# Beyond Means: Sampling Distributions of Other Common Statistics

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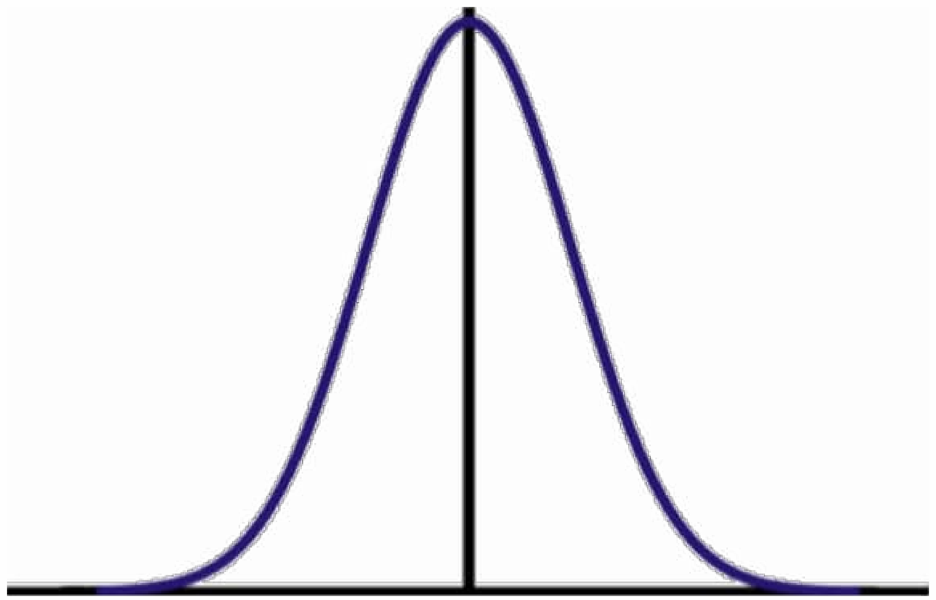
# An Interesting Result…

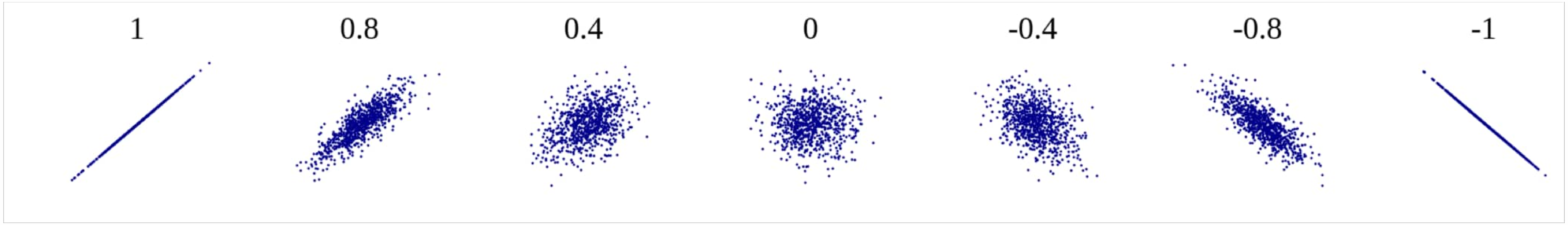
- Given large enough samples, **sampling distributions of most statistics of interest tend to normality** (regardless of how the input variables are distributed)
- This (**Central Limit Theorem**) result drives **design-based** statistical inference, or **frequentist** inference.



