Wave Energy Generation

MODELING OF OSCILLATING WATER COLUMNS

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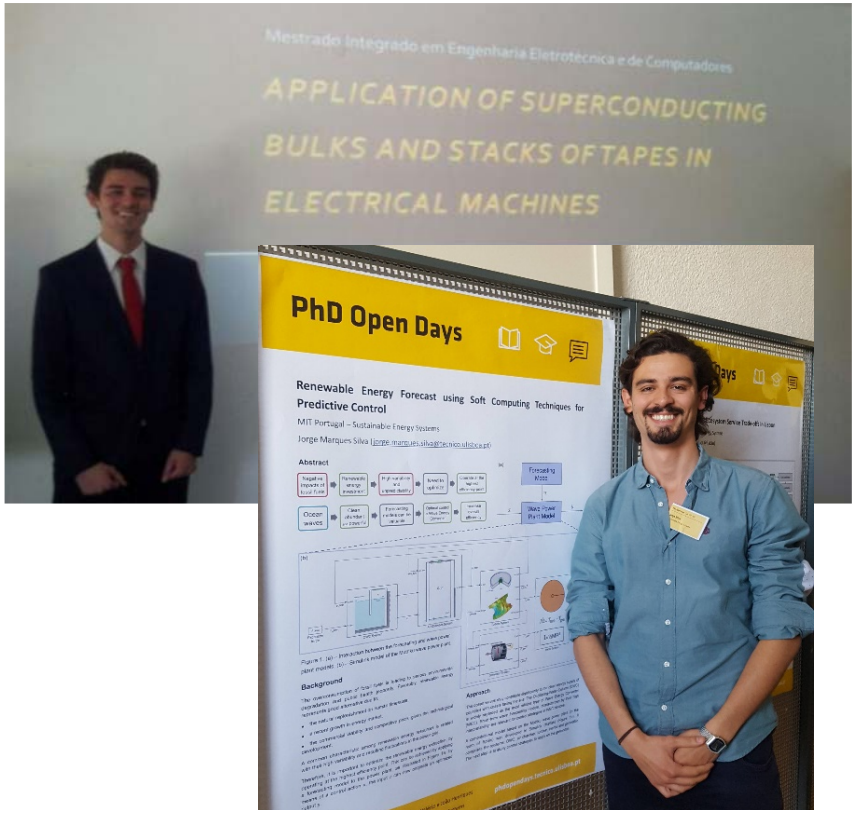
BACKGROUND

- 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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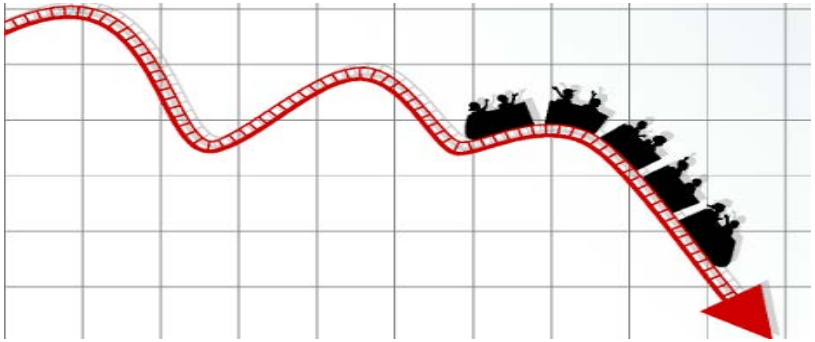
THE ALTERNATIVE

