Review

COORDINATOR:

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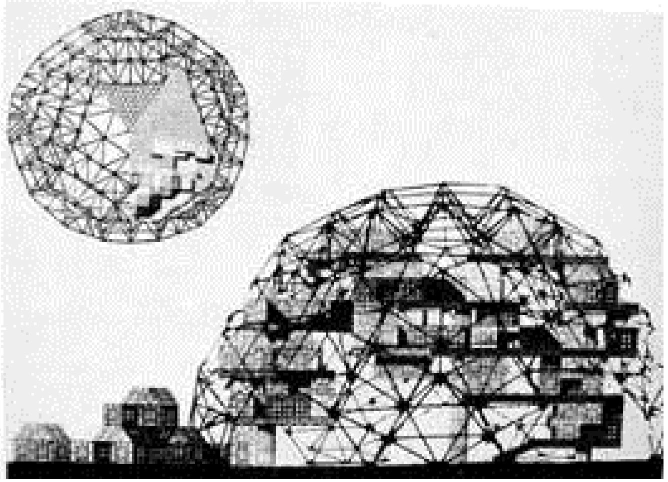


CVEN30008 Risk Analysis

week	Lecture Program		Tutorial Program
	Monday 4:15pm-5:15pm PAR-MSD-B117 (Theatre)	Wednesday 4:15pm-5:15pm PAR-MSD-B117 (Theatre)	(Student Portal)
1) Feb 27 Mon – Mar 3 Fri	**Introduction to risk management principles** (Lihai Zhang)	**Assignment 1 briefing** (Peter Bishop)	**No Tutorial**
2) March 6 Mon –10 Fri	**Qualitative Risk Analysis** (Peter Bishop)	**Qualitative Risk Analysis** (Peter Bishop)	**Tutorial 1** (Form assignment group and Matlab)
3) March 13 Mon –17 Fri	**Qualitative Risk Analysis** (Peter Bishop)	**Qualitative Risk Analysis** (Ferenc Birloni)	**Tutorial 2** (Risk identification)
4) March 20 Mon –24 Fri	**Qualitative Risk Analysis** (Ferenc Birloni)	**Qualitative Risk Analysis** (Ferenc Birloni)	**Tutorial 3** (Risk score calculation)
5) March 27 Mon –31 Fri	**Qualitative Risk Analysis** (Ferenc Birloni)	**Quantitative risk analysis** (Probability distributions) (Lihai Zhang)	**Tutorial 4** (Assignment 1 presentation)
6) April 3 Mon –7 Fri	**Quantitative risk analysis** (Probability distributions) (Lihai Zhang)	**Quantitative risk analysis** (Confidence intervals) (Lihai Zhang)	**Tutorial 5** (Continuous distributions)
7) April 10 Mon –14 Fri	**Quantitative risk analysis** (Confidence intervals) (Lihai Zhang)	**Quantitative risk analysis** (Hypothesis testing) (Lihai Zhang)	**Tutorial 6** (Discrete distributions)
April 17 Mon –21 Fri	**Easter Break**		
8) April 24 Mon –28 Fri **ANZAC Day holiday Tuesday 25 April**	**Quantitative risk analysis** (Hypothesis testing) (Lihai Zhang)	**Quantitative risk analysis** (Hypothesis testing) (Lihai Zhang)	**Tutorial 7** (Confidence interval)
9) May 1 Mon –5 Fri	**Quantitative risk analysis** (Power and sample size estimation) (Lihai Zhang)	**Quantitative risk analysis** (Simulations & Simple linear regression) (Lihai Zhang)	**Tutorial 8** **Tutorial 7** (Hypothesis testing part 1)
10) May 8 Mon –12 Fri	**Quantitative risk analysis** (Engineering reliability) (Lihai Zhang)	**Quantitative risk analysis** (Engineering reliability) (Lihai Zhang)	**Tutorial 9** (Hypothesis testing part 2)
11) May 15 Mon –19 Fri	**Review** (Lihai Zhang)	**Risk Management in Engineering projects** (Yew-Chin Koay, VicRoads)	**Tutorial 10** (linear regression)
12) May 22 Mon –26 Fri	**Risk Management in Engineering projects** (Jane Lai, Norman Disney & Young)	**Risk Management in Construction Engineering** (Mathew Jonston, John Holland)	**Tutorial 11** (Engineering Reliability)

Qualitative Risk Analysis (weeks 1–3)

Quantitative Risk Analysis (weeks 4–9)

Risk Management in Engineering Projects (weeks 10–12)

Course Program

- Lecture Program (continued)
  - Qualitative Risk Analysis
    - Assignment 1 – Identification of a project within the City of Melbourne that contains a wide range of technical and/or commercial risks
  - Quantitative Risk Analysis
    - Assignment 2 - Balancing the risks between slope failure and excavation cost.
  - Risk Management in Engineering Projects
    - Mr Peter Bishop (Senior Project Manager, Melbourne Water)
    - Dr Ferenc Birloni (Director, MW Engineers)
    - Dr Yew-Chin Koay (Senior Bridge Engineer, VicRoads)
    - Mr Mathew Jonston (Risk Manager, John Holland)
    - Mr John O'Connell (Senior Project Manager, Public Transport Victoria)

- Engineering is to carry out a desired function, using materials we do not fully understand, and interpreting physical phenomena that we cannot fully comprehend.

- Engineering Design:
  - Trying to utilise “Perceived Reality” for the purpose of defining a system in sufficient detail to permit its Realization.
- “Perceived Reality”:
  - Experience of a person. Dependant on time and place. Need not have true resemblance to Reality.
- Reality:
  - Nature of things independent of perception, time and place.
- **Crisis:**
  - **When the perceived reality does not match the reality.**

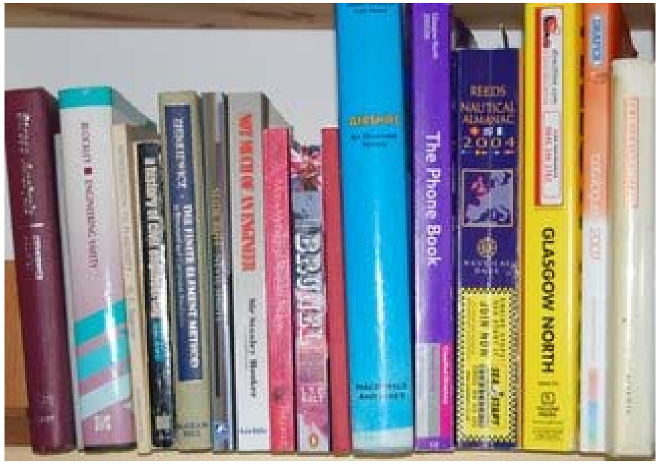
“Majority opinion <u>need not</u> resemble Reality…”

Reality of Natural Systems…

- **Laws of Nature:**
  - **When A = C and B = C then A = B.**
  - **1St Law of Thermodynamics – Something cannot be made out of nothing – No output without an input.**
  - **2nd Law of Thermodynamics – Input cannot be totally converted to output. There is always waste.**

"No matter what we desire or wish for, these represent the Reality, independent of person, place or time. Engineers must always accept and respect this natural reality."

