Analysis and Control of Multi-Agent Systems

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Organizational Matters

Instructor and Office Hours

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Teaching Assistant

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Course Web-Page

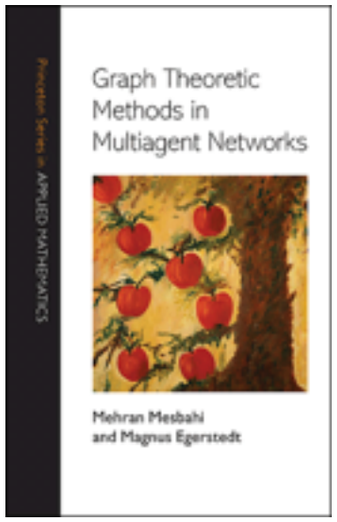
http://www.ist.uni-stuttgart.de/education/courses/Multi-Agent2014/

Schedule

Please see website for latest information!

Organizational Matters

(suggested) Text Book



"Graph Theoretic Methods in Multiagent Networks"
Mehran Mesbahi & Magnus Egerstedt
Princeton University Press, 2010.

http://press.princeton.edu/titles/9230.html

Homeworks: - There will be a series of *optional* exercises that will accompany every few lectures. It is encouraged that you try to work through these.

Final Exam (July 23, 15:00-16:30): - A comprehensive written exam.

Multi-Agent Systems

Multi-Agent Systems are systems composed of multiple interacting dynamic units.

biologically inspired...

shimmering of giant honeybees
Kastberger G, Schmelzer E, Kranner I (2008) Social Waves in Giant Honeybees Repel Hornets. PLoS ONE 3(9): e3141.

Multi-Agent Systems

Multi-Agent Systems are systems composed of multiple interacting dynamic units.

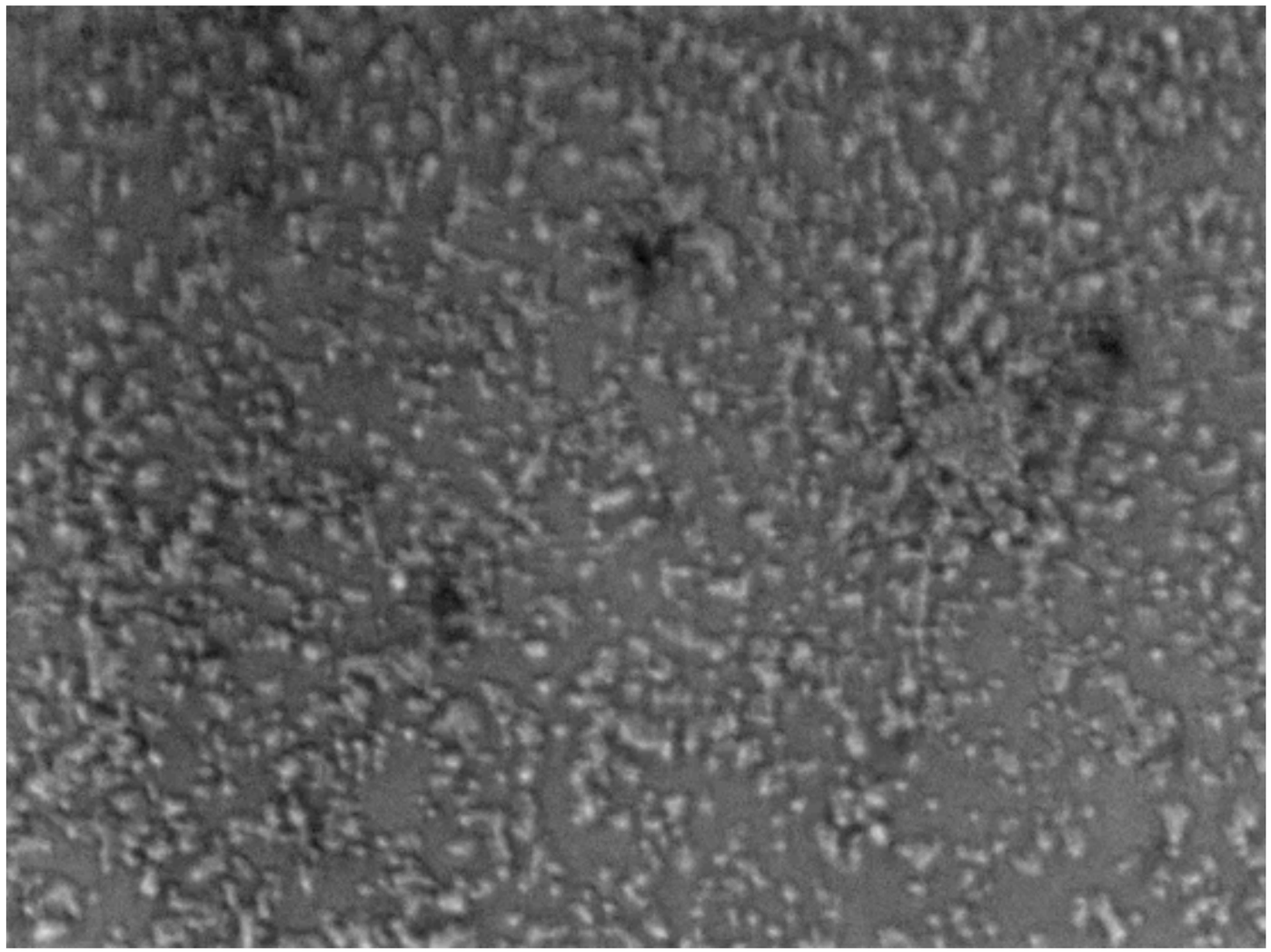
biologically inspired...