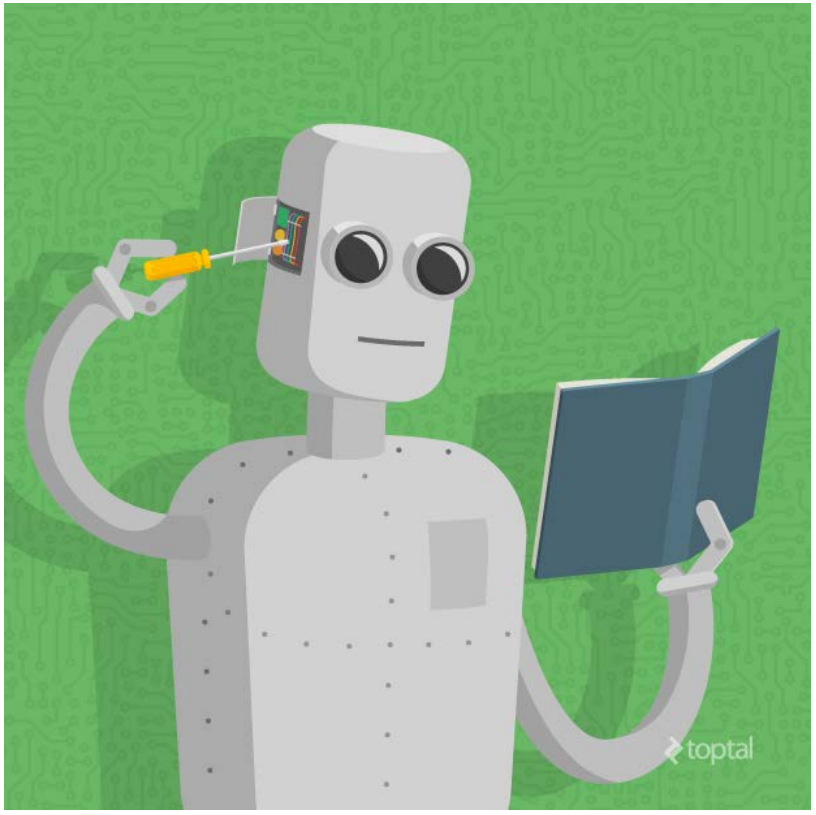
- Renewable energy resources:
  - ✓ Natural replenishment on human timescale – **sustainable**;
  - ✓ Competitive prices;
  - ✓ Small scale (household) or large scale (city);
  - ✗ Dependent on environmental variables.

