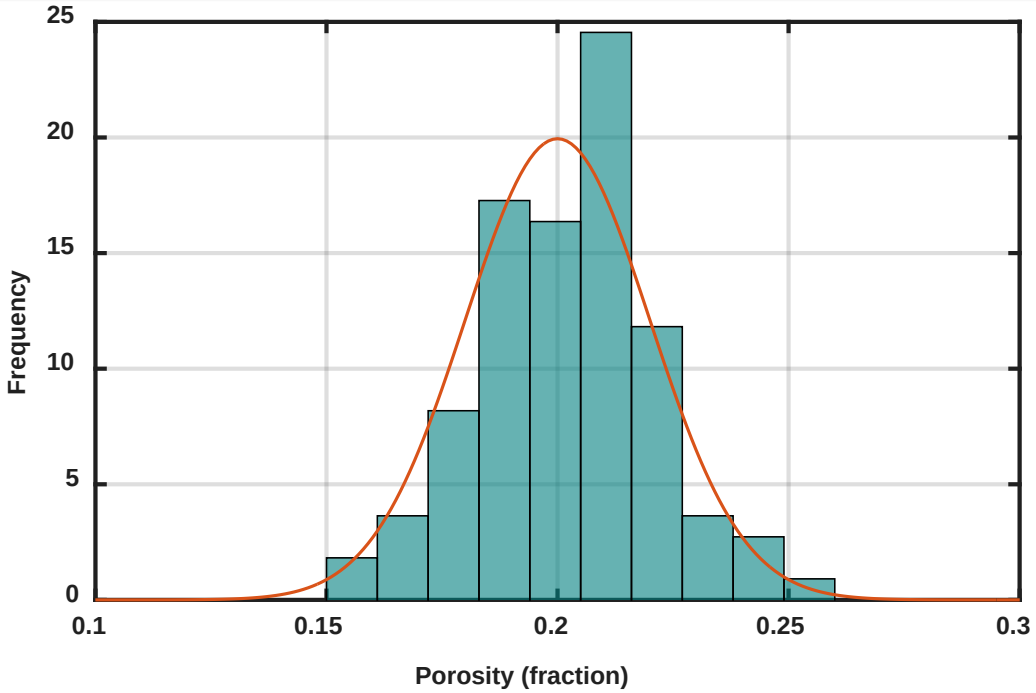
Estimation



- What is a good estimate for porosity of this formation based on the sampled data?
- How well does this sample set represent the population?
- How good is this estimate?
  - ✓ How precise is this estimate?
  - ✓ What is the bias on this estimate?

Review on Nomenclature

Sample set:

$\hat{p}$

$\overline{x}$

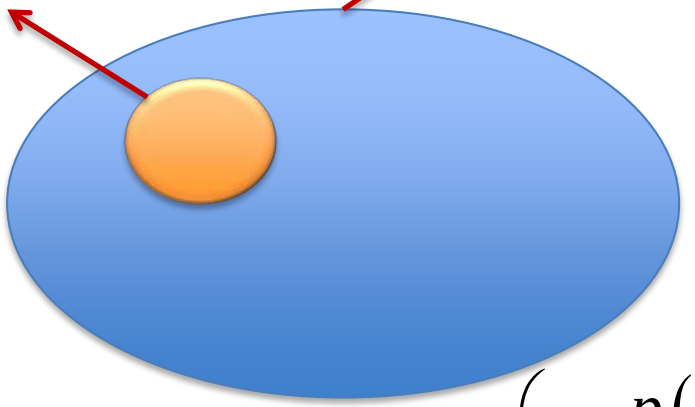
s

Population:

p

μ

σ



$$\overline{x} \sim N\left(\mu, \frac{\sigma^2}{n}\right)$$

$$\hat{p} \sim N\left(p, \frac{p(1-p)}{n}\right), np \geq 15 \;\; and \;\; n(1-p) \geq 15$$

Confidence Interval

- **A confidence interval is constructed by taking a point estimate and adding and subtracting a margin of error.**

➔ **Example: I am 95% confident that population mean will fall in this interval**

Example: if sampling distribution is normal, then 95% confidence interval will be equal to:

Point Estimate ± Margin of Error

$$\hat{p} \pm 1.96se$$

se → **Standard error**

- **A 95% confidence interval does not mean that 95% of the sample data lie within the interval.**
- **The 95% confidence relates to the reliability of the estimation procedure.**

Confidence Interval for Population Proportion

$$CI\ for\ p = \hat{p} \pm z_{\alpha}\sqrt{\frac{p(1-p)}{n}} \approx \hat{p} \pm z_{\alpha}\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$$

Z-score, N (0,1)

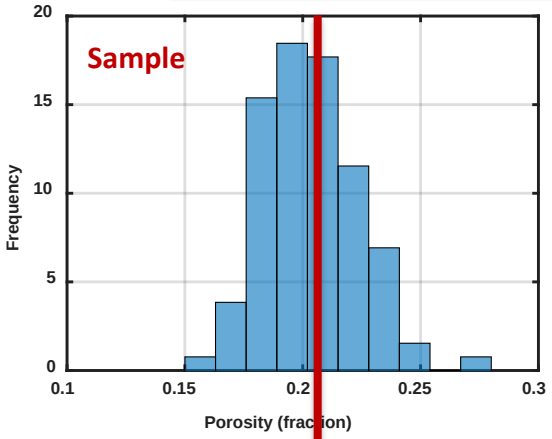
Standard error (*se*)

➔ **Estimated standard deviation of a sampling distribution**

Example

$$95\%\ CI\ for\ p = \hat{p} \pm 1.96se$$

What does 95% Confidence Mean?