- Explicit knowledge – can be expressed as information



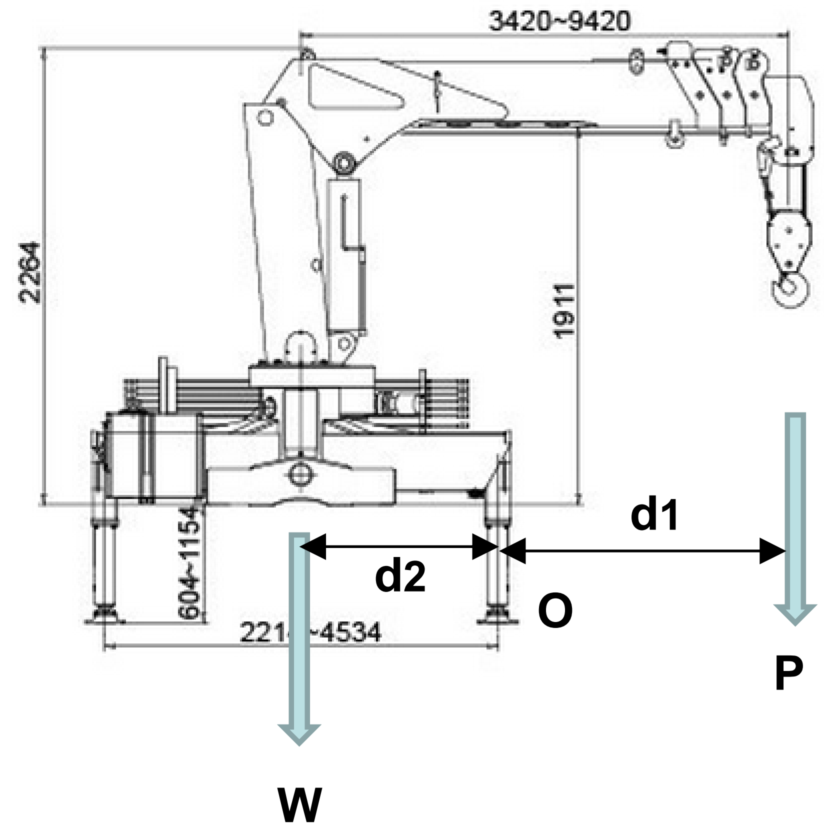
- Implicit knowledge - cannot, or has not yet been expressed as information – Risk Analysis

Risk Management in Engineering

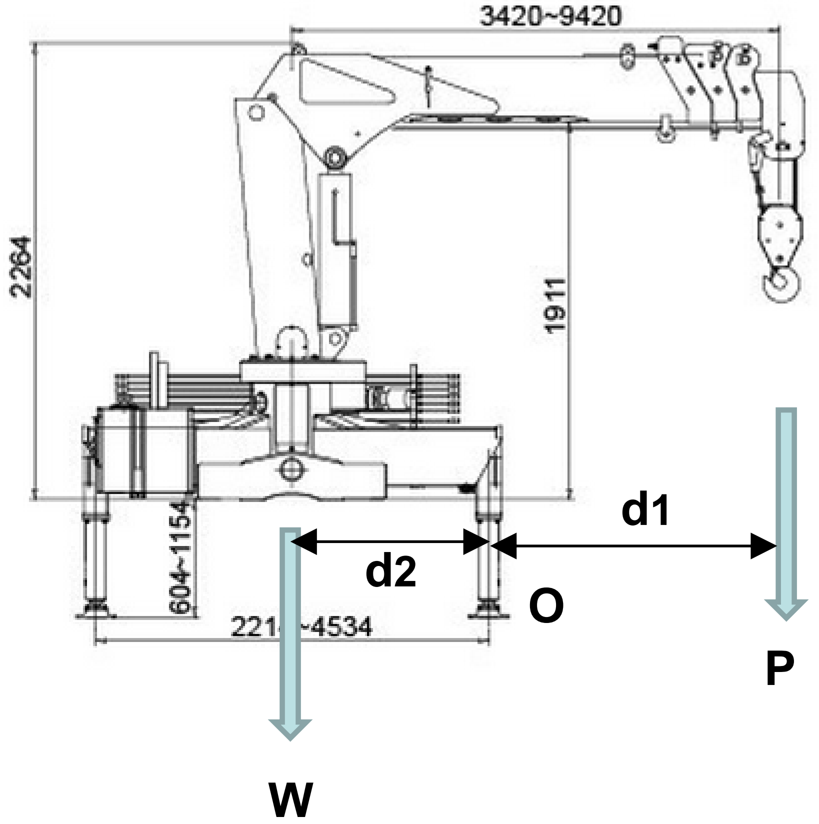
Risk Management in Engineering

What will happen next ?

Example



Example (Solution)



$$\mu_S = \mu_P \times d_1$$

$$\sigma_S^2 = \left(\sigma_P \times d_1\right)^2$$

$$\mu_R = \mu_W \times d_2$$

$$\sigma_R^2 = \left(\sigma_R \times d_2\right)^2$$

$$\beta = \frac{\mu_Z}{\sigma_Z} = \frac{\mu_R - \mu_S}{\sqrt{\sigma_R^2 + \sigma_S^2}} \qquad p_f = 1 - \Phi(\beta)$$

Final Exam

- Exam duration 2 hours. Reading time 15 minutes
- Section A (short answers)= 60
  - Risk management concepts
- Section B (numerical / calculation) = 60
  - Quantitative risk analysis by using
    - Probability distributions
    - Confidence Intervals
    - Hypothesis Testing
    - Simple Linear Regression
    - Engineering Reliability Analysis
- Total = 120

Final Exam

- Only electronic calculators approved by the School of Engineering (Casio FX82) can be used. No equivalent models of calculators are permitted.

