

AI-based Control for Nonlinear Mechanical Systems

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Agenda

- Thoughts on mechanical engineering & evolution
 - Adaption with new theories
 - Artificial Intelligence & Rise
 - Why AI is important and what is AI-based Control ?
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- Neural Networks and Back Propagation Algorithm
- Mass Spring Damper System (Linear and Nonlinear)
- How to encounter the Nonlinearity ?
- Constraints in the Adaptive Control
- AI-based Control

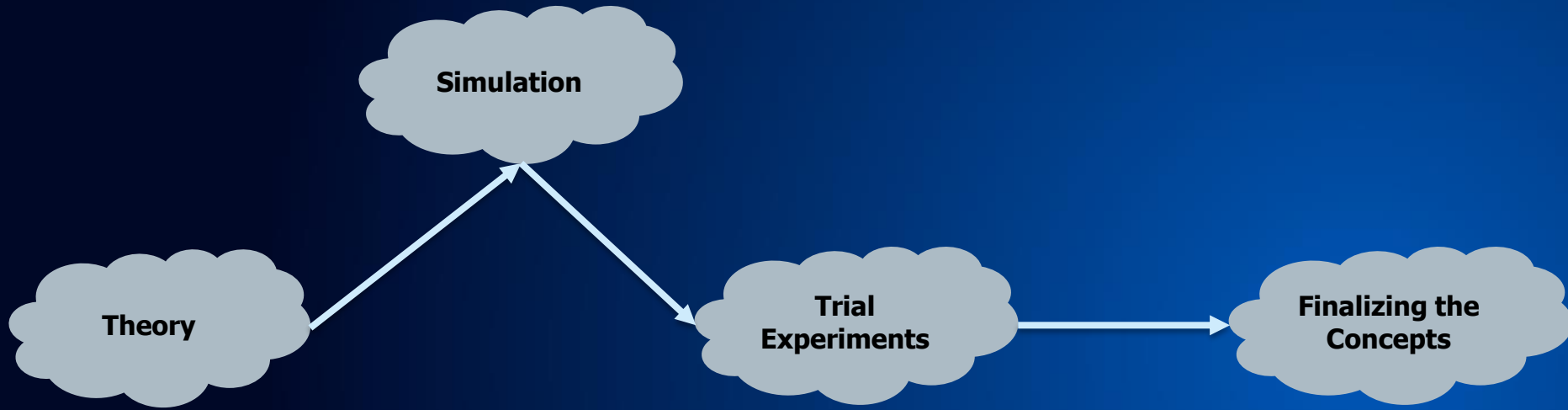
How Engineering is Evolved ?

Before the Computational Power....!



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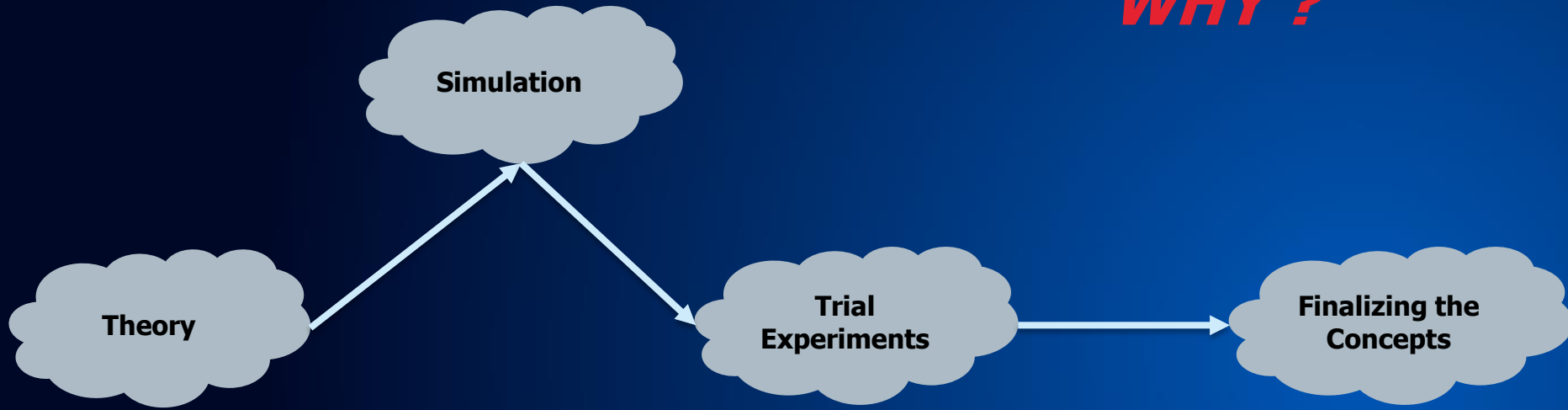
After the Computational Power....!



