

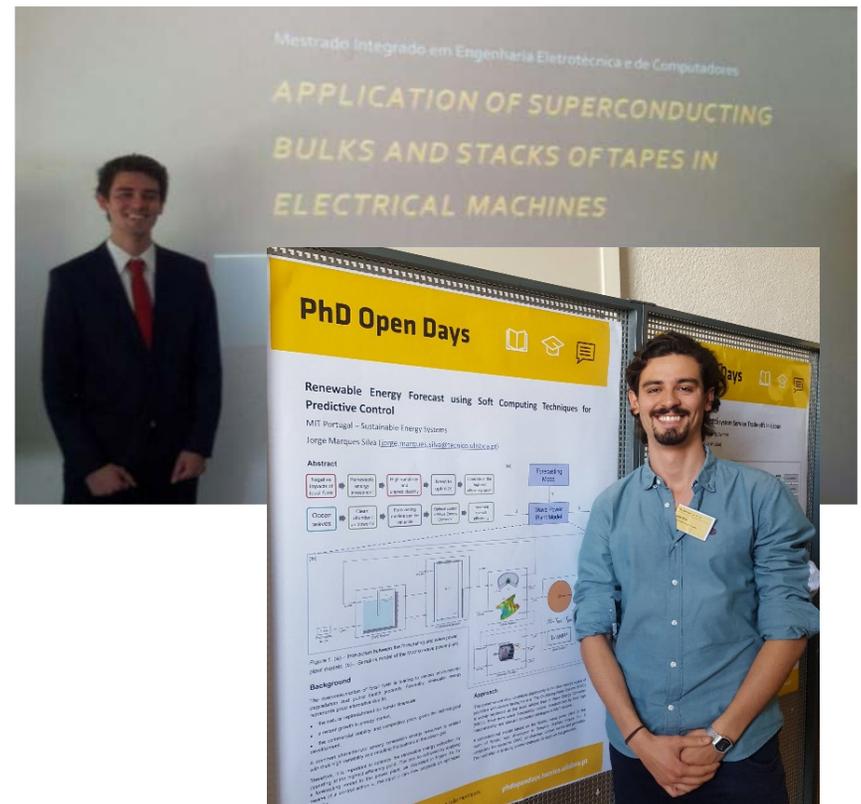
Wave Energy Generation

**MODELING OF
OSCILLATING WATER
COLUMNS**

Jorge Manuel Marques Silva

BACKGROUND

- Bachelor + Master in Electrical Engineering (Energy) in 2015;
 - Superconductors in Electrical Machines;
- Started **MIT Portugal** PhD Program – Sustainable Energy Systems in 2017:
 - Renewable Energy (Ocean Waves);
 - Machine Learning Forecasting;
 - Predictive Control.



MOTIVATION

■ Fossil fuels:

- ✓ Cheap and reliable;
- ✓ Available and easy to find;
- ✗ Environmental degradation;
- ✗ Public health issues;
- ✗ Limited energy source - depleting at fast rate.



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THE ALTERNATIVE



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- Renewable energy resources:
 - ✓ Natural replenishment on human timescale – **sustainable**;
 - ✓ Competitive prices;
 - ✓ Small scale (household) or large scale (city);
 - ✗ Dependent on environmental variables.

THE PROBLEM

- Uncertainty:
 - ✗ Fluctuations in capacity can have negative impacts;
 - ✗ Power plants lack optimal sizes, locations and configurations;
 - ✗ Market's instability.

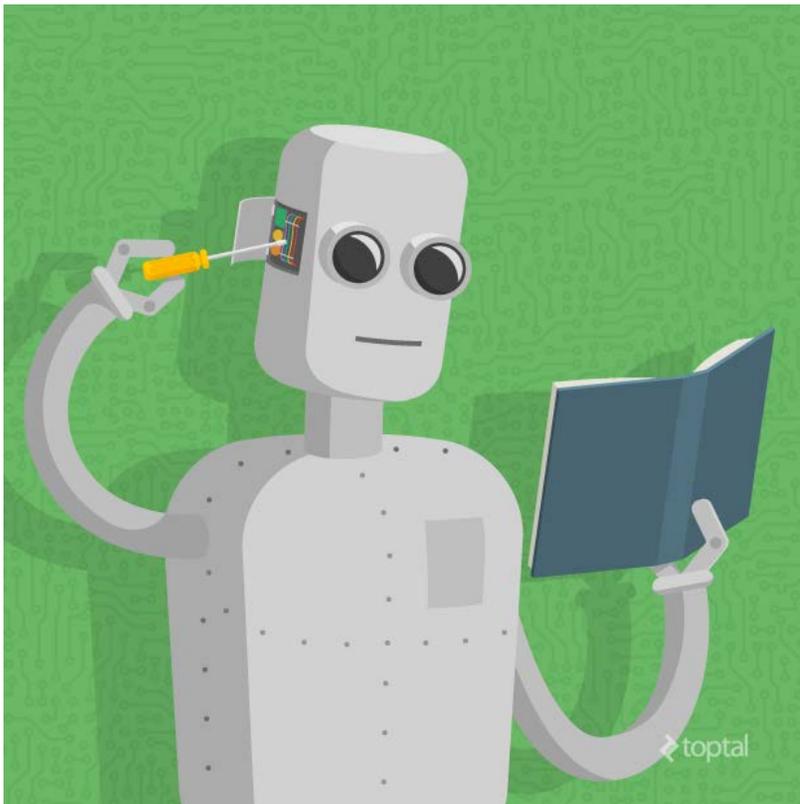


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THE IDEA



■ Machine Learning:

- ✓ Learn and improve from experience without explicit programming;
- ✓ Environmental variables forecast.