*All possible values of the statistic*

# Simulation: Pearson Correlations

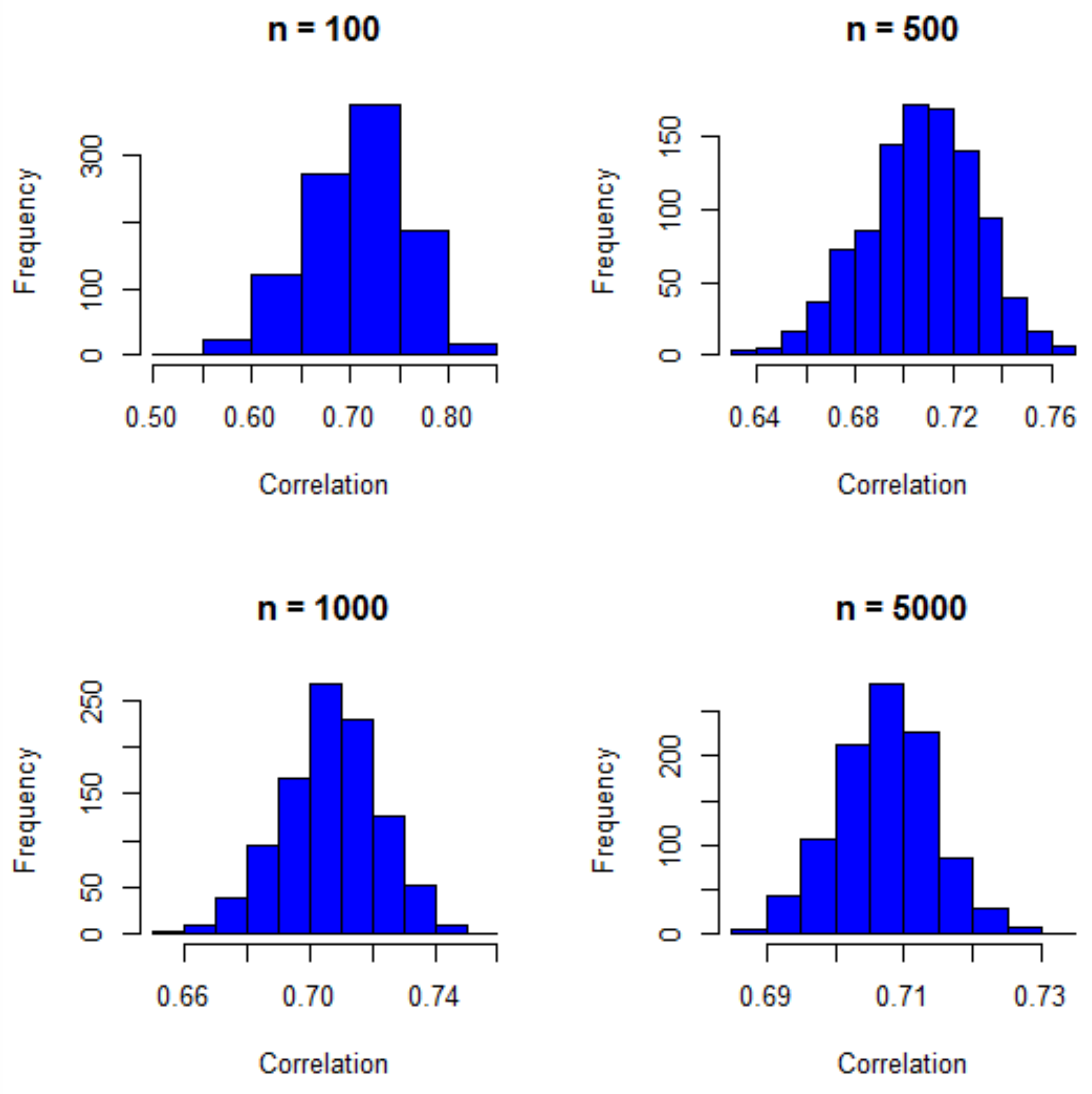
Consider Pearson's correlation coefficient, which describes the linear association between two continuous variables



# Simulation: Pearson Correlations

- **Simulate sampling distributions** for a correlation statistic:
  - Suppose **true population correlation is 0.7** (strong, positive)
  - Will **take 1,000 samples** of a specified sample size n
  - Do this for **various sample sizes** n = 100, 500, 1000, 5000

