Machine Learning Building-Block Models for Computational Fluid Dynamics
Adrian Lozano-Duran (MIT)

§1 Introduction
- Aircraft certification requires rigorous numerical simulation with minimal error tolerance
- Simulation of aerodynamics requires fluid dynamics, different flow physics
- Single model for all flow physics, captures complex geometries

§2 Equations
- Conservation of mass
- Conservation of momentum
- Boundary limits at surface edge

§3 Assumptions
- Learn flow physics from a collection of small cases, thus 'There are a collection of essential physics flows that can be combined to model flows at larger scales'
- Flows at scale of flight simulation is a combination of essential flows at smaller scales

§4 Model Architecture (NNs) (Wall Model)
- Predictor: force at location given flow class
  Each flow has a predictive model (hence building block)
- Classifier: essential physical flow

§5 Data
- Numerical solutions to training data can help label data and ensure consistency across data used in ML vs Numerical methods

§6 Validation
- Well understood physical models at small scales can be used as validation cases for ML models

§7 Conclusions
- Ensemble of classifier and predictor is quite interesting
- 'Information Theory can describe the amount of information inputs contain about the output. No information about the output can be predicted without it being in the input data.