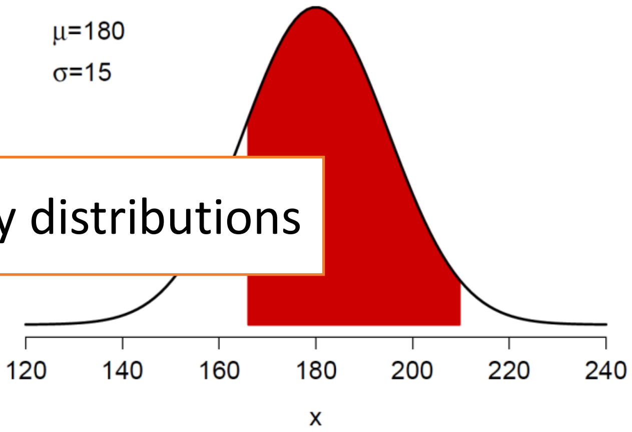
Riet van Bork

Pictures source: pixabay.org

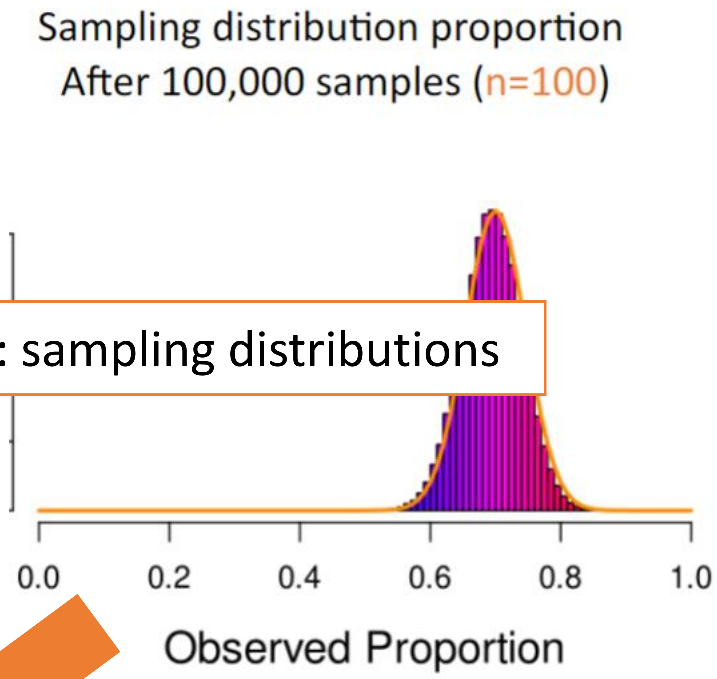
Using excel

- In the exam, the tables in the appendix of the book will not be available!
- So, practice with using Excel instead of the tables!
- Check:

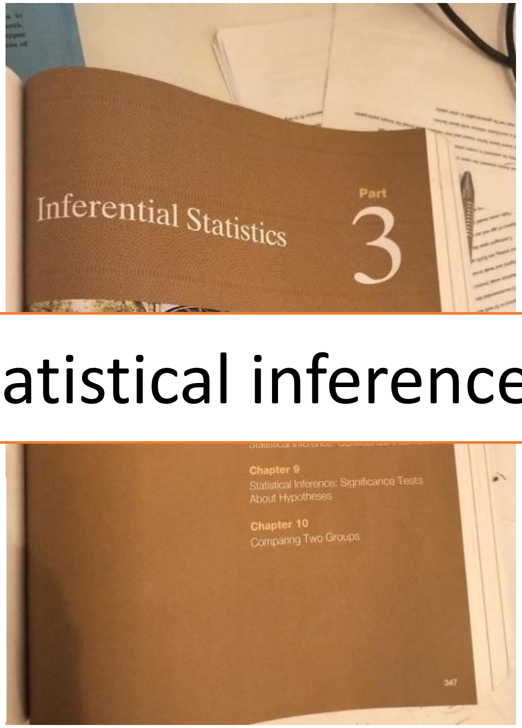
Canvas -> Modules -> Preparation for exam 2 -> Microsoft Excel



Lecture 9: probability distributions

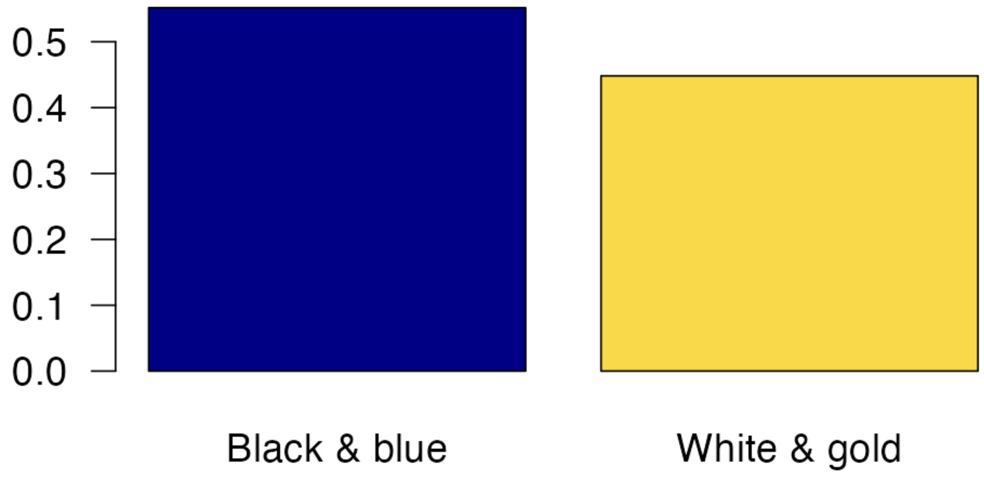


Lecture 10: sampling distributions



Statistical inference!

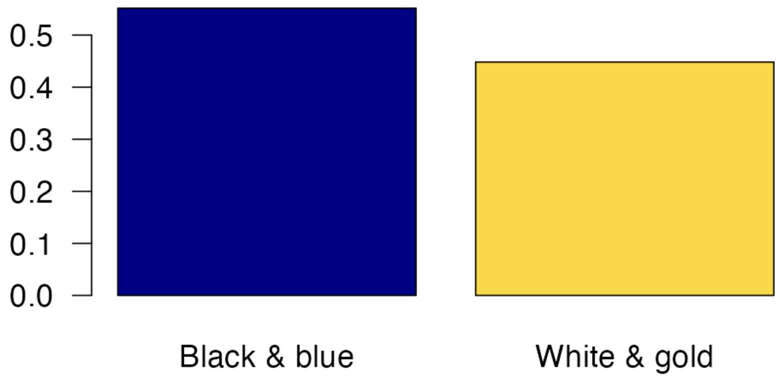
Black & blue or White & gold?



Black & blue: 144 (0.55)
White & gold: 117 (0.45)

Image source: By Cecilia Bleasdale - https://web.archive.org/web/20150227014959/http://swiked.tumblr.com/post/112073818575/guys-please-help-me-is-this-dress-white-and, Fair use, https://en.wikipedia.org/w/index.php?curid=69200610

Example: the dress



Black & blue: 144 (0.55)
White & gold: 117 (0.45)

- In this sample (you students!), the proportion of people who observed black & blue is 0.55, and the proportion who observed white & gold is 0.45

- These are *sample proportions*
- Are the population proportions different from 0.50 – 0.50?

→Inferential statistics

Today: Confidence intervals

Photo source: https://nl.m.wikipedia.org/wiki/Bestand:Unrolled_joint.jpg

Today

Memory refresh of sampling distribution

Point versus interval estimation

Constructing a confidence interval

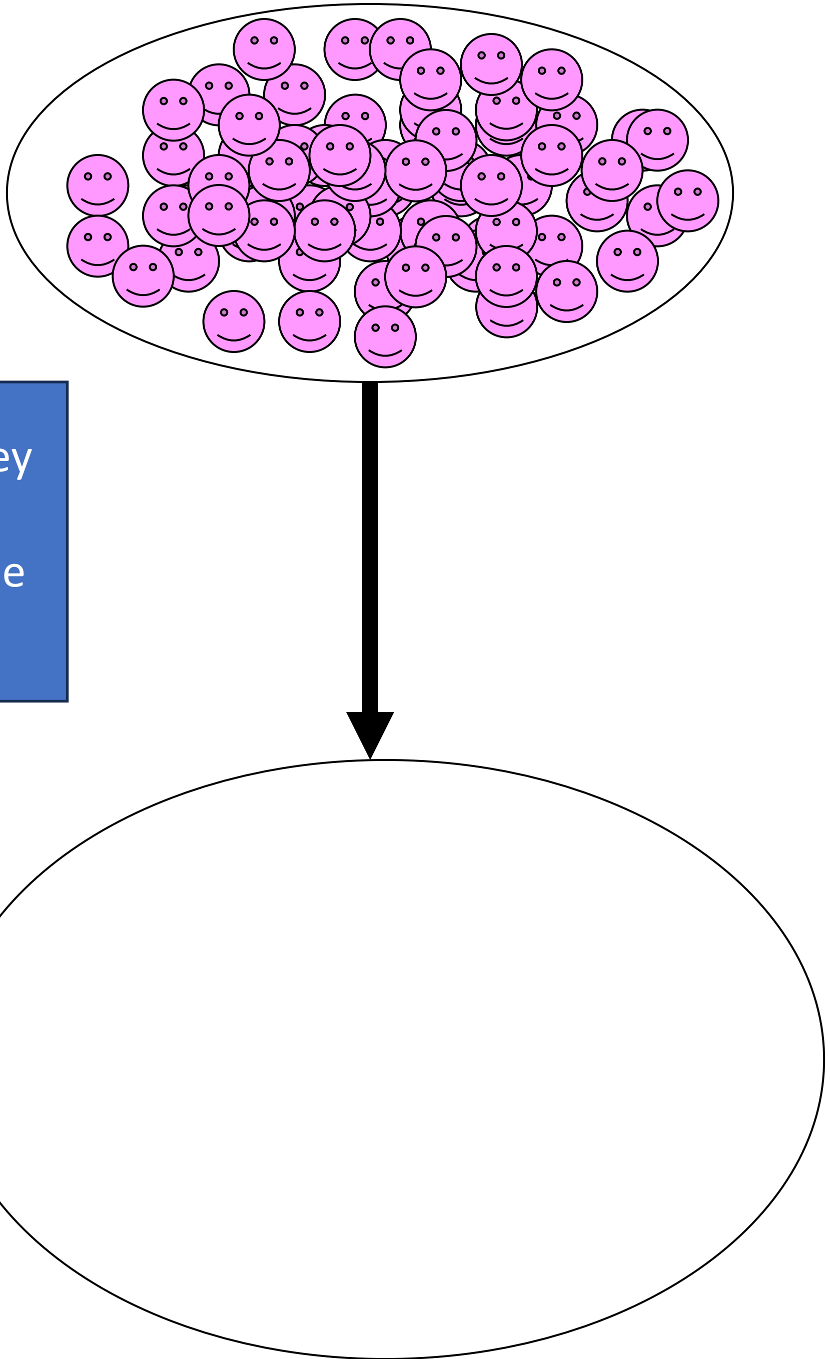
What affects confidence intervals

Interpretation of confidence intervals

Refresh your memory from last Thursday

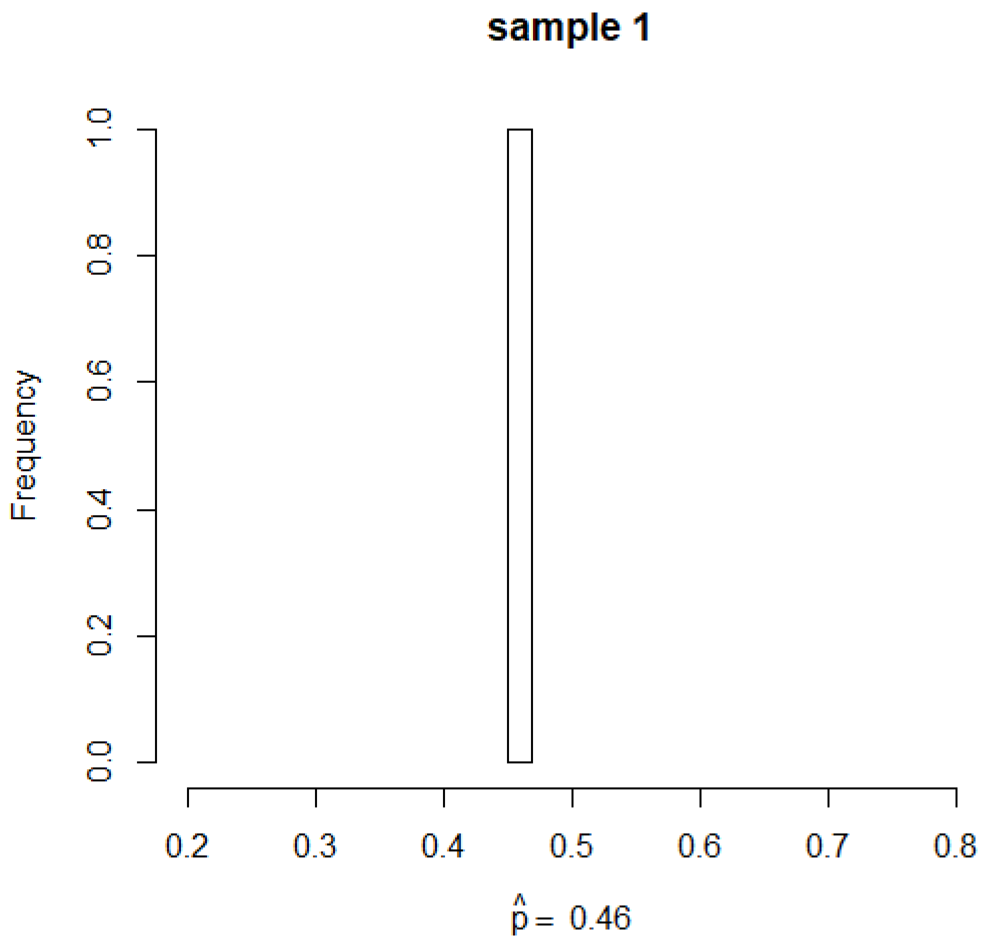
Sampling distribution

Population
$p = 0.5$

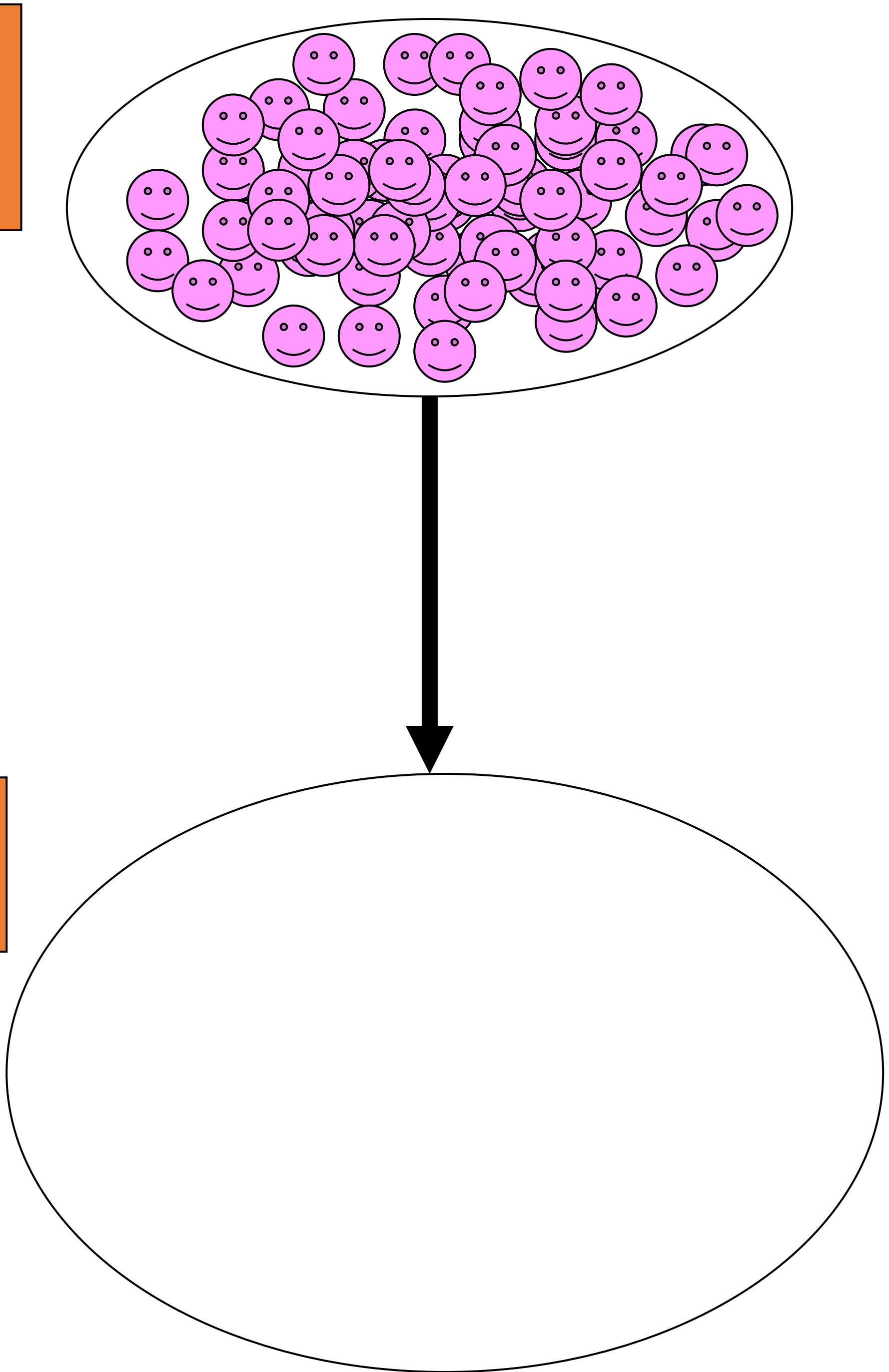


Let's suppose that each smiley is 10 people, so that each sample you sample 50 people from population: n=50