- Statistical tables and formulae sheet will be given in final exam

- MATLAB codes will <u>not</u> be tested.

- Extra consultation hours
  - June 1 (Thursday), 2:00pm-3:00pm (Engineering D207)

Course Program

- Teaching Program
  - **Risk Management Standard (AS/NZS ISO 31000:2009)**

Establish the context

Identify the risks

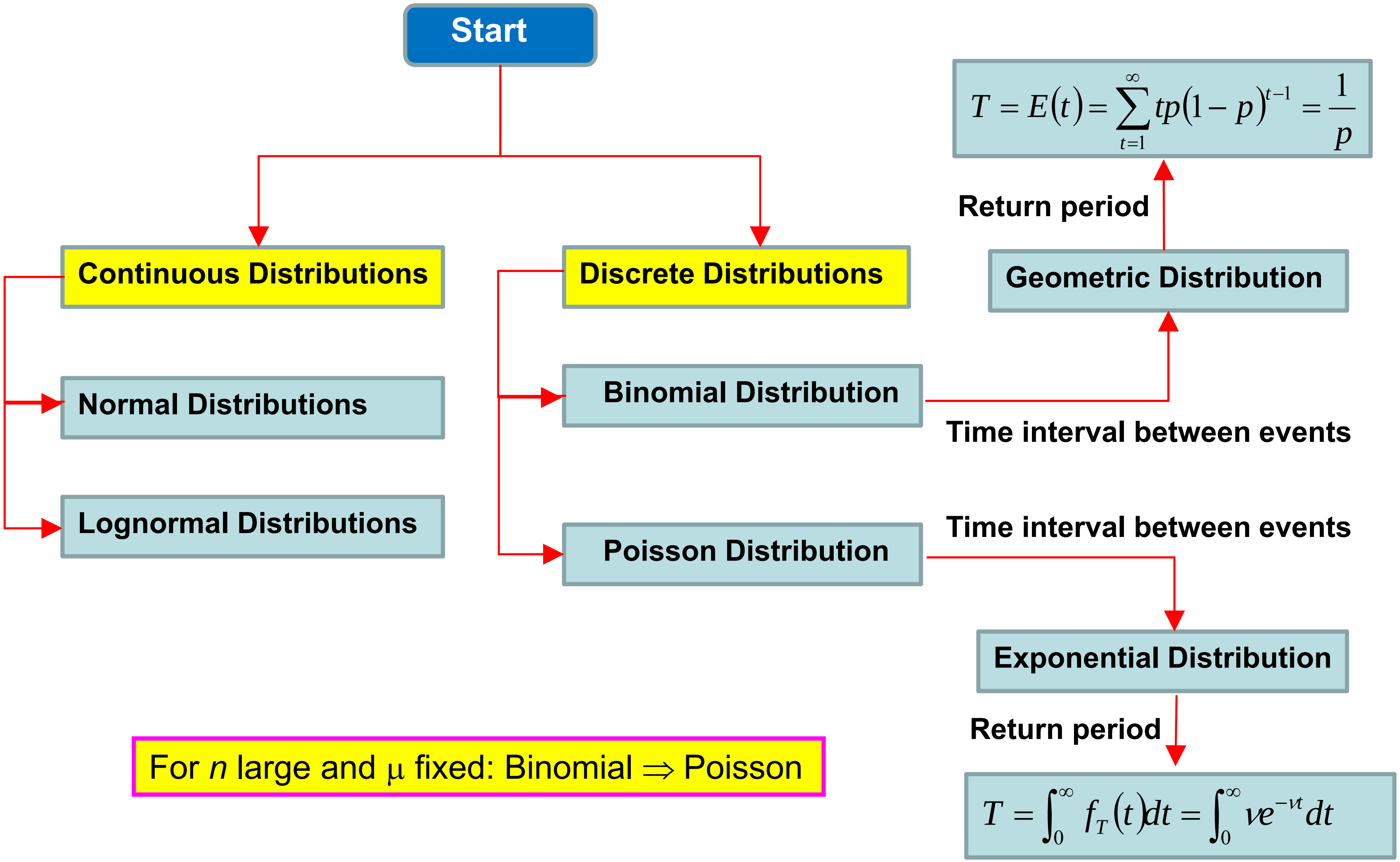
Analyse the risks

Evaluate the risks

Treat the risks

Monitoring and review

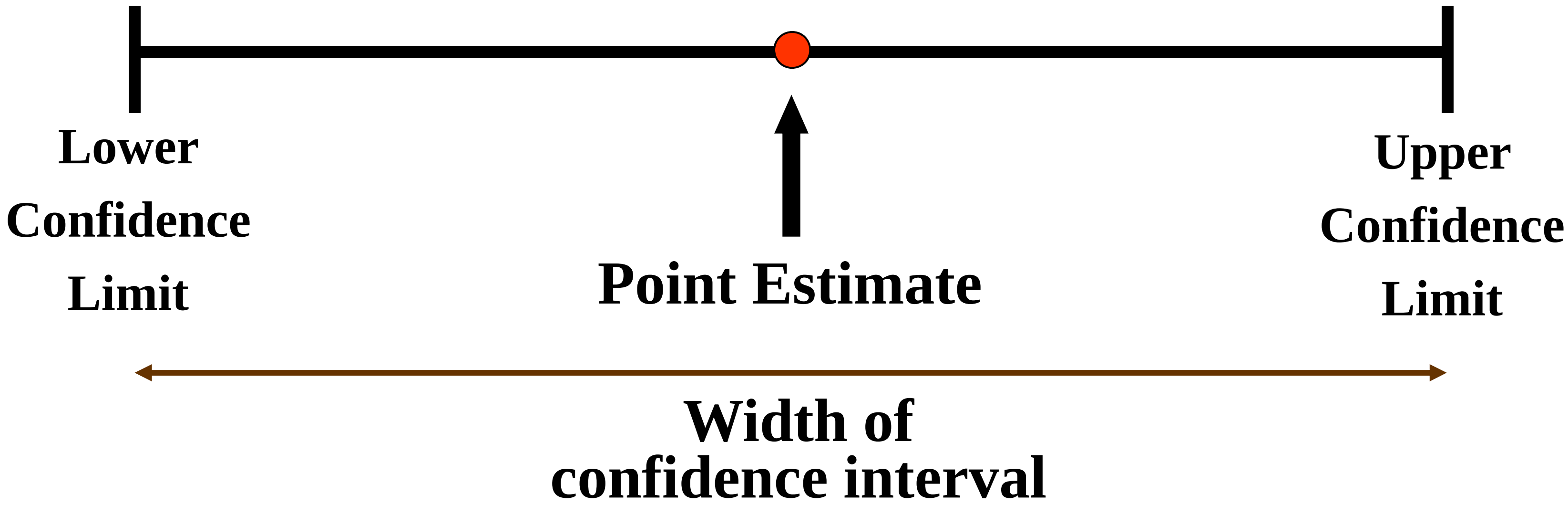
Risk Analysis using Distributions



For n large and μ fixed: Binomial $\Rightarrow$ Poisson

Confidence Interval Estimates for Population μ

