**Distributed Decision Theory Group**

Nuno C. Martins

---

### Distributed Decision Systems

![Diagram showing distributed decision systems](image)

**System 1**
- Decision 1
- System 2
- Decision 2
- System 3
- Decision 3

**Information pattern:**
- Physical system
- Decision system

---

### Broader Impacts

**Control of large-scale and power-constrained distributed systems**

---

### Intellectual Merit

**Underlying communication network creates the following challenges:**
- Joint design of control and comm.
- Provable performance certification
- Modeling and analysis methods

---

### Sample Research Themes

#### Optimal Control subject to Communication Costs

**Goal:** minimize the following cost

\[
J = \sum_k E[x_k^T x_k + u_k^T u_k] + CE[1_k, \text{link } S \text{ to } C]
\]

**Main results:**
- First analytical proof of the optimality of threshold-type policies
- Concrete methods to compute optimal soln.
- New analysis methodology based on majorization theory

**Sample publications:**
- G. Lipsa and N. C. Martins, “Optimal Memoryless Control of a Delay in Gaussian Noise: A Simple Counterexample,” Accepted in 2010 for publication in Automatica
- G. Lipsa and N. C. Martins, “Remote State Estimation With Communication Costs For First-Order LTI Systems,” Accepted in 2010 for publication in the IEEE Transactions on Automatic Control

---

#### Topology Design and Convex Parameterizations for Decentralized Control

**Goal:** optimal control design subject to sparsity constraints

**Main results:**
- A new coordinate-free parameterization for numerically efficient design of decentralized controllers that are robust to uncertainty/delays.
- Efficient methods for the design of the sparsest and yet nested information structures.

**Sample publications:**
- M. C. Rotkowitz and N. C. Martins, “On the Nearest Quadratically Invariant Information Constraint,” Accepted in 2010 for publication in the IEEE Transactions on Automatic Control