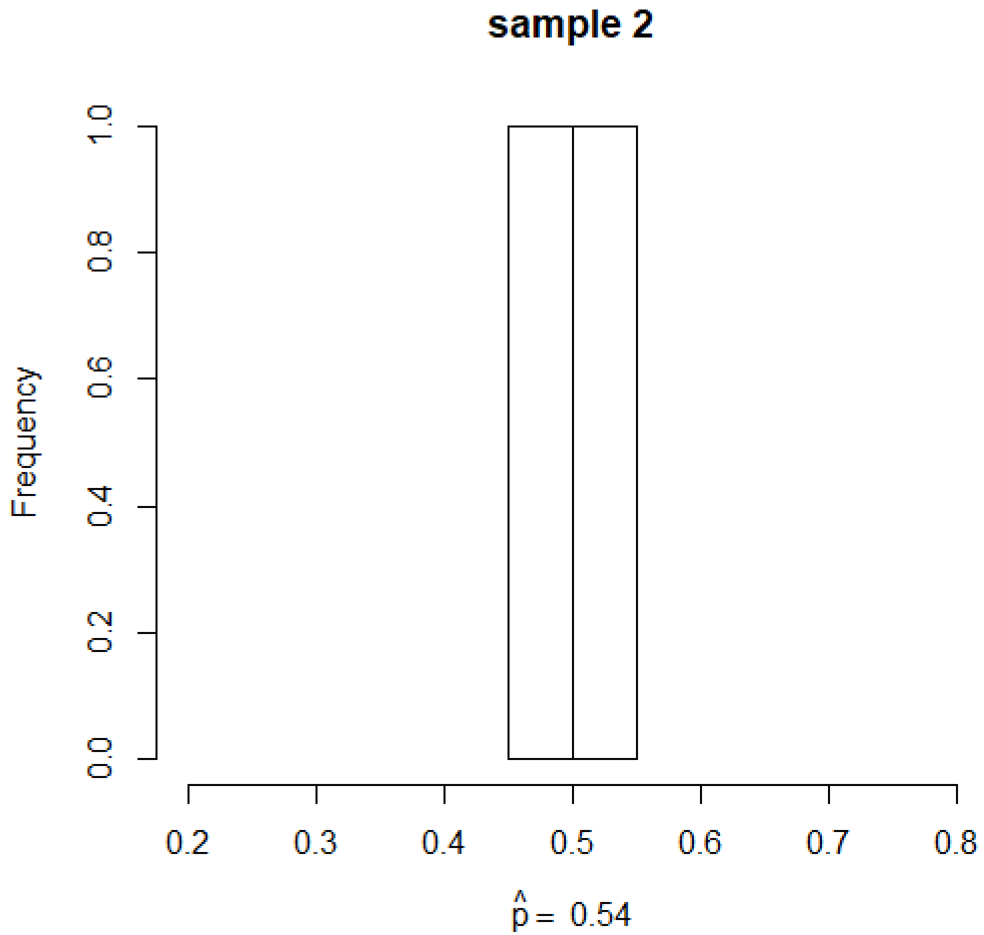
Sample
$\hat{p} = 0.46$



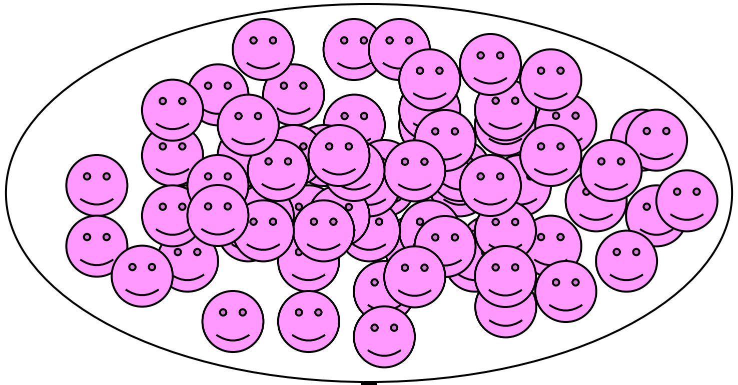
Population
$p = 0.5$



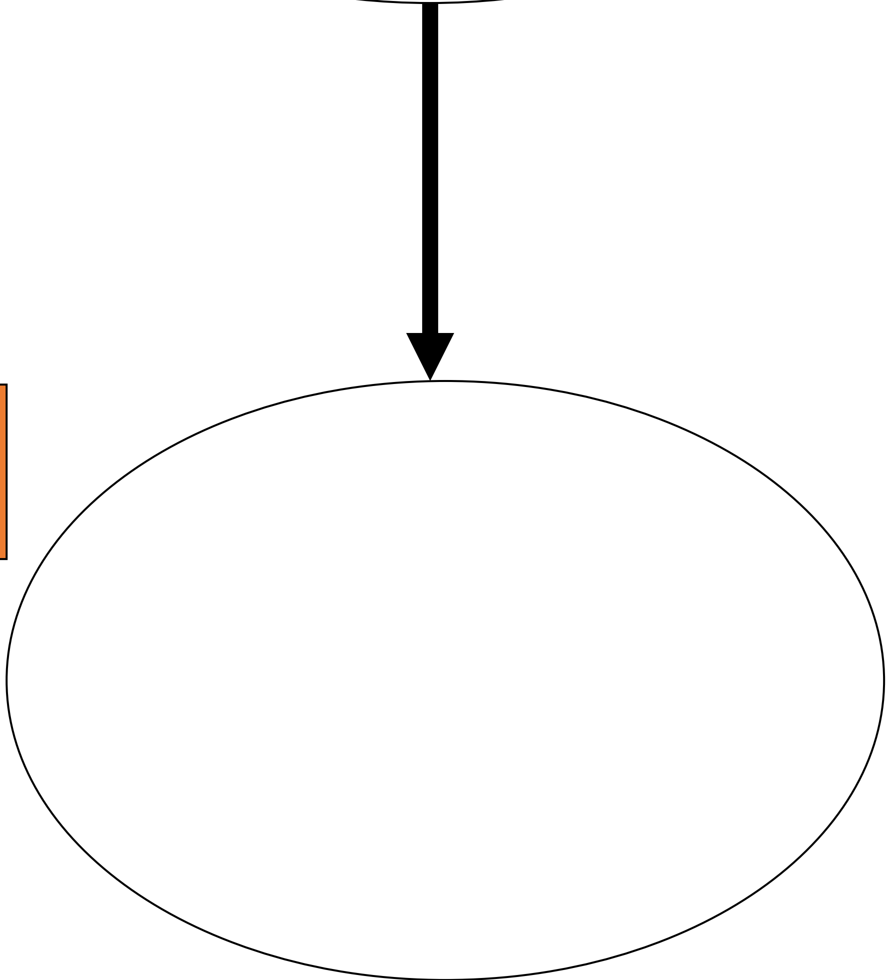
Sample
$\hat{p} = 0.54$

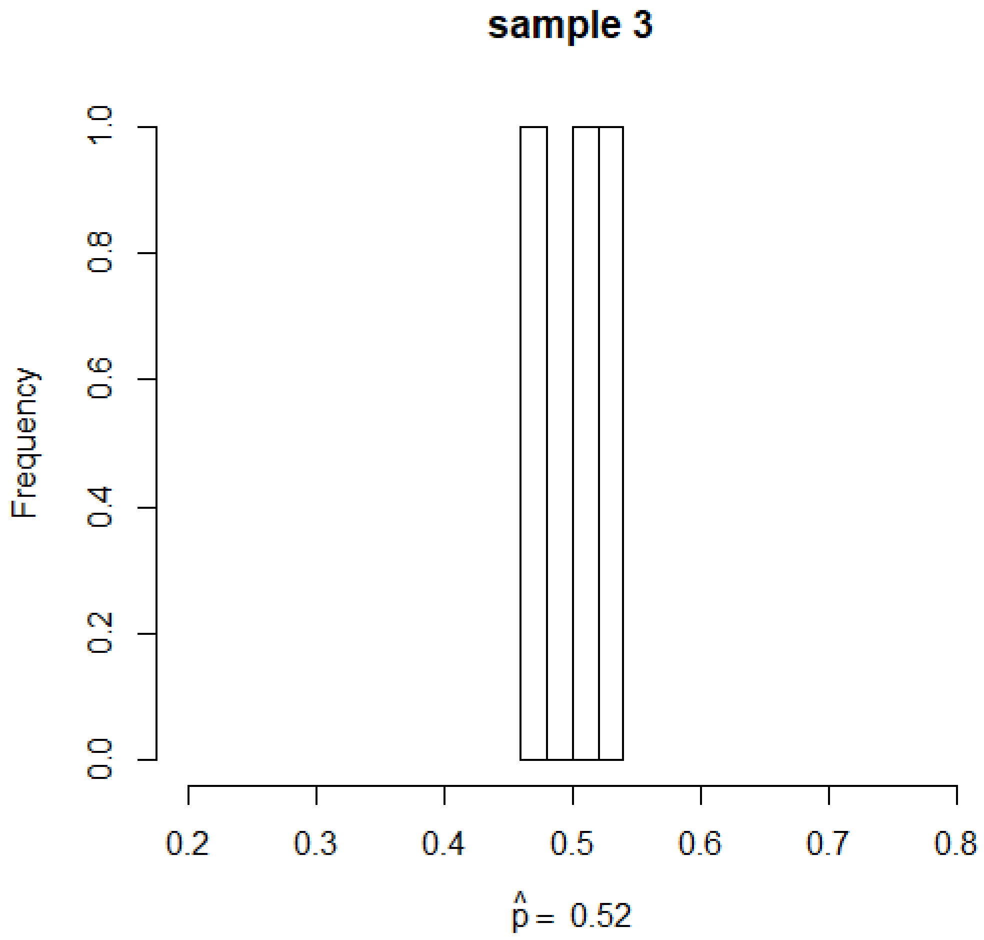


Population
$p = 0.5$

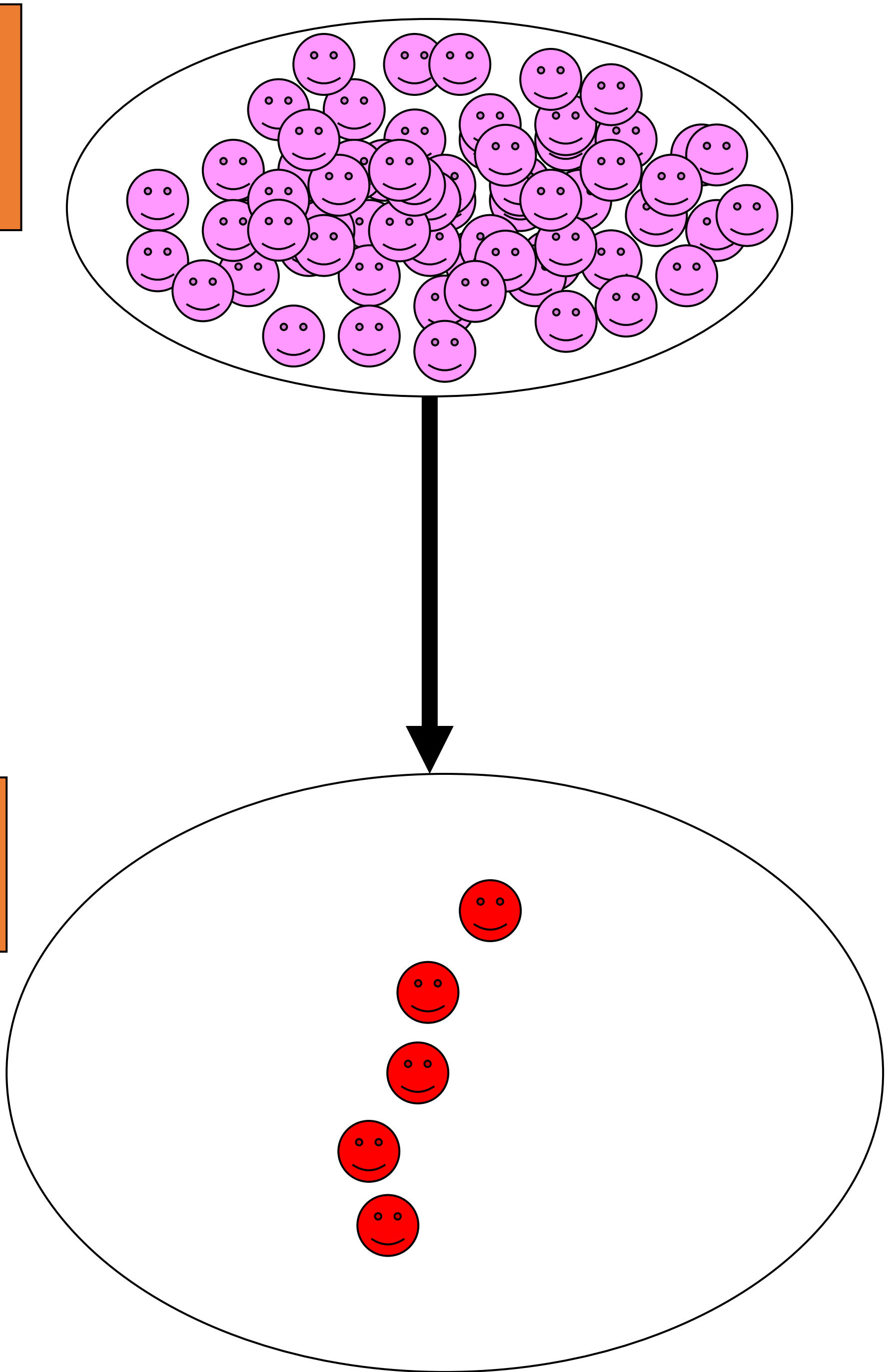


Sample
$\hat{p} = 0.52$

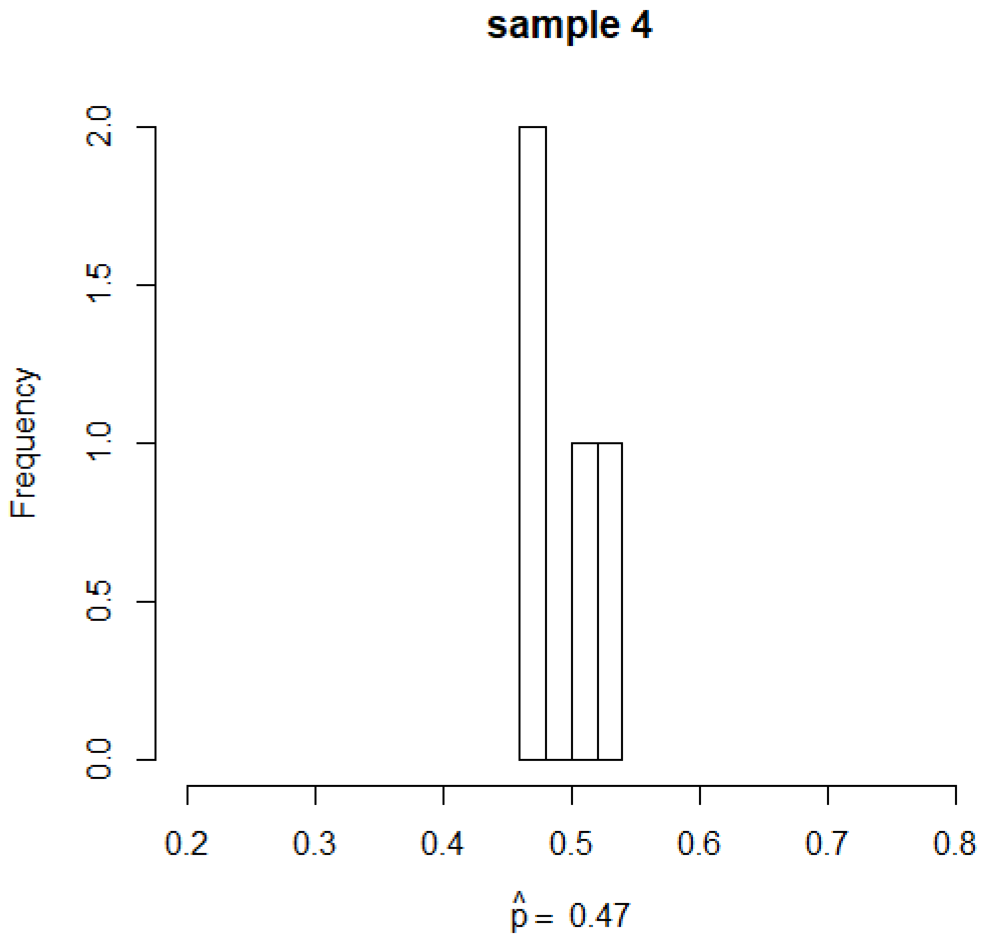




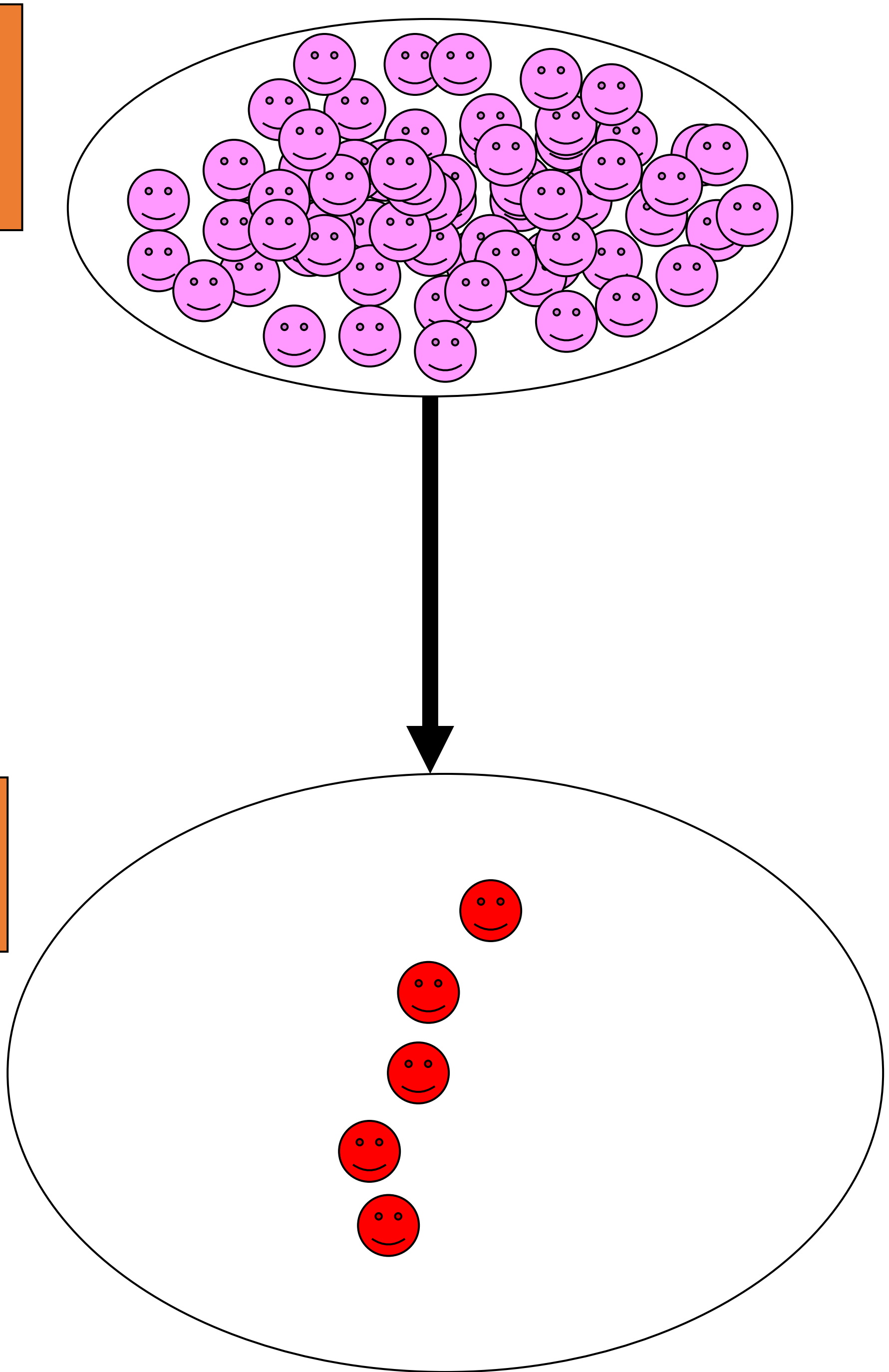
Population
$p = 0.5$



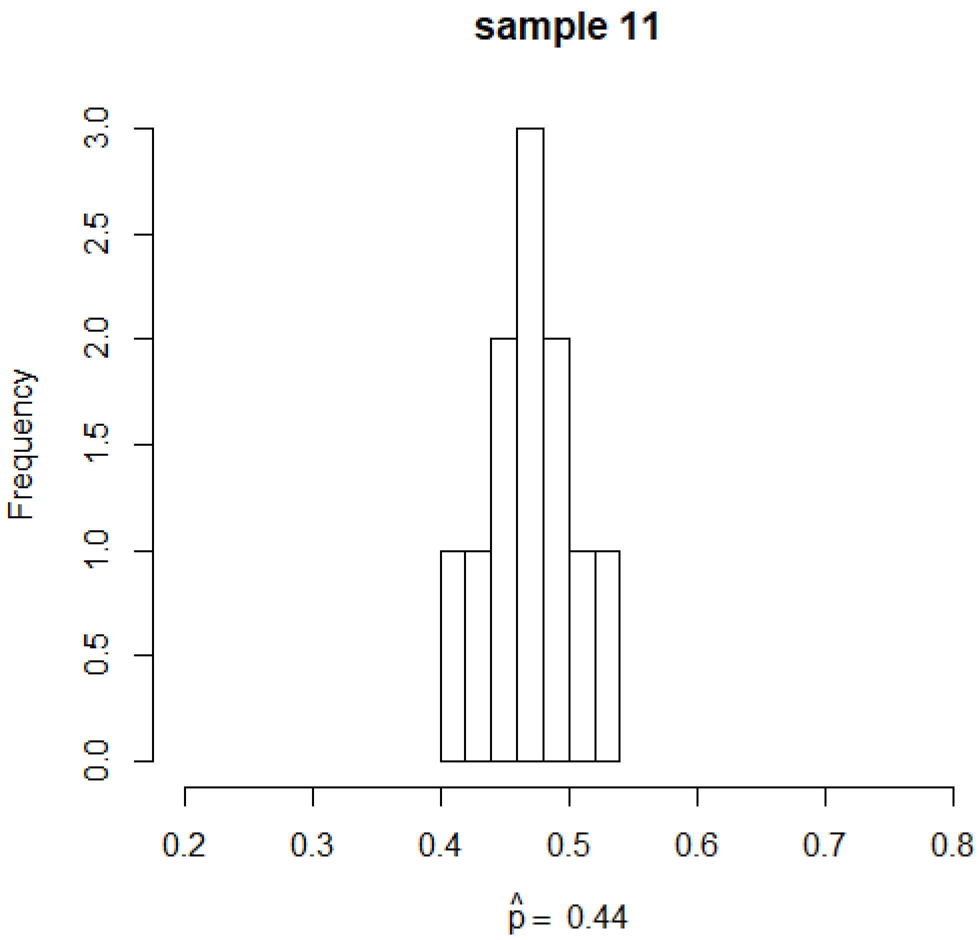
Sample
$\hat{p} = 0.47$



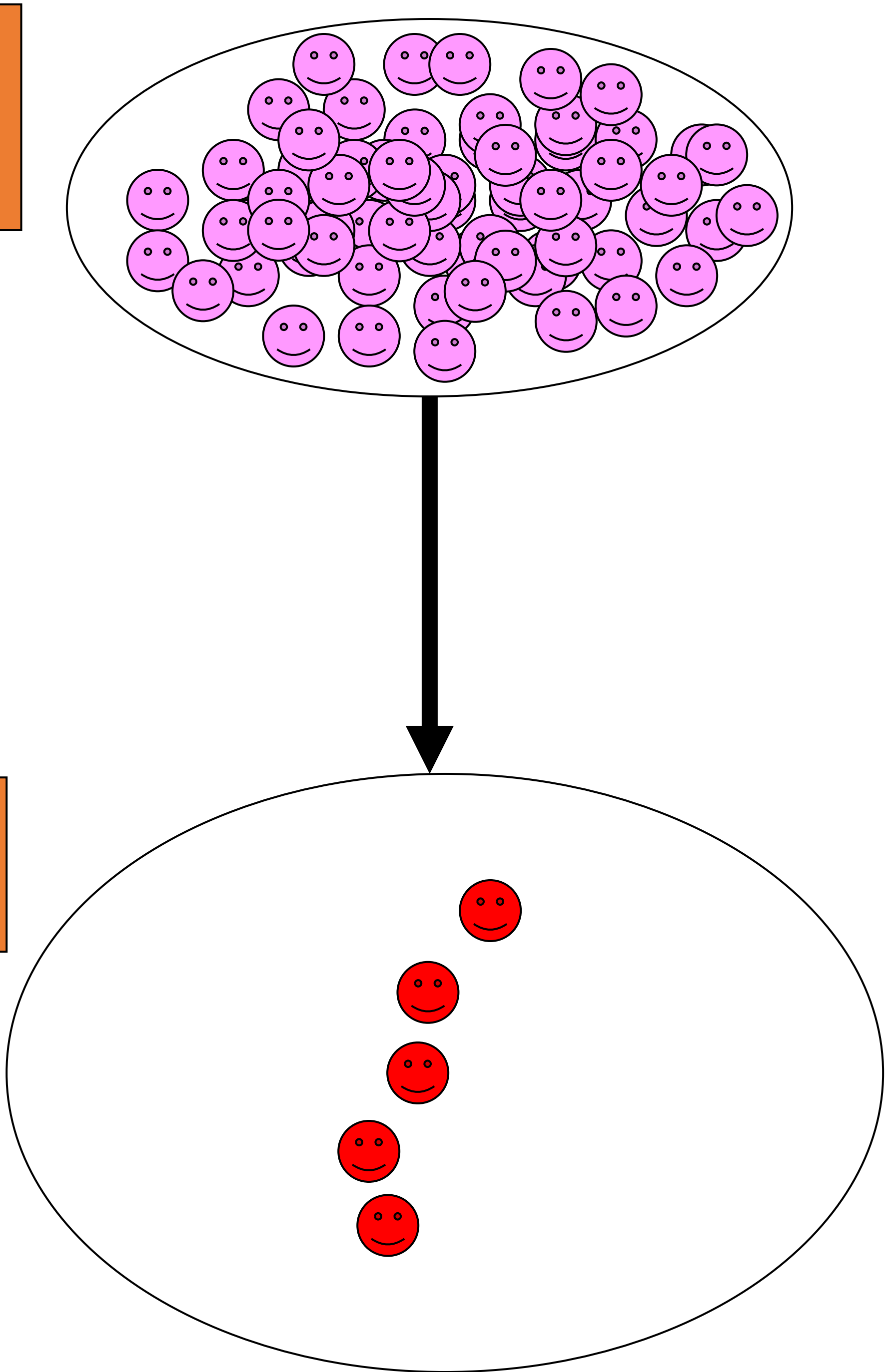
Population
$p = 0.5$



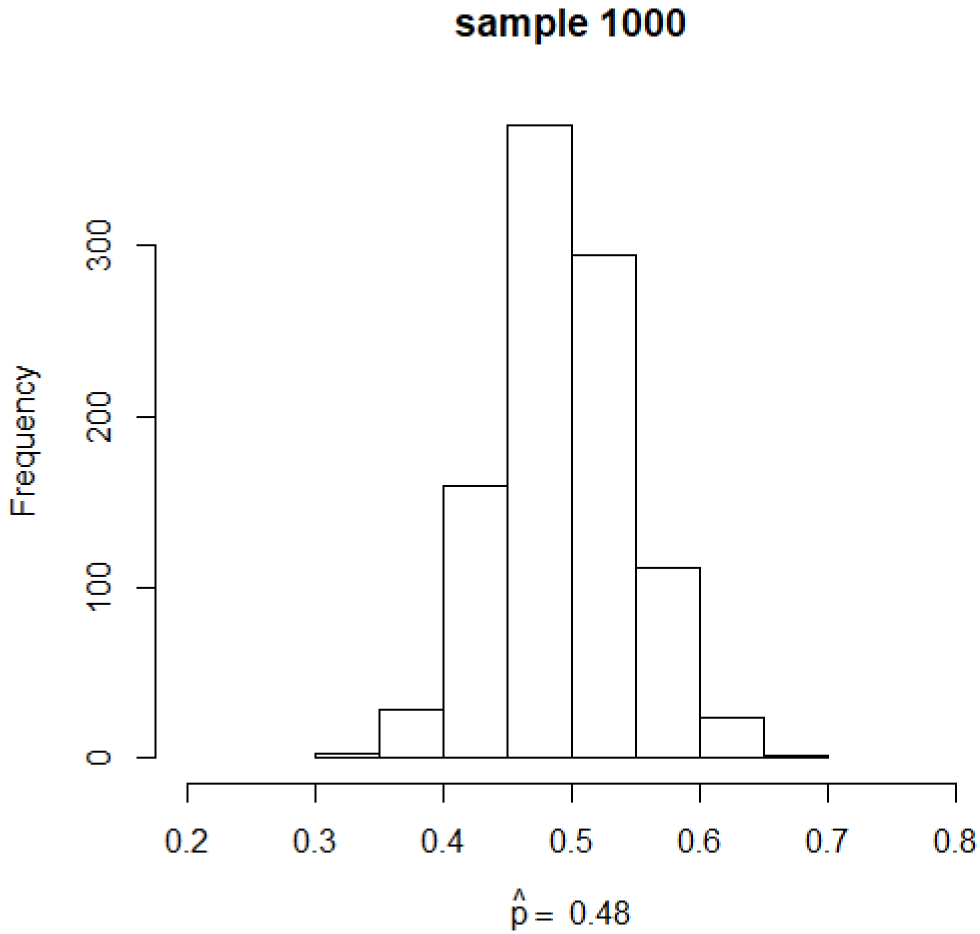
Sample
$\hat{p} = 0.44$



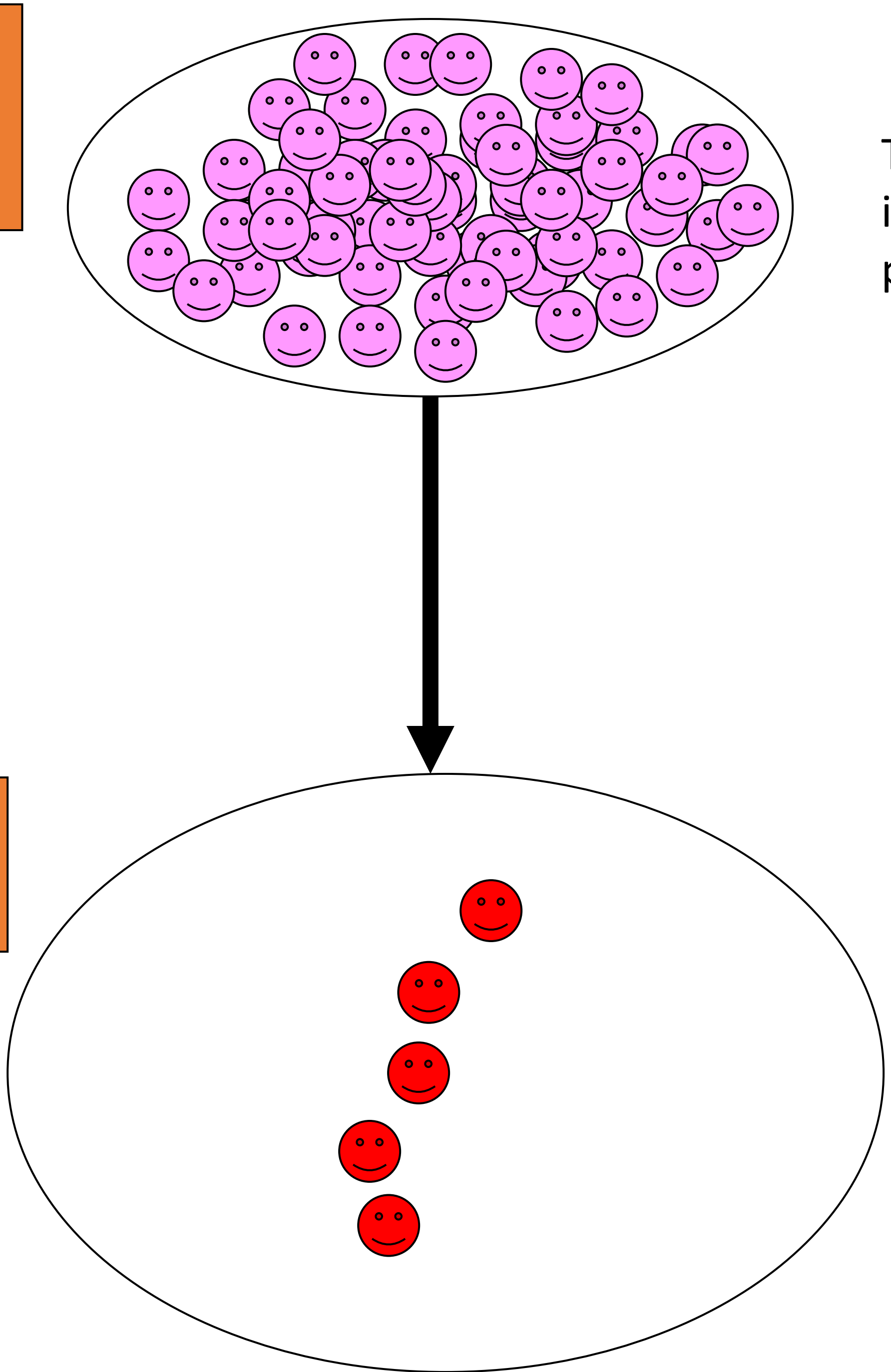
Population
$p = 0.5$



Sample
$\hat{p} = 0.48$

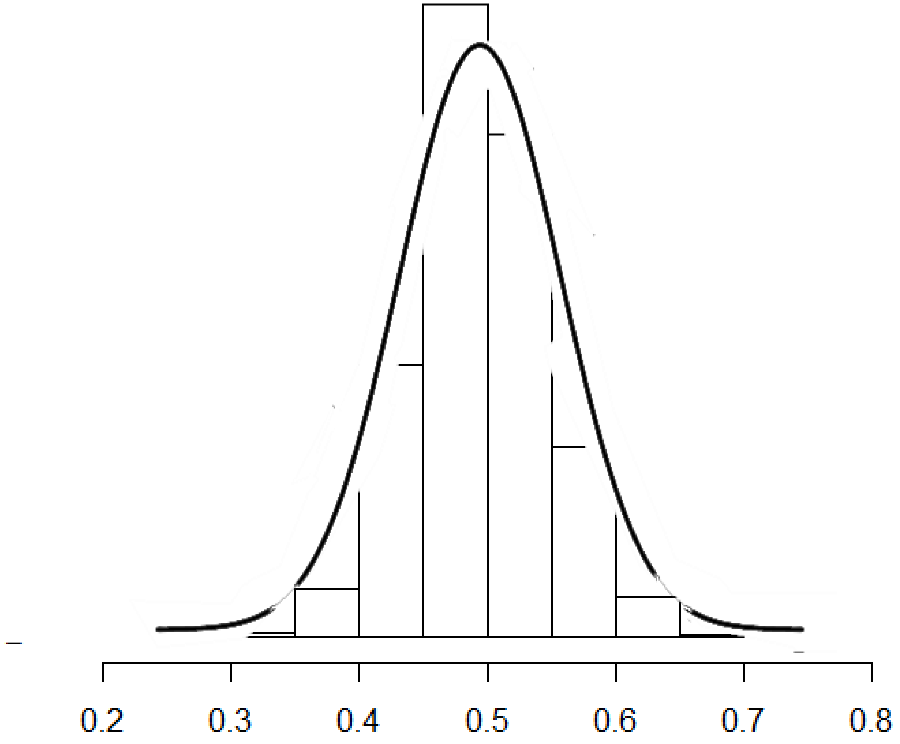


Population
$p = 0.5$



Sample
$\hat{p} = 0.48$

The **sampling distribution** of a statistic (in this case $\hat{p}$) is the probability distribution that specifies probabilities for the possible values of the statistic



