



# Fundamentals of Stress-Strength Analysis

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# Stress



A photograph of a dirt path winding through a dense forest. Sunlight filters through the trees, creating a misty, ethereal atmosphere. The path is covered in fallen leaves and moss. The word "Strength" is written in a large, yellow, serif font in the lower right corner.

Strength



Compare  
Stress to  
Strength

What are four ways

Stress/Strength  
changes with time?

# Stress



Measure      Movement      Model

# Stress Measurement



This is where the fun starts

Min and max is not good enough

Worst case isn't good enough

Focus on getting the distribution

And, over time and degradation

# Stress Movement



Things change over time,  
or use, or storage, or  
whatever

How does the stress mean change?

How does the stress variance change?

The the distribuiton shape change?

# Stress Modeling



A lot of work at first, yet  
useful for many tasks

Parametric or non-parametric

Time variable or time slices

Know stress load for different  
percentiles of the possible distribution

Where can you find  
stress data?

# Strength



Measure      Movement      Model





# Movement



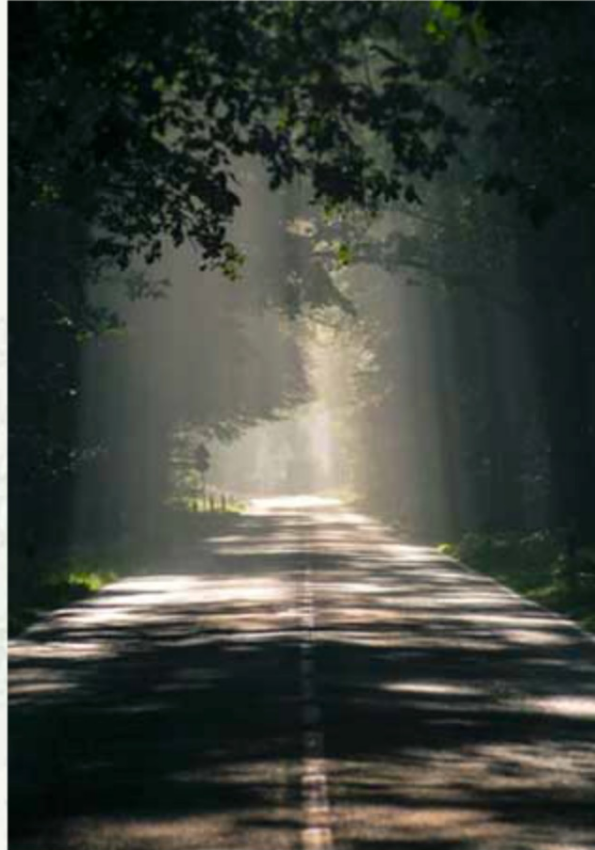


How important is  
the measurement  
system?