How Engineering is Evolved ?

After the Computational Power....!

WHY ?



Mass Spring Damper Simulation:

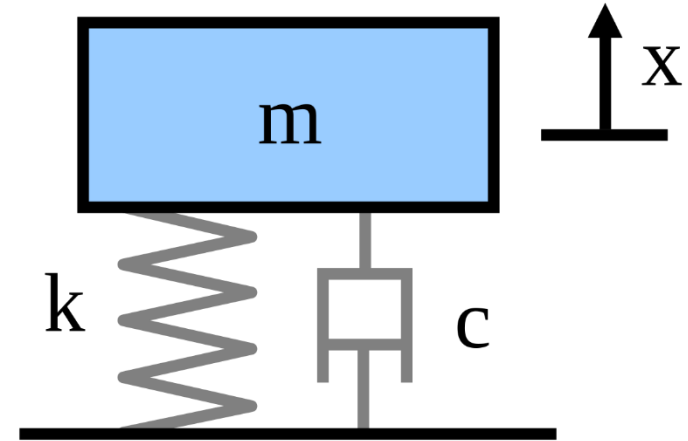
Can we solve this by simple python code ?

$$m = 10 \text{ Kg}$$

$$C = 5 \text{ Ns/m}$$

$$K = \text{N/m}$$

$$m \ddot{x} + c \dot{x} + kx = F$$



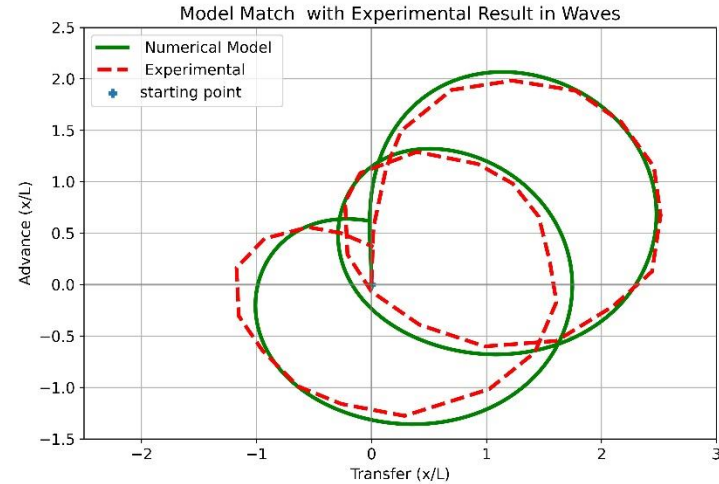
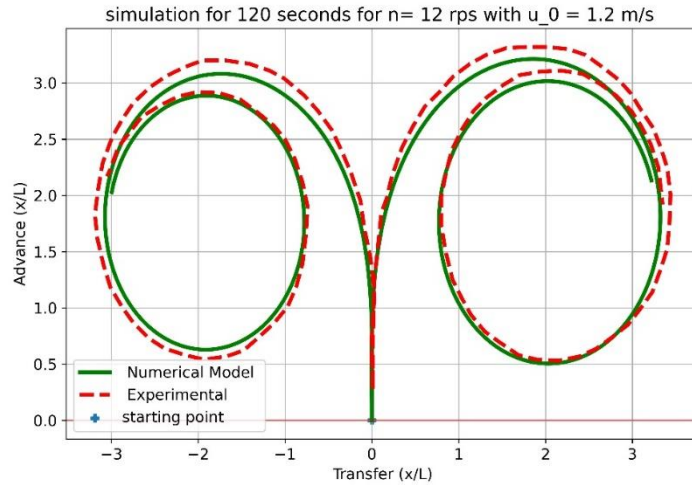
How to tackle the nonlinearity ?

Adaptive Control ...!

Optimization Tool...!

Data Driven Control...!

KVLCC2 Tanker trajectory in calm water and Waves



Control Non-affine Form...!

Governing Equation :

$$(m + m_x)\dot{u} - (m + m_y)vr - x_G m r^2 = X_H + X_R + X_P + X_S$$

$$(m + m_y)\dot{v} - (m + m_x)ur + x_G m \dot{r} = Y_H + Y_R + Y_S$$

$$(I_z G + x_G^2 m + J_z)\dot{r} + x_G m(\dot{v} + ur) = N_H + N_R + N_S$$

Back Propagation Algorithm

Real Time AI in Industry ?

Supervised Learning-based Feed Forward Control for Curvature Tracking.pptx