- An **interval estimate** provides more information about a population characteristic than does a point estimate. It provides a confidence level for the estimate. Such interval estimates are called **confidence intervals**.



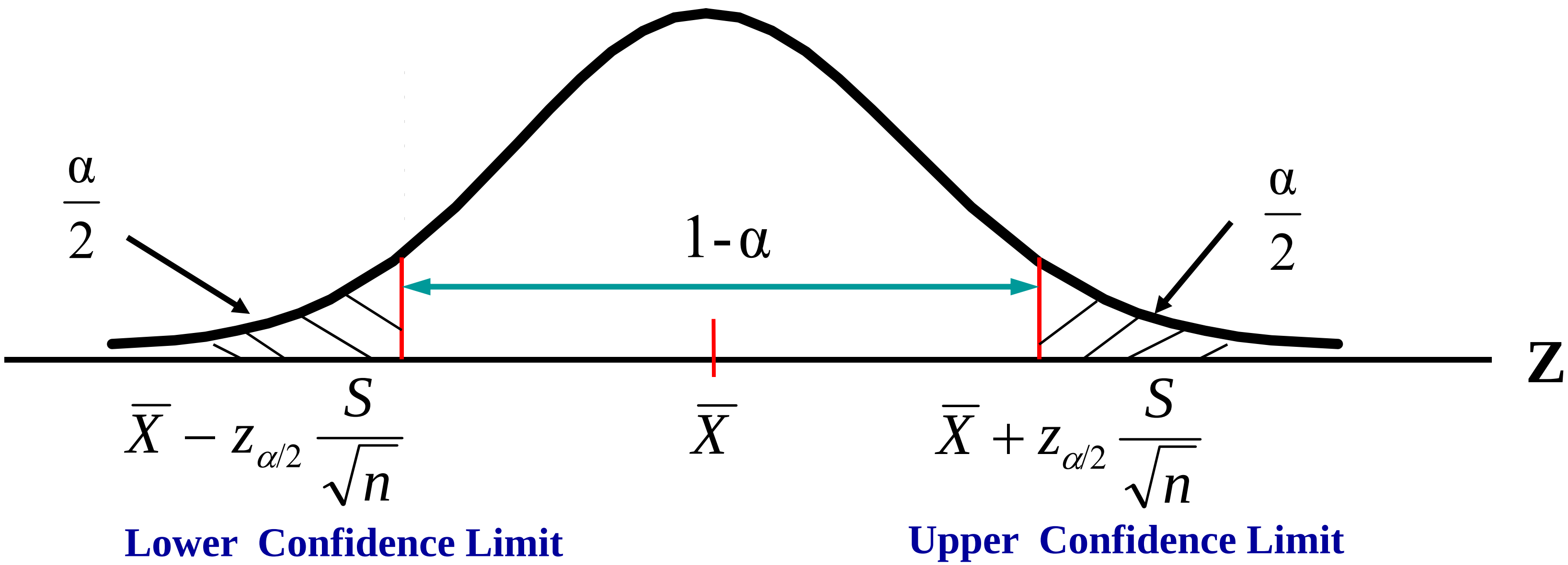
Best Point Estimate of population mean μ is sample mean

Large-Sample Confidence Intervals for Population μ

- **For a large (n > 30) random sample from a population**

$$\mu = \overline{X} \pm z_{\alpha/2} \frac{S}{\sqrt{n}}$$

α is the proportion of the distribution in the two tails areas outside the confidence interval



The general formula for all confidence intervals is equal to

Population mean

$$\mu = \text{Sample mean } \bar{X} \pm (\text{Critical Value}) \times (\text{Standard Error})$$