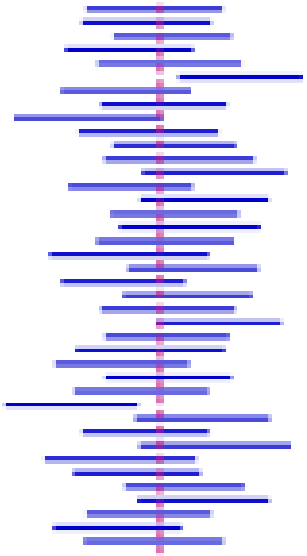


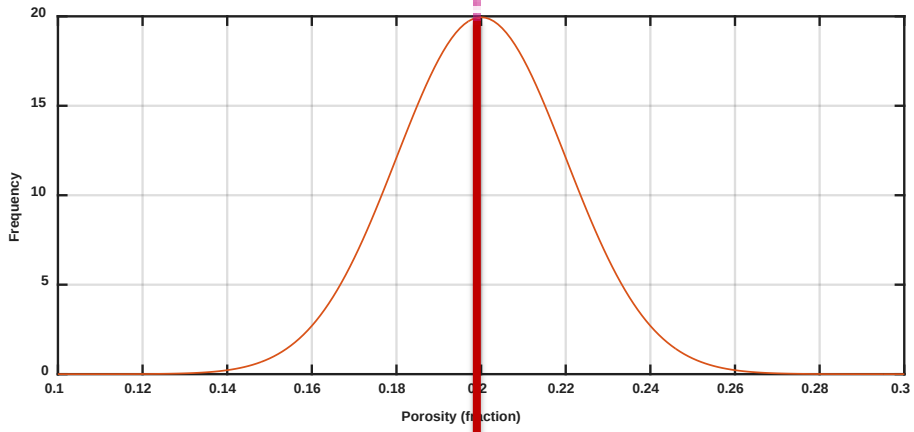
Mean of the sample $\hat{p}$

95% confidence interval

$$\hat{p} \pm 1.96se$$

Calculated for the sample

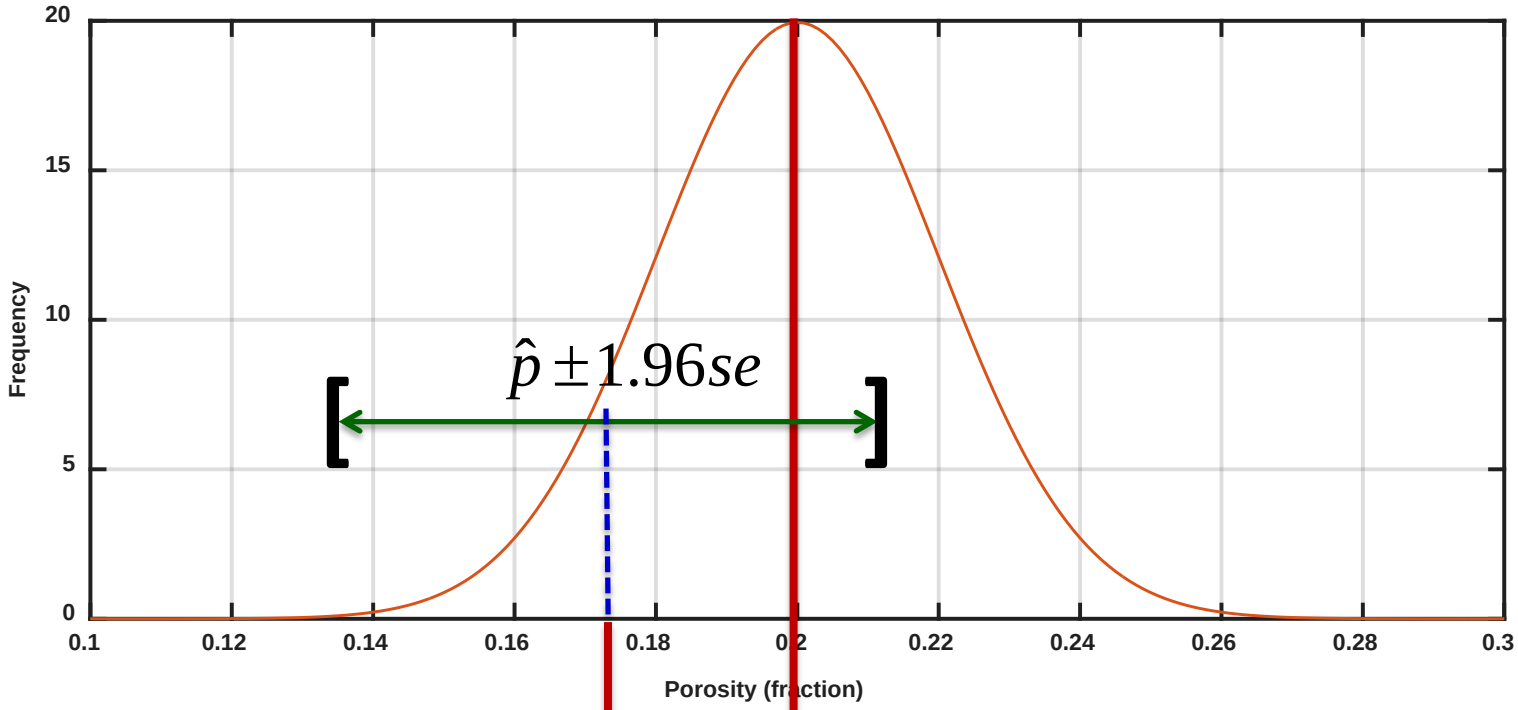




Mean of population p

In 95% of the cases, the population p falls within this confidence interval, which is calculated based on statistics of this sample set