# Simulation: Pearson Correlations

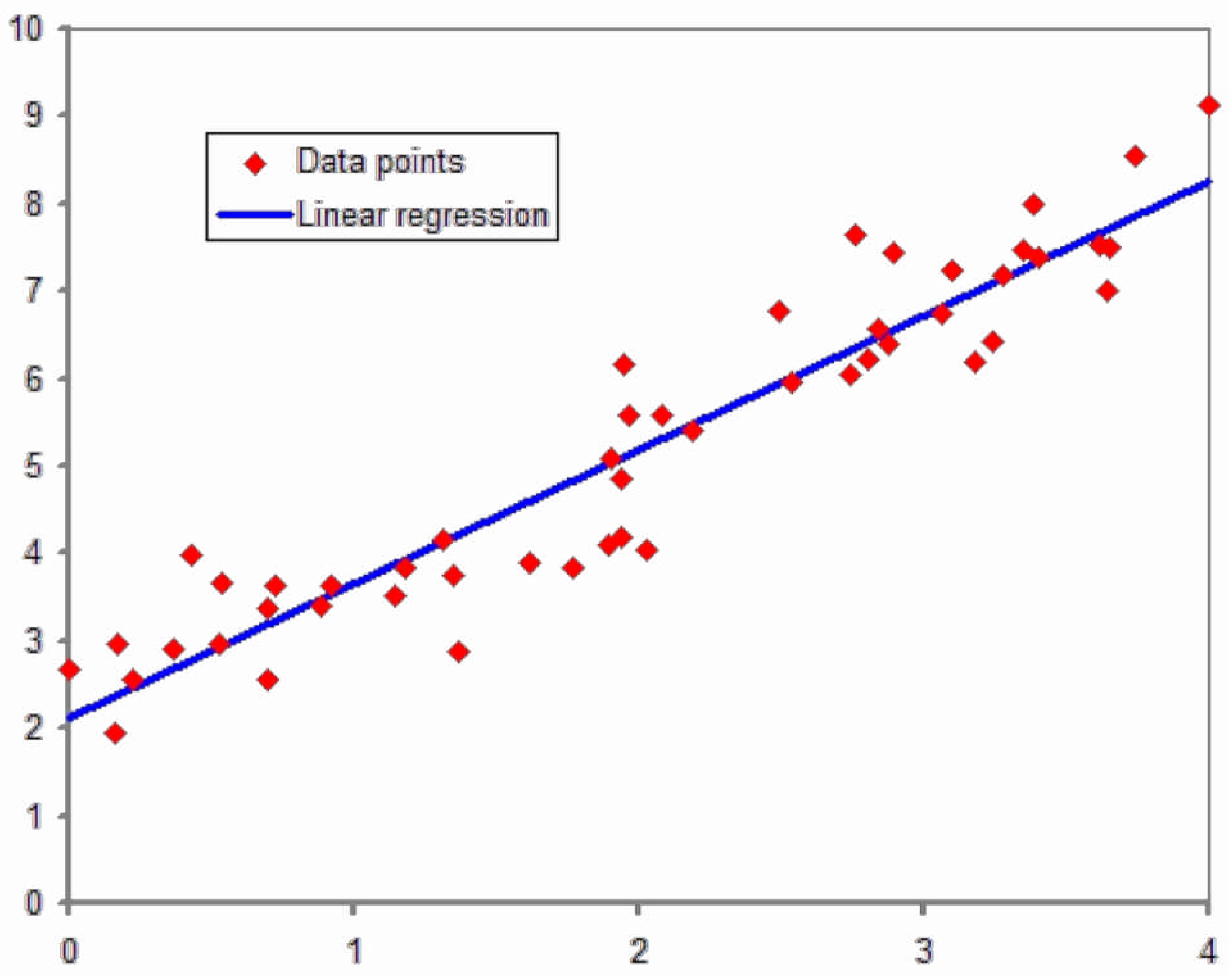



**What do you notice about these sampling distributions?**

- all approx. normal, centered at true correlation (0.7)
- as sample size *n* ↑ more symmetric and less spread