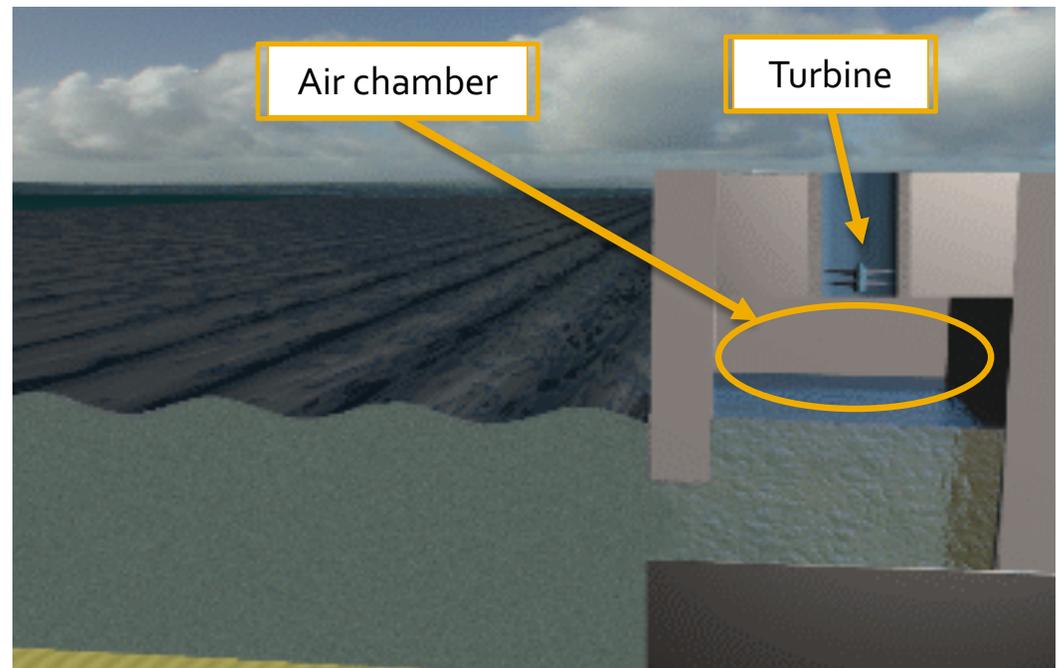
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INTRODUCTION



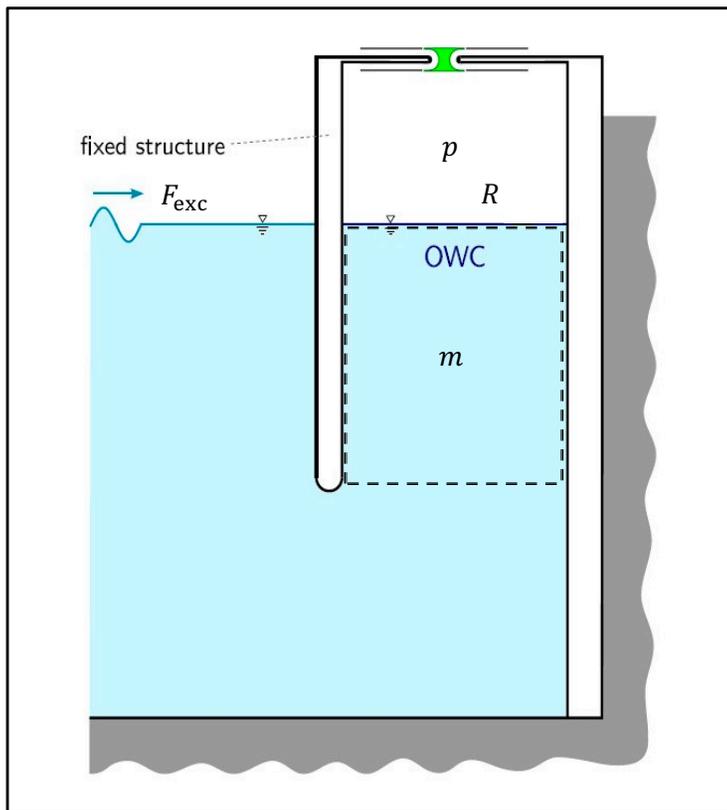
- Oscillating Water Column (OWC):