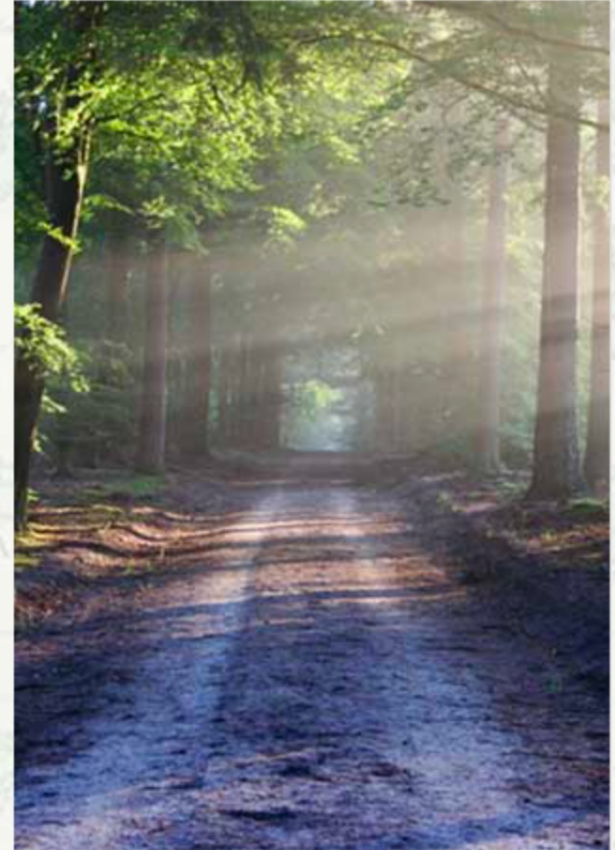
# Simple Math



Normal



Math

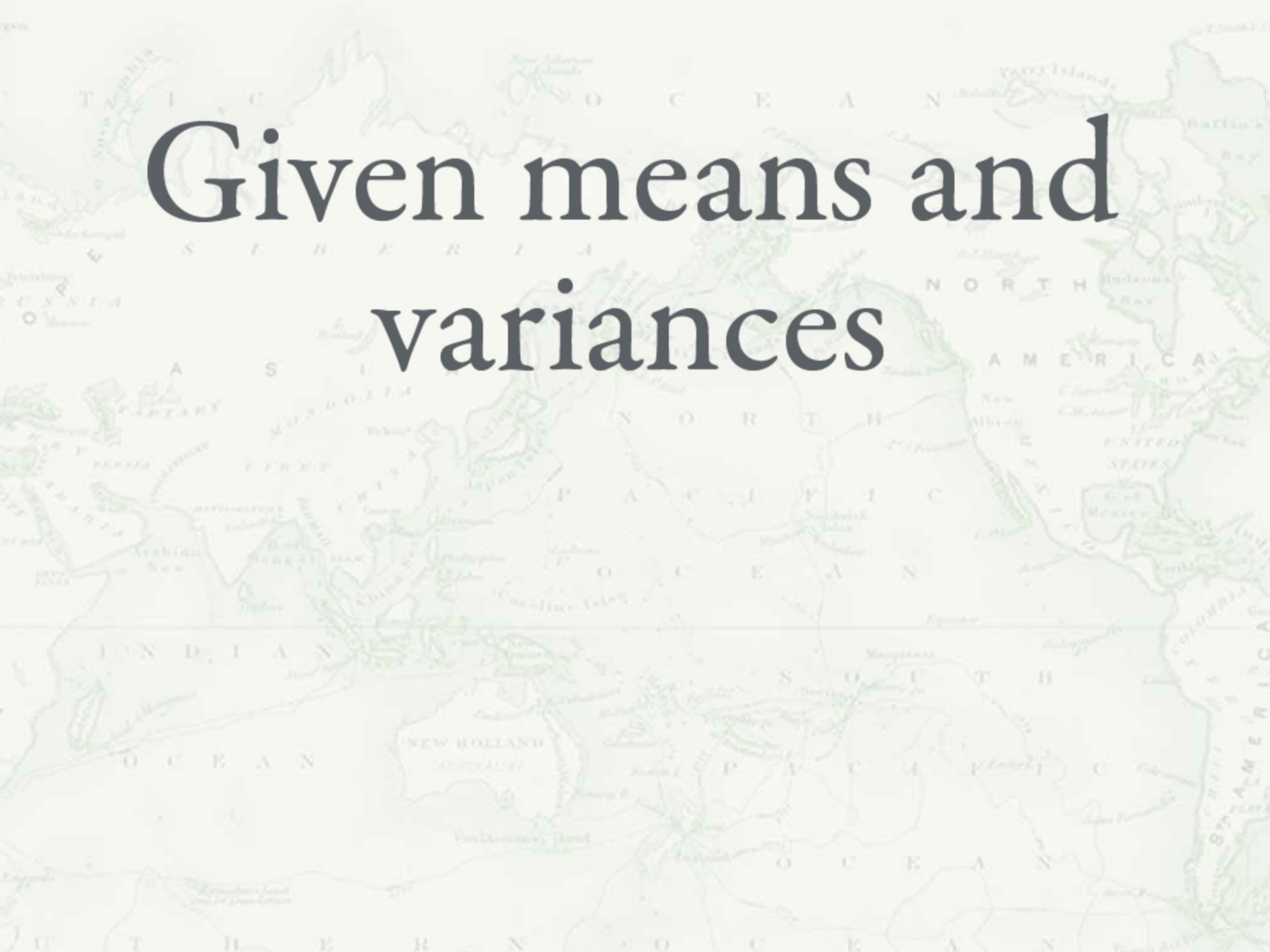


Formula

A historical map of the world, likely from the 18th century, showing continents and oceans. The map is oriented with North at the top. The text "Both distributions are normal" is overlaid in a large, dark, serif font. The map includes labels for continents like Asia, Europe, Africa, North America, and South America, as well as oceans like the Indian Ocean, Pacific Ocean, and Atlantic Ocean. Various islands and smaller geographical features are also labeled.