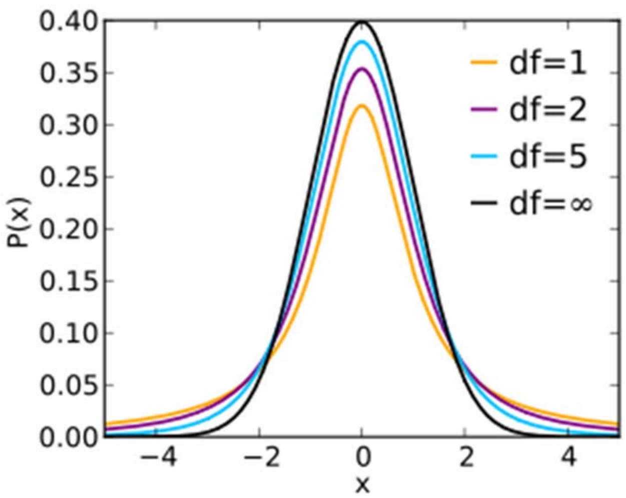
Depending on the sampling distribution

Small-Sample Confidence Intervals for Population μ

- **For a small ($n \leq 30$) random sample from a population**

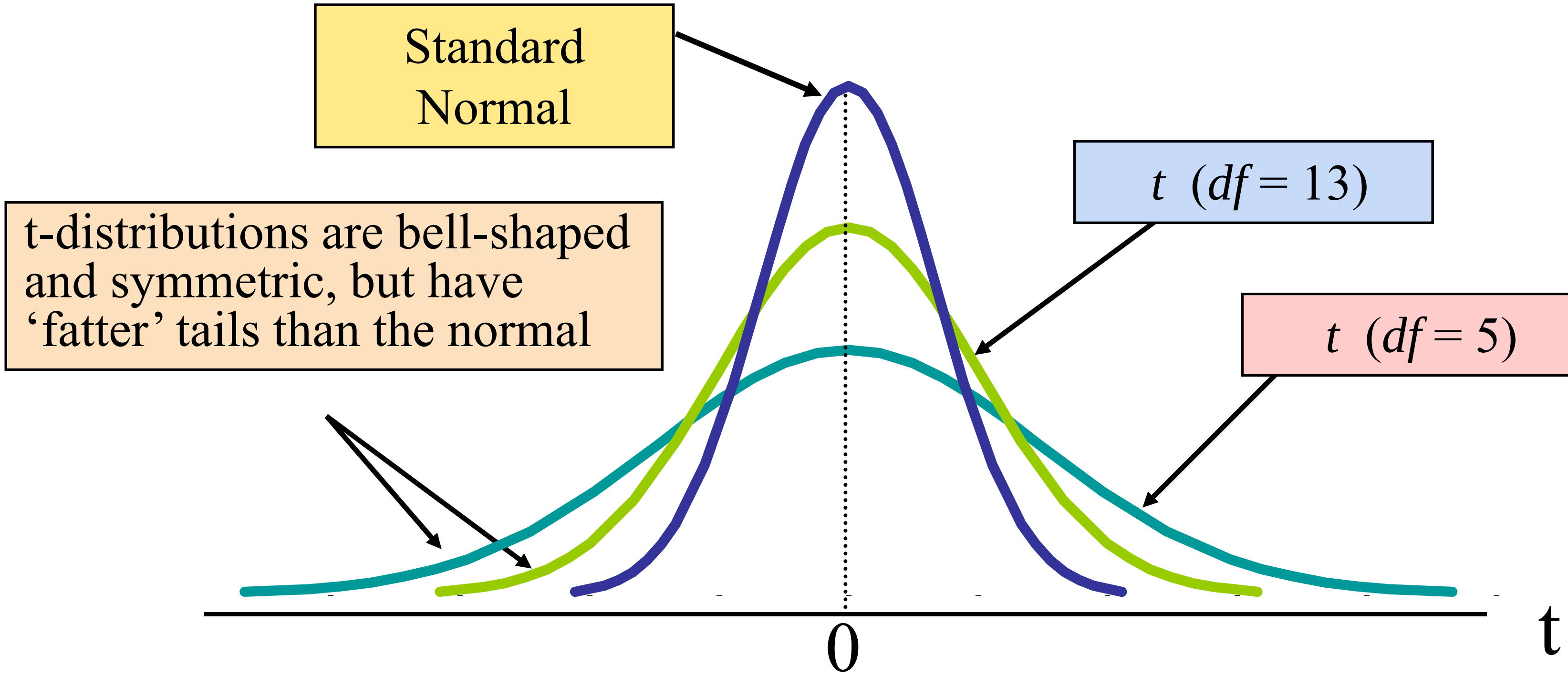
$$\mu = \overline{X} \pm t_{n-1,\ \alpha/2} \frac{S}{\sqrt{n}}$$

where *t* is the critical value of the t distribution with n-1 degrees of freedom and an area of α/2 in each tail.



Small-Sample Confidence Intervals for Population μ

- t distribution is symmetrical around its mean of zero, like Z distribution.
- Compared to Z distribution, a larger portion of the probability areas are in the tails.
- As n increases, the t distribution approached the Z distribution.
- t values depends on the degree of freedom.



The Null Hypothesis, H_0

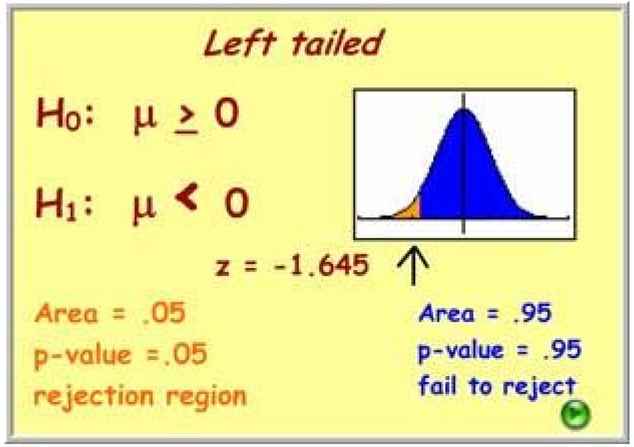
- Begins with the assumption that the null hypothesis is true
  - Similar to the notion of innocent until proven guilty
- Refers to the status quo
- Always contains the **"="** sign
- May or may not be rejected

Calculation of *P*-value

- For a large (e.g. $n > 30$) sample from a population, the ***P*-value** is an area under the normal curve.
- For a small (e.g. $n \leq 30$) sample from a population, the ***P*-value** is an area under the Student's *t* curve with n-1 degrees of freedom.
- The smaller the ***P*-value**, the stronger the evidence is against H_0.
- The larger the ***P*-value**, the more plausible H_0 becomes.