synchronizing fireflies
Buck, J and Buck, E
(1968) Mechanism of Rhythmic Synchronous Flashing of Fireflies. Science 22 159(3821):1319-1327.

Multi-Agent Systems

Multi-Agent Systems are systems composed of multiple interacting dynamic units.

biologically inspired…



Aggregation of Dictyostelium
Goldbeter, Bulletin of Mathematical Biology 2006

Multi-Agent Systems

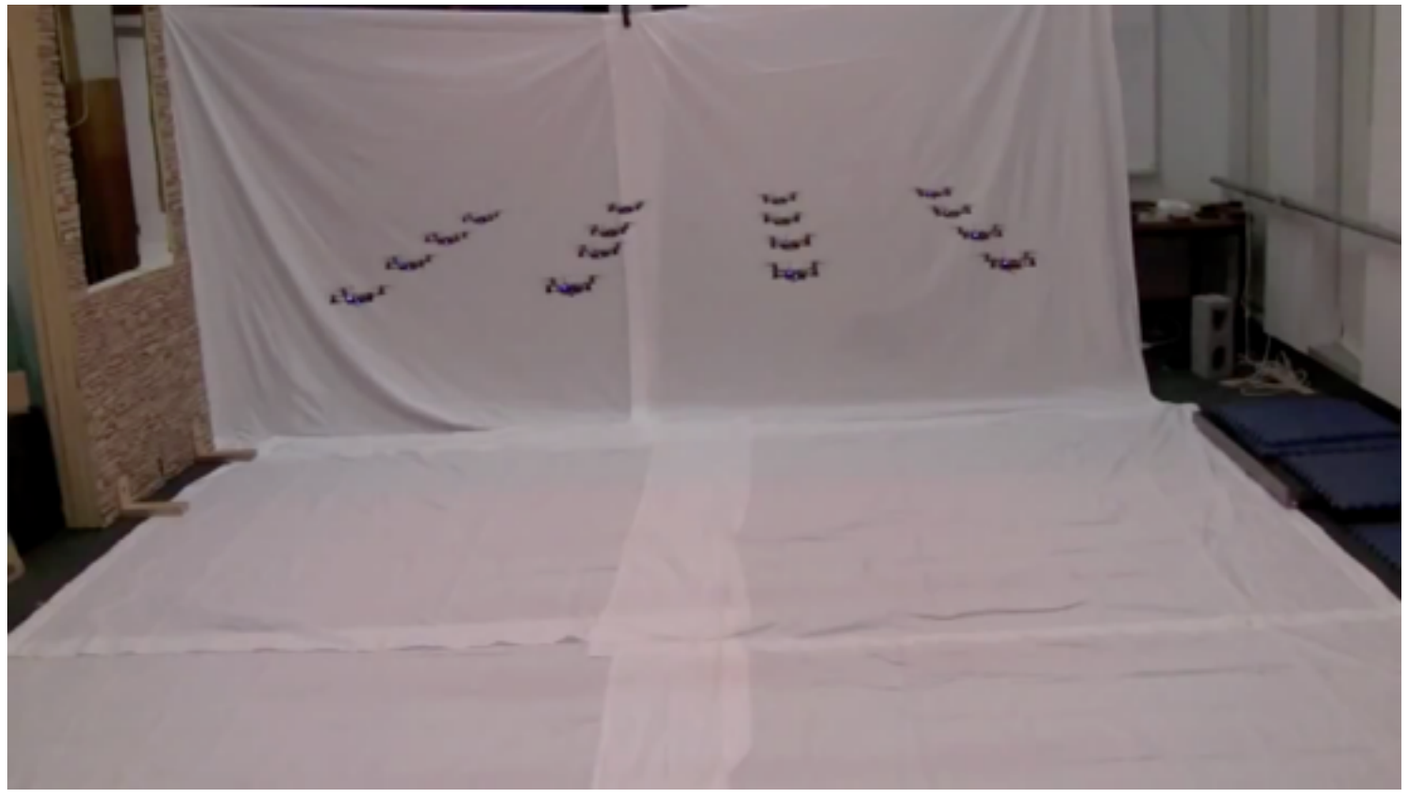
Multi-Agent Systems are systems composed of multiple interacting dynamic units.