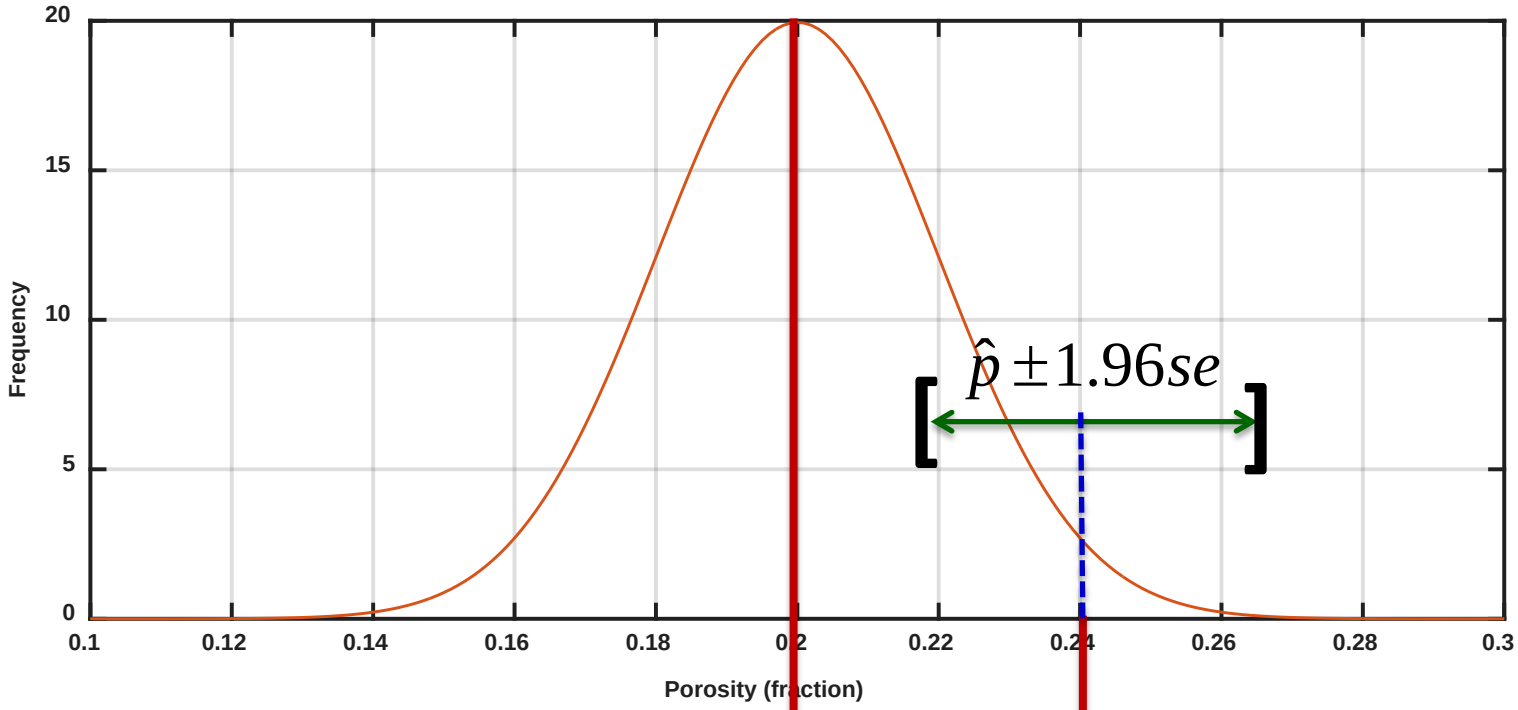
95% Confidence



Observed parameter provided by the sampling distribution $\hat{p}$

p **True parameter**

95% Confidence



n ↑ ➔ se ? ➔ CI ?

Confidence ↑ ➔ CI ?