Today

Memory refresh of sampling distribution

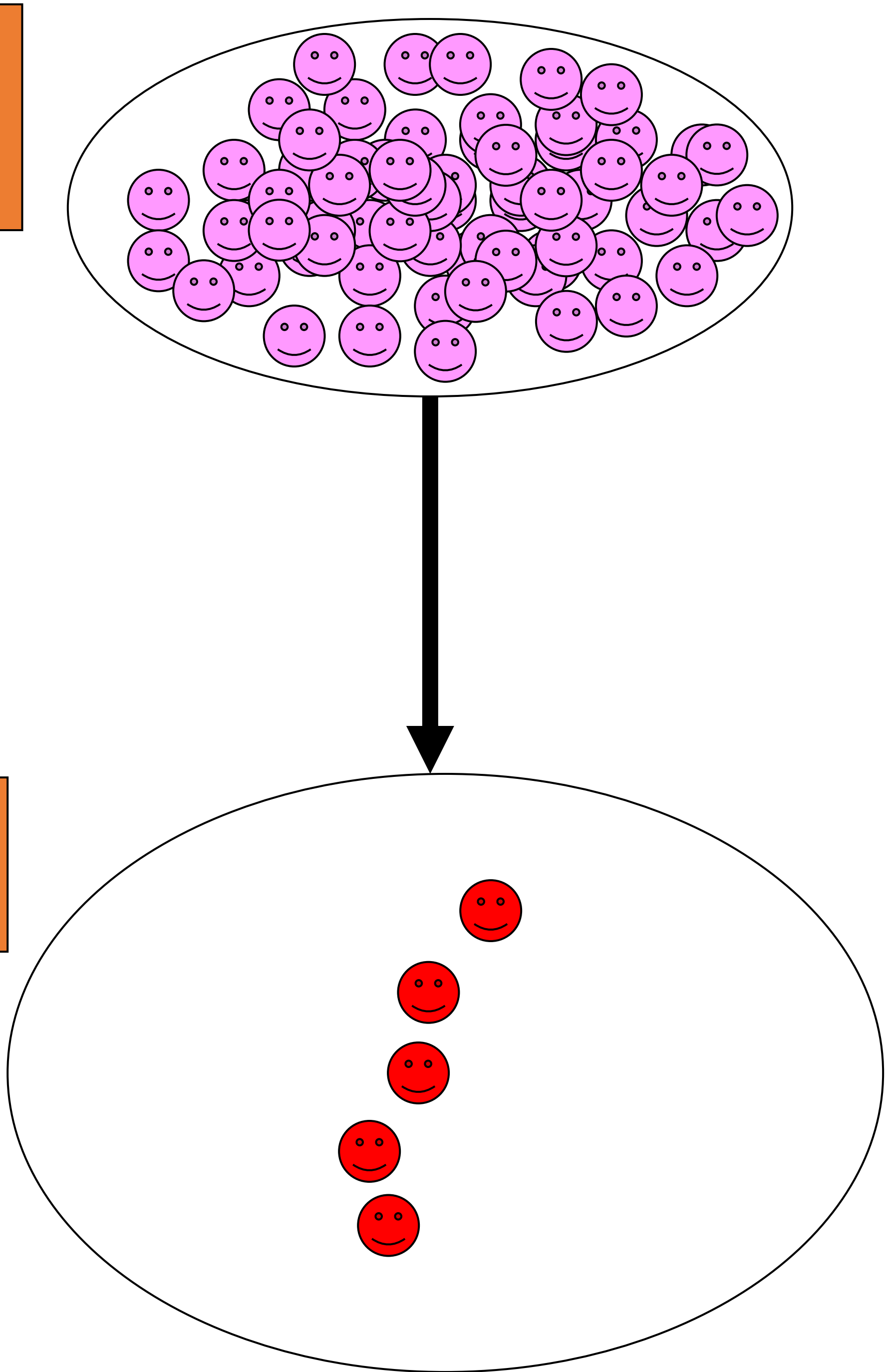
Point versus interval estimation

Constructing a confidence interval

What affects confidence intervals

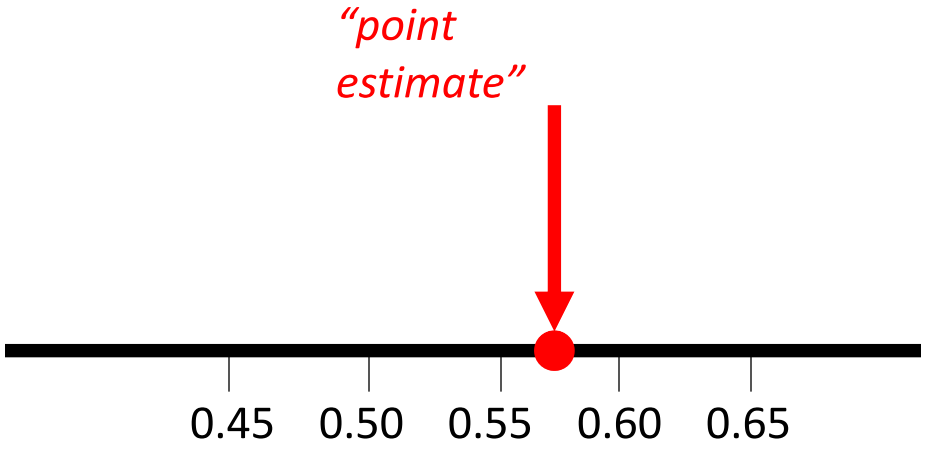
Interpretation of confidence intervals

Population
$p = 0.5$

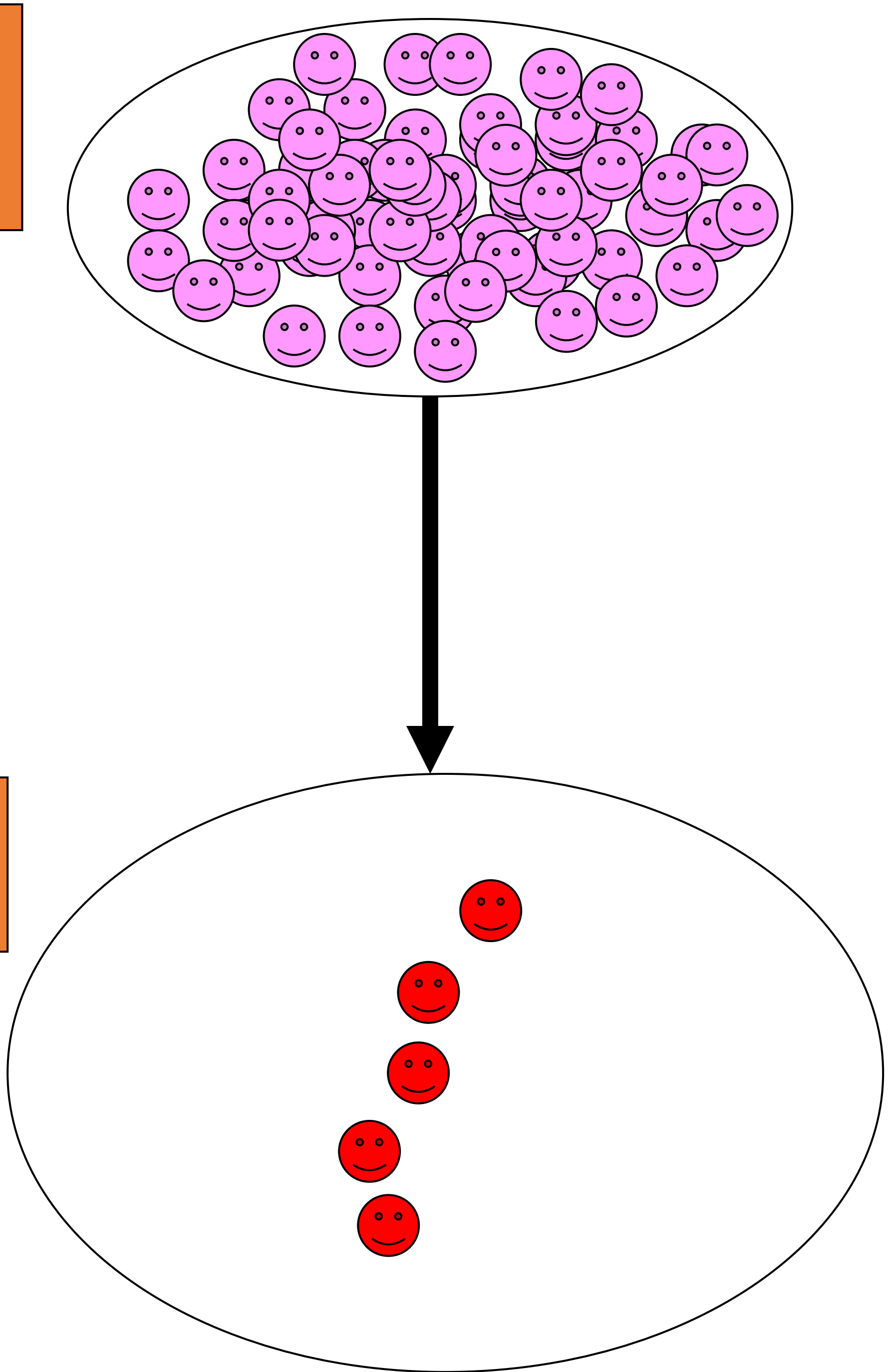


Sample
$\hat{p} = 0.57$

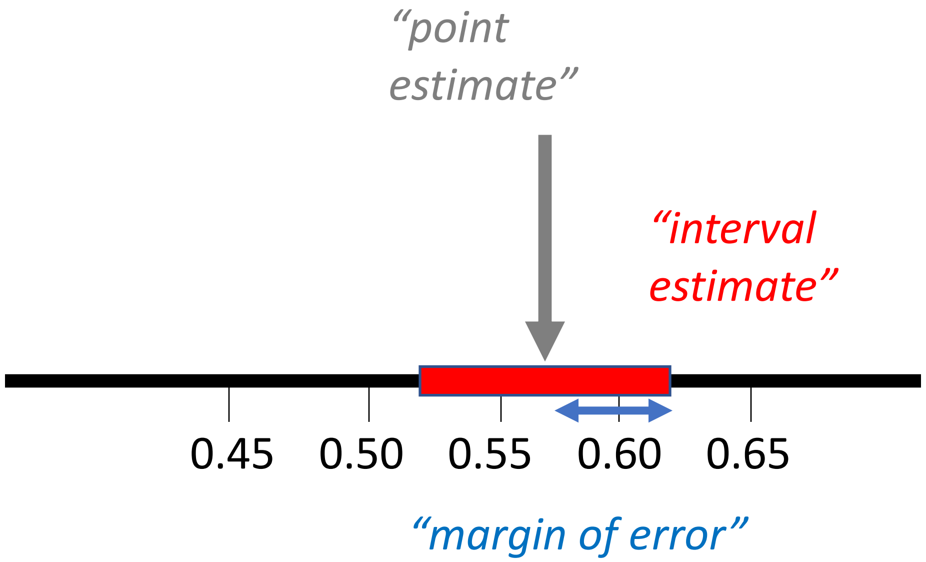
Means that it is a ***point estimate***



Population
$p = 0.5$



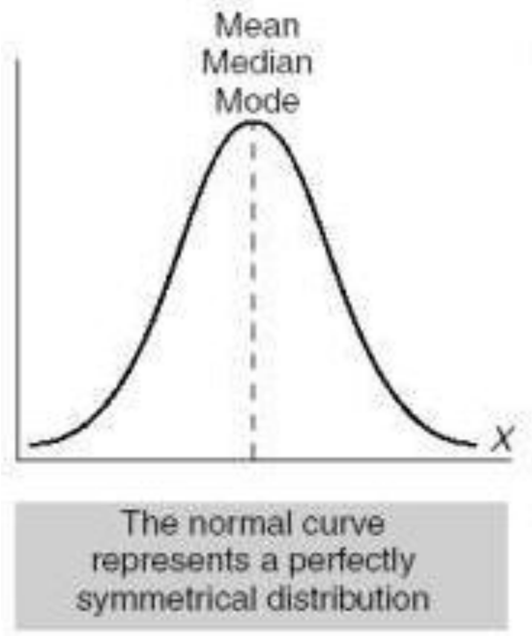
Sample
$\hat{p} = 0.57$

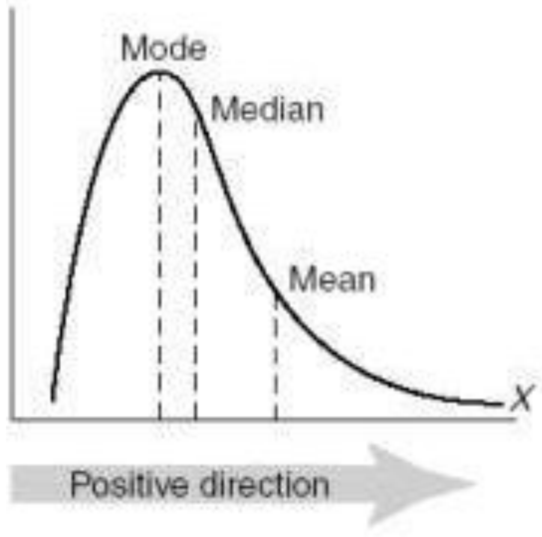


A good point estimator

1) **Unbiased**: The estimator should not be systematically wrong

- The sample average is an **unbiased** estimor of the population mean parameter
- In a symetrical distribution, the median is an **unbiased** estimator of the population mean
- In a skewed distribution, the median is a **biased** estimator of the population mean



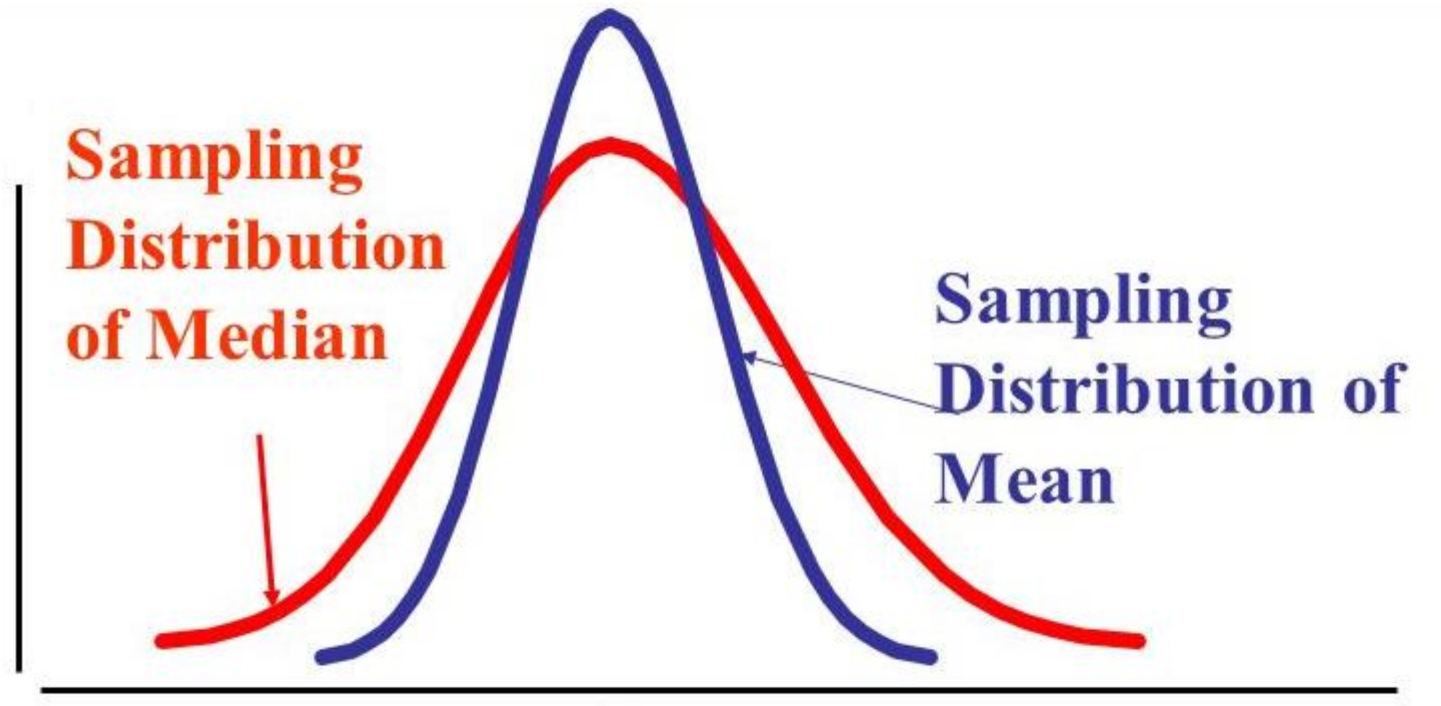


Picture source: https://deepa404.wordpress.com/2017/02/26/acceptable-range-of-value-of-skewness-for-normality/

A good point estimator

2) **Small standard deviation**: The estimator should not be imprecise

- Even in a symetrical population distribution, the sampling distribution of the median has a larger standard deviation than the sampling distribution of the mean, and so the mean is a more precise estimator than the median



Interval estimation

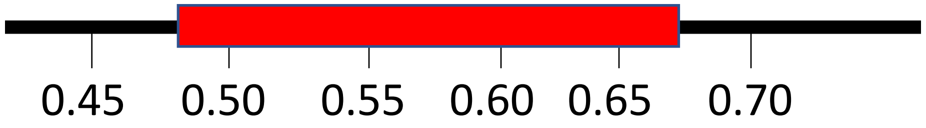
Confidence interval: Interval containing the most believable values for a parameter

Confidence level: the probability that this method produces an interval that contains the parameter (when you construct an interval over and over again for different samples)

confidence level

e.g., a 95% confidence interval:

means that *in the long run* 95% of the intervals will contain the population parameter



In this case, the 95 % confidence interval is: (0.47; 0.67)

Today

Memory refresh of sampling distribution

Point versus interval estimation

Constructing a confidence interval

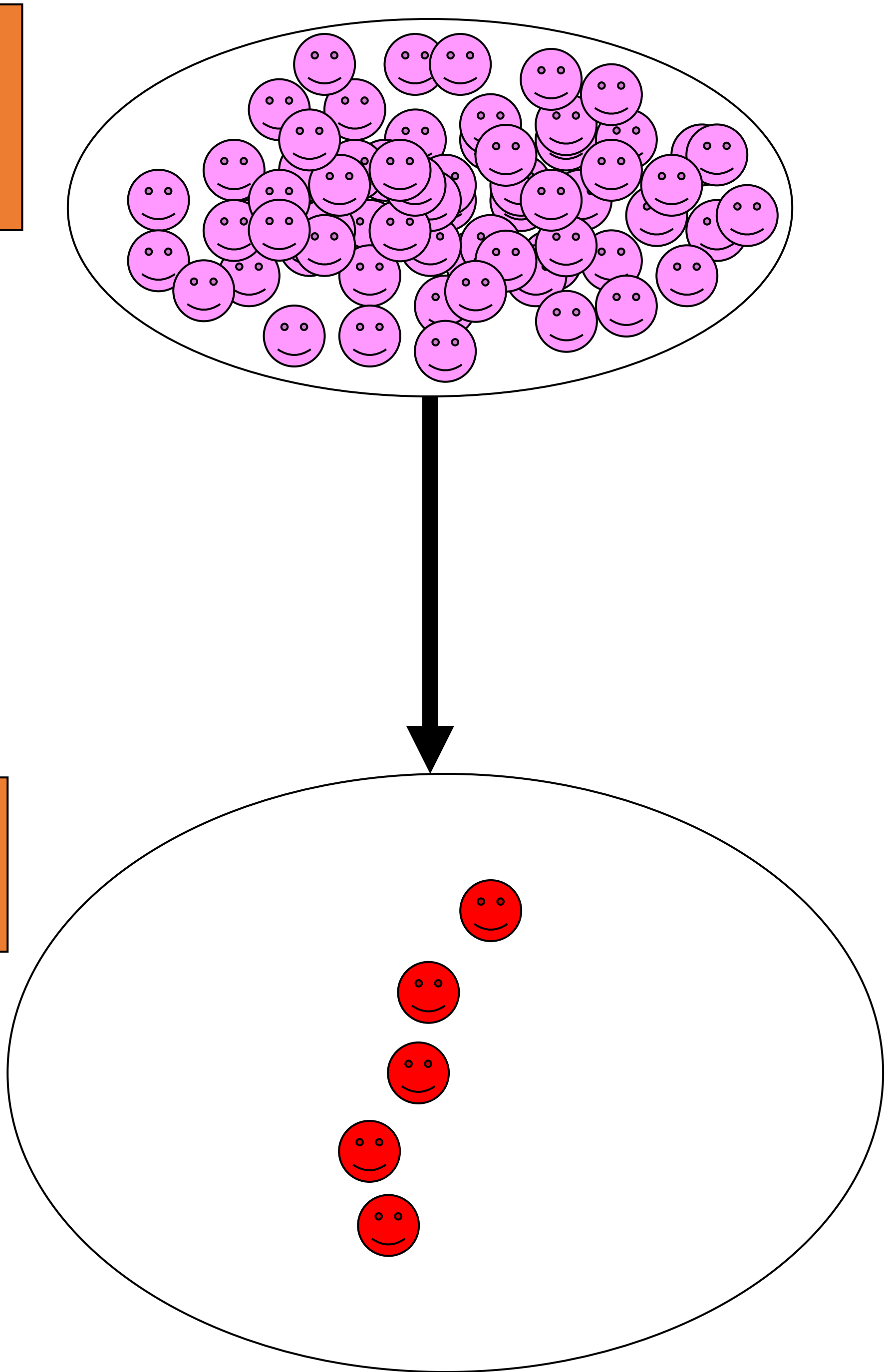
What affects confidence intervals

Interpretation of confidence intervals

Constructing a confidence interval

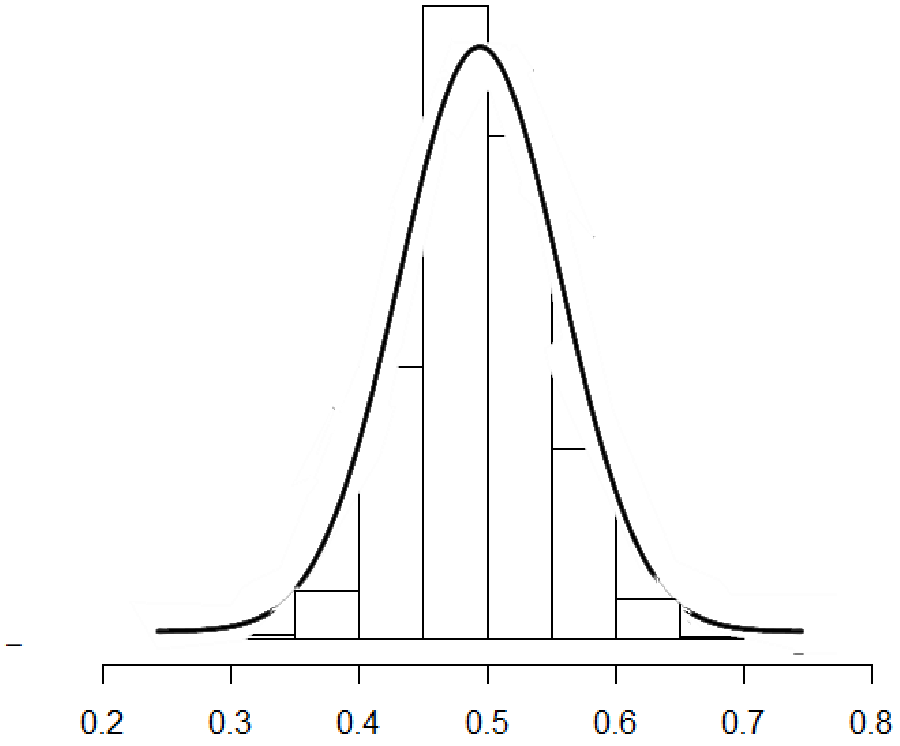
- If we want to construct a 95% confidence interval for the sample proportion, we need the *sampling distribution*

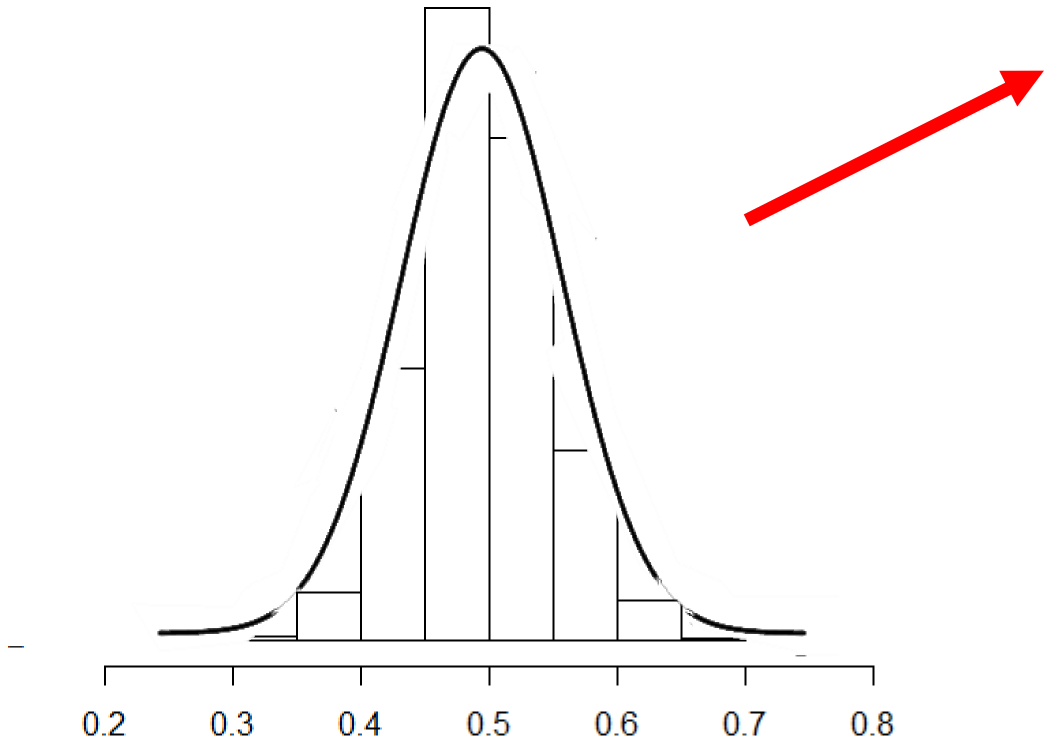
Population
$p = 0.5$



Sample
$\hat{p} = 0.48$

Sampling distribution of a proportion





Chapter 7: "Sampling distribution of a proportion"

If np ≥ 15 and n(1-p) ≥ 15 then binomial distribution approximates a normal distribution

When this happens, the sampling distribution of p also approximates a normal distribution!

(sampling distribution of proportion is closely related to binomial distribution, see 7.3)

Sampling distribution of a proportion:

Mean: p

standard deviation: $\sqrt{\frac{p(1-p)}{n}}$

Constructing a confidence interval

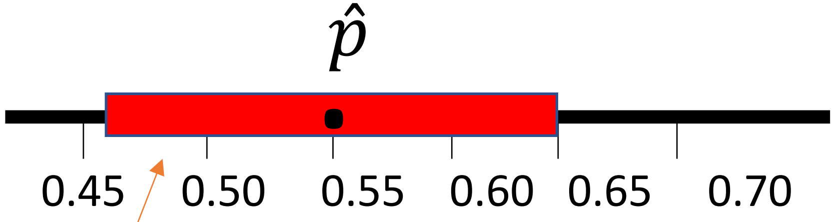
$\hat{p}$ = the sample proportion, e.g., 0.55 saw ‘black &blue’

What we want: deciding on the width of the interval such that if we would do the procedure over and over again, some high percentage of intervals includes *p*

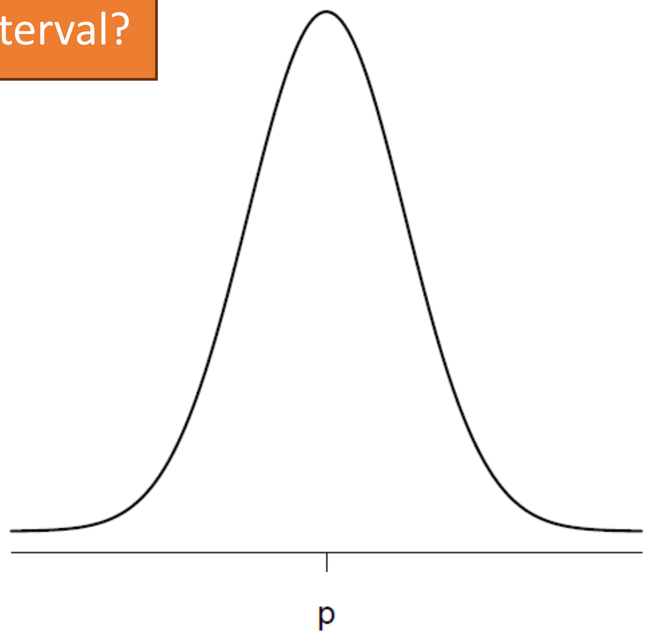
Most often, this high percentage is set to 95%, but it can be a different percentage as well.

But let’s start with a 95% confidence interval.

