# SYNTHETIC DATA GENERATION USING MACHINE LEARNING FOR IMPROVED PREDICTION OF DYNAMIC VISCOSITY IN WECS

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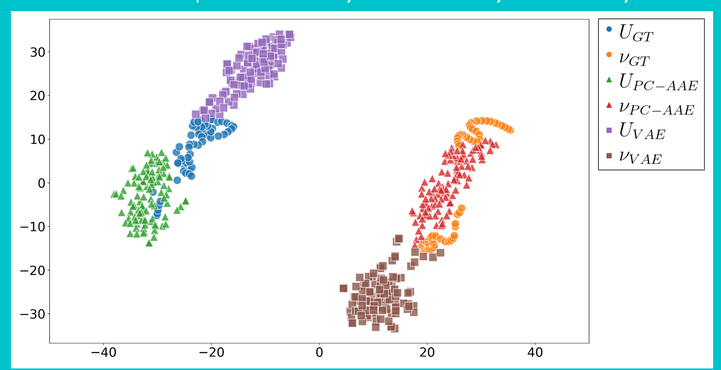
## Computational Fluid Dynamics are too expensive to run. What if we have small dataset?

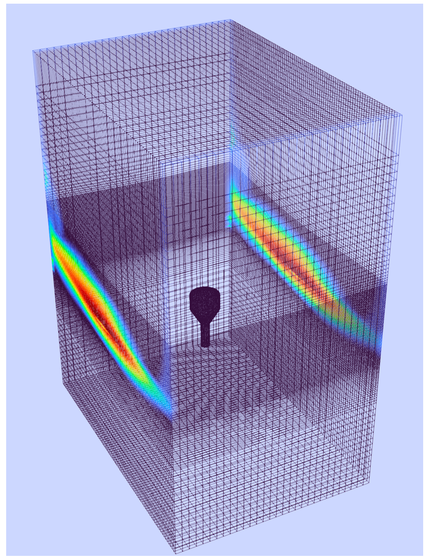
**Computational Fluid Dynamics** (CFD) simulations of how WEC systems behave due to ocean wave perturbations can be computationally expensive to run and time-consuming. Often it can produce a small number of samples to work with, yielding poor predictors for a predictive model of the dynamic viscosity due to the lack of a high number of samples. Therefore, an attractive solution is to generate new simulations, at a considerable speedup, that learn from the original CFD simulations. Here, we explore the use of a Beta-Variational Autoencoder (VAE) and a Principal Components-based adversarial autoencoder (PC-AAE) for generating new synthetic data.

The compression plus the generation of synthetic data introduces an exceptionally fast model surrogate of the original simulation and delivers more samples of either dynamic viscosity and velocity fields.




t-SNE projection of the newly generated synthetic data versus the ground truth data

The high-fidelity data is achieved by generating fields of **dynamic viscosity** and **velocity fields** at the same time. Thus, the physicality between both fields is then preserved. Future work will include the deformation of the mesh due to its interaction with incoming waves



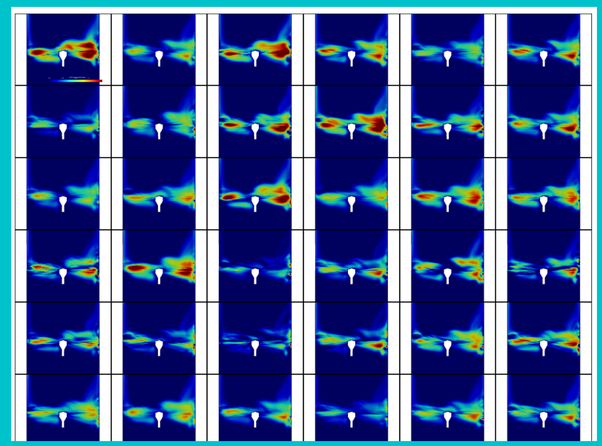
The 3D CFD simulation of the point absorber Wave Energy converter

## MOTIVATION

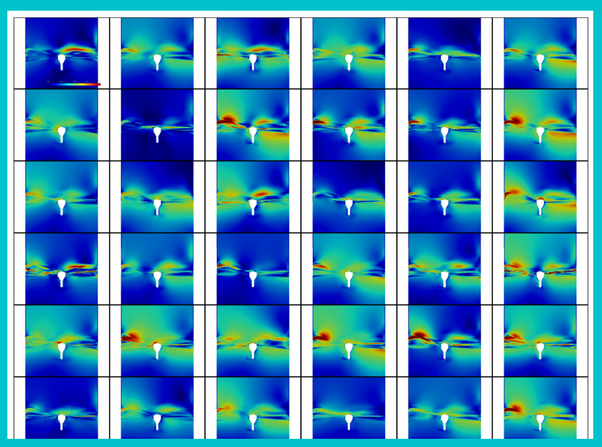
**Wave energy converters (WECs)** are devices that convert the kinetic and potential energy associated with a moving ocean wave into useful mechanical or electrical energy. Whilst the potential to study, understand and take advantage of these converters for renewable energy is immense, the simulations to analyse the response of these systems to incoming waves are lengthy and computationally expensive to obtain.

## Synthetic Data at a fraction of the computational cost

THESE MODELS CAN GENERATE 100 SAMPLES IN 0.5 S (VAE) AND 3.5 S (PC-AAE), COMPARED TO 1 WEEKS TIME OF SIMULATION USING OPENFOAM



XZ projection of 36 new samples of dynamic viscosity



XZ projection of 36 new samples of velocity fields (u,v,w)