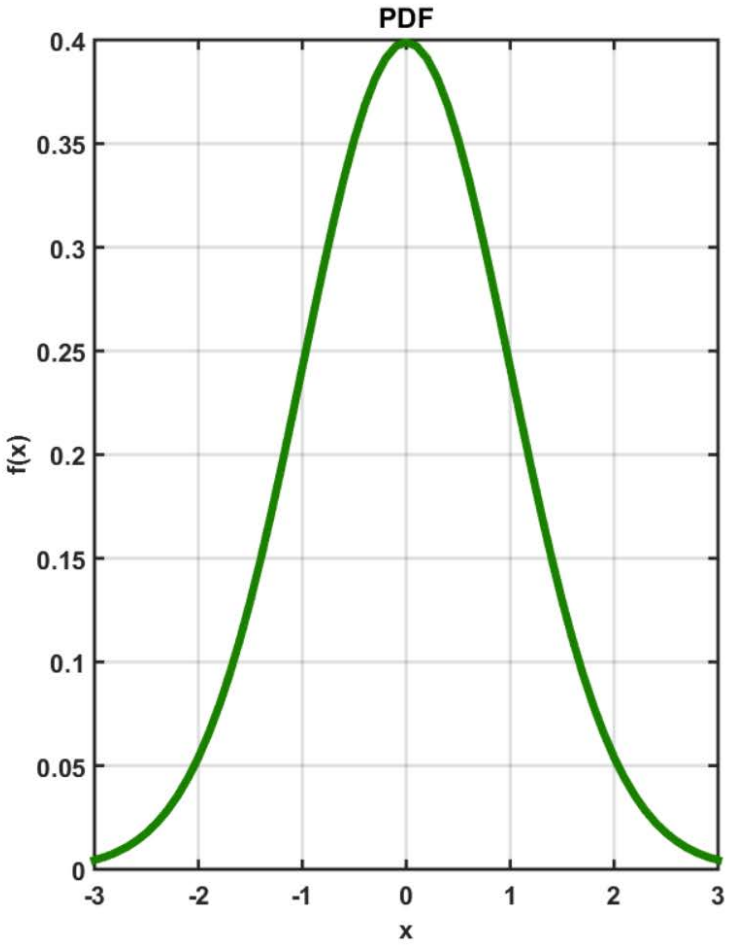
Confidence Level

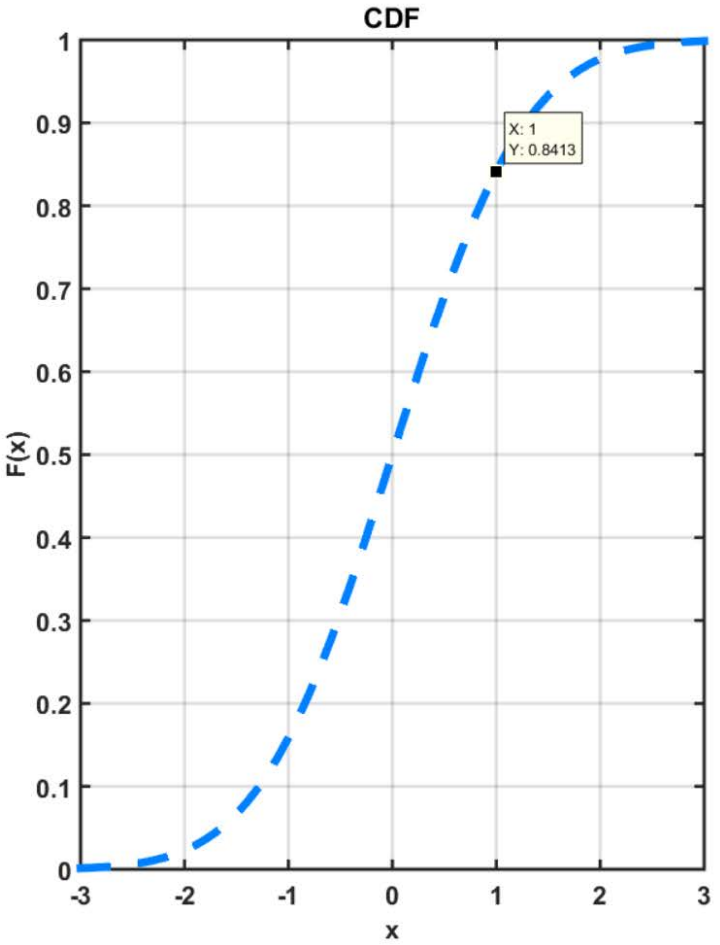
Confidence Level	Error Probability	z-Score	Confidence Interval
0.90	0.10	1.645	$\hat{p} \pm 1.645se$
0.95	0.05	1.96	$\hat{p} \pm 1.96se$
0.99	0.01	2.58	$\hat{p} \pm 2.58se$

How can we calculate it?

Norminv (1-(1-CL)/2,0,1)

How to Calculate z-Score?





Confidence Interval for Population Mean

$$\bar{x} \sim N\left(\mu, \frac{\sigma^2}{n}\right)$$

Variance of sample mean

$$CI \ for \ \mu = \bar{x} \pm z_{\alpha}\frac{\sigma}{\sqrt{n}} \approx \bar{x} \pm t_{\alpha/2}\frac{s}{\sqrt{n}}$$

Standard error (*se*)

In reality we do not have this

t-score, Provides wider confidence interval, which is needed because of the approximations

Example

$$95\%\ CI \ for \ \mu = \bar{x} \pm t_{0.025}se = \bar{x} \pm t_{0.025}\frac{s}{\sqrt{n}}$$

If sample size (n) is huge $z_{\alpha} \approx t_{\alpha/2}$

α = 1- confidence level

significance level