VRIJE UNIVERSITEIT BRUSSEL

The faculty of Engineering of the Vrije Universiteit Brussel invites you to attend the public defense leading to the degree of

DOCTOR OF ENGINEERING SCIENCES

of **Sadegh Ebrahimkhani**

The public defense will take place on **Monday 17th November 2025 at 4 pm** in room **D.2.01** (Building D, VUB Main Campus)

To join the digital defense, please click here

DATA-DRIVEN MODELING OF NONLINEAR SYSTEMS VIA LPV APPROXIMATION AROUND VARYING OPERATING POINTS

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Abstract of the PhD research

Modern engineered systems — from robots and aircraft to chemical plants — often behave in complicated, nonlinear ways. Trying to write down every twist and curve of that behavior makes models huge and hard to understand. This thesis shows how to build much simpler, useful models by watching the system as it moves through different operating conditions and asking only small, controlled "what if" questions (tiny nudges) along the way.

Concretely, we make many local, linear snapshots of the system while it slowly follows a reference trajectory. Those snapshots tell us how the system reacts to small changes at each moment. By stitching those snapshots together and using mathematical tools to find which directions matter most, we produce compact models that change smoothly with the operating condition — easy to analyze, faster to simulate, and more interpretable than a giant black box.

We also develop methods that automatically pick which variables and model parts are truly important (so the model stays small), and extend the approach to state-space models using a neural-ODE architecture that respects the same `big trajectory + small wiggles' structure. The result is a practical toolbox for creating accurate, low-complexity models that engineers can use for design, control, and measurement — without needing to model every nonlinear detail.