# Modelling / Simulation / Prediction of Dynamic Behavior

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**Expertise: Machine Learning, AI, Simulation**

# Modelling / Simulation / Prediction of  Dynamic Behavior

for example

- Usage Patterns

- System dynamics of technical components, e.g. a battery

- Reach of an electric car
  e.g. "Can I reach city A within 2 hours?"
  depending on
    - Battery state (as observed from previous usages)
    - Route profile
    - Behavior of the driver (as observed when driving similar routes)

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# Echo State Networks

patented by **■ Fraunhofer**
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- ■ ESNs are a universal method for **time series processing**
  e.g. system identification, prediction, system diagnosis, sensor data fusion.

- ■ ESNs can model **highly non-linear** dynamics.

- ■ ESNs exploits the power of Recurrent Neural Networks (RNNs)
  but instead of previous learning schemes,
  ESN **training is fast and** by far more **stable**.

- ■ ESNs may be big (1000 nodes and more) **capable of learning
   non-linear, real-life systems**.

- ■ ESNs have been applied for wind energy prediction, gas detection in freight
   containers, hand writing recognition, signal processing, robotics, and many more.

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