Lecture 1: Introduction to Predictive Modeling

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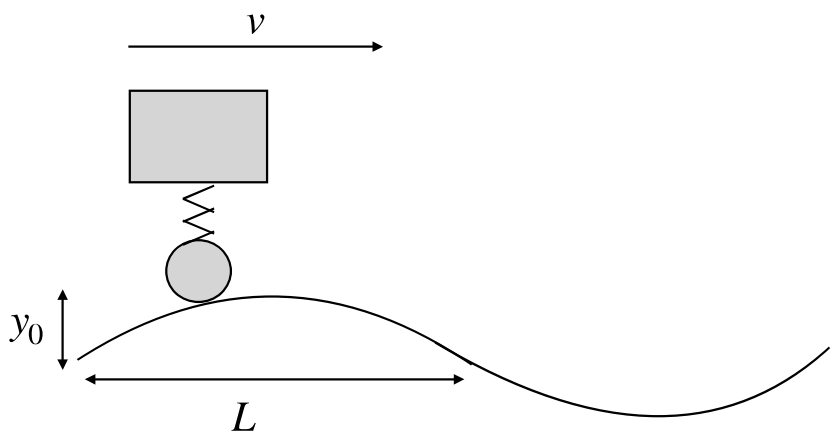
The uncertainty propagation problem

Example: Driving a trailer on a bumpy road

- m: mass
- k: spring constant
- v: velocity
- y_0: amplitude of road roughness
- L: "wavelength" of road roughness



Dynamics

$$\omega = \frac{2\pi v}{L}$$

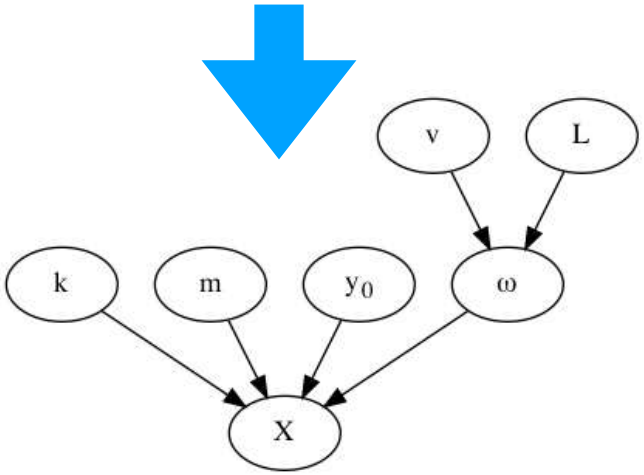
Angular velocity

$$X = \left| \frac{k y_0}{k - m\omega^2} \right|$$

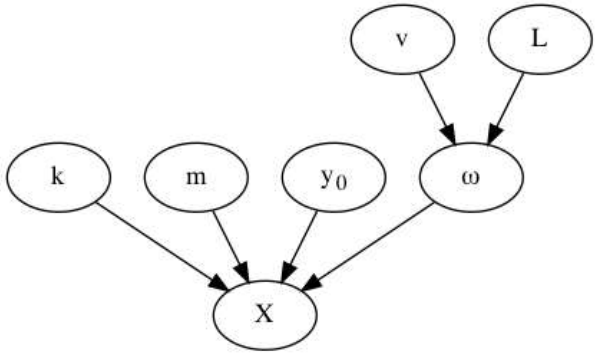
Amplitude

Example: Driving a trailer on a bumpy road

$$\omega = \frac{2\pi v}{L} \qquad X = \left| \frac{k y_0}{k - m\omega^2} \right|$$



Example: Driving a trailer on a bumpy road



Variable	Type	Values
k	Manufacturing uncertainty	[159,999, 160,001] N/m
v	Operating condition	[80, 150] km/hour
m	Loading condition	[100, 200] kg
y	Road condition	[0, 100] mm
L	Road condition	[1, 2] m

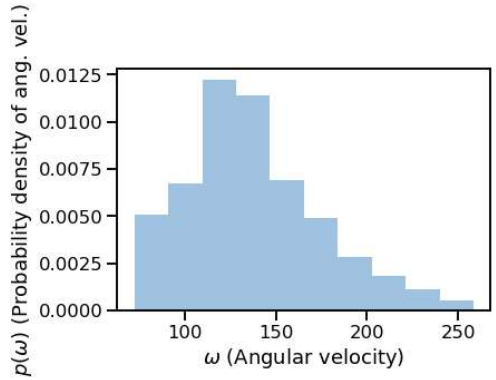
Our state of knowledge about the problem.

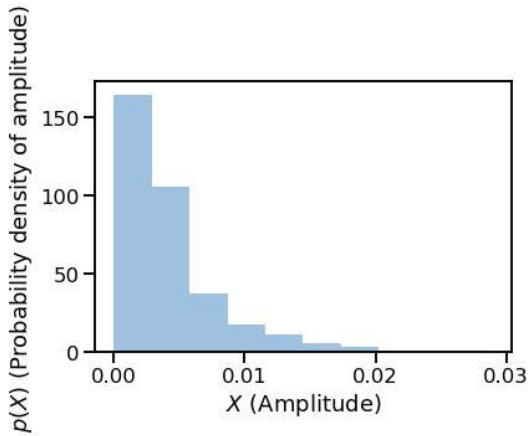
The uncertainty propagation problem

Having quantified our uncertainty about all unknowns, propagate this uncertainty through the causal model to characterize our uncertainty about a quantity of interest.

The Monte Carlo solution to the uncertainty propagation problem

- Sample random inputs many times.
- Evaluate model outputs at these inputs.
- Estimate any statistics of interest.





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