To do so, we will use the sampling distribution! (which is unknown to us)

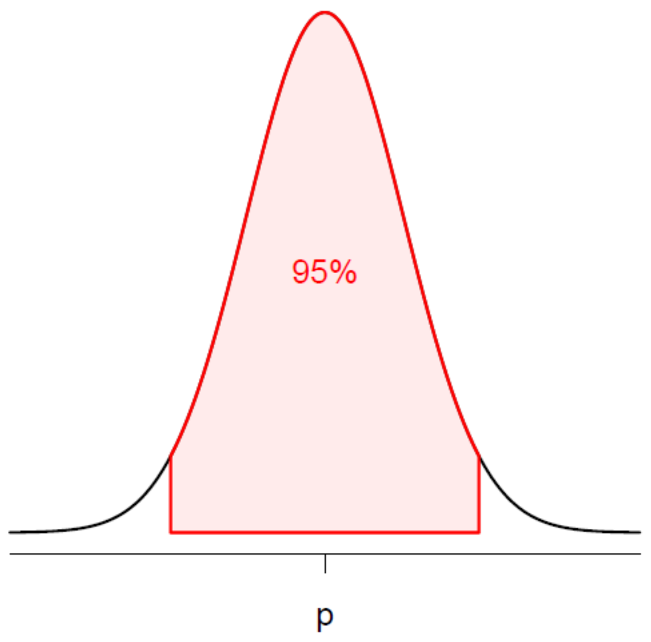


How wide should we make this red interval?

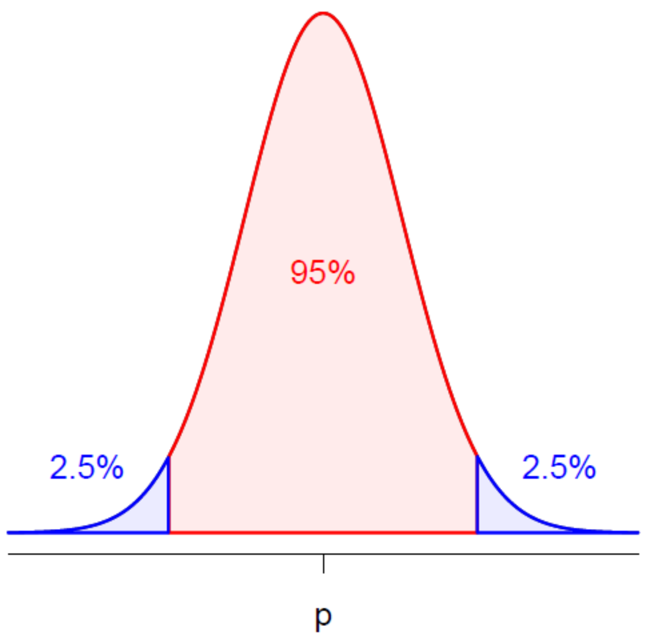


The sampling distribution is a probability distribution and so we can calculate the interval that includes 95% of the distribution

That is, with 95% probability, we draw a sample that has a $\hat{p}$ that is in the red area:

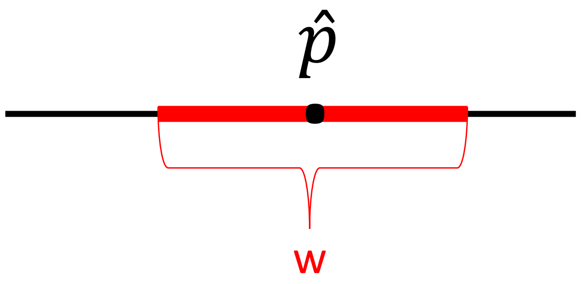


And we have 5% probability to draw a sample that has a $\hat{p}$ that is in the blue area:

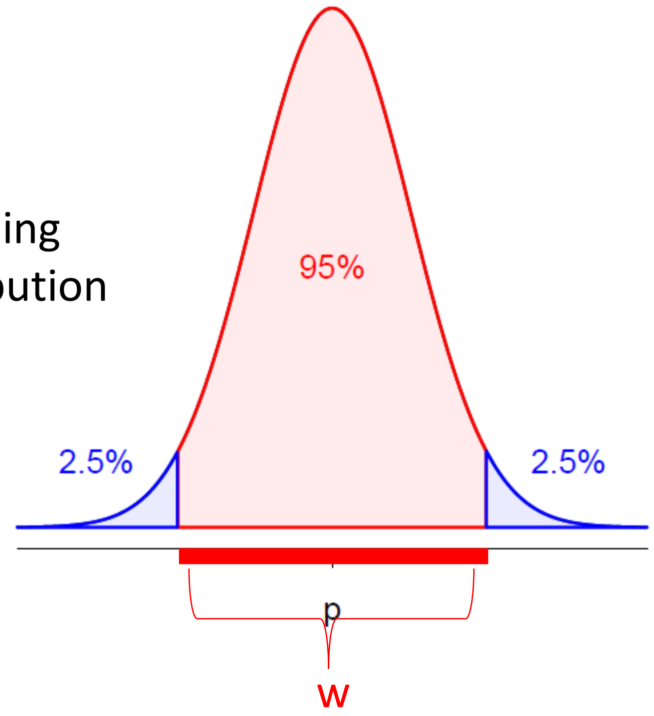


Now we use a trick!

Suppose that we use the interval w as the interval around $\hat{p}$ ..

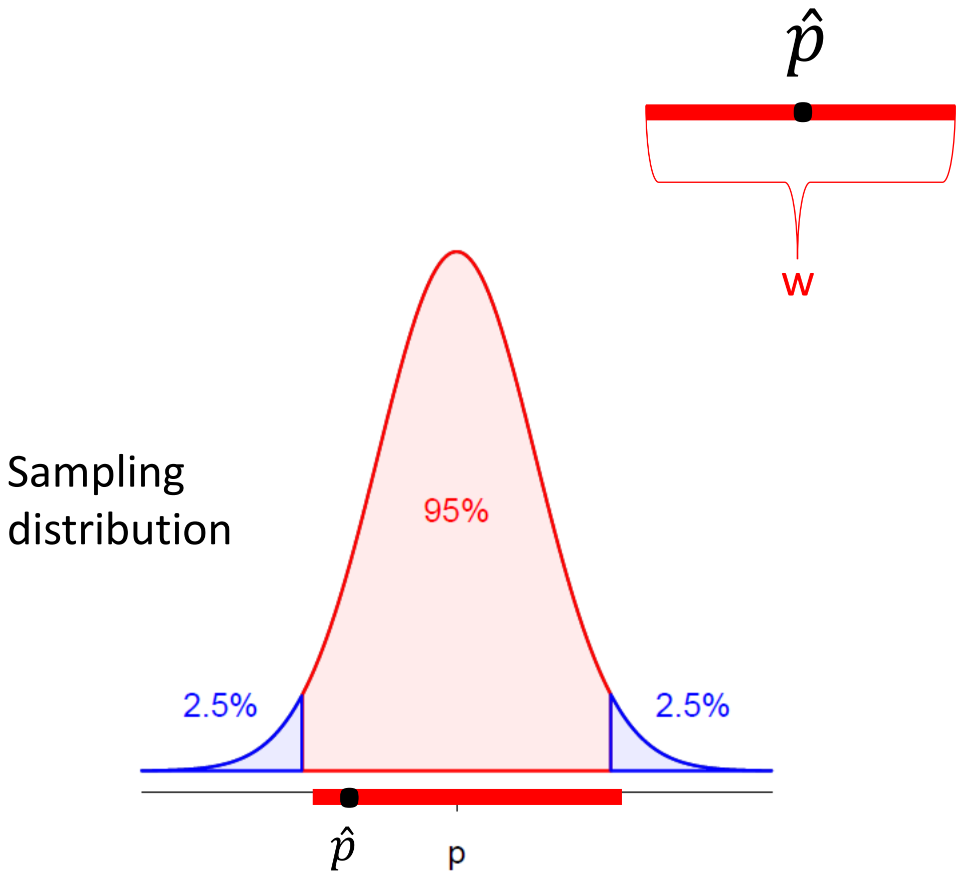


Sampling distribution



Now we use a trick!

Suppose that we use the interval w as the interval around $\hat{p}$ ..



Suppose you draw a sample that has a proportion $\hat{p}$ that is in the red area of the sampling distribution. Will the interval around $\hat{p}$ include p ?

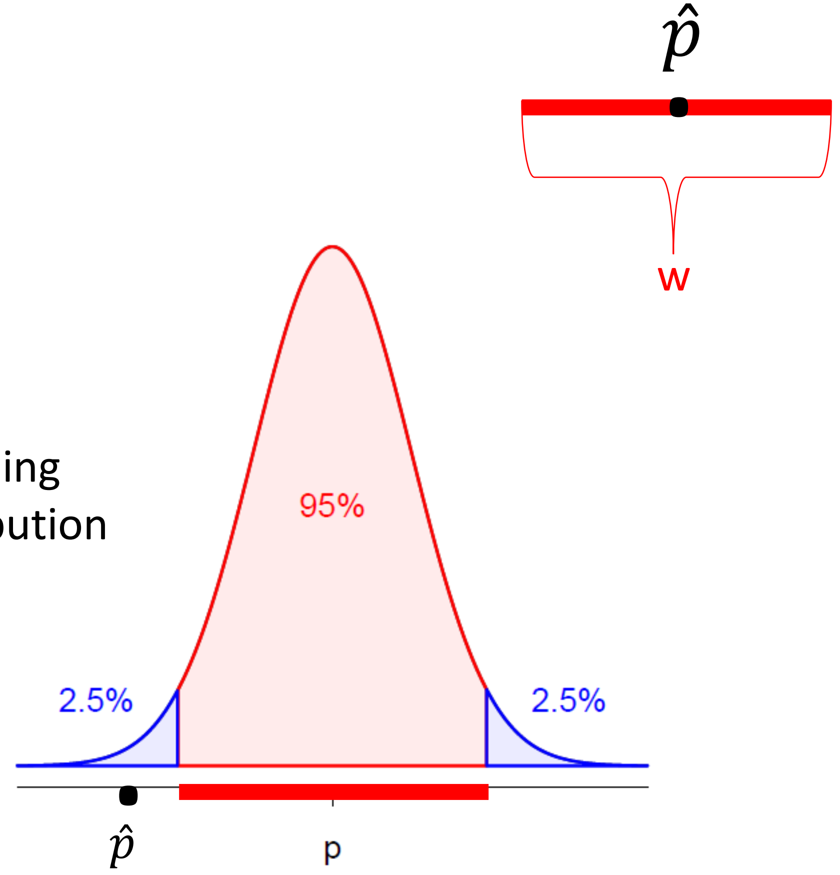
Yes!

And how often does that happen?
95% of samples!

Now we use a trick!

Suppose that we use the interval w as the interval around $\hat{p}$ ..

Sampling distribution



And when you draw a sample that has a proportion $\hat{p}$ that is in the blue area of the sampling distribution, will the interval around $\hat{p}$ include p ?

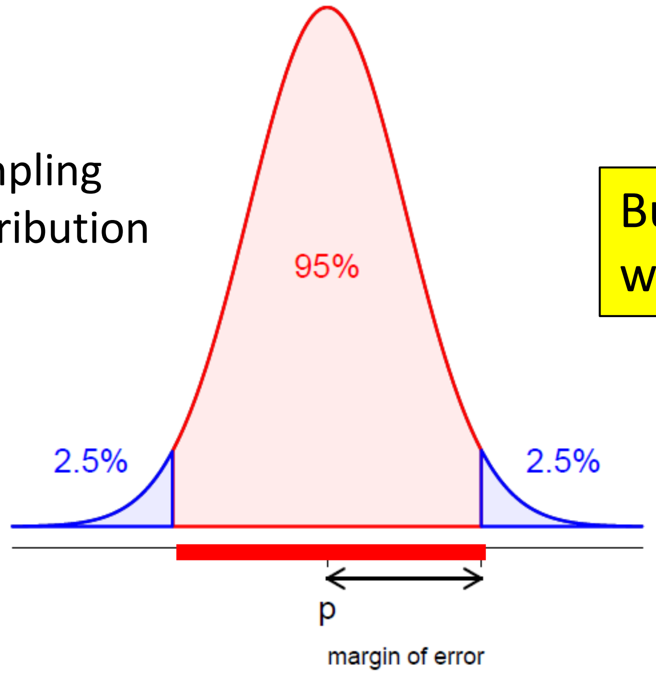
No!

And how often does that happen?
5% of samples!

So, using this method, we find that for 95% of the samples the interval will include the correct population value.

The $margin\ of\ error$ is the distance from the middle of the interval to the upper or lower bound.

Sampling distribution



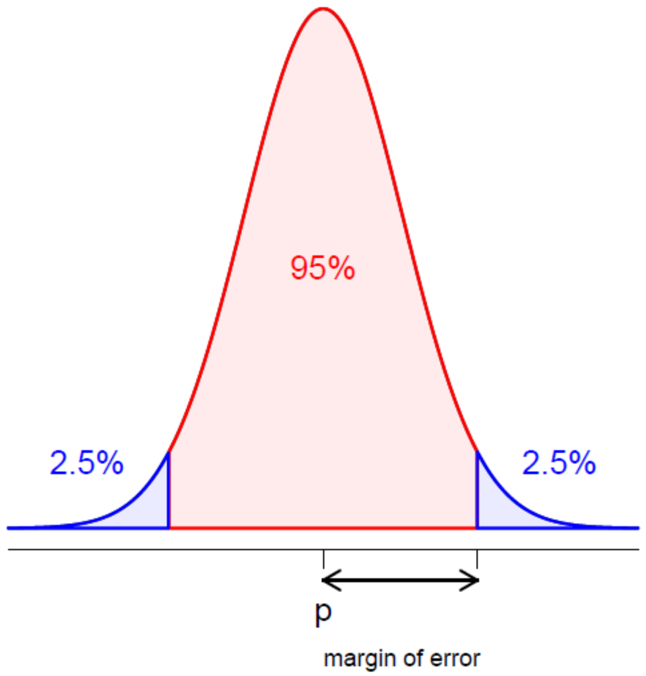
But how to calculate what this distance is?

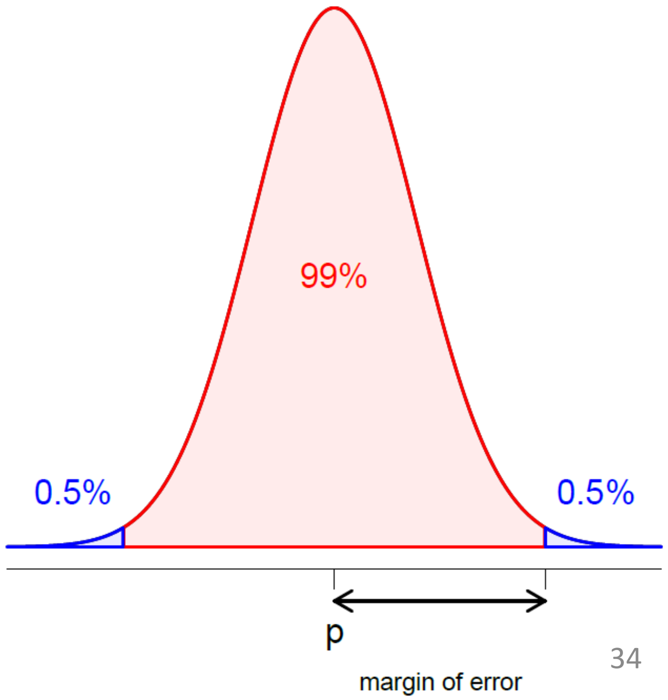
Confidence interval

- margins of error are defined in the sampling distribution of $\hat{p}$ like this →

- But how to obtain the exact values?

1) Sampling distribution is normal (see before)
2) →Use excel to get the corresponding z-score
3) Transform the z-score to the original variable

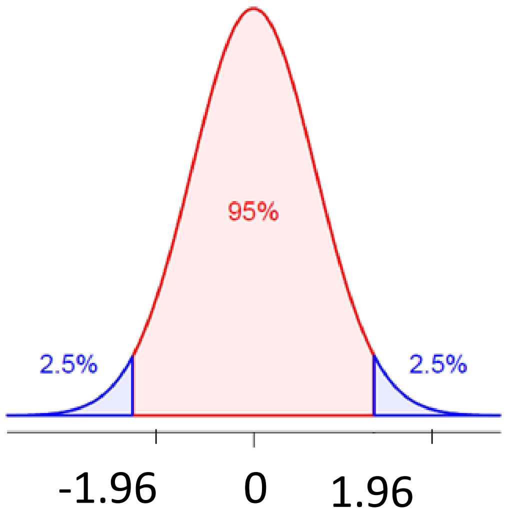




Confidence interval

First calculate the corresponding z-scores for a 2.5% tail of the distribution:
=NORM.INV(0,025;0;1) in excel → for z = -1.96 you have a 0.025 probability

Because of symmetry, you know: z=1.96 corresponds to 97.5% (i.e., the upper 2.5% tail)

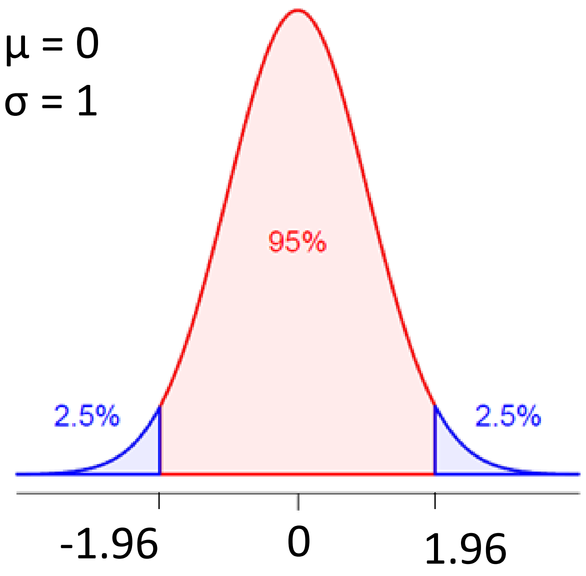


z-distribution

Z-score: the number of standard deviations that a given observation falls from the mean

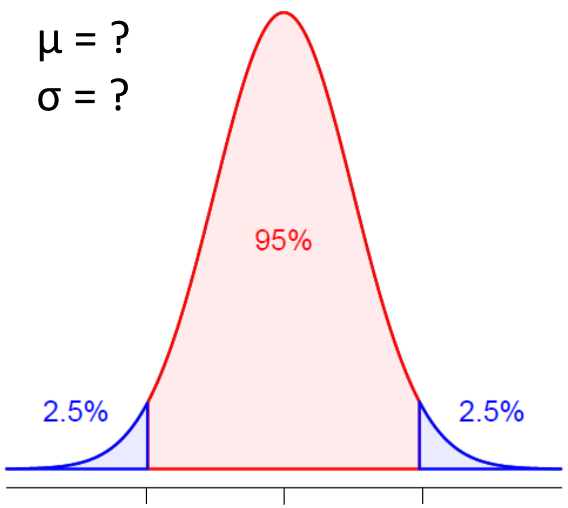
Z-score

μ = 0
σ = 1



Original variable (statistic $\hat{p}$)

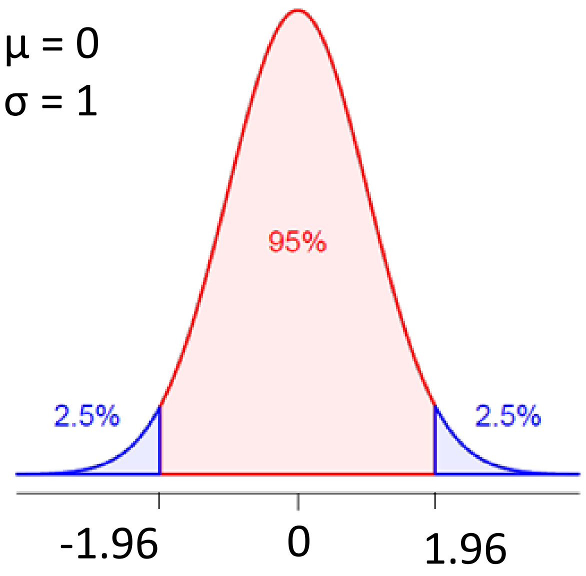
μ = ?
σ = ?



Z-score: the number of standard deviations that a given observation falls from the mean

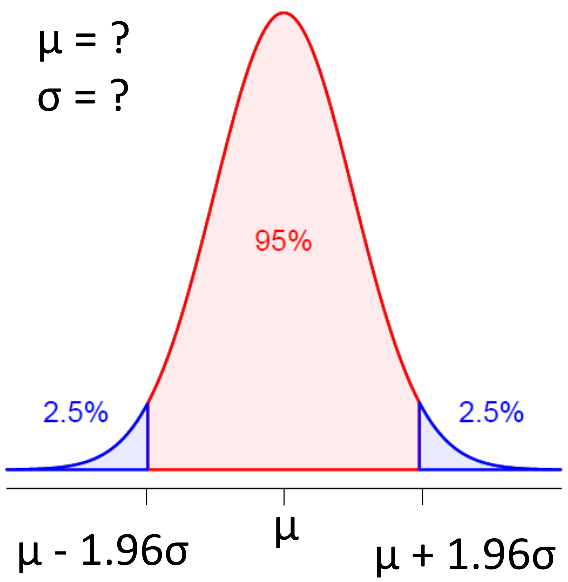
Z-score

$\mu = 0$
$\sigma = 1$

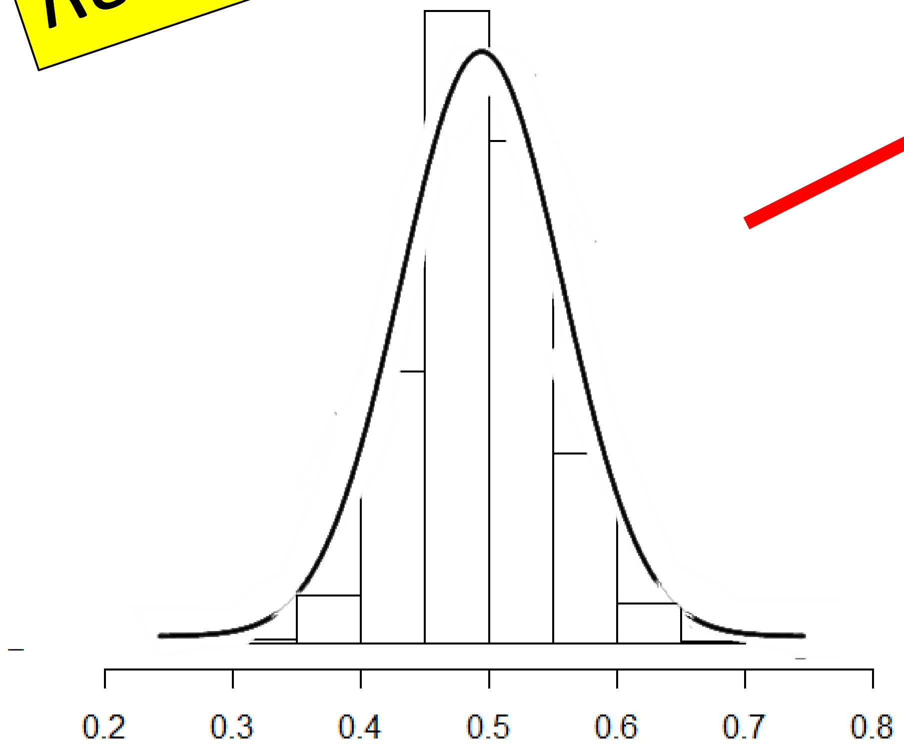


Original variable (statistic $\hat{p}$)

$\mu = ?$
$\sigma = ?$



Remember?



Chapter 7: "Sampling distribution of a proportion"

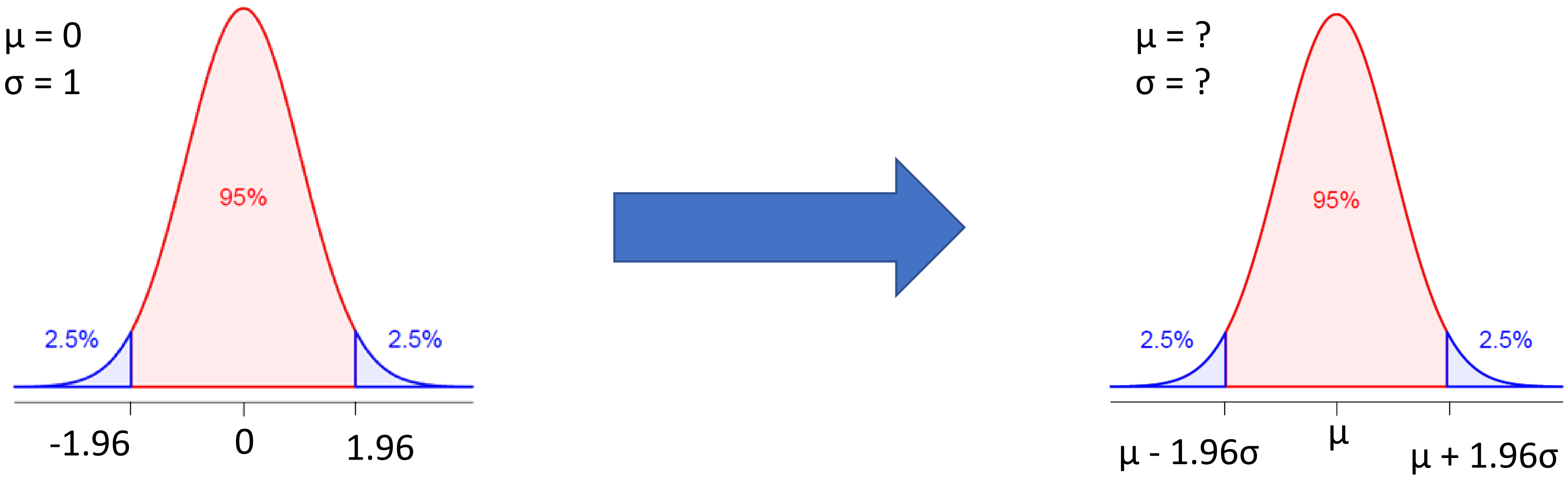
If np ≥ 15 and n(1-p) ≥ 15 then it approximates a normal distribution!