Synchronization

An agreement by multiple systems on a common state

Coordination

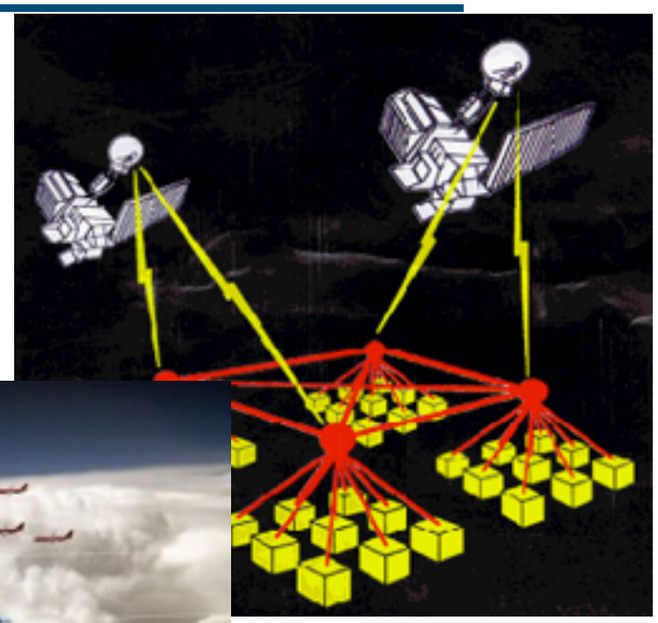
Managing of multiple interacting systems to achieve a team objective

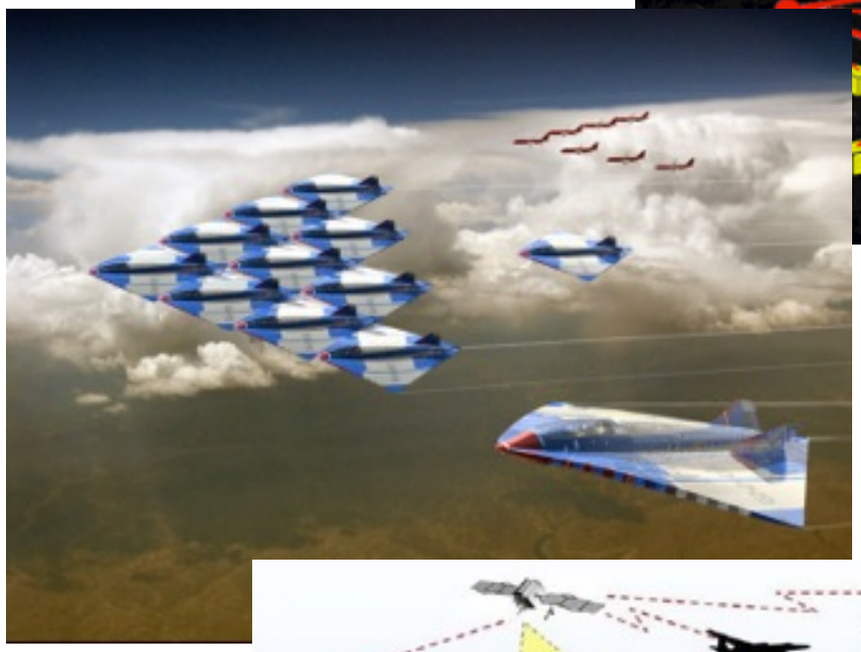


Course Goals

Course Goals

- Modeling of multi-agent systems
  - dynamics
  - interconnections
- Analysis of multi-agent systems
  - stability and performance
  - convergence
- Synthesis of multi-agent systems
  - control
  - interconnection design
- Applications of multi-agent systems
  - formations

