Stochastic Planning & Control of Dynamical Systems Workshop

IEEE Conference on Decision and Control (CDC)
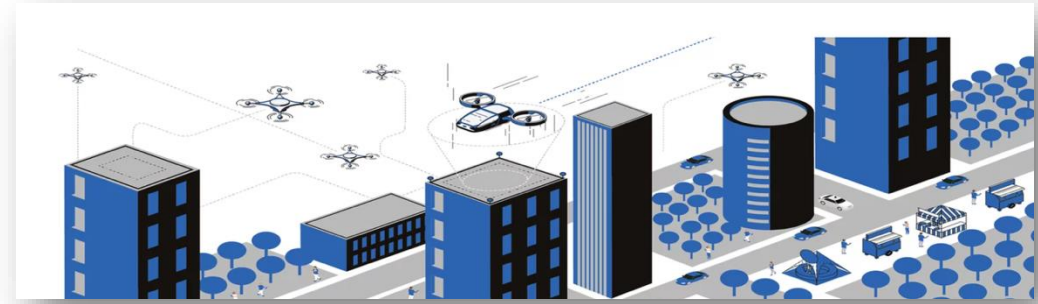Rio de Janeiro, Brazil, Dec 9, 2025
Vignesh Sivaramakrishnan, **Joshua Pilipovsky**,
Alex Soderlund, Sean Phillips

Introduction

Building reliable systems will require a fresh look at how to *characterize* and *handle* **uncertainty**
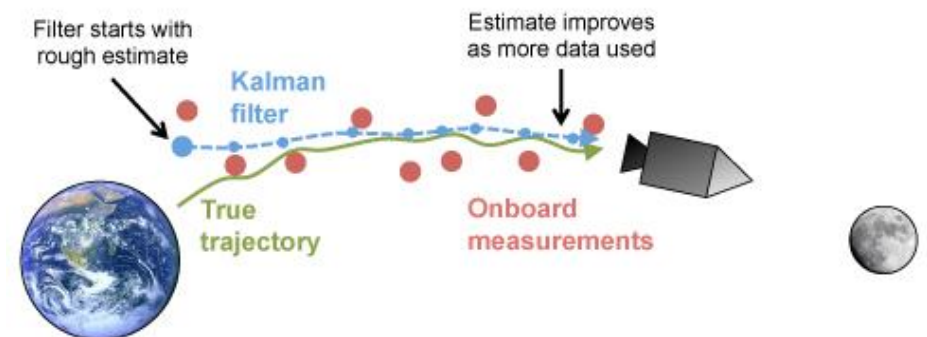
Introduction

Building reliable systems will require a fresh look at how to *characterize* and *handle* **uncertainty**

1960-1980
Optimal Control / Deterministic Optimization

$$\min_x \; \ell_x(\xi) \qquad \bullet^\xi$$

Filter starts with rough estimate

Estimate improves as more data used

Kalman filter

True trajectory

Onboard measurements

Introduction

Building reliable systems will require a fresh look at how to *characterize* and *handle* **uncertainty**

1960-1980
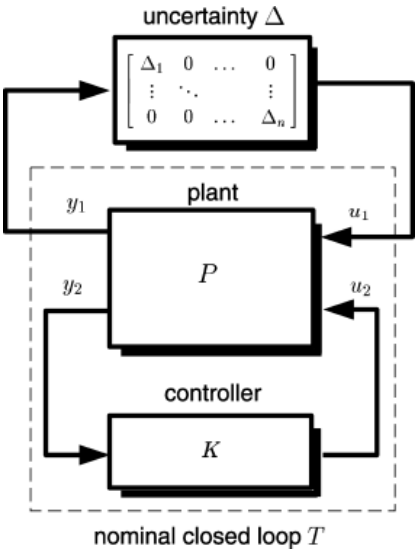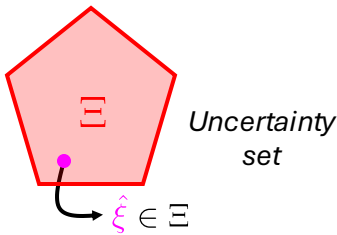Optimal Control / Deterministic Optimization

$$\min_{x} \; \ell_x(\xi)$$

$\bullet \, \xi$

1980s
Robust Control / Robust Optimization

$$\min_{x} \max_{\xi \in \Xi} \; \ell_x(\xi)$$

$\hat{\xi} \in \Xi$

Ξ

Uncertainty set

uncertainty Δ

$$\begin{bmatrix} \Delta_1 & 0 & \dots & 0 \\ \vdots & \ddots & & \vdots \\ 0 & 0 & \dots & \Delta_n \end{bmatrix}$$