Mean: p

standard deviation: $\sqrt{\frac{p(1-p)}{n}}$

Z-score

Original variable (statistic $\hat{p}$)

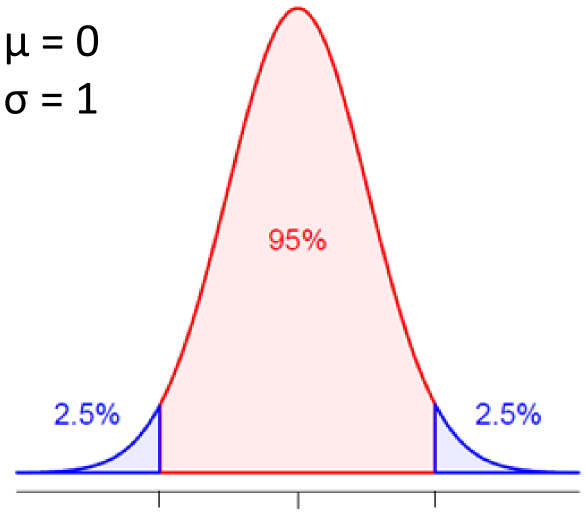


Thus:

Z-score

μ = 0

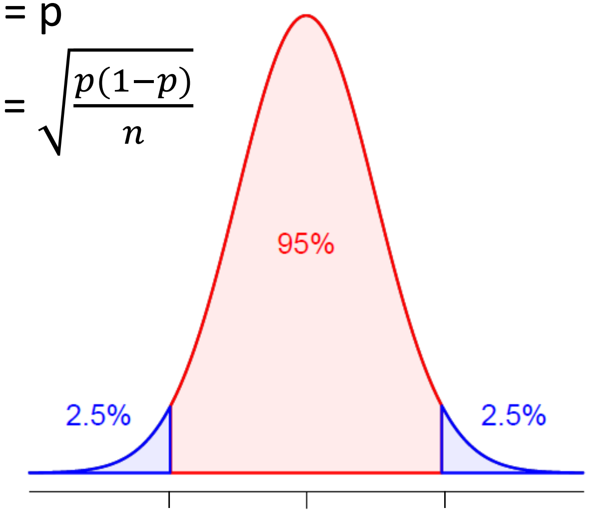
σ = 1



Original variable (statistic $\hat{p}$)

μ = p

σ = $\sqrt{\frac{p(1-p)}{n}}$

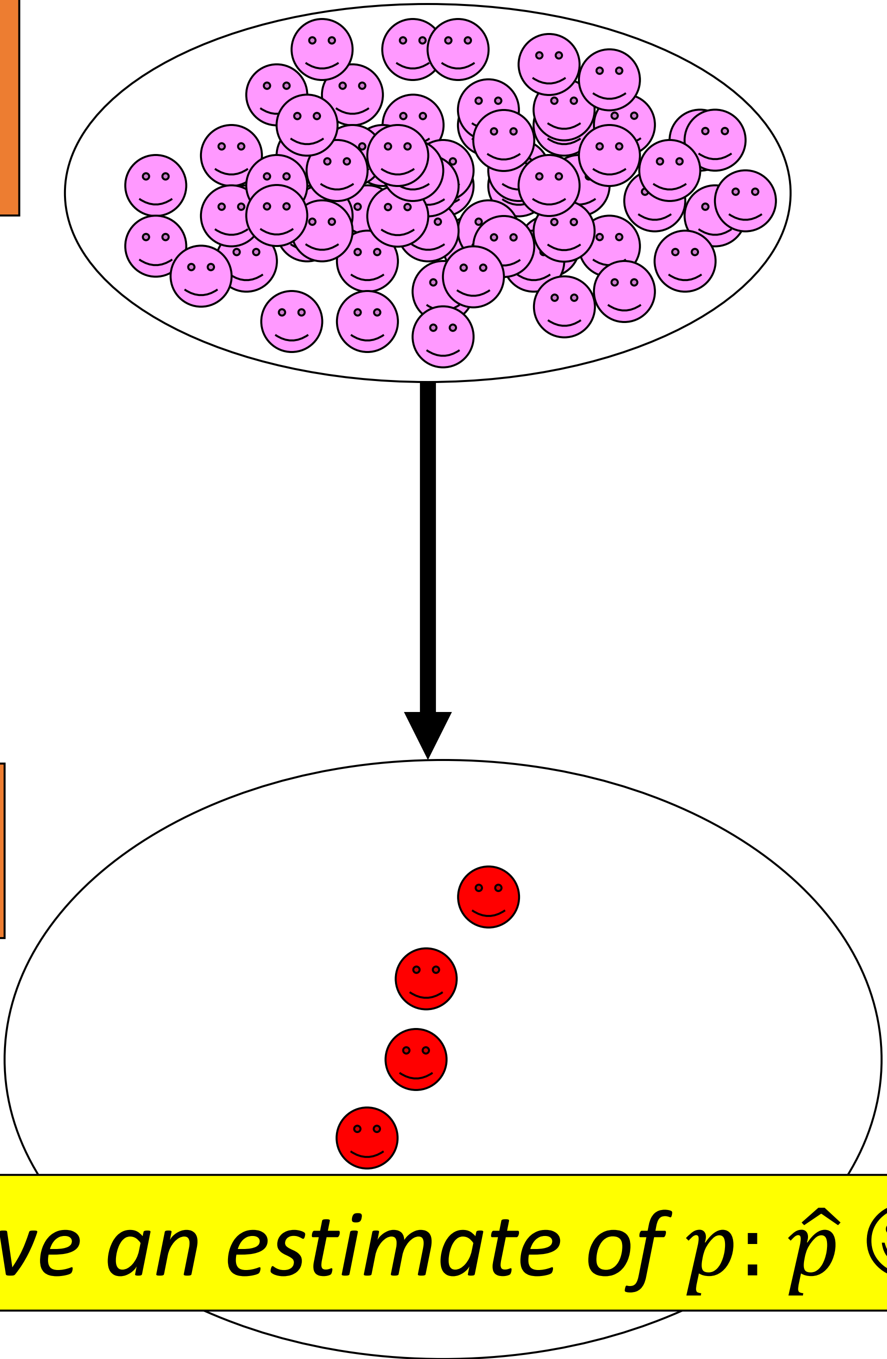


p - 1.96 $\sqrt{\frac{p(1-p)}{n}}$

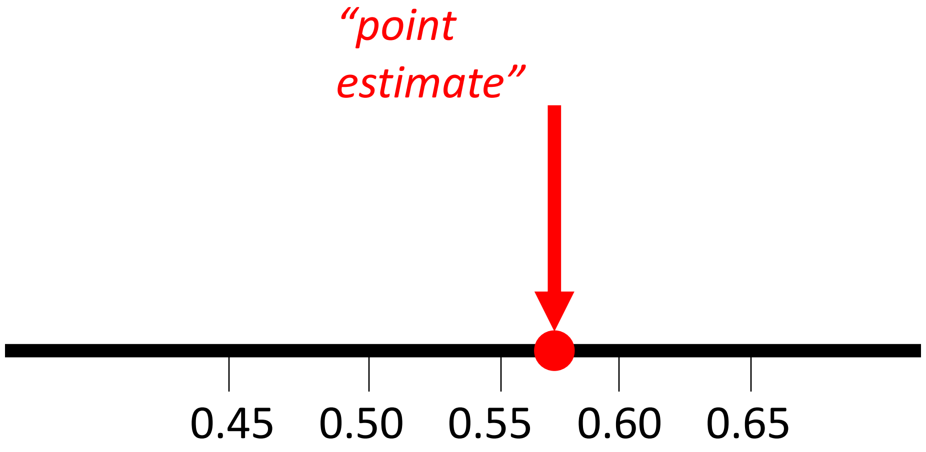
p + 1.96 $\sqrt{\frac{p(1-p)}{n}}$

But we don't know p ☹

Population
$p = 0.5$



Sample
$\hat{p} = 0.57$



But we ***do*** *have an estimate of* p: $\hat{p}$ ☺

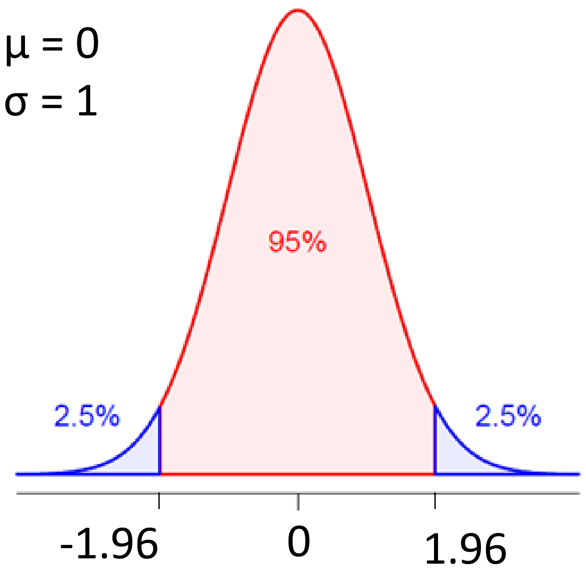
Thus:

if you use an estimate of the standard deviation of the sampling distribution, you call this a **standard error, or *se***

Z-score

$\mu = 0$

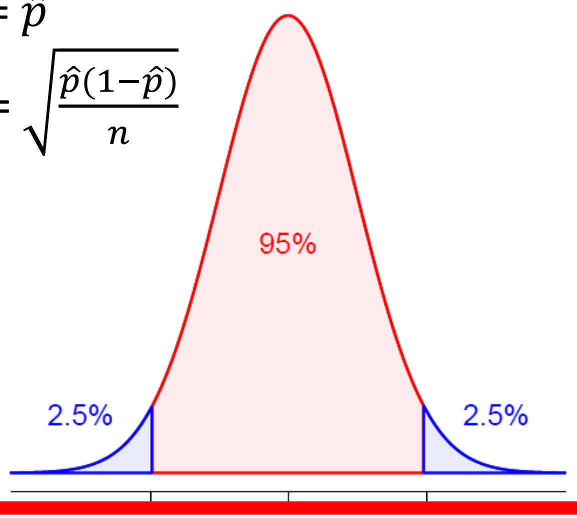
$\sigma = 1$



Original variable

$\hat{\mu} = \hat{p}$

$\hat{\sigma} = \sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$



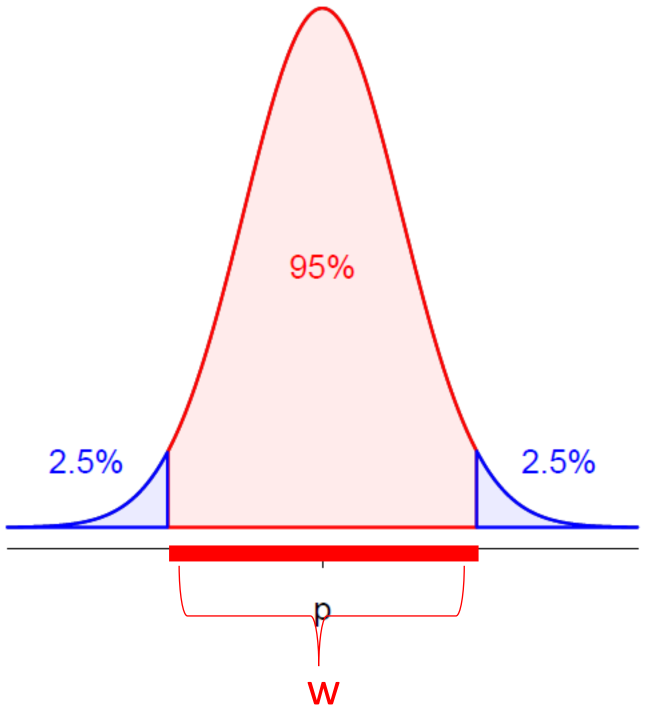
$\hat{p} - 1.96\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$ $\qquad$ $\hat{p} + 1.96\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$

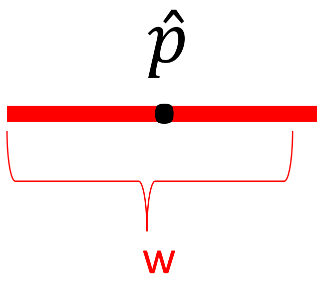
formula for 95% confidence interval of proportion

Remember?

Now we use a trick!

Suppose that we use this interval w as the interval around $\hat{p}$ ..



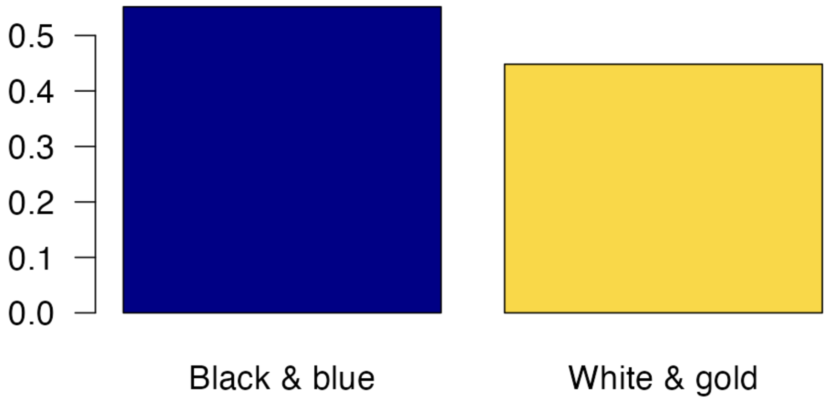


So, the interval w =

$$\hat{p} \pm 1.96\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$$

And for this interval it is the case that for 95% of samples, if we compute this interval, it will include p

Example: the dress



Black & blue: 144 (0.55)
White & gold: 117 (0.45)

Let's compute a 95% confidence interval for the proportion who sees "Black & blue" using these data (n = 261)

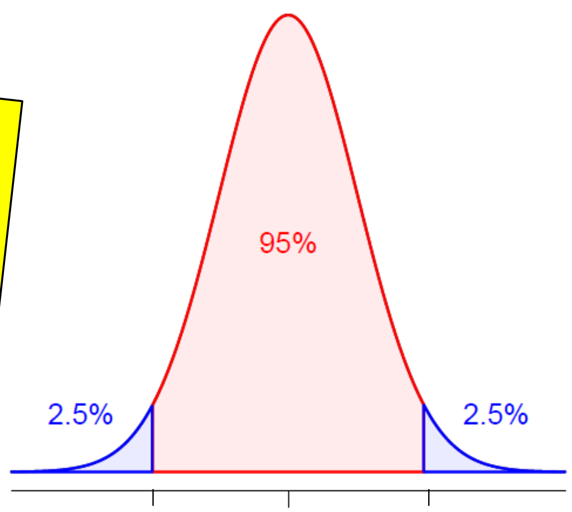
Image source: By Cecilia Bleasdale - https://web.archive.org/web/20150227014959/http://swiked.tumblr.com/post/112073818575/guys-please-help-me-is-this-dress-white-and, Fair use, https://en.wikipedia.org/w/index.php?curid=69200610

Example

Check whether normal approximation is allowed:
n*p = 261 * 0.55 = 143.55 larger than 15
n * (1-p) = 261 * 0.45 = 117.45 larger than 15
OK!

- n=261, $\hat{p} = 0.55$

- 95% confidence interval:



$\hat{p} - 1.96\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$ $\hat{p} + 1.96\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$

$$\hat{p} - 1.96\sqrt{\frac{\hat{p}(1-\hat{p})}{n}} = 0.55 - 1.96\sqrt{\frac{0.55(1-0.55)}{261}} = 0.55 - 0.06 = 0.49$$

$$\hat{p} + 1.96\sqrt{\frac{\hat{p}(1-\hat{p})}{n}} = 0.55 + 1.96\sqrt{\frac{0.55(1-0.55)}{261}} = 0.55 + 0.06 = 0.61$$

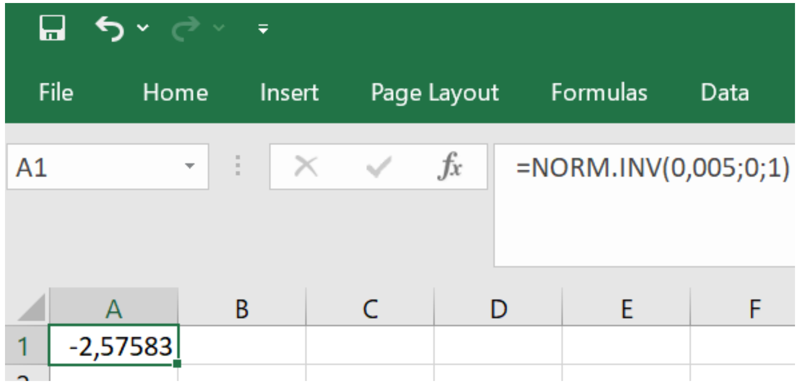
Margin of error is 0.06

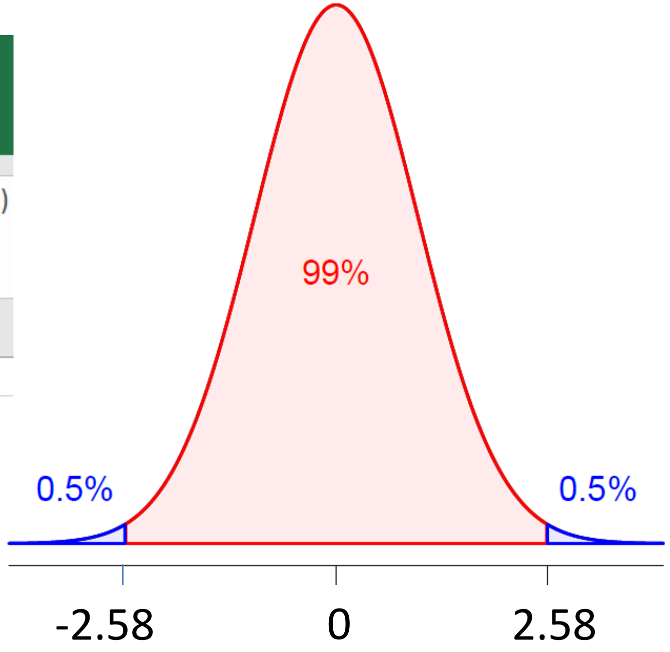
The values in this interval are ‘believable values’ for the population parameter. In 95% of cases when I construct an interval in this way, the interval will include the population parameter!

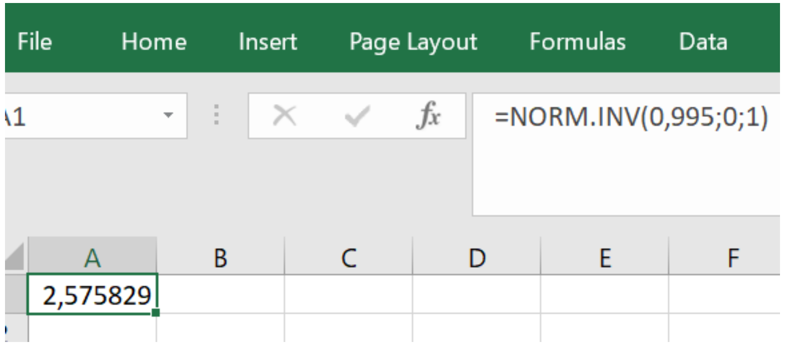
0.5 is also in the interval! So 0.5 is also a believable value!

99% confidence interval?

From Excel:





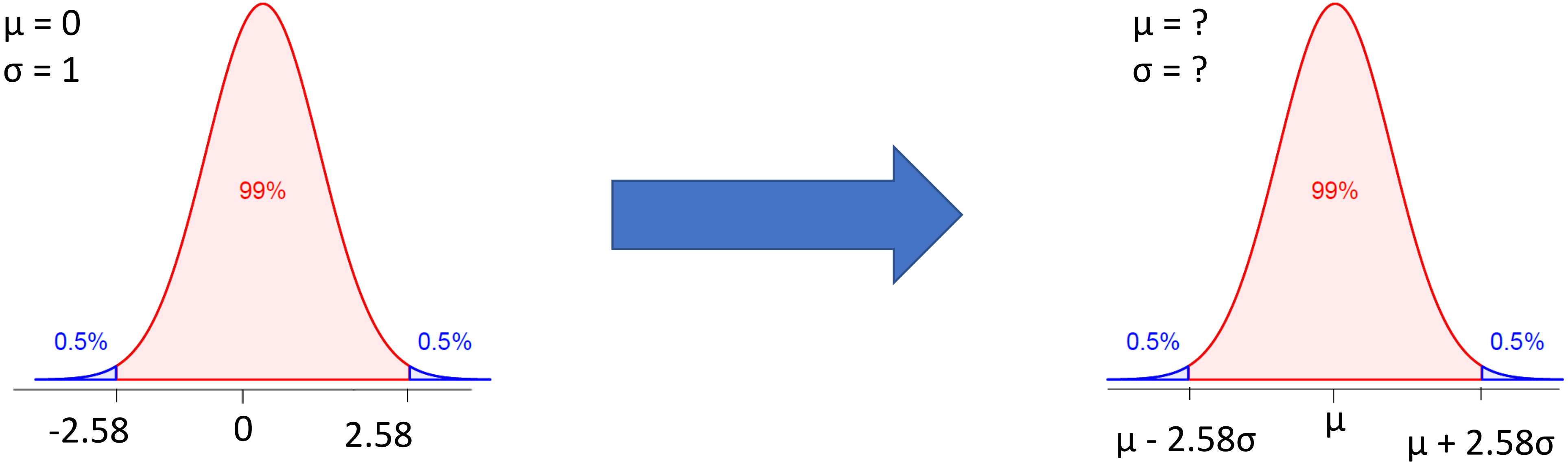


Z-score

$\mu = 0$
$\sigma = 1$

Original variable

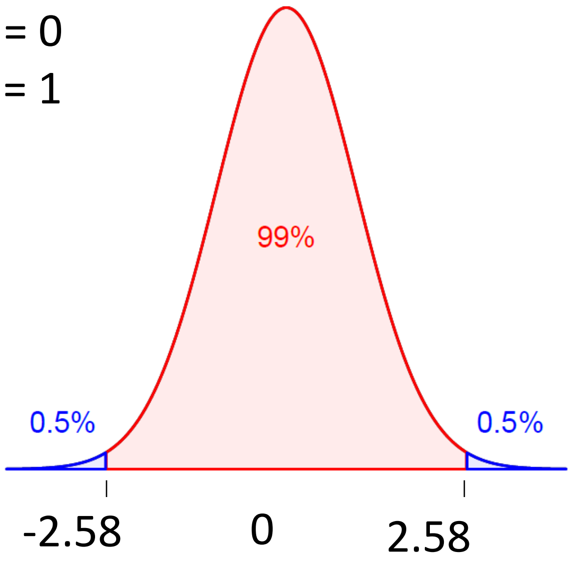
$\mu = ?$
$\sigma = ?$



Z-score

$\mu = 0$

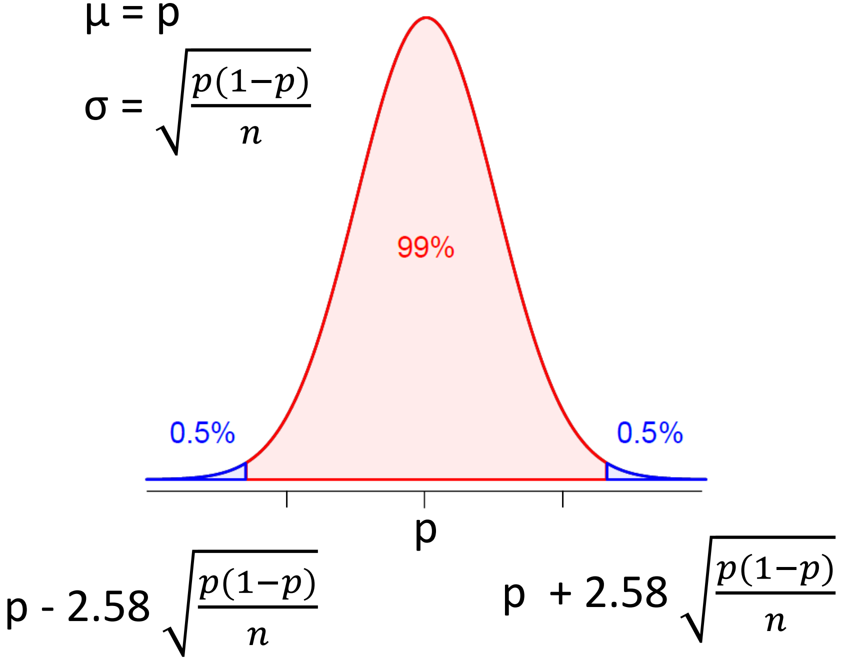
$\sigma = 1$



Original variable

$\mu = p$

$\sigma = \sqrt{\frac{p(1-p)}{n}}$

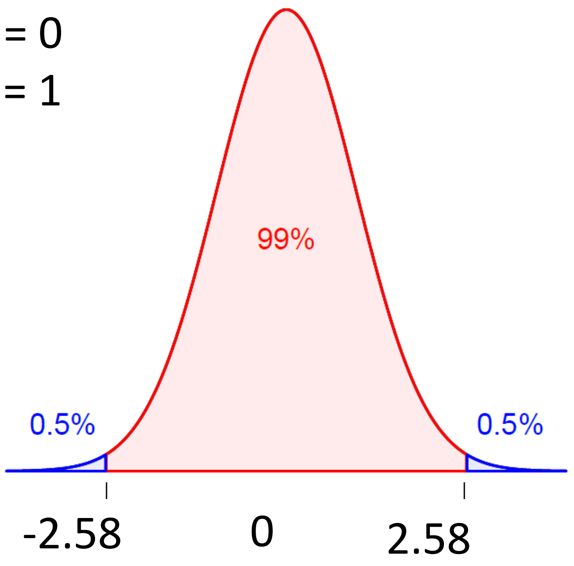


substituting $\hat{p}$ for p:

Z-score

$\mu = 0$

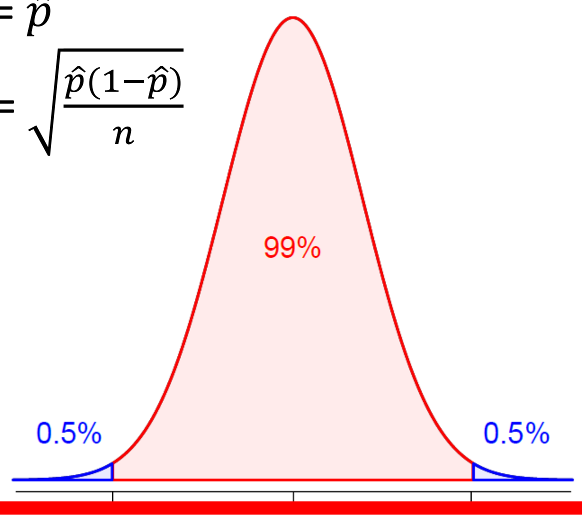
$\sigma = 1$



Original variable

$\hat{\mu} = \hat{p}$

$\hat{\sigma} = \sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$

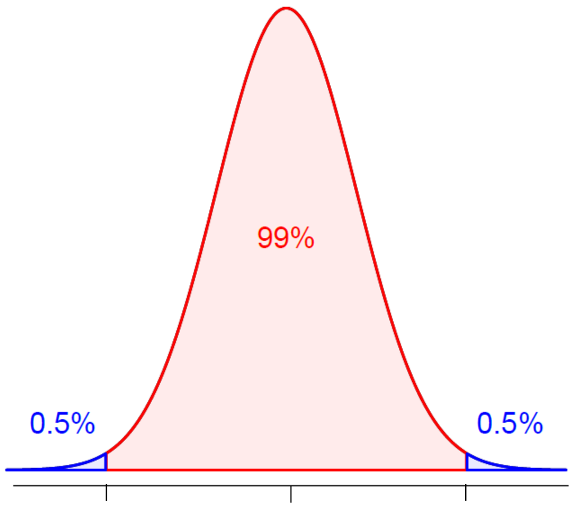


$\hat{p} - 2.58\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$ $\qquad$ $\hat{p} + 2.58\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$

formula for 99% confidence interval of proportion

Example

- n=261, $\hat{p} = 0.55$



$\hat{p} - 2.58\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$ $\hat{p} + 2.58\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$

- 99% confidence interval:

$$\hat{p} - 2.58\sqrt{\frac{\hat{p}(1-\hat{p})}{n}} = 0.55 - 2.58\sqrt{\frac{0.55(1-0.55)}{261}} = 0.55 - 0.08 = 0.47$$

$$\hat{p} + 2.58\sqrt{\frac{\hat{p}(1-\hat{p})}{n}} = 0.55 + 2.58\sqrt{\frac{0.55(1-0.55)}{261}} = 0.55 + 0.08 = 0.63$$

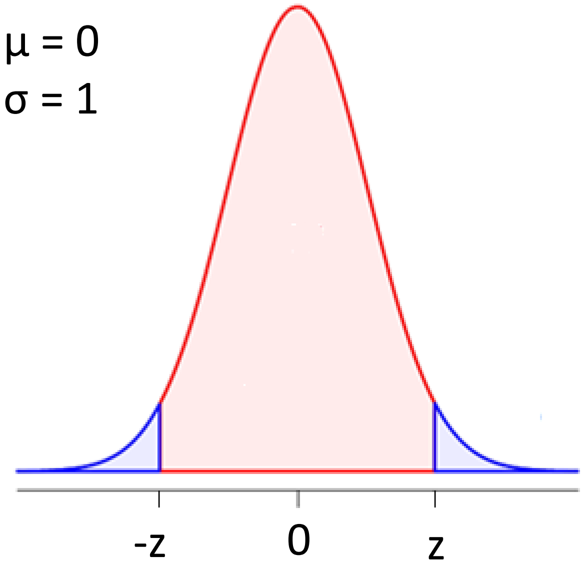
Margin of error increased to 0.08

In 99% of cases when I construct an interval in this way, the interval will include the population parameter!