# Simulation: Regression Coefficients

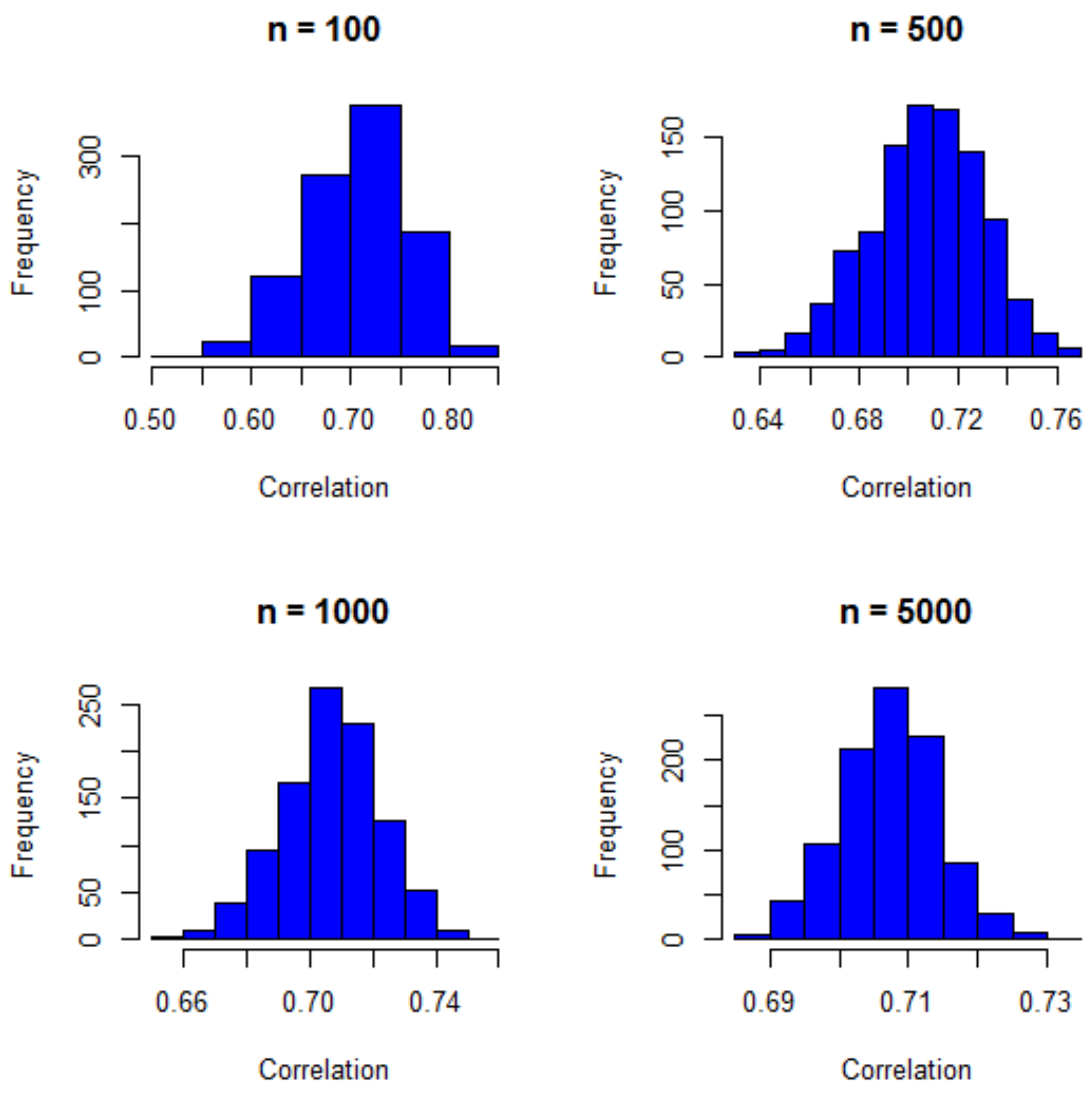
Consider the **estimated slope**
(estimated change in y for a one unit ↑ in x)
for a **linear relationship**
between two continuous
variables



# Simulation: Regression Coefficients

- **Simulate sampling distributions** for a **slope** statistic:
  - Suppose **true linear relationship in the population is** y = 2x + error, **so true slope is 2.**
  - Will **take 1,000 samples** of a specified sample size n
  - Do this for **various sample sizes** n = 100, 500, 1000, 5000

# Simulation: Regression Coefficients




**What do you notice about these sampling distributions?**

- all approx. normal, centered at true slope (2)
- as sample size $n \uparrow$ more symmetric and less spread

# Sampling Distribution Properties

- Properties of sampling distributions for many popular statistics (regardless of complexity):
  - Normal, symmetrical, and centered at the true value
  - Larger sample sizes → less variability in estimates!

**Key Point:**
**Can estimate variances** of these normal distributions
***based on only one sample***
→ Enables **INFERENCE!**

# Non-Normal Sampling Distributions

- **Not all** statistics have normal sampling distributions
- In these cases, **more specialized procedures needed** to make population inferences (e.g., **Bayesian methods**)

**Cool example**: variance components in multilevel models
*(we will discuss these later in the specialization!)*

# What's Next?

**So how exactly do we make population inferences based on one sample?**

We can estimate features of the sampling distribution based on one sample…

but how do we get from that to population inference?