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COMPUTATIONAL MODEL

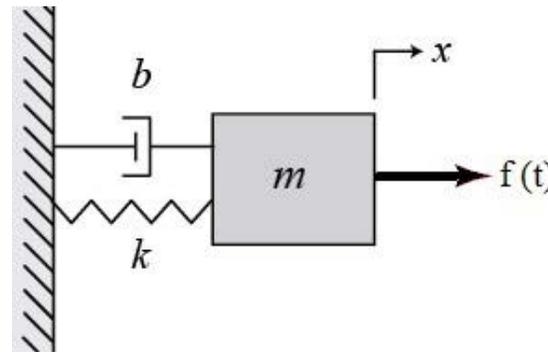


- Hydrodynamics:

$$F_{exc} = m\ddot{z} + R(\dot{z}) + \rho_w g S z + S(p - p_{at})$$

(\cdot denotes $\frac{d}{dt}$)

- Similar to mass-spring-damper system:



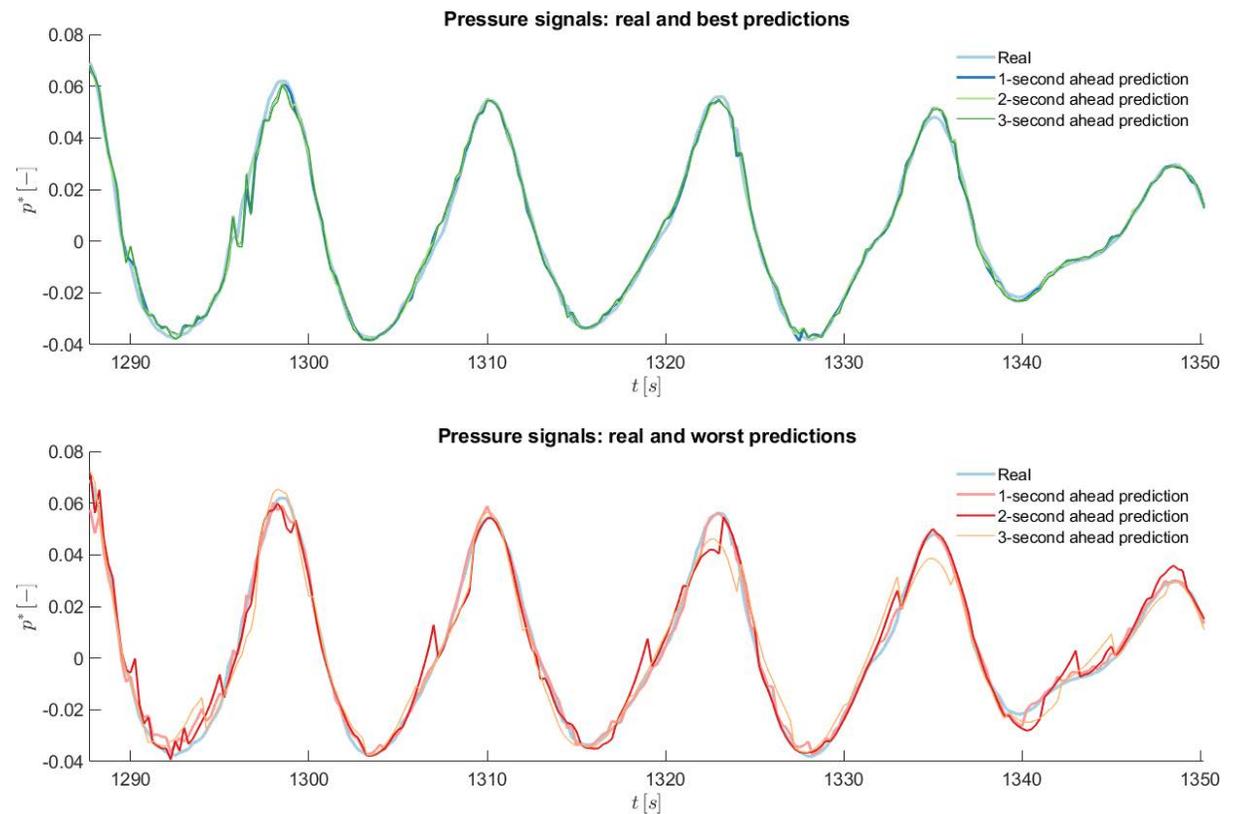
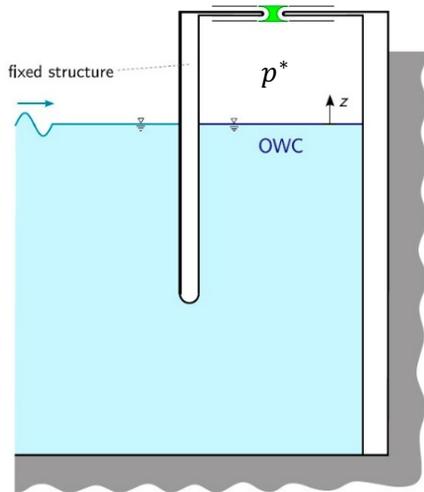
$$\sum F = m\ddot{x}$$

$$f - b\dot{x} - kx = m\ddot{x}$$

$$f = m\ddot{x} + b\dot{x} + kx$$

RESULTS

- Forecasting:
 - Air chamber pressure;
 - Support Vector Machines.



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