General formula

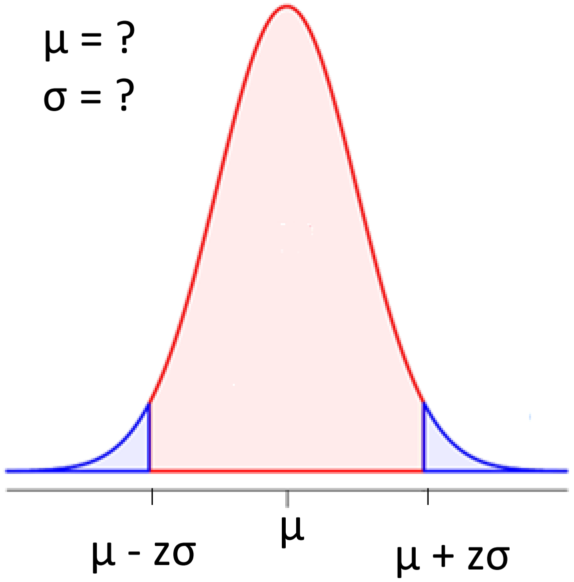
Z-score

μ = 0
σ = 1



Original variable

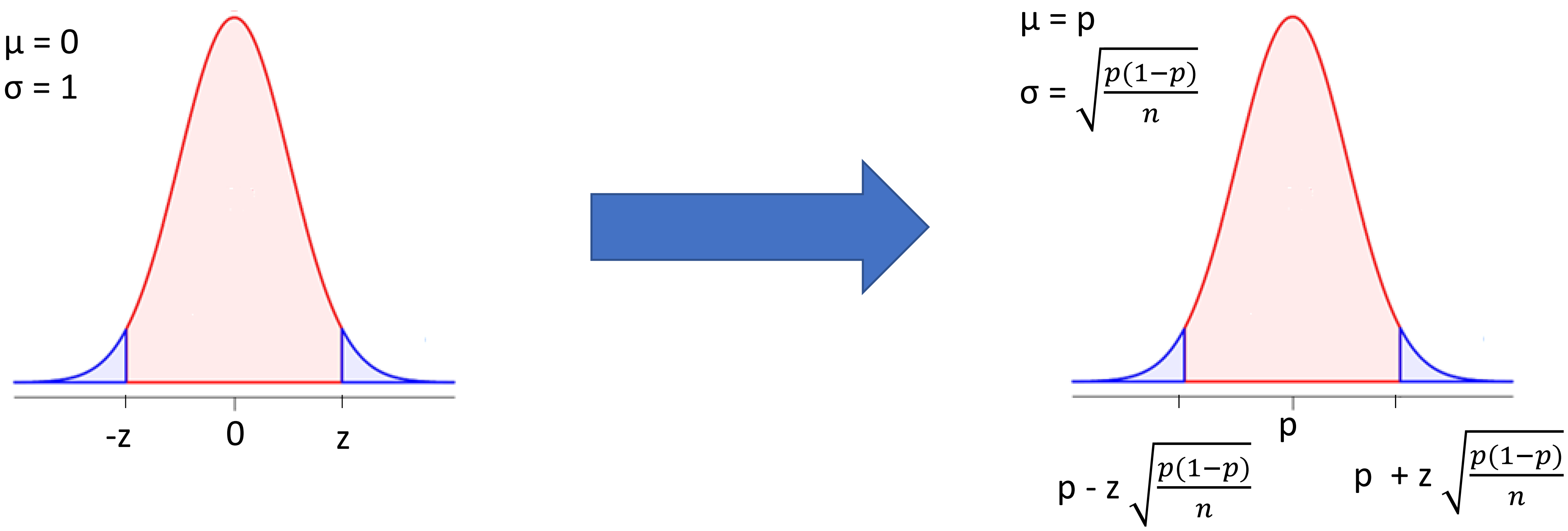
μ = ?
σ = ?



General formula

Z-score

Original variable



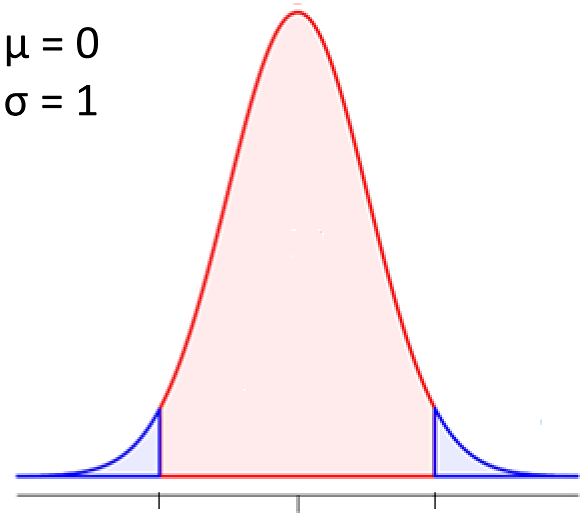
General formula

substituting $\hat{p}$ for p:

Z-score

$\mu = 0$

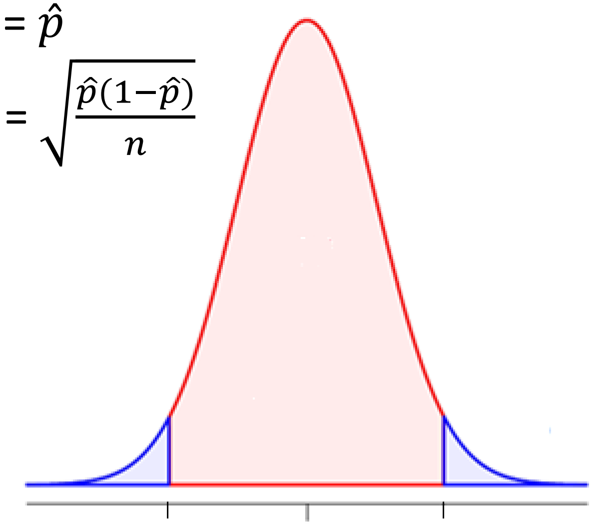
$\sigma = 1$



Original variable

$\hat{\mu} = \hat{p}$

$\hat{\sigma} = \sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$



$\hat{p} - z\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$ $\hat{p} + z\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$

general formula for confidence interval
of proportion (the one on the formula sheet)
And it will also mention:
for 95% z = 1.96 and for 99% z = 2.58

$\hat{p} \pm z(se)$ which is $\hat{p} \pm z\sqrt{\hat{p}(1-\hat{p})/n}$

Today

Memory refresh of sampling distribution

Point versus interval estimation

Constructing a confidence interval

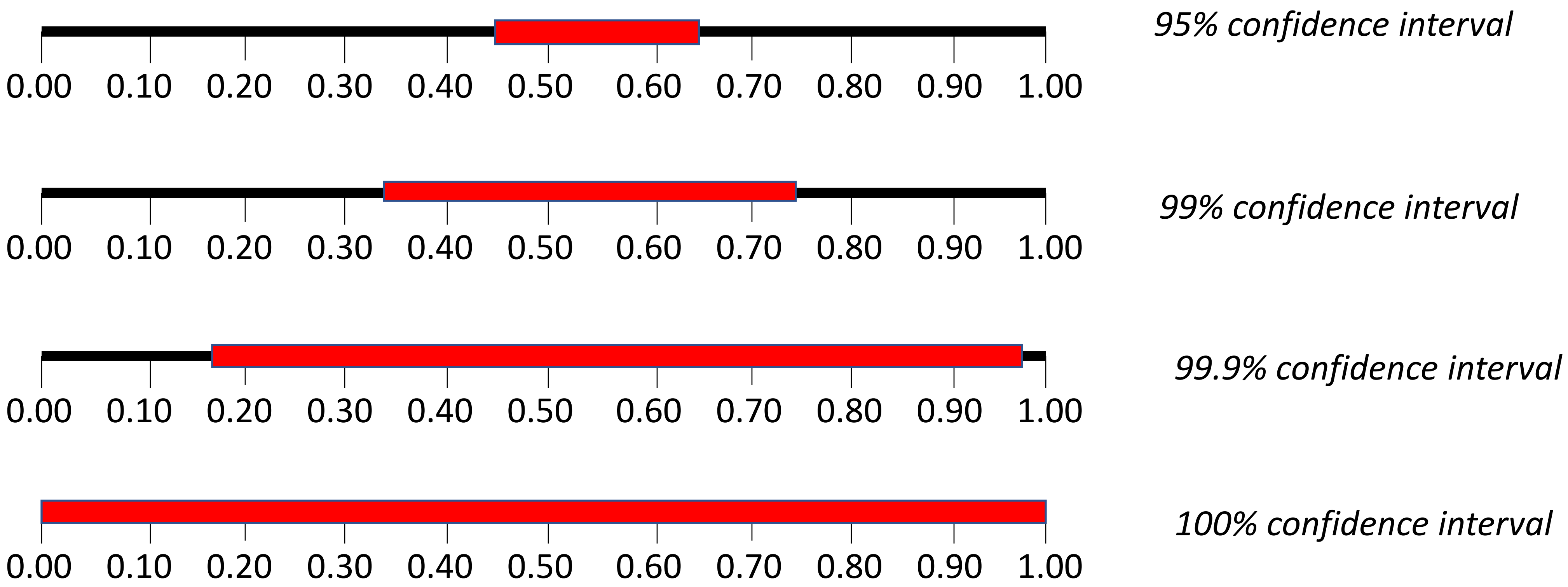
What affects confidence intervals

Interpretation of confidence intervals

Formula for confidence interval:
$\hat{p} \pm$ **z**(se) which is $\hat{p} \pm \mathbf{z}\sqrt{\hat{p}(1-\hat{p})/n}$

What affects confidence intervals?

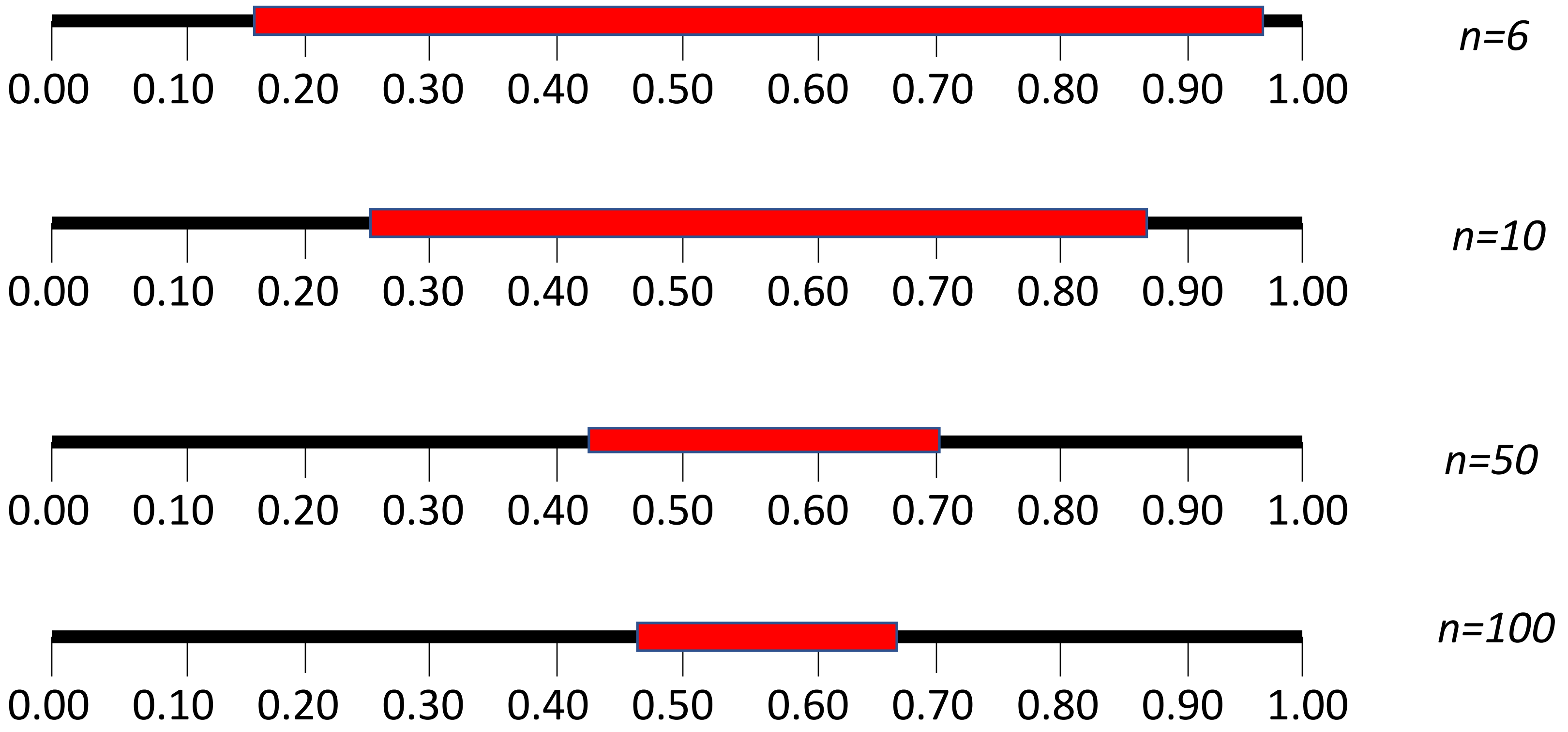
1) The confidence level (if level goes up, ***z*** goes up making the interval wider)



Formula for confidence interval:
$\hat{p} \pm$ z(se) which is $\hat{p} \pm z\sqrt{\hat{p}(1-\hat{p})/\boldsymbol{n}}$

What affects confidence intervals?

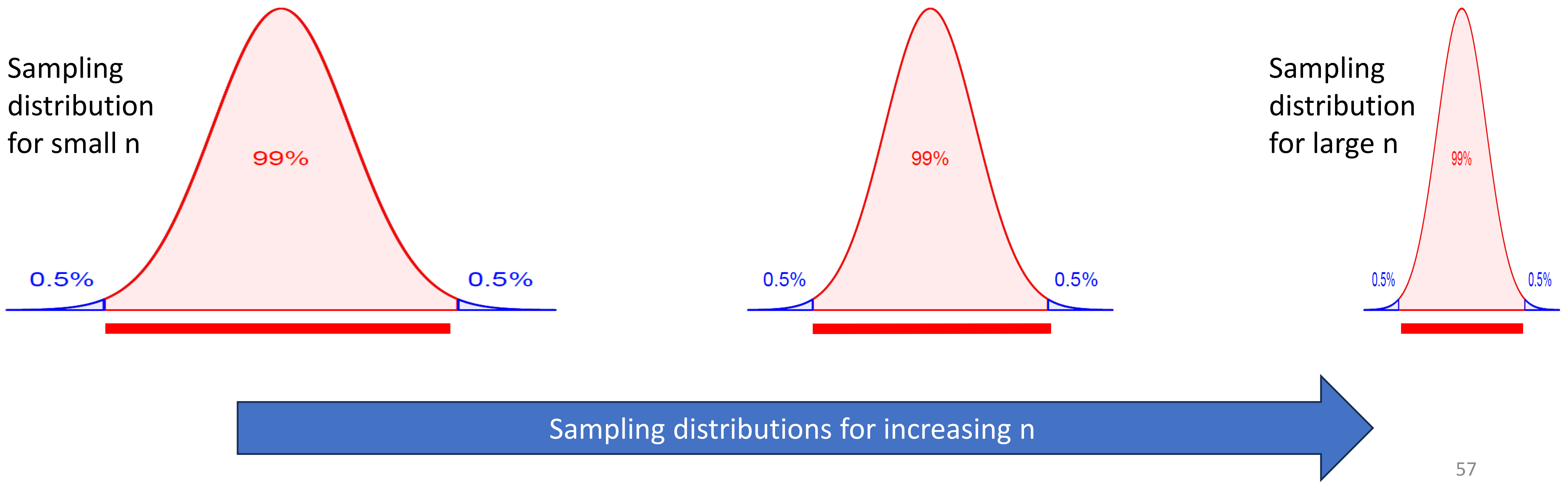
2) The sample size, n (*if **n** goes up, se goes down, making the interval smaller*)



Formula for confidence interval:
$\hat{p} \pm$ z(se) which is $\hat{p} \pm z\sqrt{\hat{p}(1-\hat{p})/\boldsymbol{n}}$

What affects confidence intervals

2) The sample size, n (*if **n** goes up, se goes down, making the interval smaller*)



Today

Memory refresh of sampling distribution

Point versus interval estimation

Constructing a confidence interval

What affects confidence intervals

Interpretation of confidence intervals

Interpretation of a confidence interval

Psychon Bull Rev
DOI 10.3758/s13423-013-0572-3

BRIEF REPORT

Robust misinterpretation of confidence intervals

Rink Hoekstra · Richard D. Morey · Jeffrey N. Rouder · Eric-Jan Wagenmakers

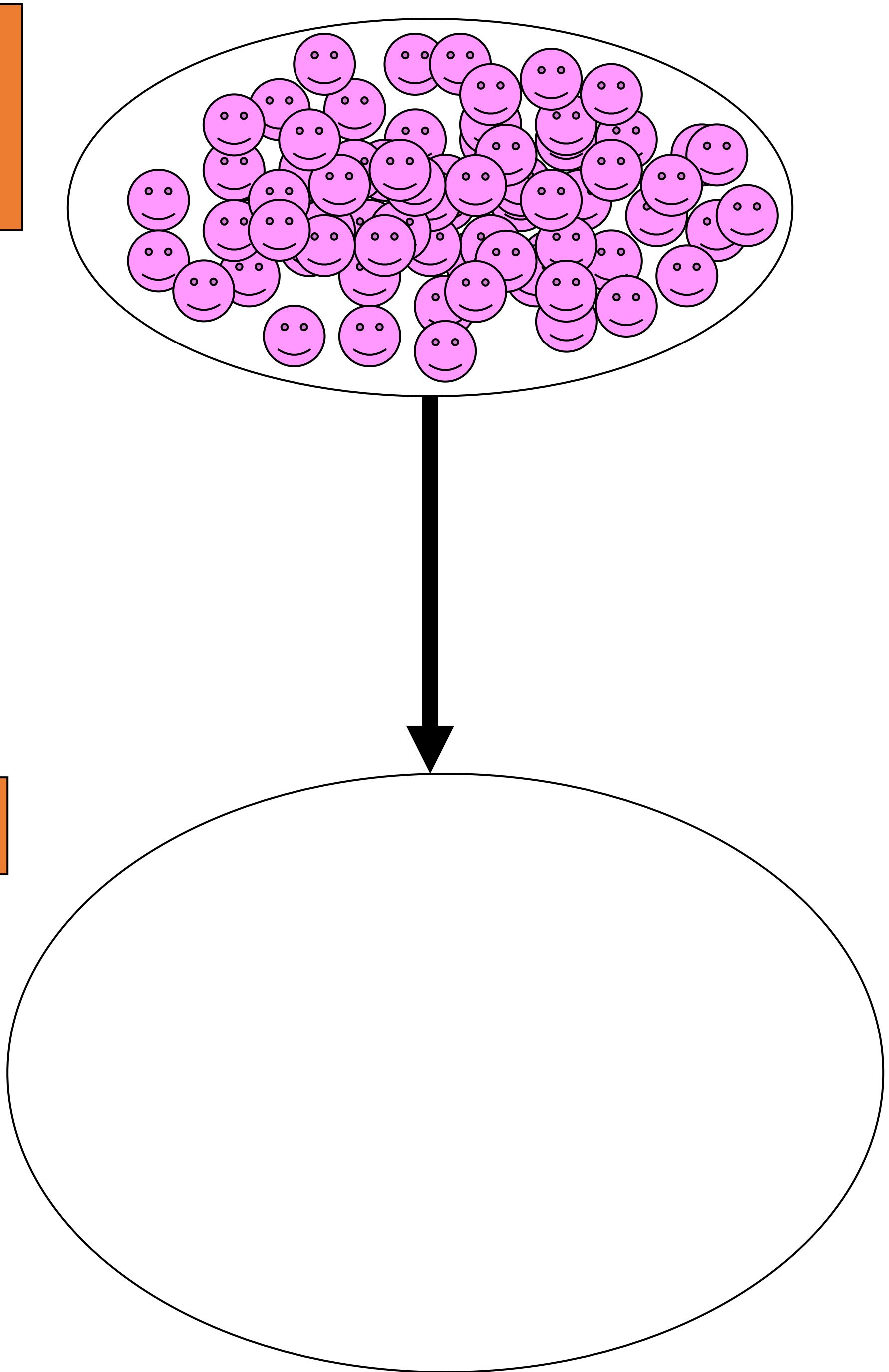
Abstract Null hypothesis significance testing (NHST) is undoubtedly the most common inferential technique used to justify claims in the social sciences. However, even staunch defenders of NHST agree that its outcomes are often misinterpreted. Confidence intervals (CIs) have frequently been proposed as a more useful alternative to NHST, and their use is strongly encouraged in the APA Manual. Nevertheless, little is known about how researchers interpret CIs. In this study, 120 researchers

Keywords Confidence intervals · Significance testing · Inference

Introduction

Statistical inference is central to the justification of claims across scientific fields. When statistics such as *p*-values or confidence intervals (CIs) serve as the basis