THE PROBLEM

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



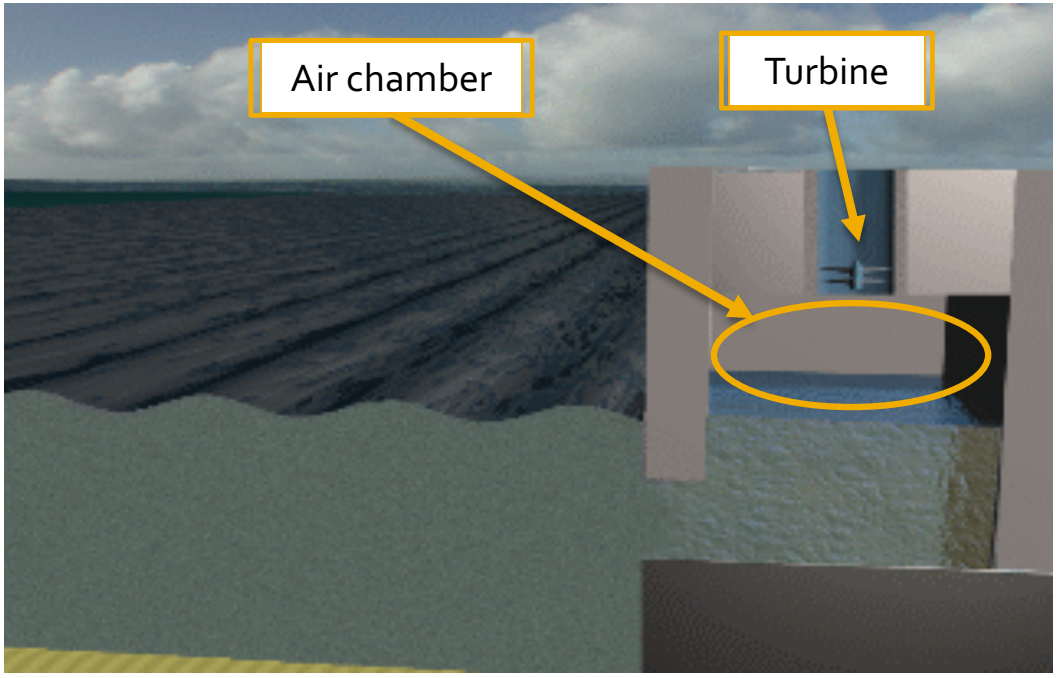
THE IDEA



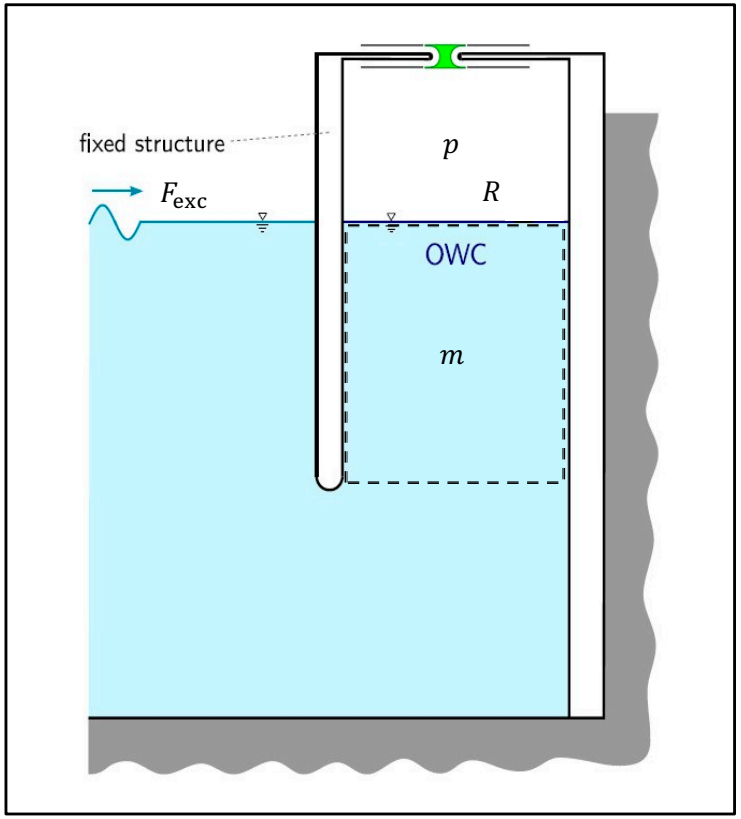
- Machine Learning:
  - ✓ Learn and improve from experience without explicit programming;
  - ✓ Environmental variables forecast.

INTRODUCTION

- Oscillating Water Column (OWC):



COMPUTATIONAL MODEL

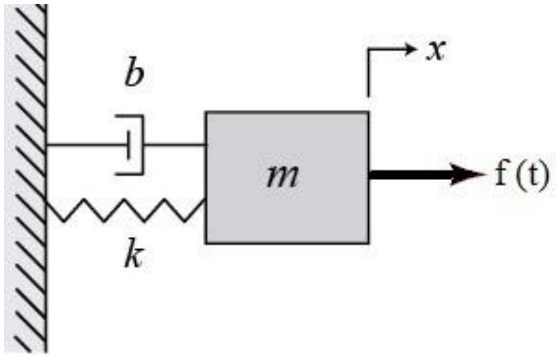


- Hydrodynamics:

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

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

- Similar to mass-spring-damper system:



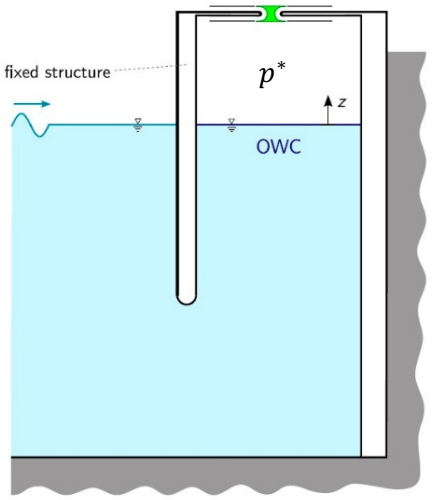
$$\sum F = m\ddot{x}$$

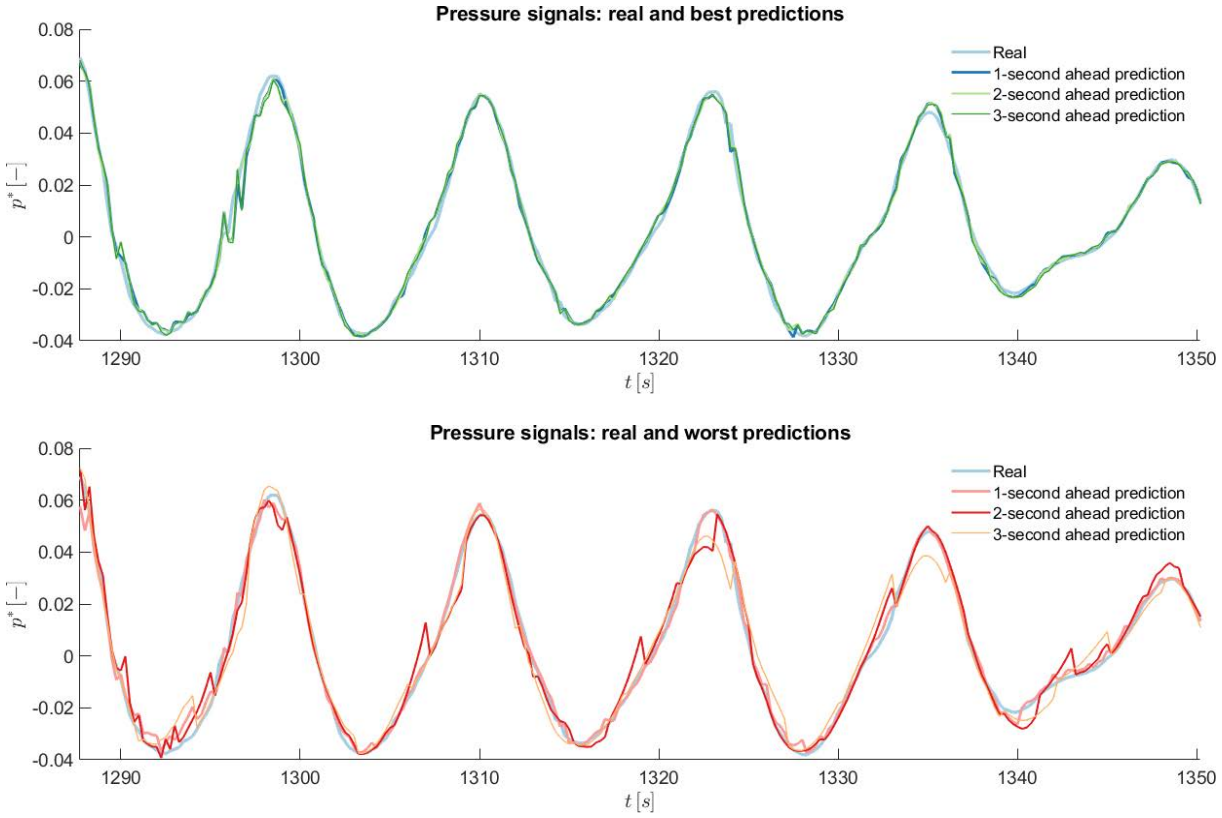
$$f - b\dot{x} - kx = m\ddot{x}$$

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

RESULTS

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






THANK YOU!

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