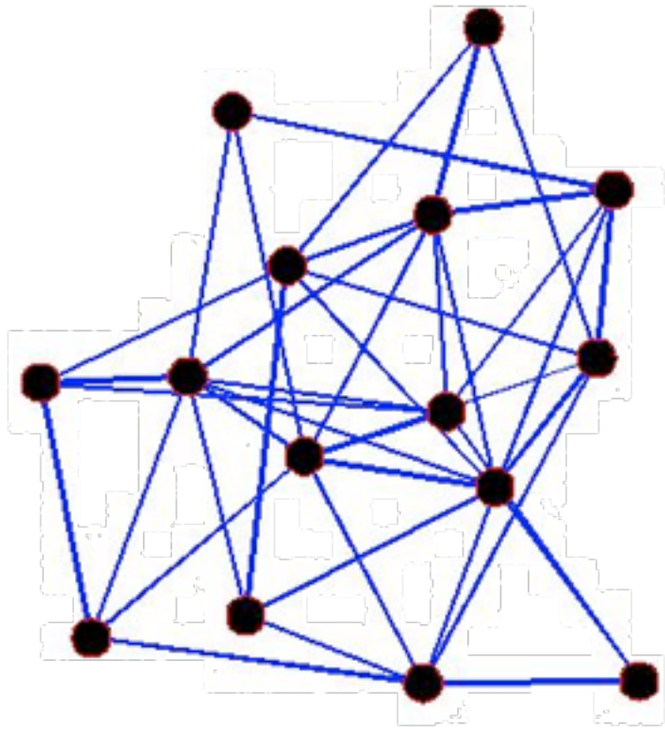


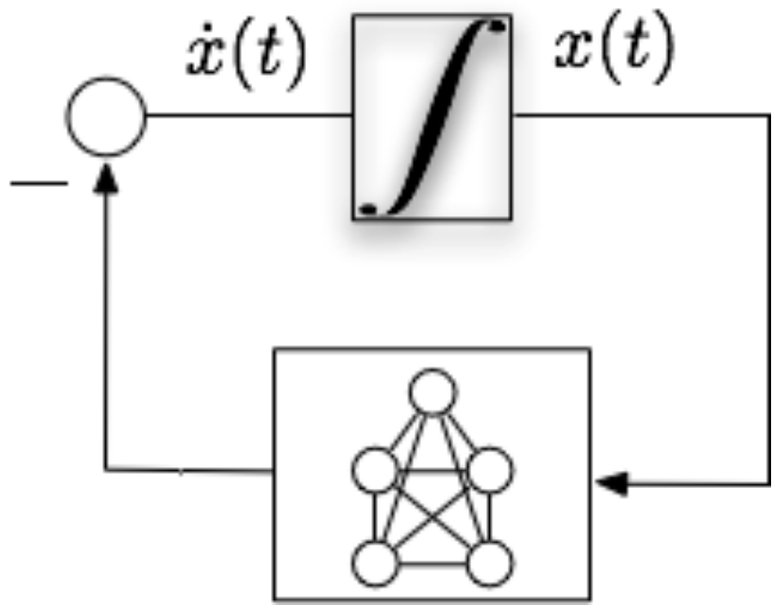


Course Goals

Course Goals

- Graph Theory
  - combinatorics
  - algebraic graph theory
- Consensus and Agreement Protocols
  - continuous and discrete systems
  - undirected/directed communication
  - linear and non-linear systems, switched systems
- Networks as Systems
  - graph theory $\longleftrightarrow$ systems theory