plant

y_1 $\quad$ u_1

P

y_2 $\quad$ u_2

controller

K

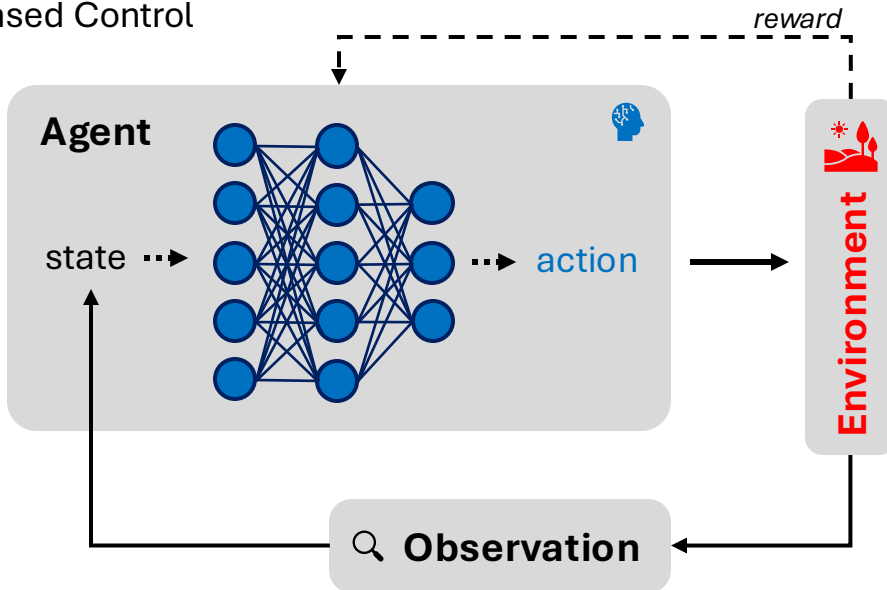nominal closed loop T

Princeton Series in APPLIED MATHEMATICS

Robust Optimization

Aharon Ben-Tal
Laurent El Ghaoui
Arkadi Nemirovski

Introduction

Building reliable systems will require a fresh look
at how to *characterize* and *handle* **uncertainty**

2000s - Present (??)
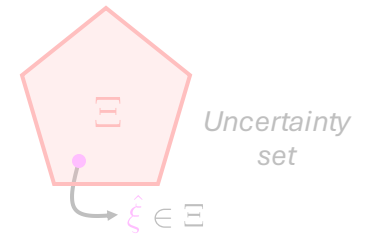Learning-Based Control

1960-1980
Optimal Control / Deterministic Optimization

$$\min_x \; \ell_x(\xi)$$

$\cdot\, \xi$

1980s
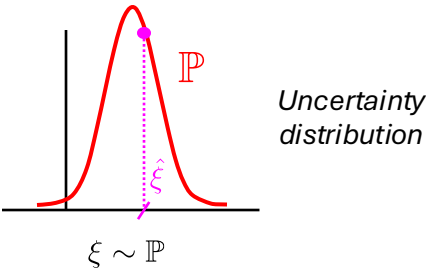Robust Control / Robust Optimization

$$\min_x \max_{\xi \in \Xi} \; \ell_x(\xi)$$

Ξ

Uncertainty set

$\hat{\xi} \in \Xi$

Introduction

Building reliable systems will require a fresh look at how to *characterize* and *handle* **uncertainty**

1960s – Present
Stochastic Control / Optimization

$$\inf_{x} \; \mathbb{E}^{\mathbb{P}}[\ell_x(\xi)]$$

Uncertainty distribution

$$\xi \sim \mathbb{P}$$

1990s – Present
Distributionally Robust Control / Optimization

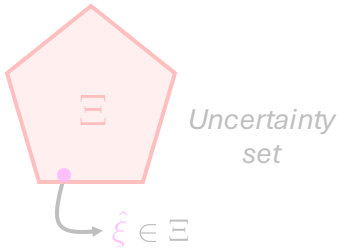$$\inf_{x} \sup_{\mathbb{P} \in \mathcal{P}} \; \mathbb{E}^{\mathbb{P}}[\ell_x(\xi)]$$
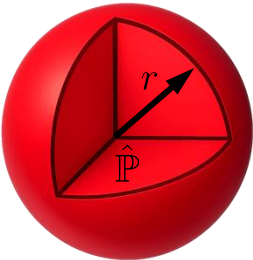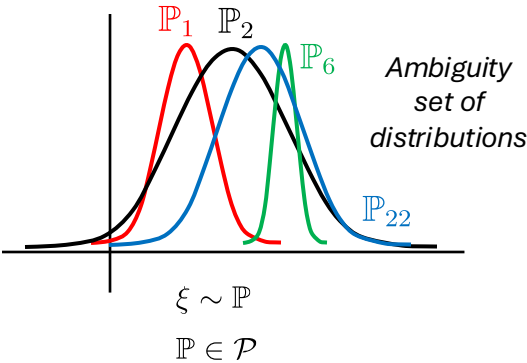
$\mathbb{P}_1$ $\mathbb{P}_2$ $\mathbb{P}_6$