Large-Sample Tests for a Population mean

Compute the z-score: $$z = \frac{\bar{X} - \mu_0}{S / \sqrt{n}}$$

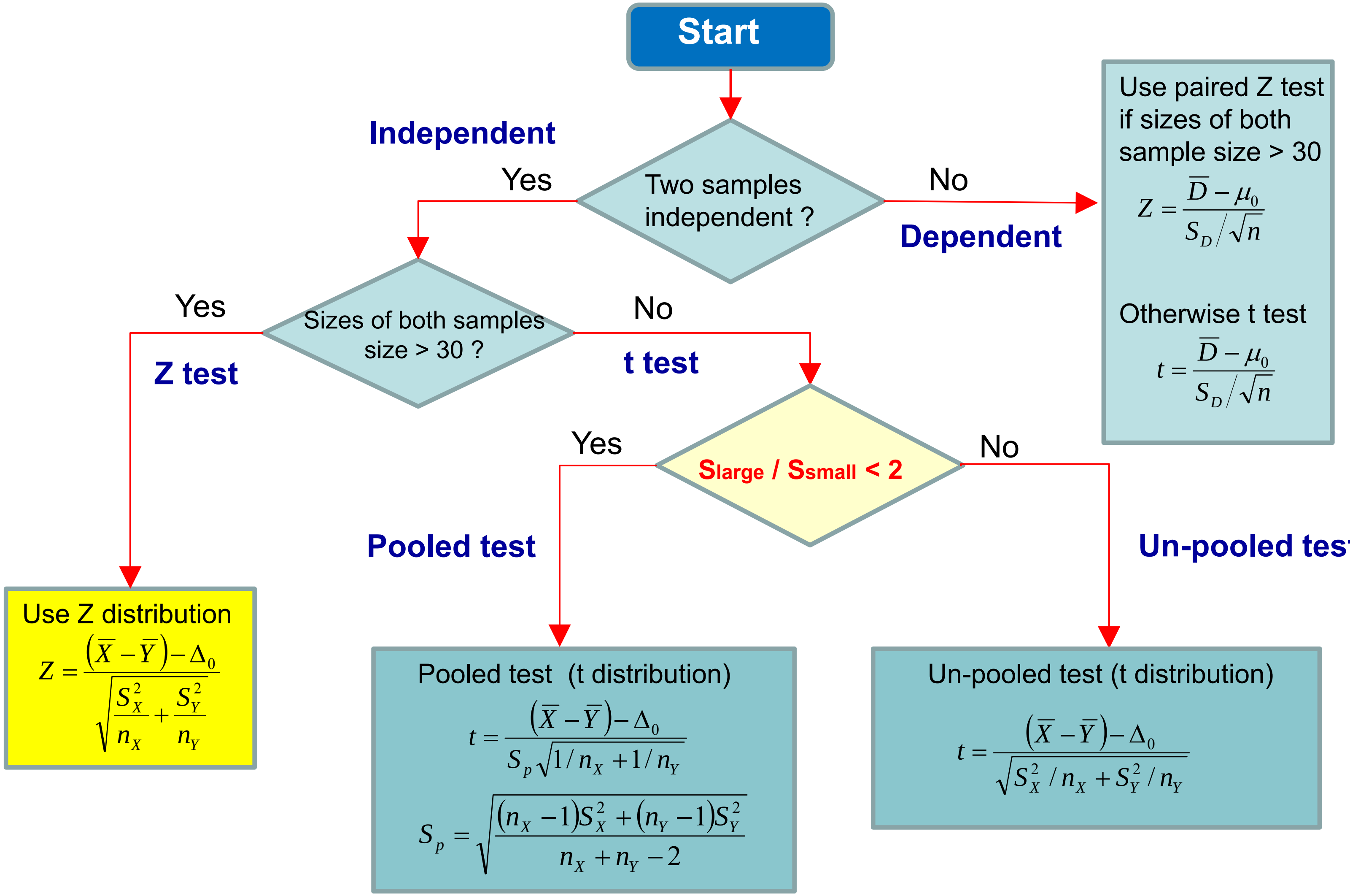


Compute the ***P*-value** :

Null Hypothesis	Alternative Hypothesis	*P* - value
$H_0 : \mu \le \mu_0$	$H_1 : \mu > \mu_0$	Area to the right of *z*
$H_0 : \mu \ge \mu_0$	$H_1 : \mu < \mu_0$	Area to the left of *z*
$H_0 : \mu = \mu_0$	$H_1 : \mu \ne \mu_0$	Sum of the areas in the tails cut off by z and -z

- If the null hypothesis is rejected, then we accept the alternative hypothesis.
- If the null hypothesis is not rejected, then we do not accept the alternative hypothesis.

Hypothesis Testing for the Difference Between Two Means



- **Limitations of Hypothesis Testing**

Hypothesis testing involving a significance level α, has two types of errors:

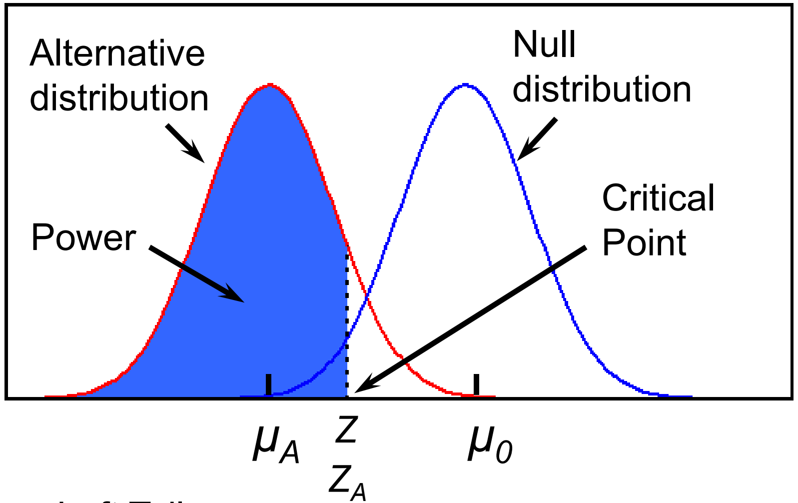
- **Type I error**: H_0 is rejected when it is True.
- **Type II error**: H_0 is not rejected when it is False.

Estimation of Power

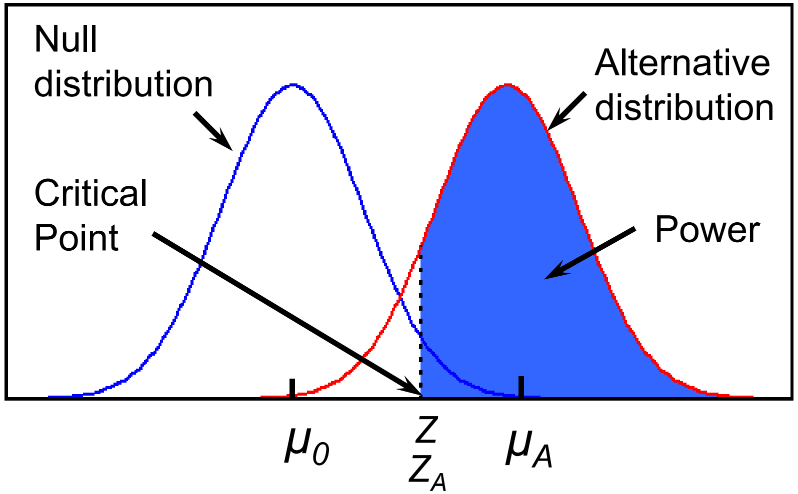
The **Power** is the probability of ***avoiding*** **Type II error**:

$$\text{Power} = 1 - \text{P(Type II error)}$$

Power ≥ 0.8 is generally considered to be acceptable



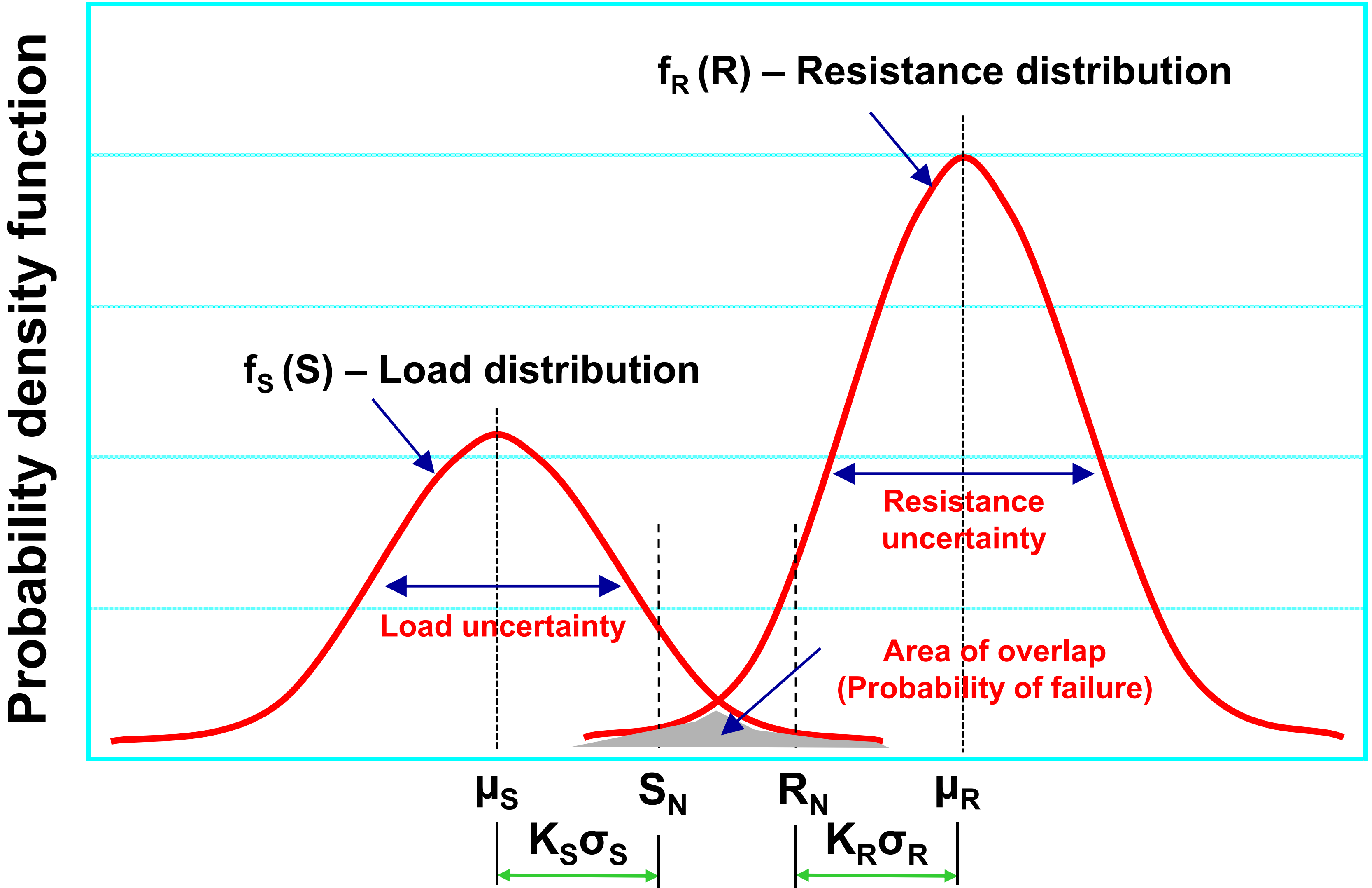
Left Tail $H_0 : \mu \geq \mu_0$



Right Tail $H_0 : \mu \leq \mu_0$

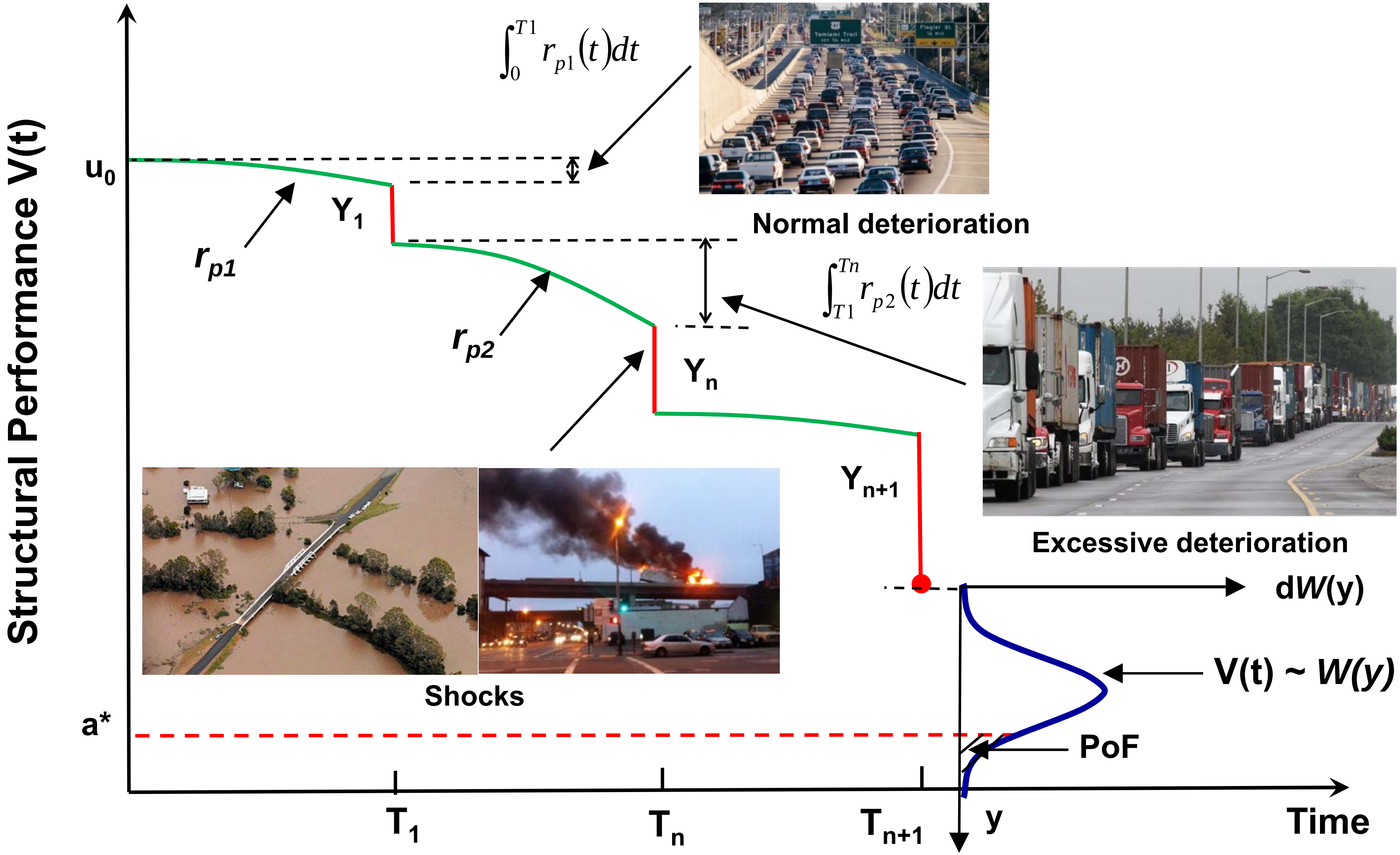
$$\mu_0 + Z\frac{\sigma}{\sqrt{n}} = \mu_A + Z_A\frac{\sigma}{\sqrt{n}}$$