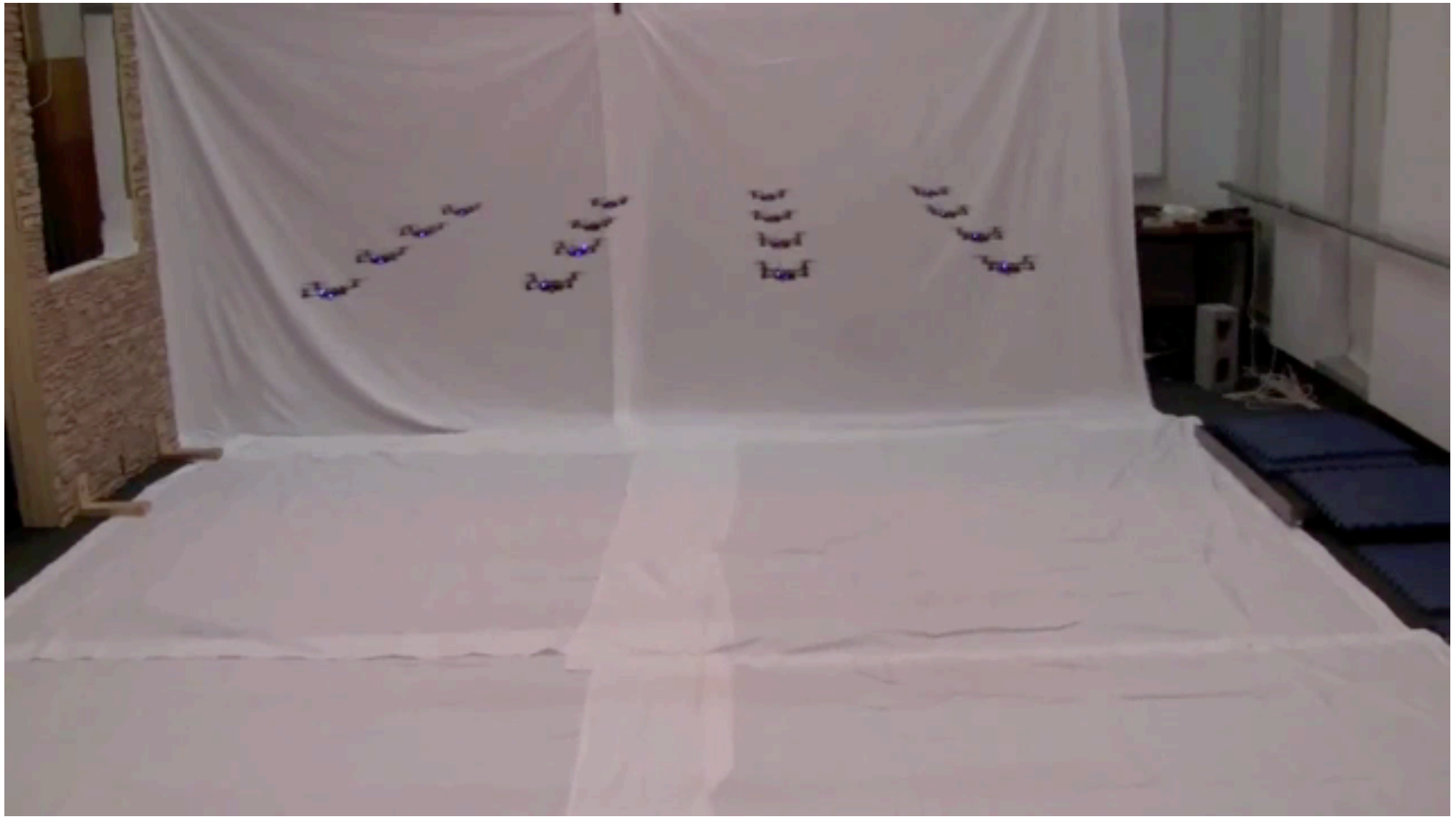
Course Goals

Course Schedule

June 30 - July 23

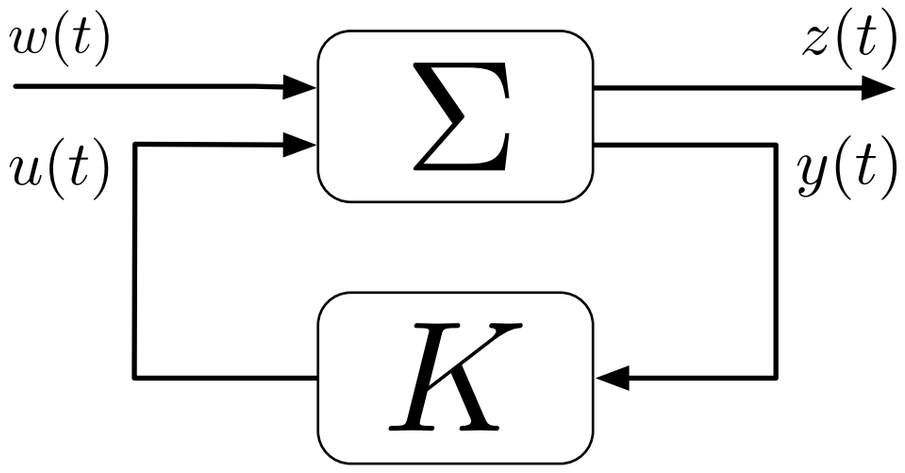
	Montag	Dienstag	Mittwoch	Donnerstag	Freitag
Week 1	- Introduction to MAS - Graph Theory	- Linear Consensus I - Gradient Systems	No Class	- Linear Consensus II	- Control of Networks
Week 2	- Performance of Networks	- Design of Networks	No Class	- Formation Control I	- Formation Control II - Conclusions and Outlook
Week 3	No Class				
Week 4	No Class	No Class	Final Exam 15:00 - 16:30	No Class	No Class