Ambiguity set of distributions

$\mathbb{P}_{22}$

$$\xi \sim \mathbb{P}$$

$$\mathbb{P} \in \mathcal{P}$$

r

$\hat{\mathbb{P}}$

1960-1980
Optimal Control / Deterministic Optimization

$$\min_{x} \; \ell_x(\xi)$$

ξ

1980s
Robust Control / Robust Optimization

$$\min_{x} \max_{\xi \in \Xi} \; \ell_x(\xi)$$

Ξ

Uncertainty set

$$\hat{\xi} \in \Xi$$

2000s - Present (??)
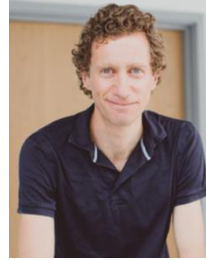Learning-Based Control

Agent

state

action
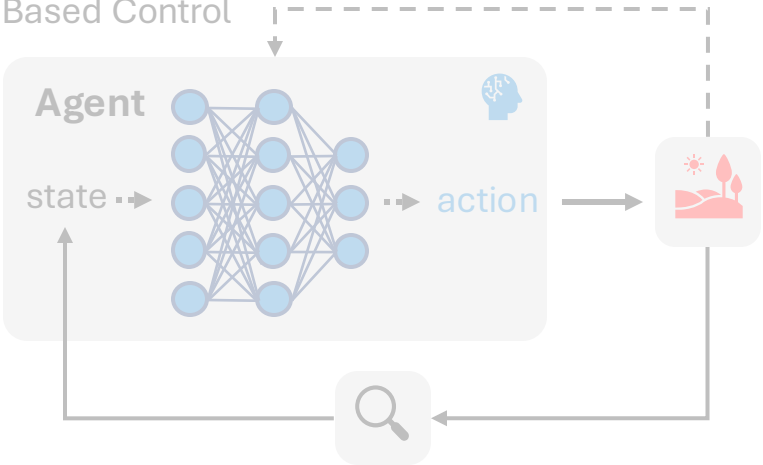
Agenda

Stochastic Control and Safety I
8:35 AM – 10:00 AM

Francesc o Borrelli

Alessandro Abate

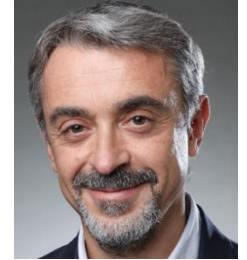**Distributional Control**
10:30 AM – 12:15 PM

Tryphon T. Georgiou

Panagiotis Tsiotras

Andrea Martin

Giancarlo Ferrari-Trecate

Stochastic Control and Safety II
1:45 PM – 3:30 PM

Yongxin Chen

András Sasfi

Florian Dörfler

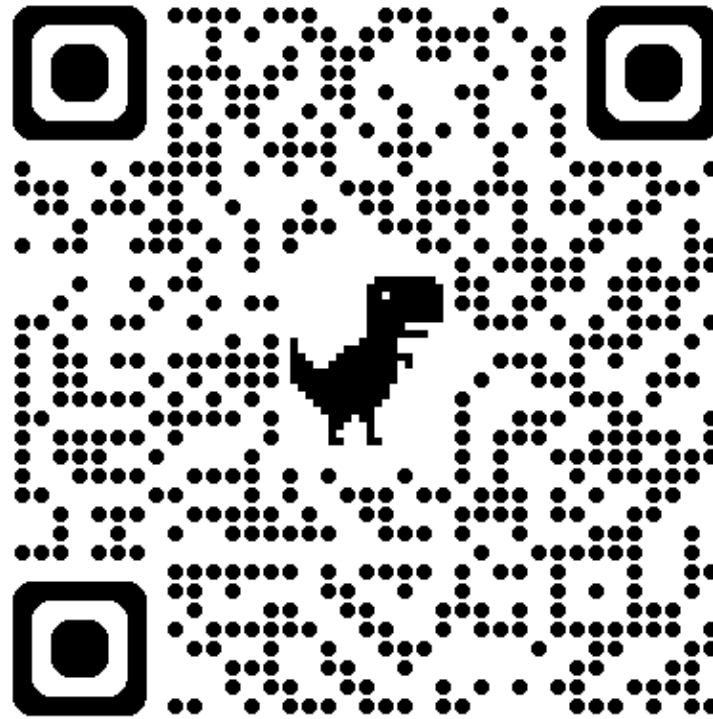**Applications in Aerospace**
4:00 PM – 5:30 PM

Behçet Açıkmeşe

Kenshiro Oguri

https://spc-cdc25.github.io/

Lightning Talk Speakers and Abstracts

Lunch Recommendations!