Probabilistic Approaches

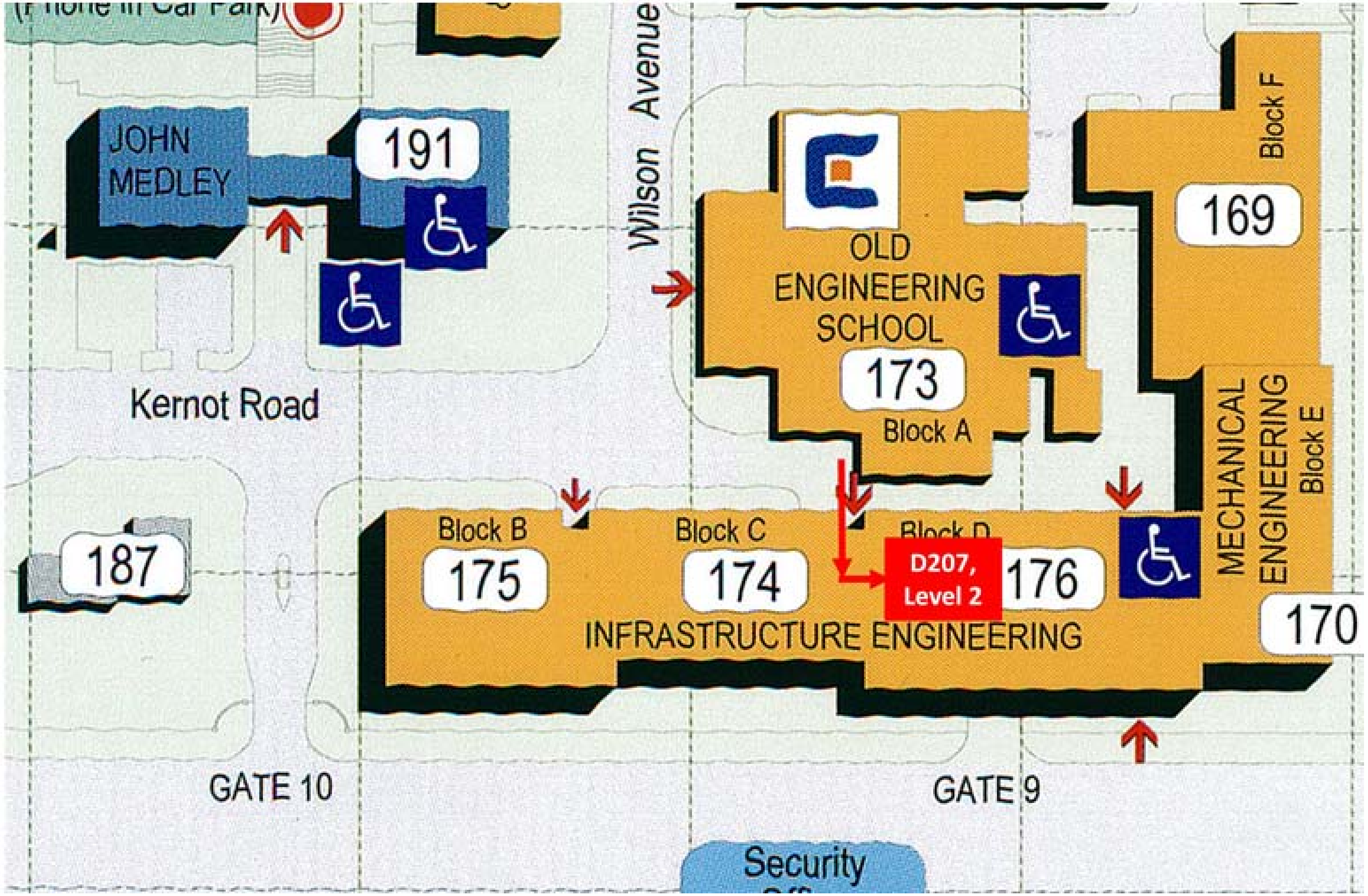


Probabilistic approaches are required to quantify the probability of failure !

Life-cycle deterioration of infrastructures



Engineering Design Office D207



Take the lift in Block C to 2nd floor

Feedback

Login to the survey site here:

(use your standard University username and password)

https://subjecteval.unimelb.edu.au

also available on mobile devices

Note that this year, the SES has been incentivised - students submitting their surveys are eligible to win one of two $500 cash prizes!


Once again, thank you !