Both distributions  
are normal

# Given means and variances



# Simple Formula

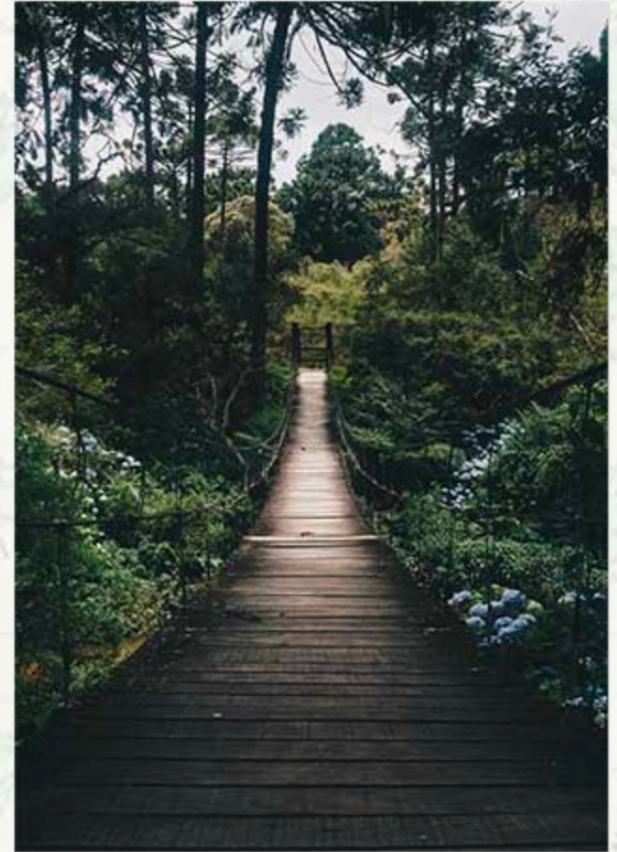
$$p_f = \Phi \left( -\frac{\mu_y - \mu_x}{\sqrt{\sigma_y^2 + \sigma_x^2}} \right)$$

<https://accendoreliability.com/stress-strength-normal-assumption/>

What are we really

trying to solve here?