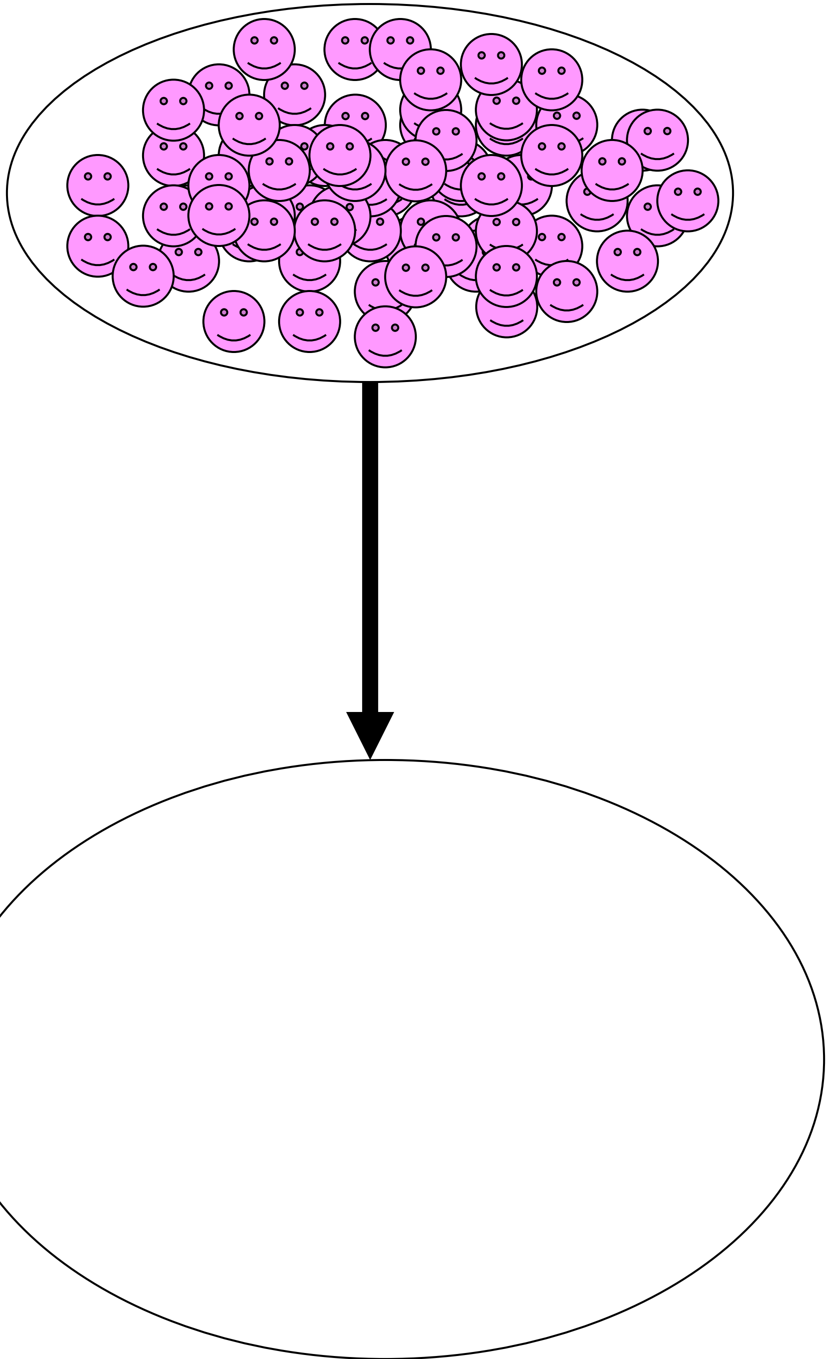
Population
$p = 0.4$



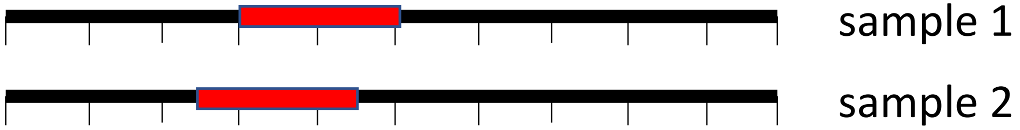
Sample

sample 1

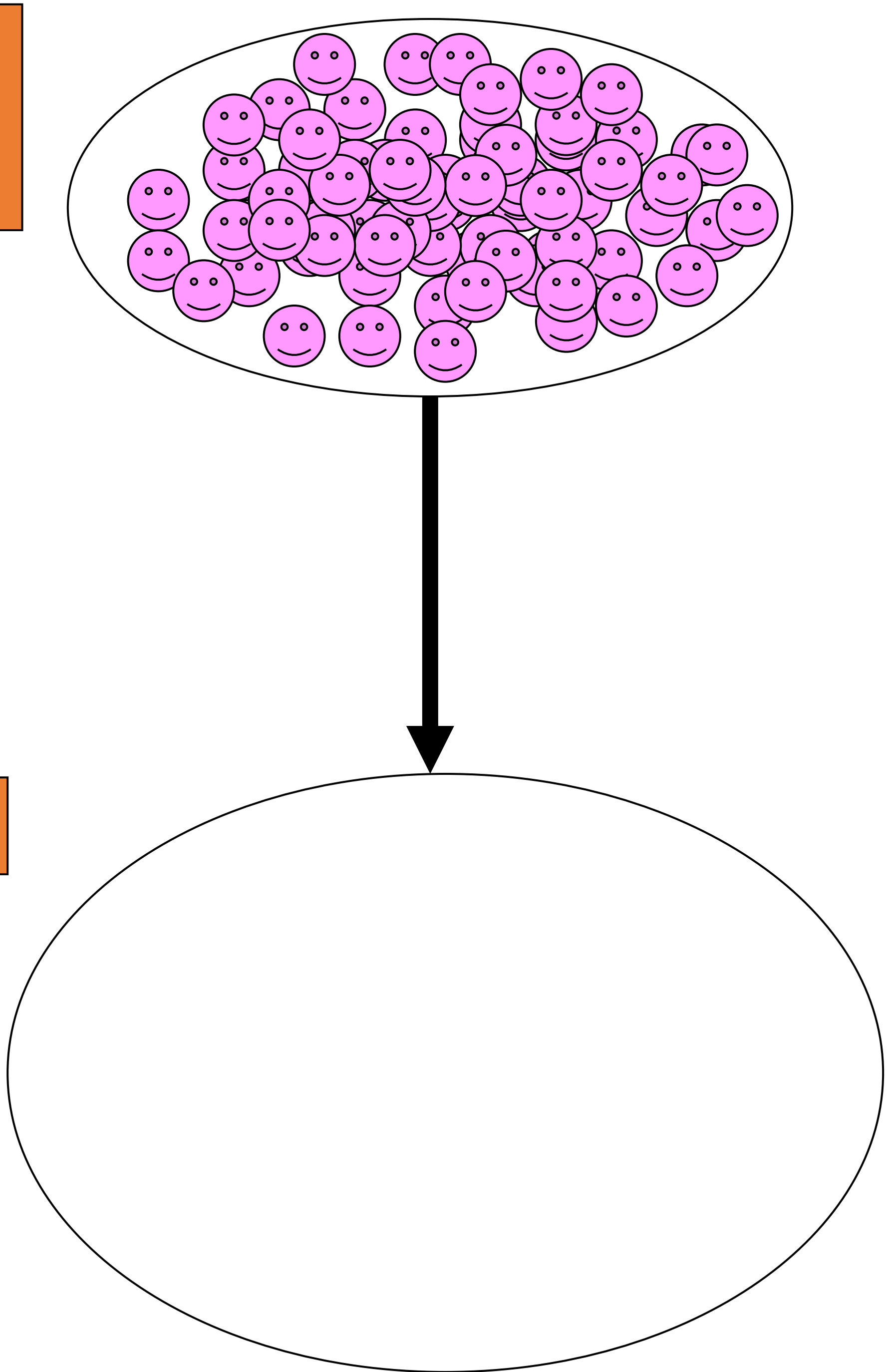
Population
$p = 0.4$



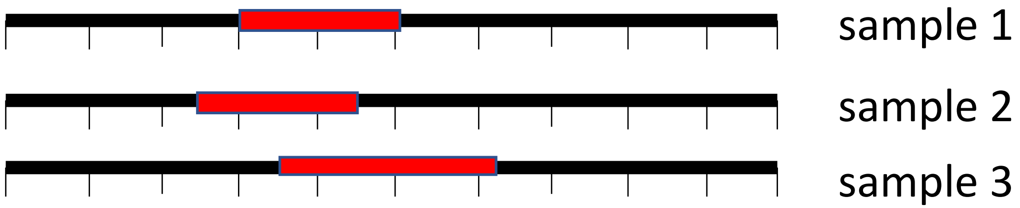
Sample



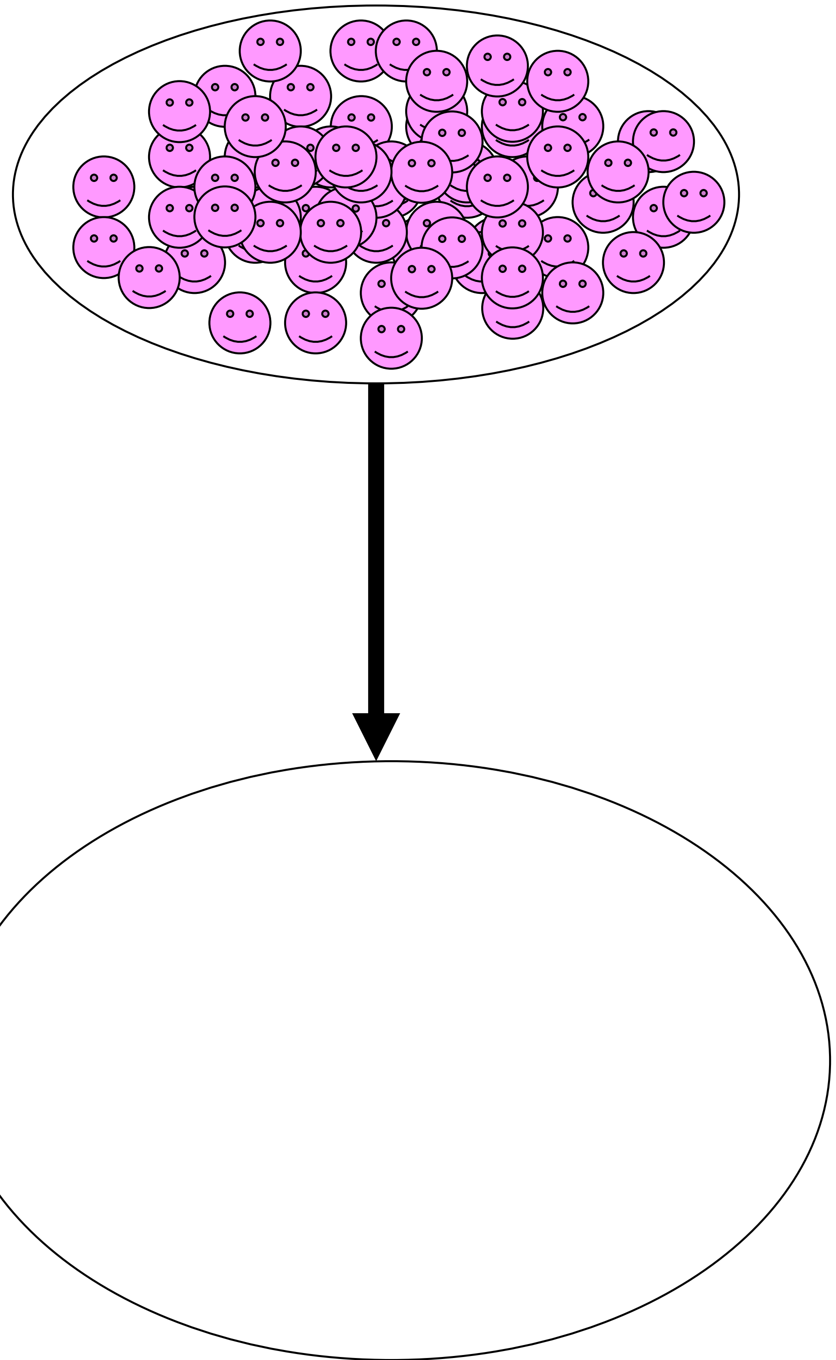
Population
$p = 0.4$



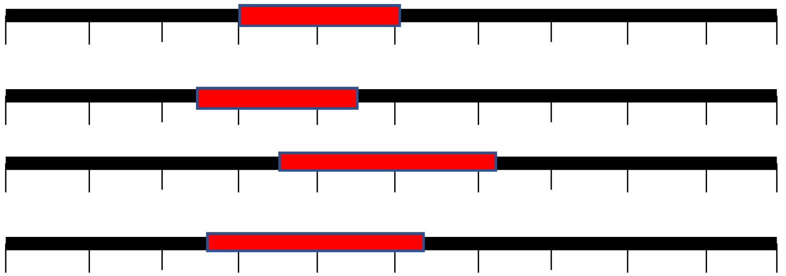
Sample



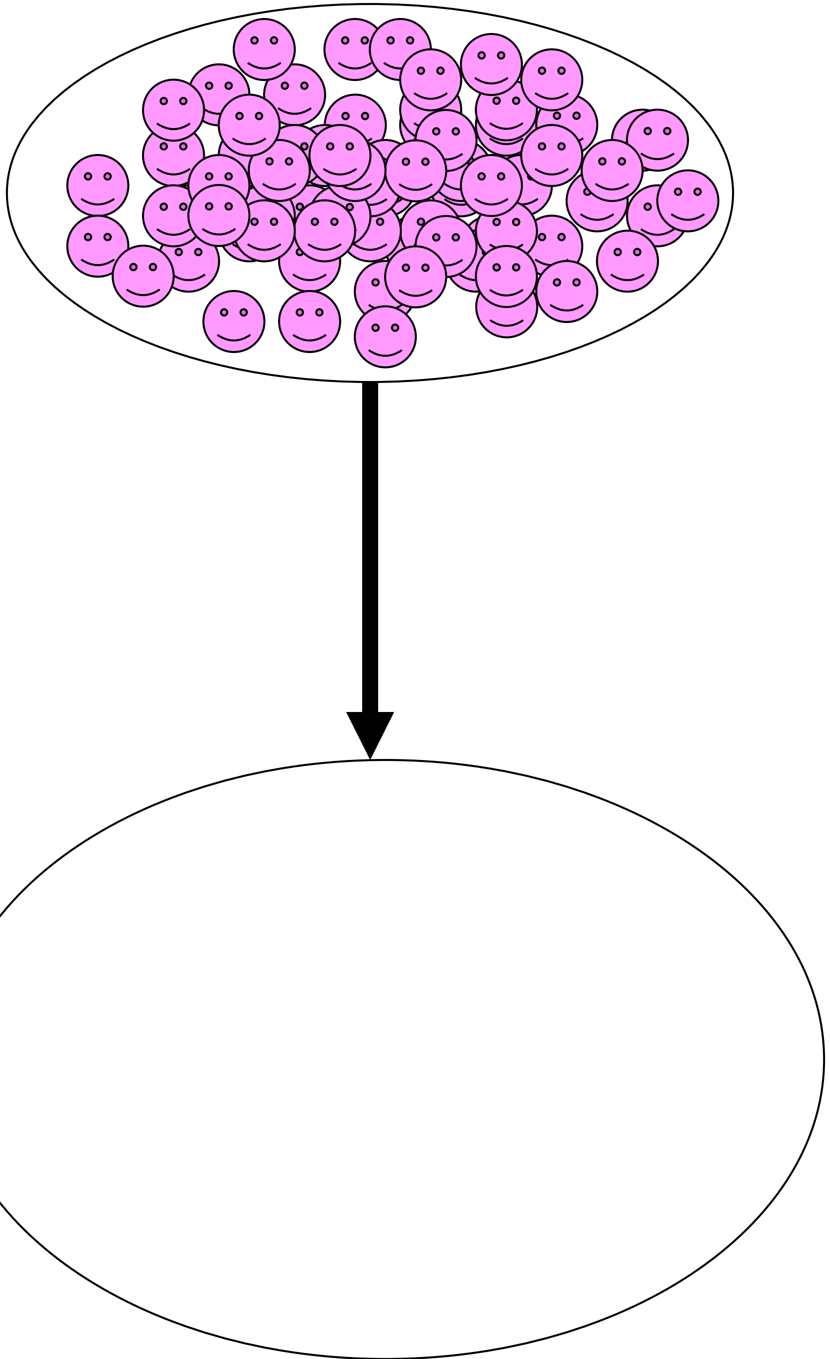
Population
$p = 0.4$



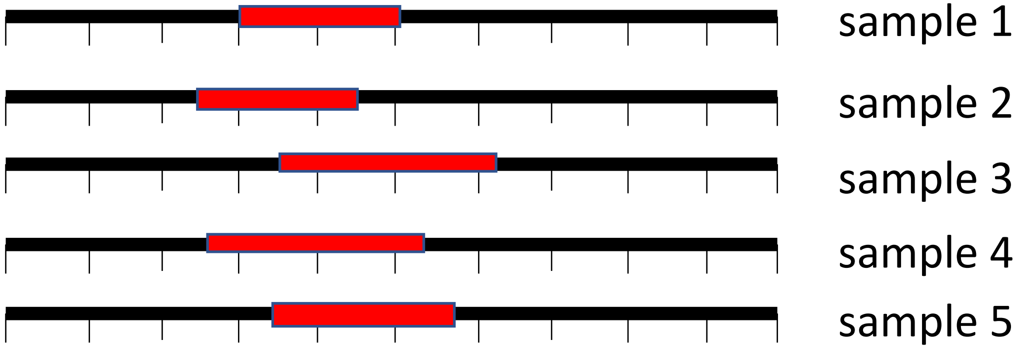
Sample



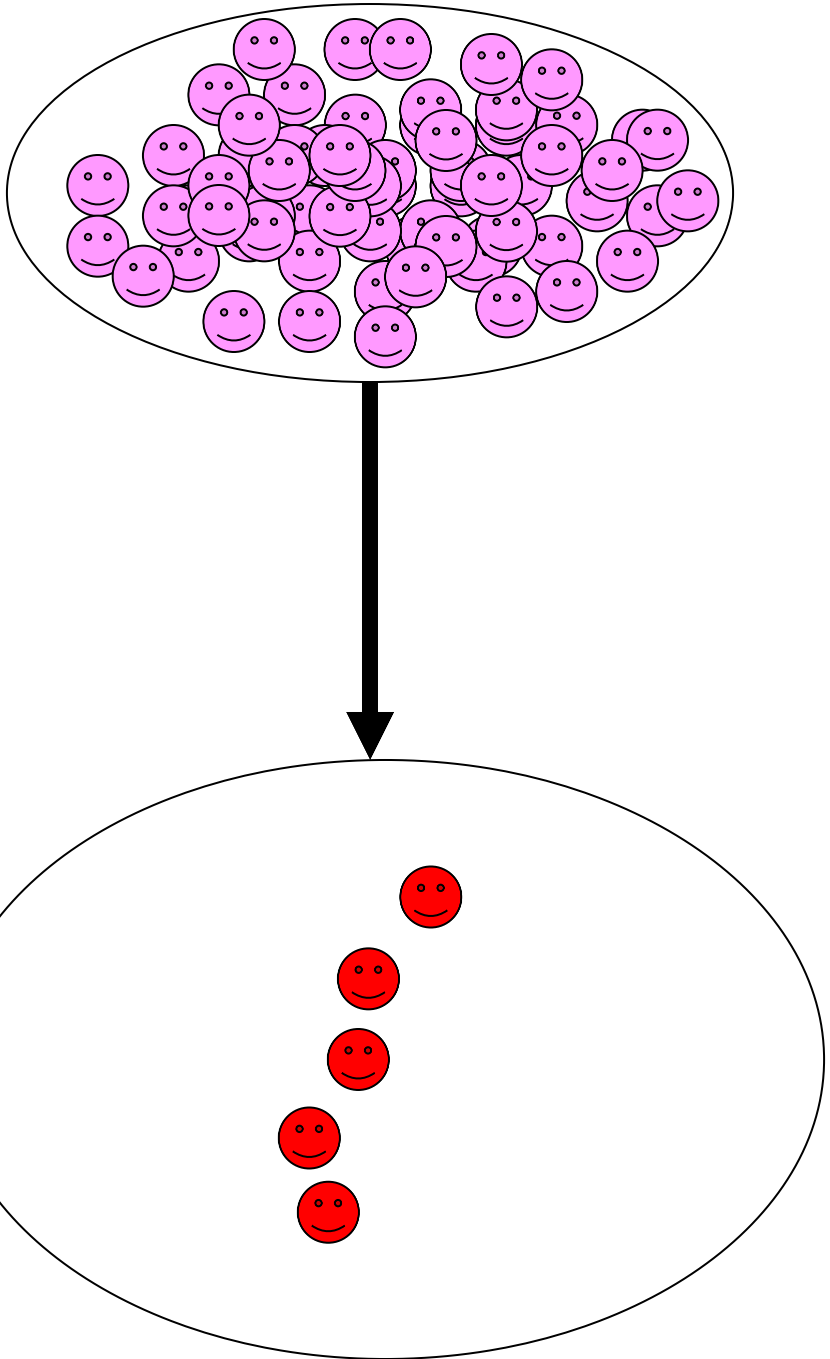
Population
$p = 0.4$



Sample

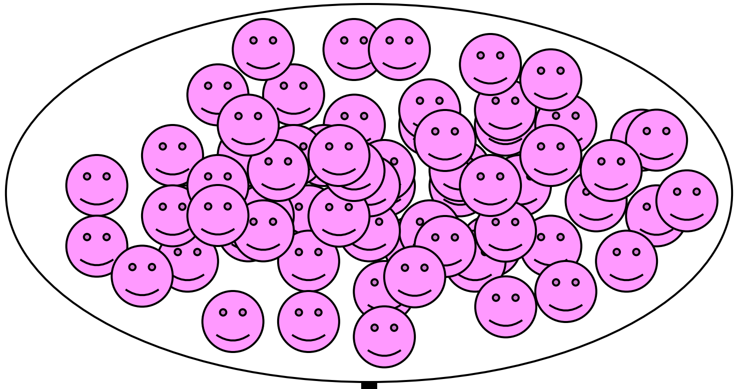


Population
$p = 0.4$

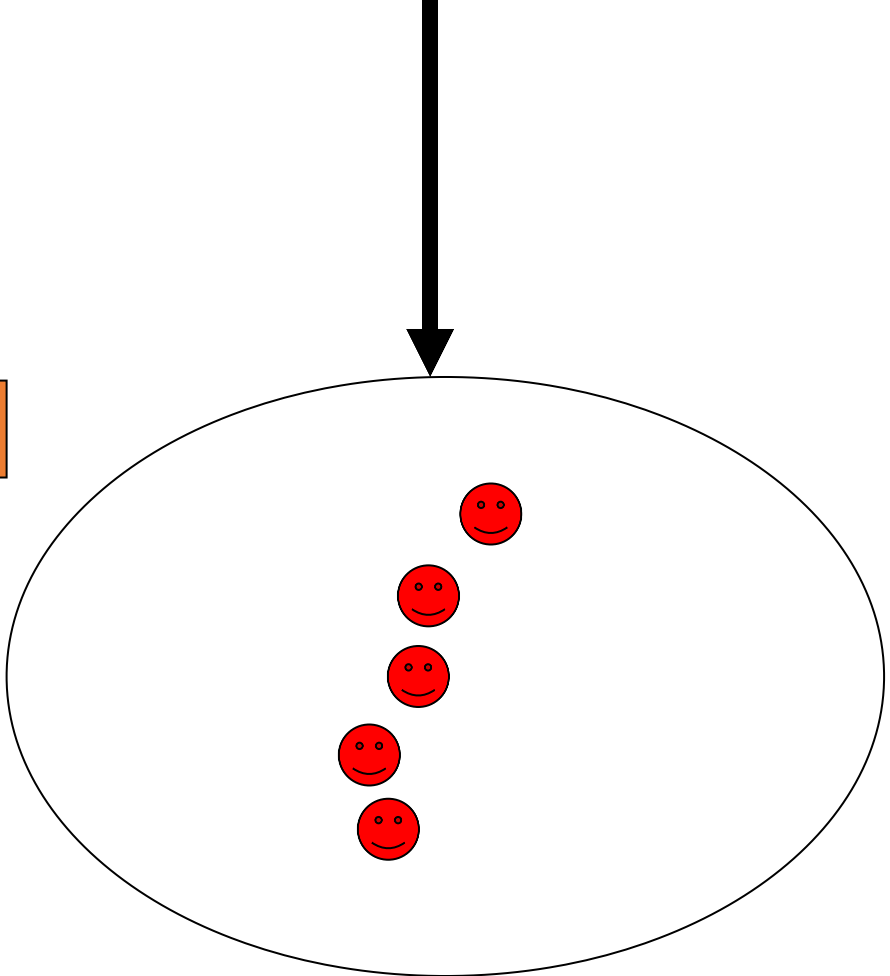


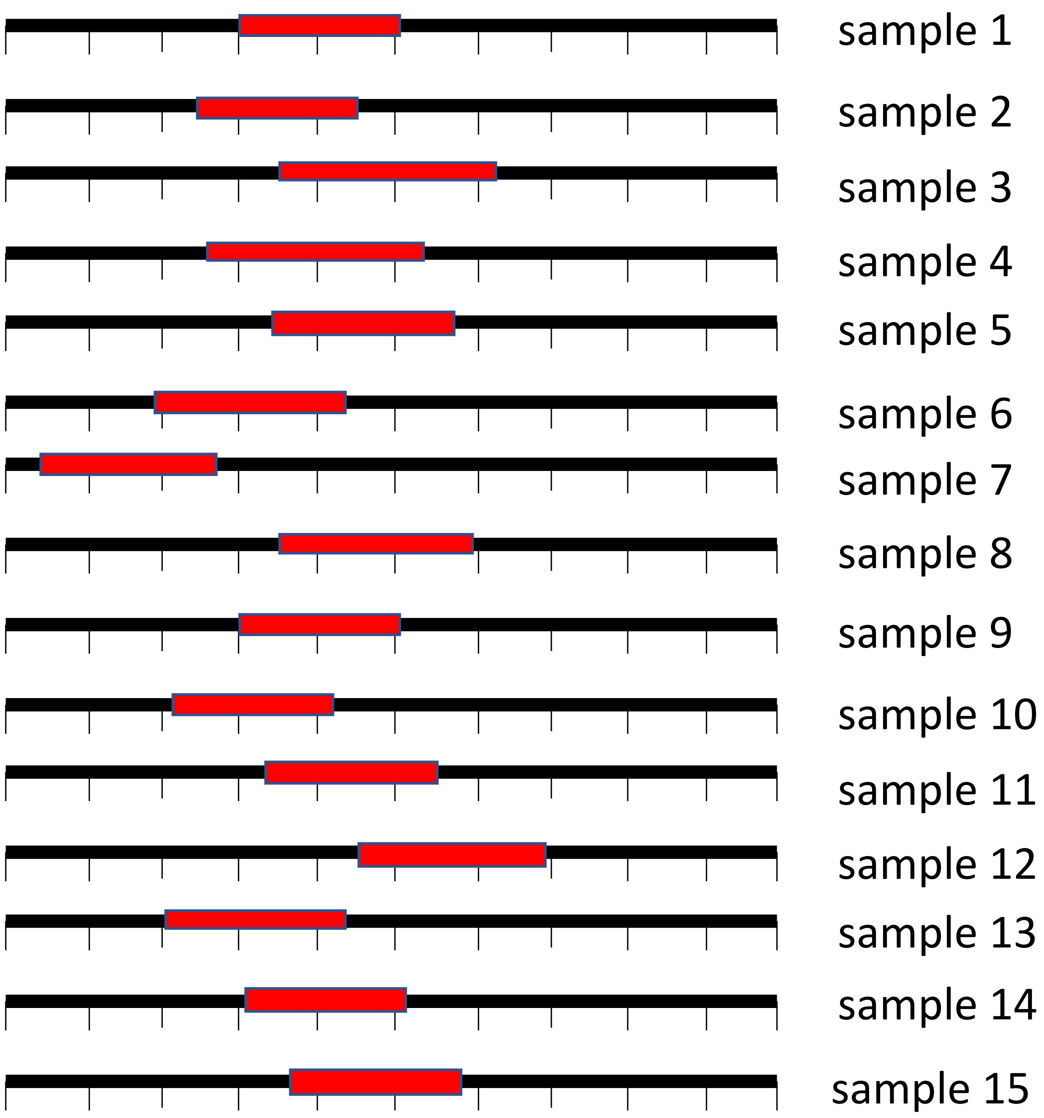
Sample

Population
$p = 0.4$



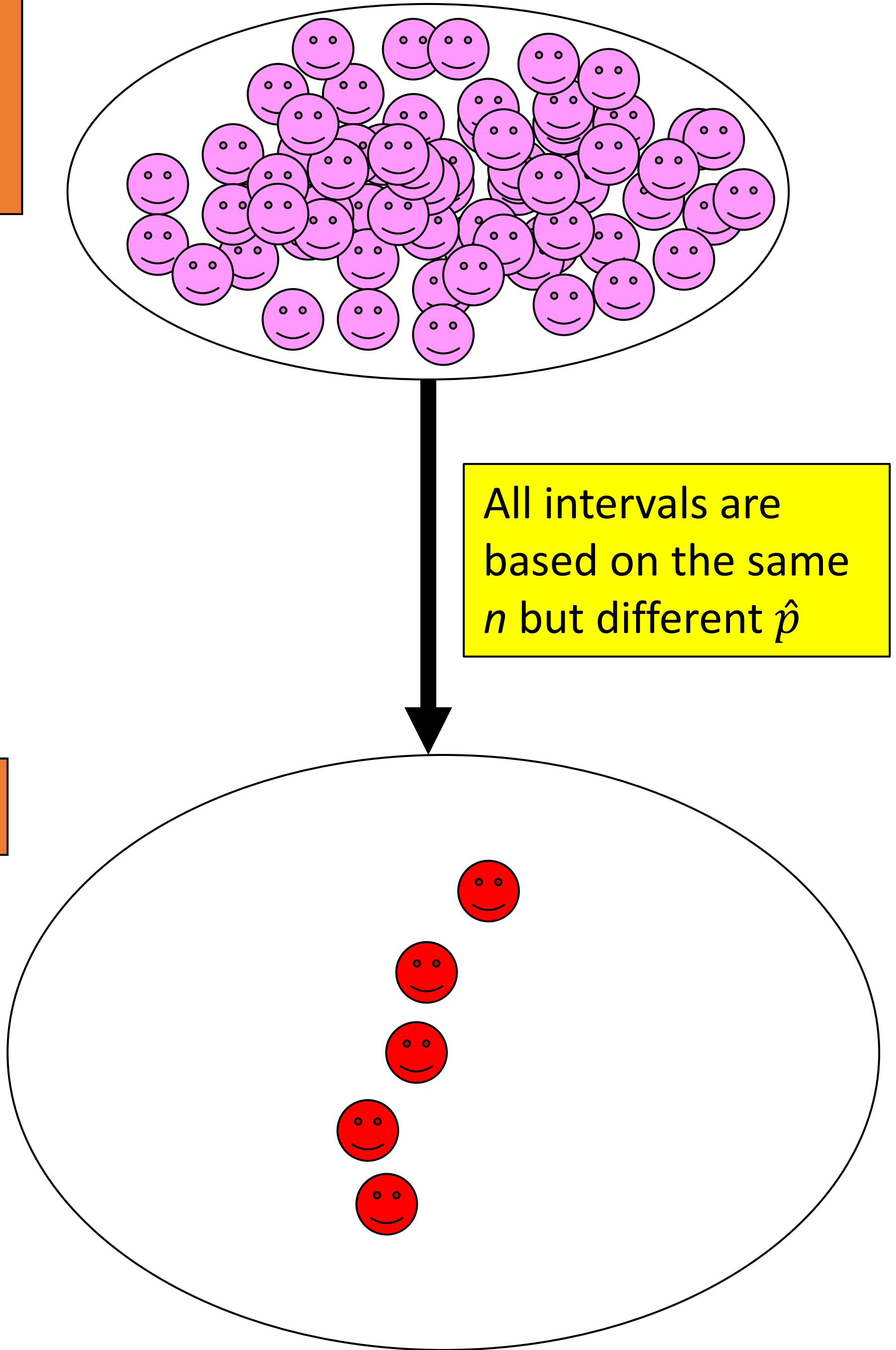
Sample



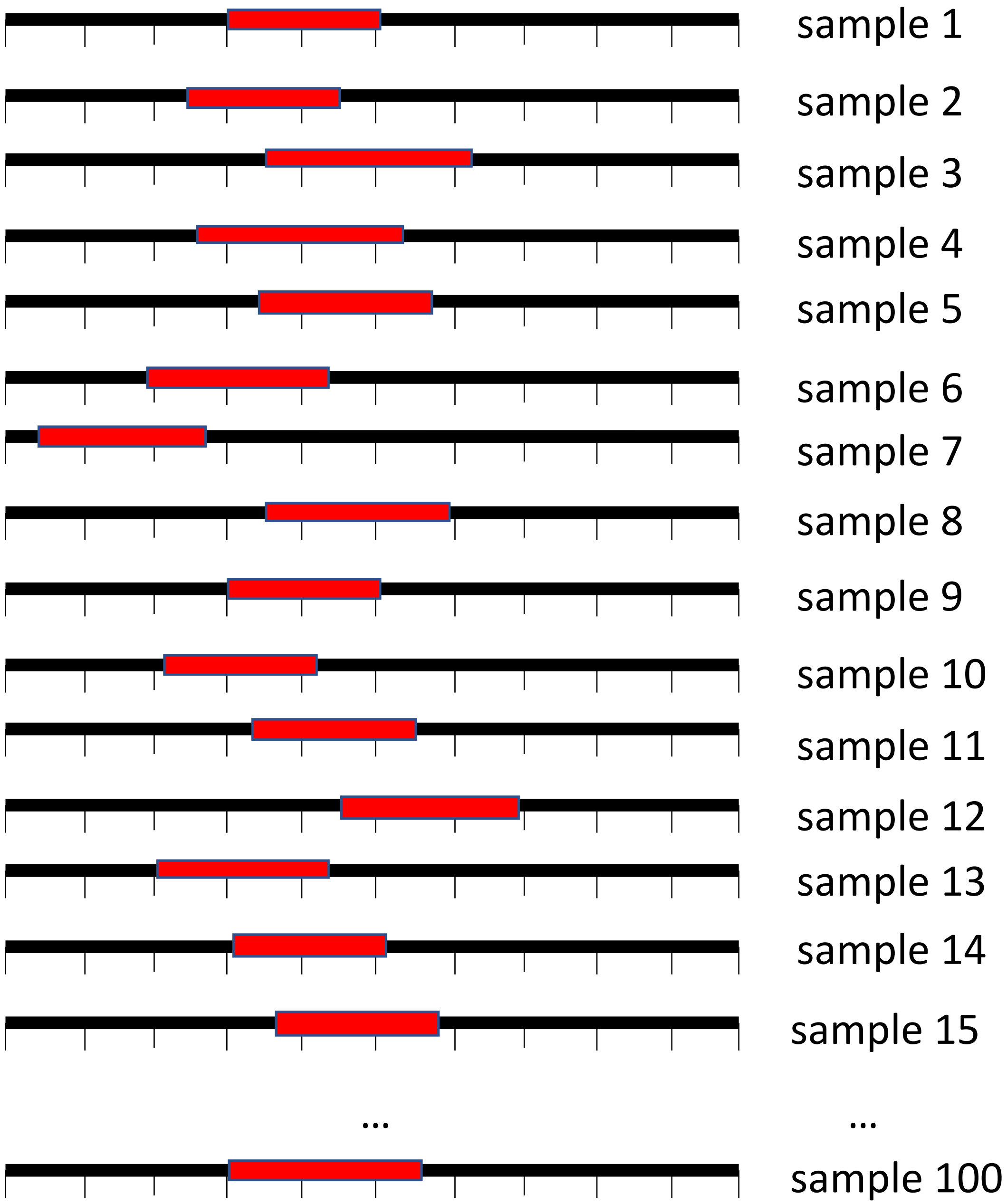


Population
$p = 0.4$

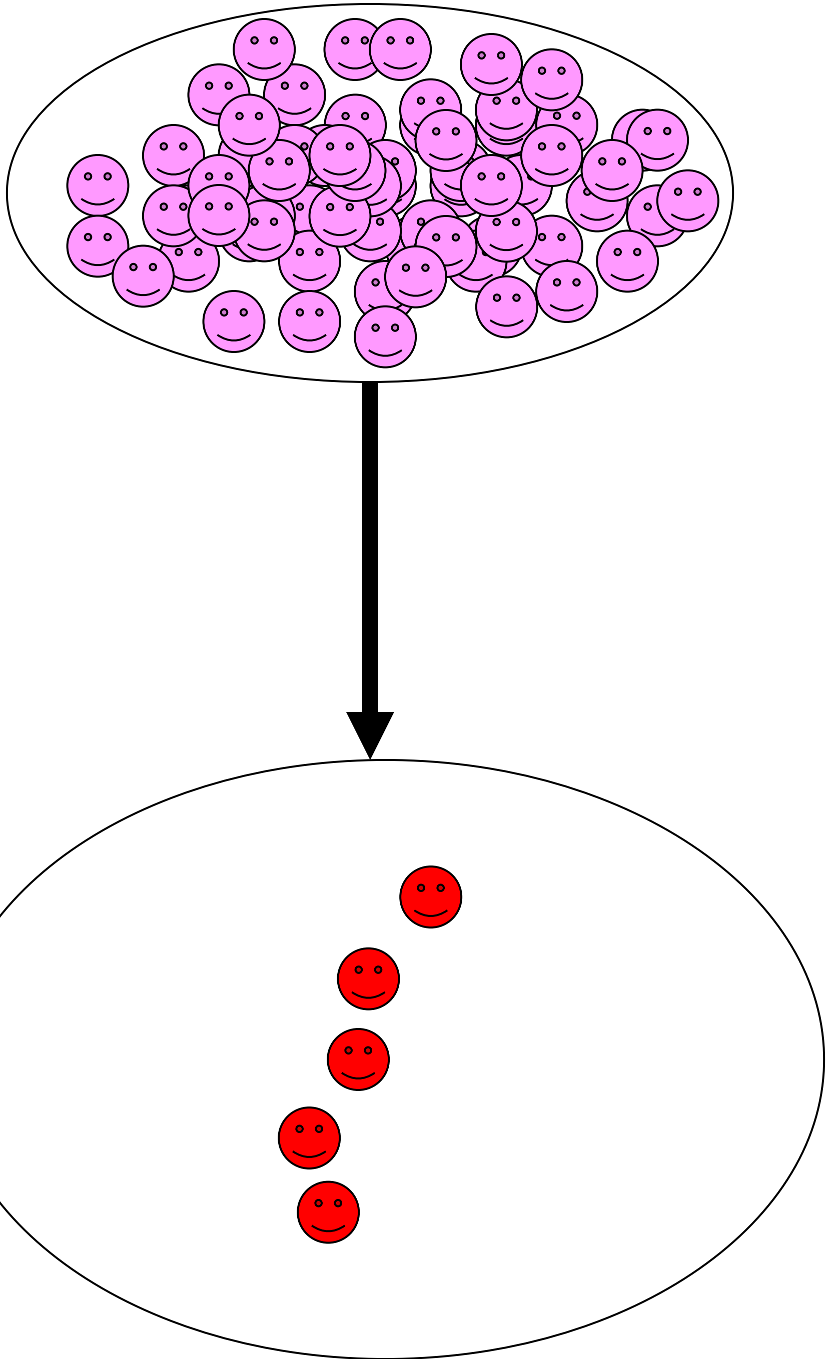
Sample



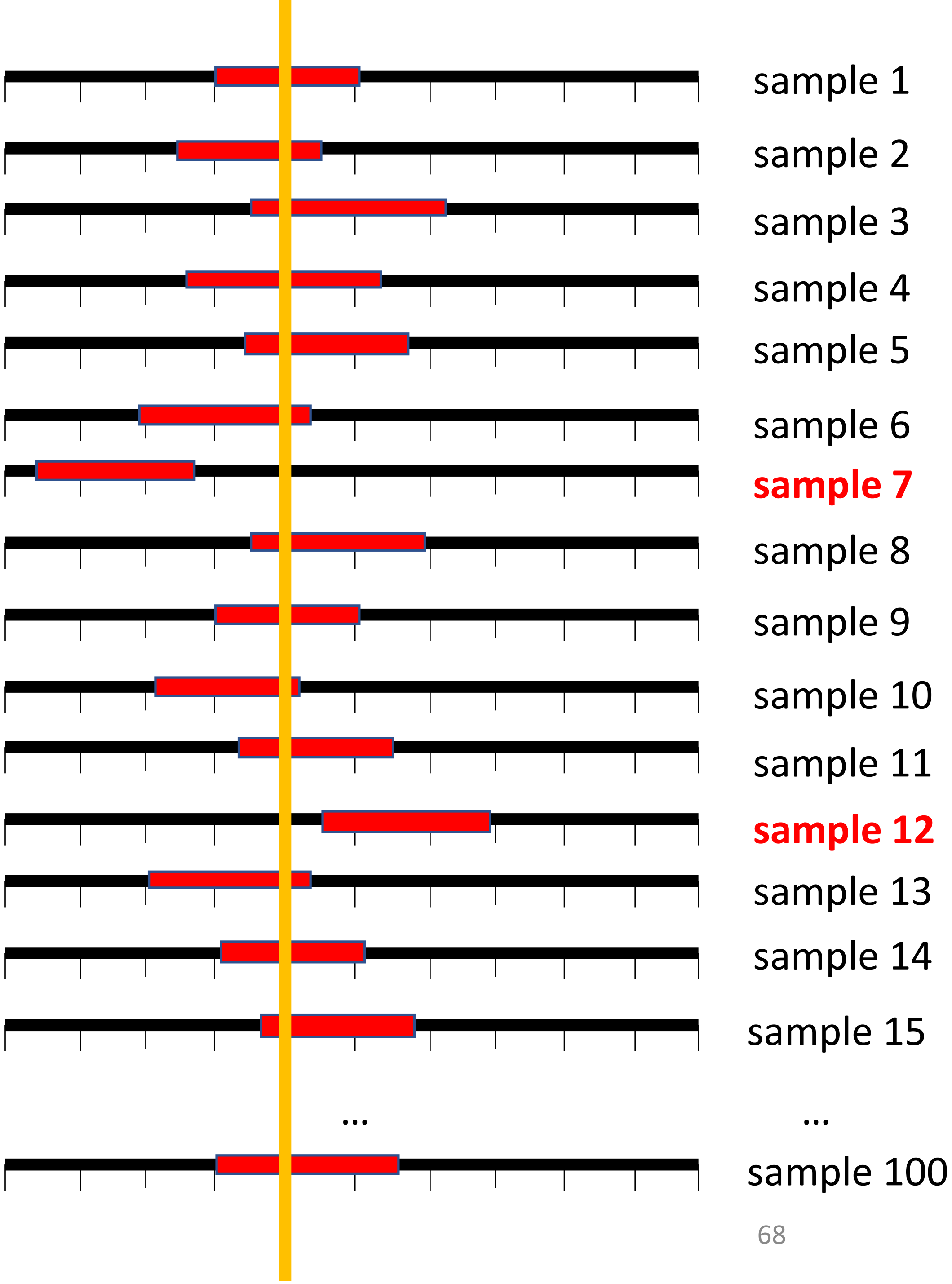
All intervals are based on the same n but different $\hat{p}$



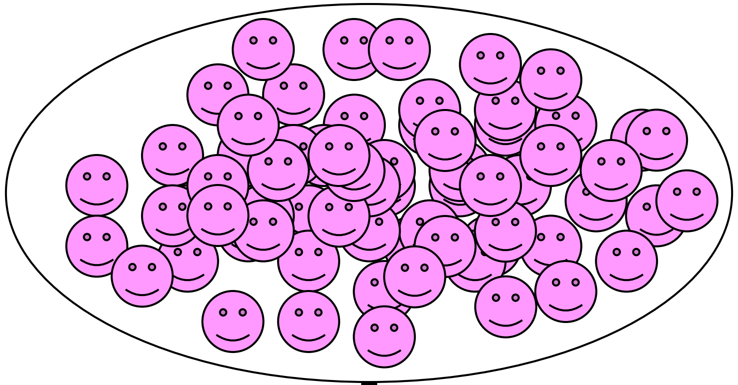
Population
$p = 0.4$



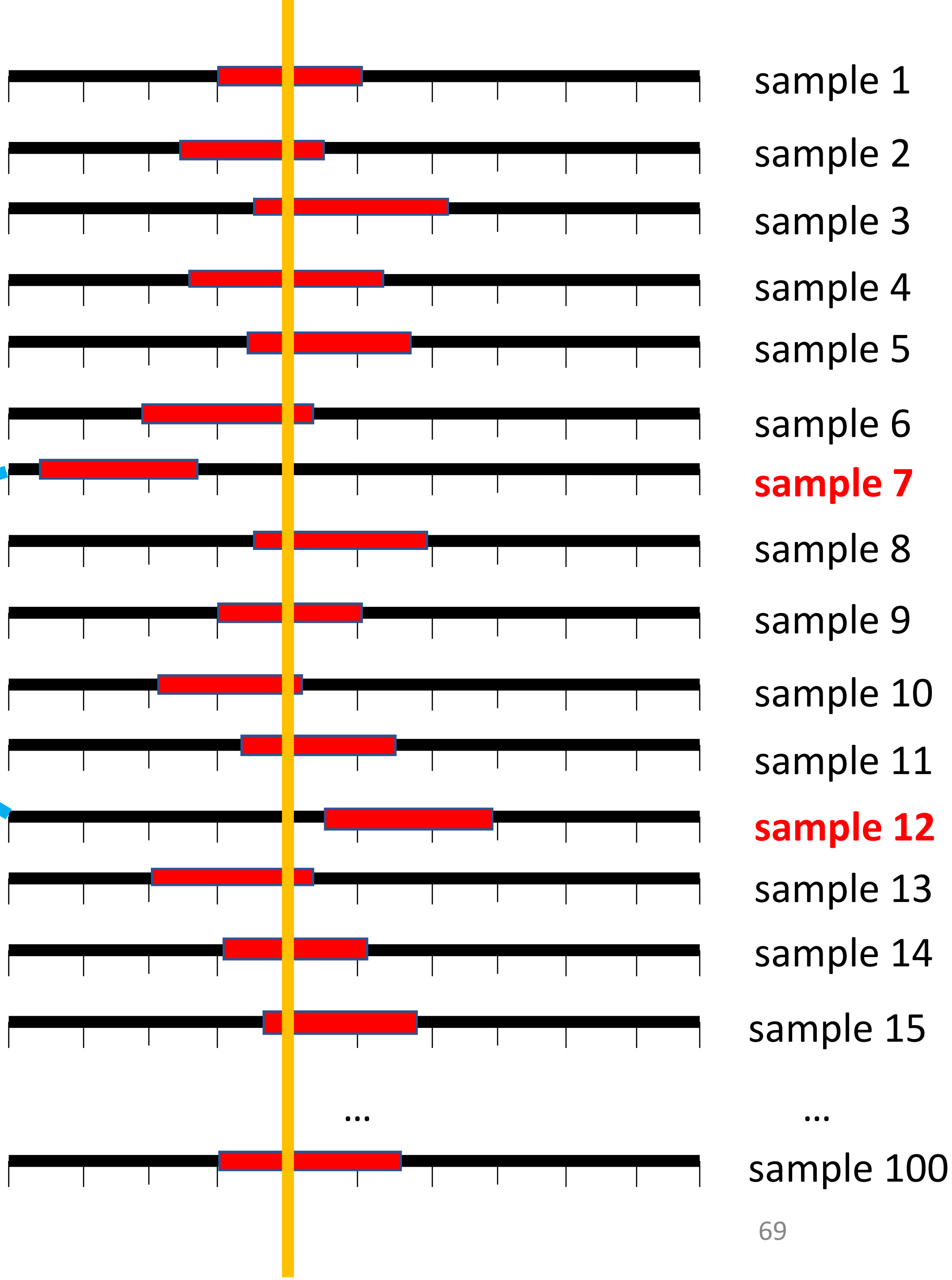
Sample



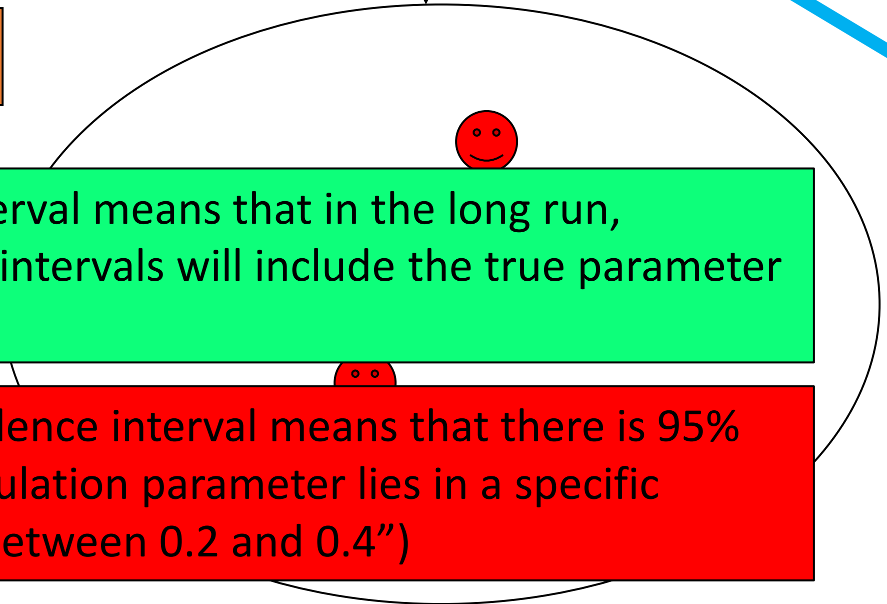
Population
$p = 0.4$



This will happen for 5% of the intervals, i.e., 5 times (for the 100 confidence intervals)



Sample



→A 95% confidence interval means that in the long run, 95% of your confidence intervals will include the true parameter value

DON'T say: a 95% confidence interval means that there is 95% probability that the population parameter lies in a specific interval (for example, "between 0.2 and 0.4")

Summary

A confidence interval gives an interval of believable values for the population parameter.

Most often, a 95% confidence interval is used.

The 95% interval for a proportion is constructed in such a way that if you take a sample of *n* people over and over again, for 95% of these samples the interval $\hat{p} \pm 1.96\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$ contains *p* (the true proportion in the population)

The confidence interval can be used to make inferences about the population. For example, if 0.5 is not part of the interval, then we consider it believable that the proportion in the population *differs* from 0.5.

Leo constructed a confidence interval for the proportion of people who prefer cats over dogs. He uses the following formula:

$$\hat{p} \pm 1.28\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$$

What is the margin of error?

a) $\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$

b) $1.28\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$

What is the percentage confidence for this interval?

a) 95% confidence interval
b) 90% confidence interval
c) 80% confidence interval

Leo is constructing a confidence interval for the proportion of people who prefer cats over dogs. He chooses a confidence level that corresponds with a z-value of 1.28.

What is the margin of error?

a) $\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$

b) $1.28\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$

c) $\hat{p} \pm 1.28\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$

Leo is constructing a confidence interval for the proportion of people who prefer cats over dogs. He chooses a confidence level that corresponds with a z-value of 1.28.

What is the margin of error?

a) $\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$ → This is the standard error

b) $1.28\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$

c) $\hat{p} \pm 1.28\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$

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c) $\hat{p} \pm 1.28\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$

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b) 90% confidence interval
c) 80% confidence interval

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What is the margin of error?

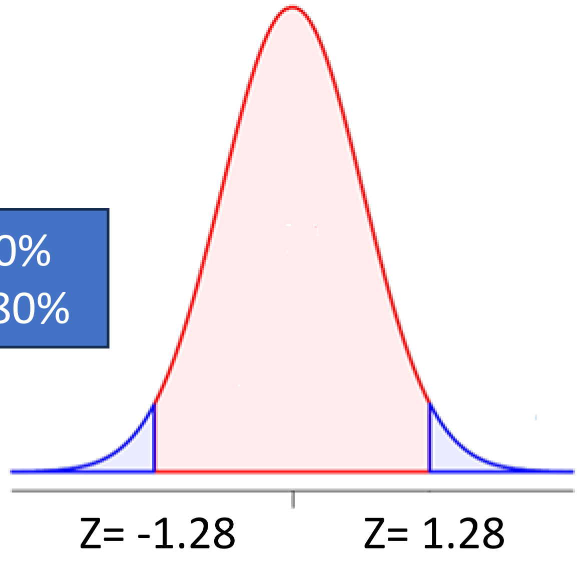
a) $\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$