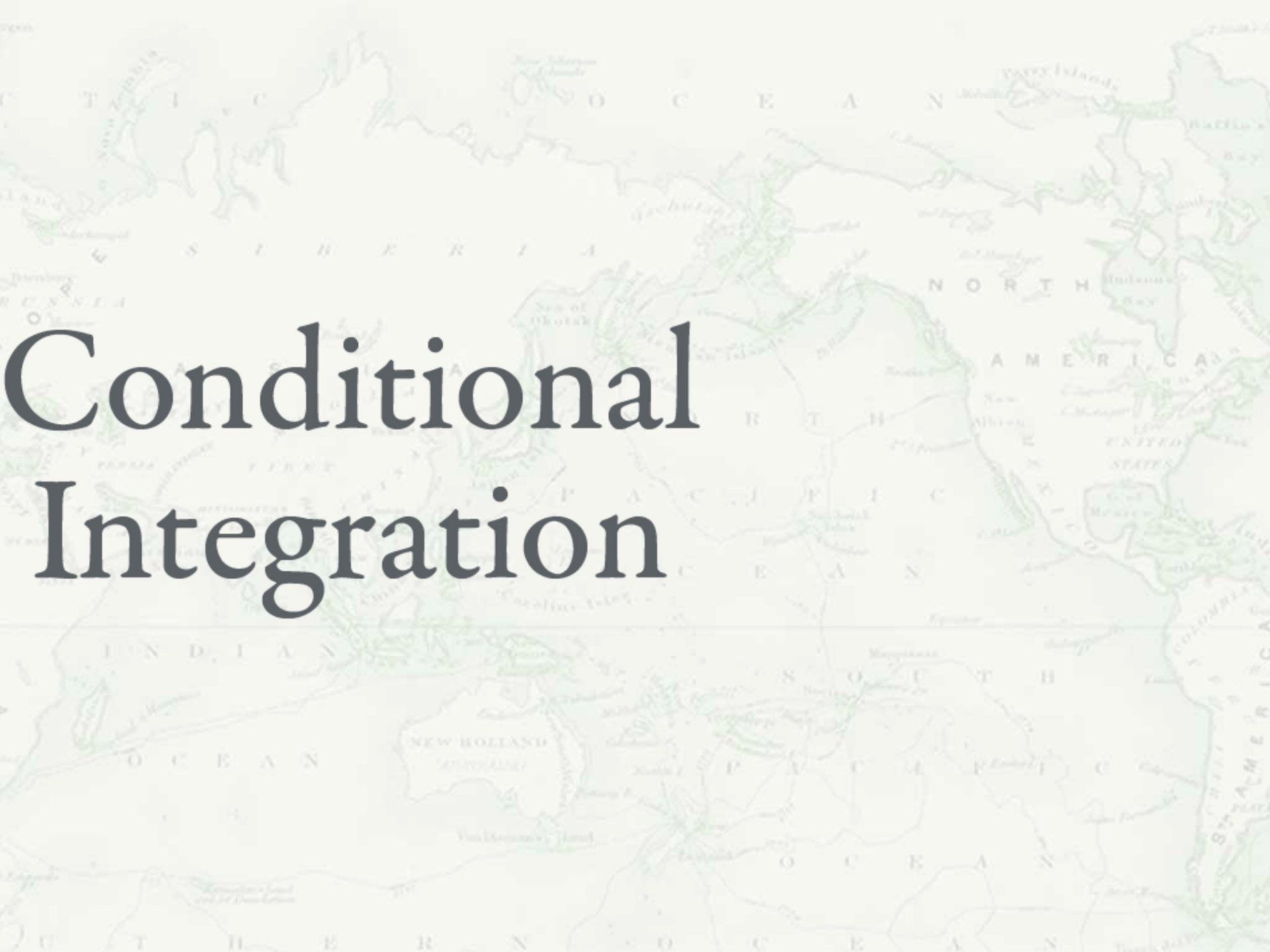
# General Math Solution



Conditional

Calculus

Missing



# Conditional Integration

# The math is a bit more complex

$$R = P[\text{Stress} \leq \text{Strength}] = \int_0^{\infty} f_{\text{stress}}(x) R_{\text{stress}}(x) dx$$



Yet, what is  
missing  
here?

How can we analyze  
a more complex  
interaction?