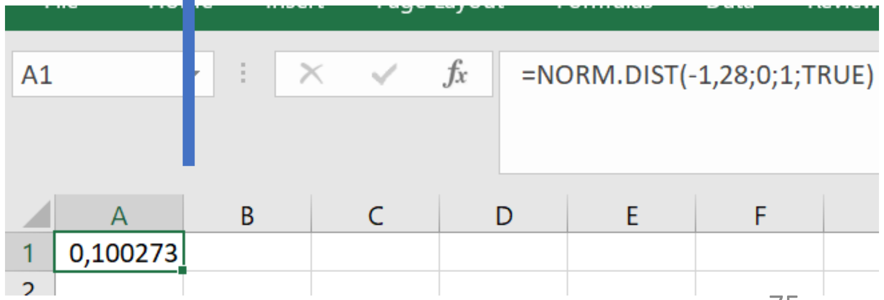
b) $1.28\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$

c) $\hat{p} \pm 1.28\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$

This is the standard error

Blue area is 10%
So red area is 80%





What is the percentage confidence for this interval?

a) 95% confidence interval

b) 90% confidence interval

c) 80% confidence interval

Another example exam question

The minister of health wants to know what proportion of students is addicted to their smartphones. To this end, a study is conducted. The researchers draw a random sample of 500 students and find 30 students to be addicted.

What is the 95% confidence interval for the proportion *p* of addicted students in the population

A) $\hat{p} \pm 0.01$
B) $\hat{p} \pm 0.02$
C) $\hat{p} \pm 0.03$

Another example exam question

Explanation:

$$\hat{p} = \frac{30}{500} = 0.06$$

For the 95% confidence interval, we use z = 1.96

So: $\hat{p} \pm 1.96$(se)

se = $\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$ = $\sqrt{\frac{0.06*0.94}{500}}$ = $\sqrt{\frac{0.0564}{500}}$ = 0.011

1.96(se) = 1.96*0.011=0.02

Another example exam question

The minister of health wants to know what proportion of students is addicted to their smartphones. To this end, a study is conducted. The researchers draw a random sample of 500 students and find 30 students to be addicted.

What is the 95% confidence interval for the proportion *p* of addicted students in the population

A) $\hat{p} \pm 0.01$
B) $\hat{p} \pm 0.02$
C) $\hat{p} \pm 0.03$

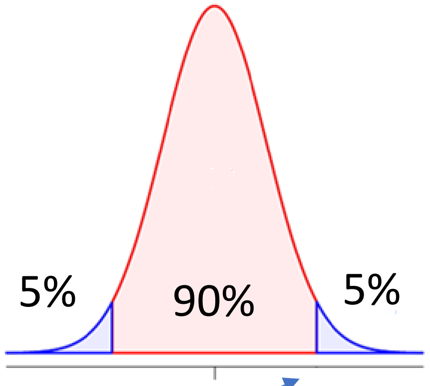
Example of question in the book

- 8.19 (p.425): Which z-score is used in a (a) 90%, (b) 98%, (c) 99.9% confidence interval for a population proportion?

- For an explanation of how to solve this excercise using excel, see next slides.

Explanation of answer to excercise 8.19

(a) It helps to draw the distribution.

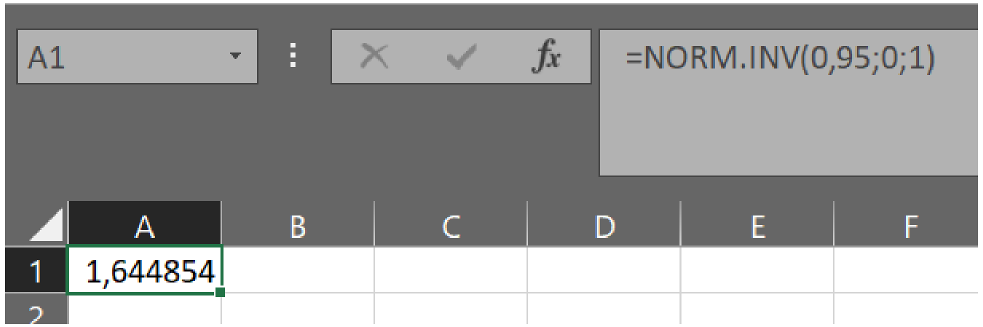


To get the red area to be 90 %, you want each blue tail to be 5%.

For a 90% confidence interval you need to find the z-value that has a lower tail of 95%. After all, in that case there will be 5% in the upper tail (the extreme tail).

So, we use NORM.INV(0,95;0;1) to get the positive z-value

Inserting this in Excel gives a Z-value of 1.64



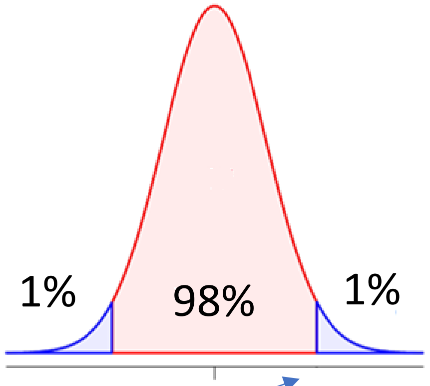
Explanation of answer to excercise 8.19

(b) It helps to draw the distribution

To get the red area to be 98 %, you want each blue tail to be 1%.

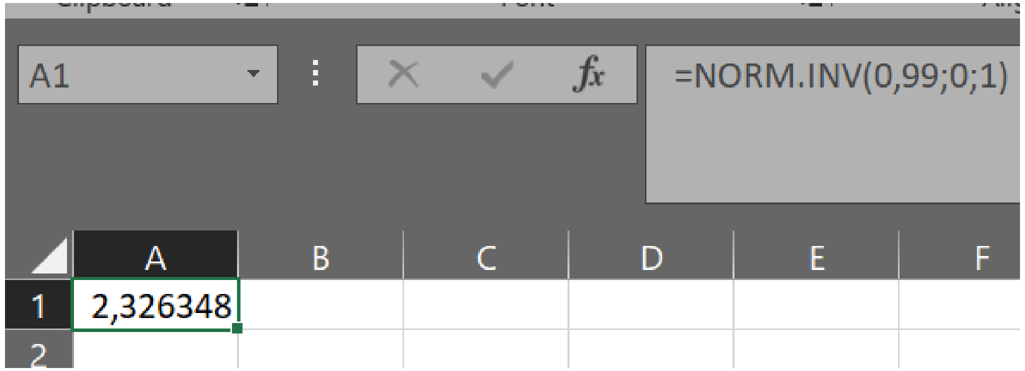
For a 98% confidence interval you need to find the z-value that has a lower tail of 99%. After all, in that case there will be 1% in the upper tail (the extreme tail).

So, we use NORM.INV(0,99;0;1) to get the positive z-value



Inserting this in Excel gives a

Z-value of 2.33



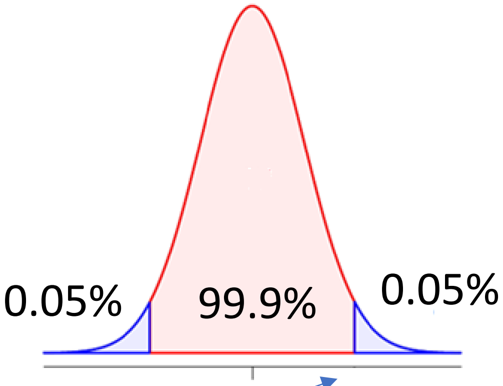
Explanation of answer to excercise 8.19

(c) It helps to draw the distribution

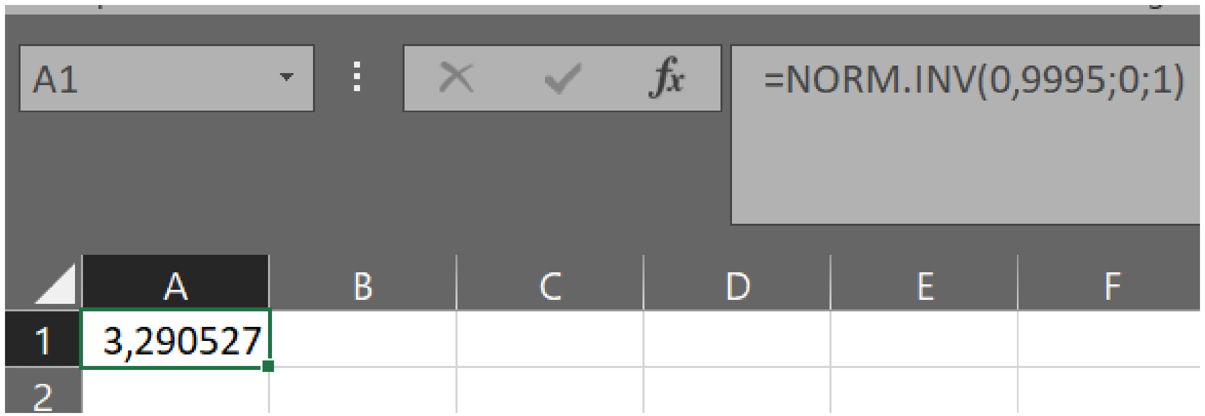
To get the red area to be 99.9%, you want each blue tail to be 0.05%.

For a 98% confidence interval you need to find the z-value that has a lower tail of 99.95%. After all, in that case there will be 0.05% in the upper tail (the extreme tail).

So, we use NORM.INV(0,9995;0;1) to get the positive z-value



Inserting this in Excel gives a Z-value of 3.29



Practice with excercises!

- Some excercises to focus on: 8.2, 8.3, 8.4, 8.14, 8.16, 8.17, 8.19,8.23, 8.25, 8.26, 8.30, 8.31, 8.33
- Note that this list is not exhaustive: other excercises not in this list also help practice for the exam, so the more the better!
- Also work through the examples (e.g., example 3 in 8.2)
- In doubt about how to get to the correct answer to an excercise? You can post questions on the discussion board.
- On the discussion board you can help each other! We will also check the discussion board to help out. (but not every day, so don’t start posting one day before the exam!)