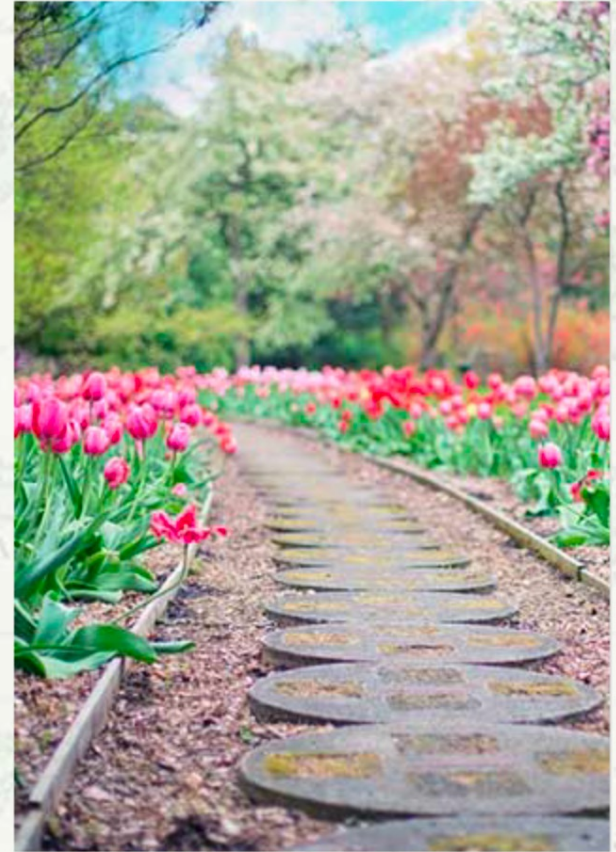
# Monte Carlo Solution



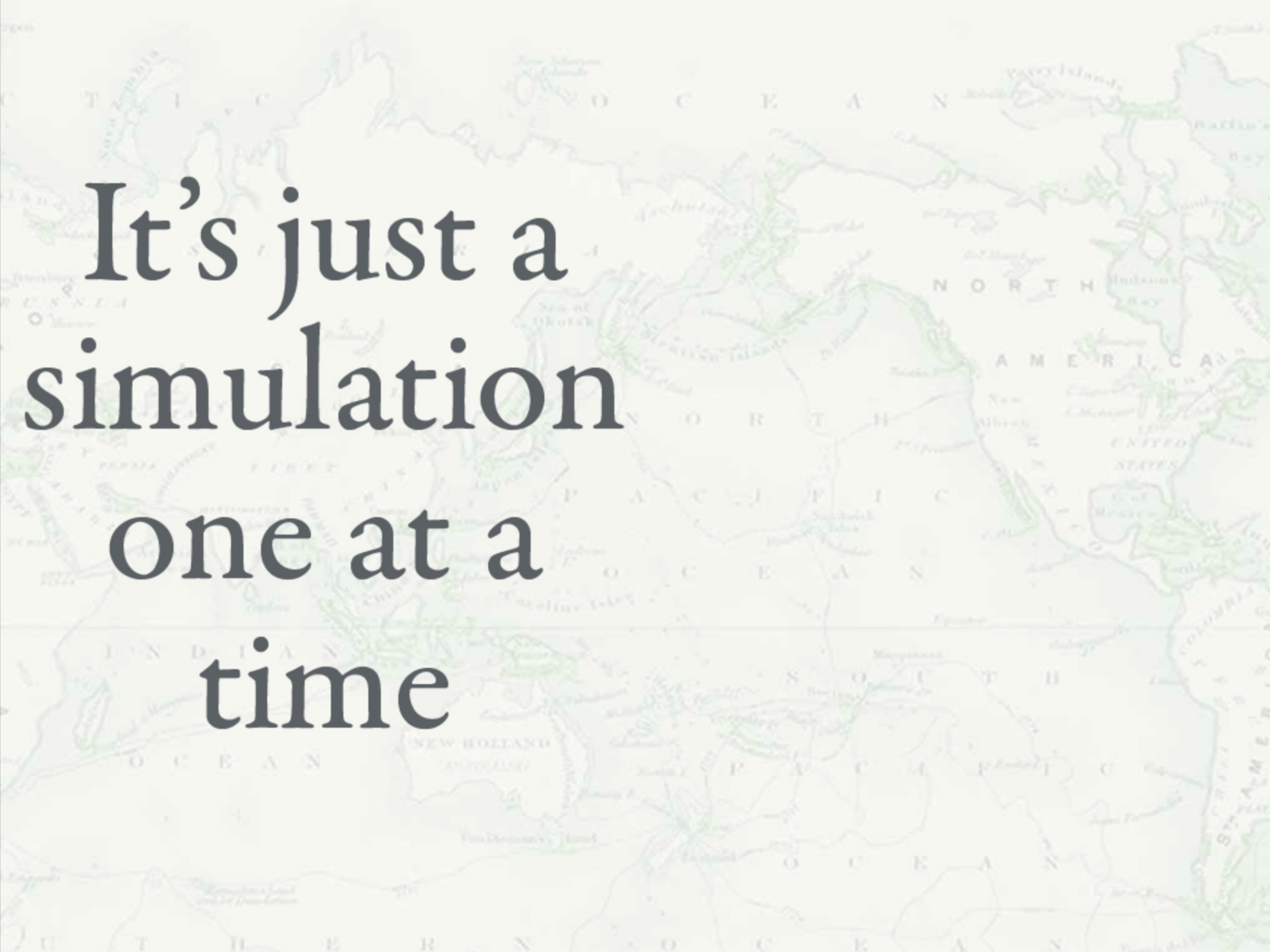
Simulation




Time



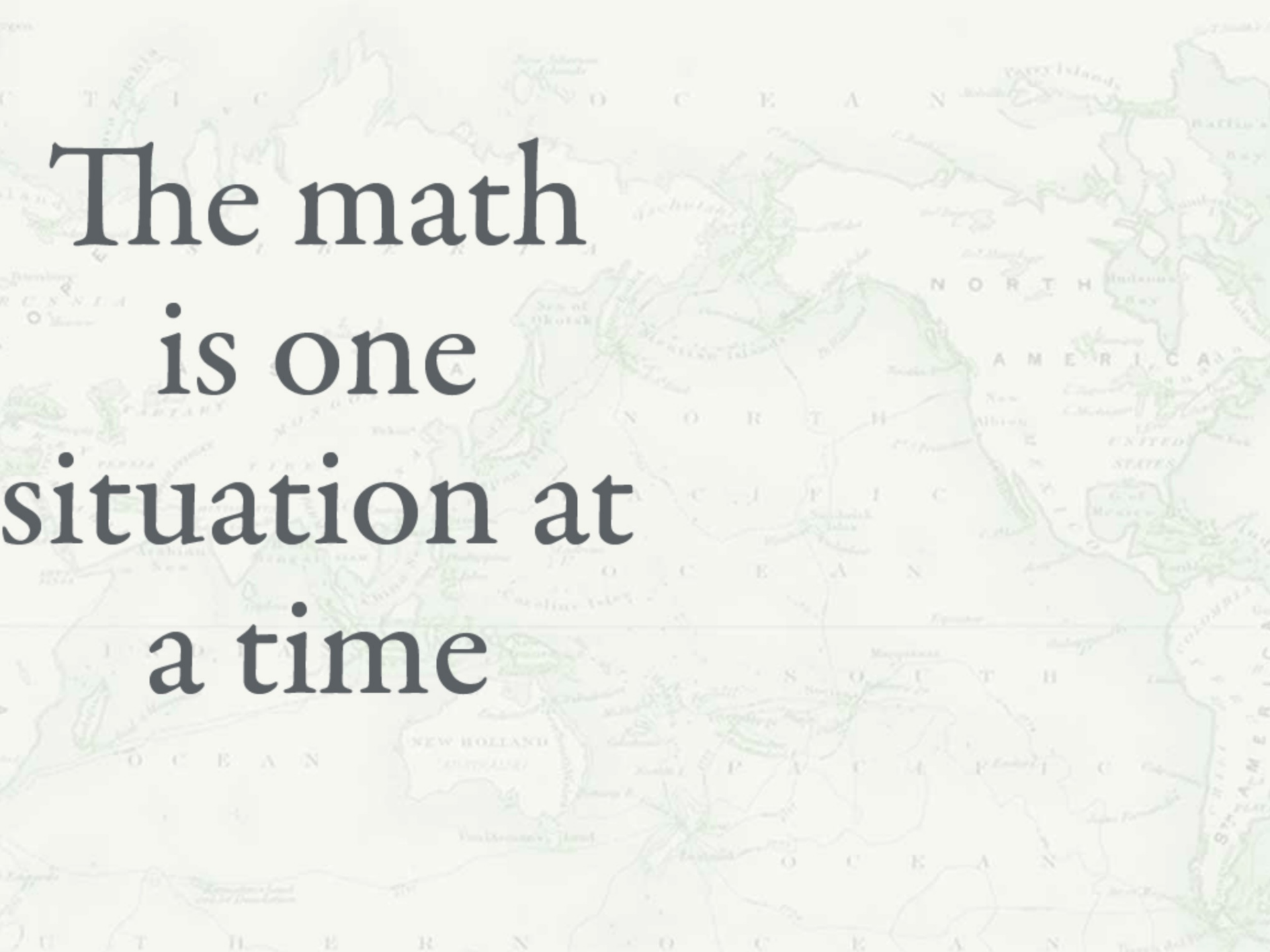
Math



It's just a  
simulation  
one at a  
time



We can alter  
distributions  
over time



The math  
is one  
situation at  
a time

# In Summary

Stress



Strength



Better Data  
Better Analysis



Is Stress > Strength?



# More Information

Visit [AccendoReliability.com](https://www.AccendoReliability.com)

Let me know if you have any questions.

Check out the reliability engineering podcast network at [Reliability.FM](https://www.Reliability.FM)

Go out and question then plan to end any currently running stress screens.