Modeling



Modeling

$$\dot{x}_1(t) = f(x_1(t), u_1(t), t)$$



linear
non-linear
CT, DT
hybrid
stochastic
...

trajectory tracking
robust control
optimal estimation

optimal control
nonlinear control
model predictive control

Modeling

$$\dot{x}_1(t) = f(x_1(t), u_1(t), t)$$

$$\dot{x}_2(t) = f(x_2(t), u_2(t), t)$$

$$\dot{x}_3(t) = f(x_3(t), u_3(t), t)$$

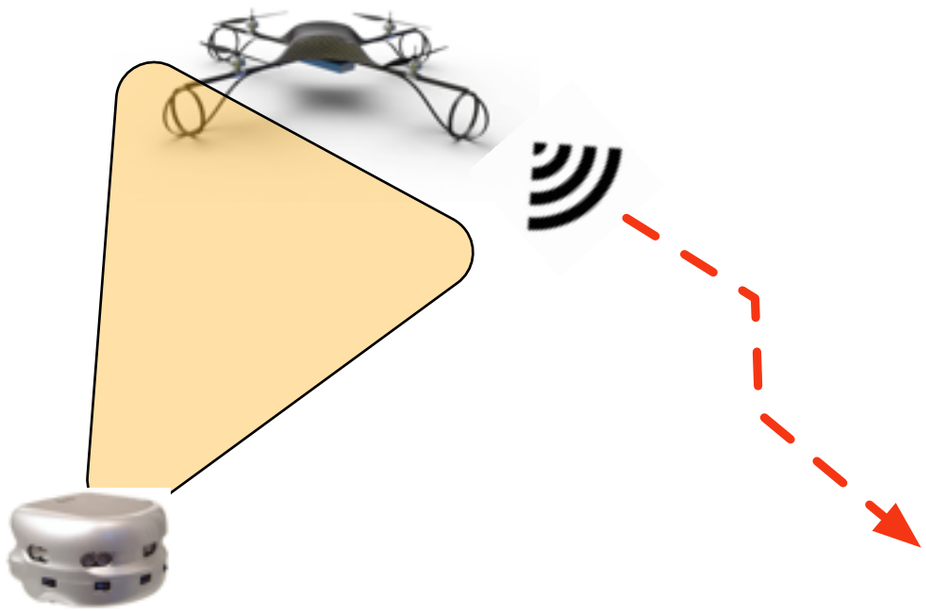
Modeling

$$\dot{x}_1(t) = f_1(x_1(t), u_1(t), t)$$

$$\dot{x}_2(t) = f_2(x_2(t), u_2(t), t)$$

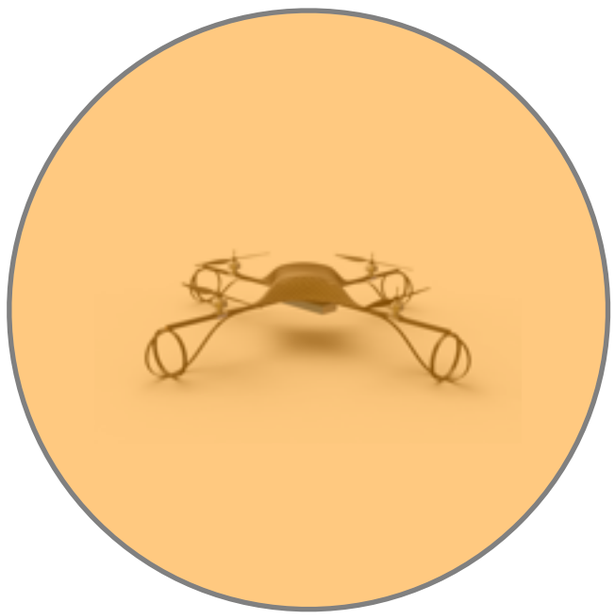
$$\dot{x}_3(t) = f_1(x_3(t), u_3(t), t)$$

Modeling



omnidirectional
vision
radar
relative sensing
range measurements

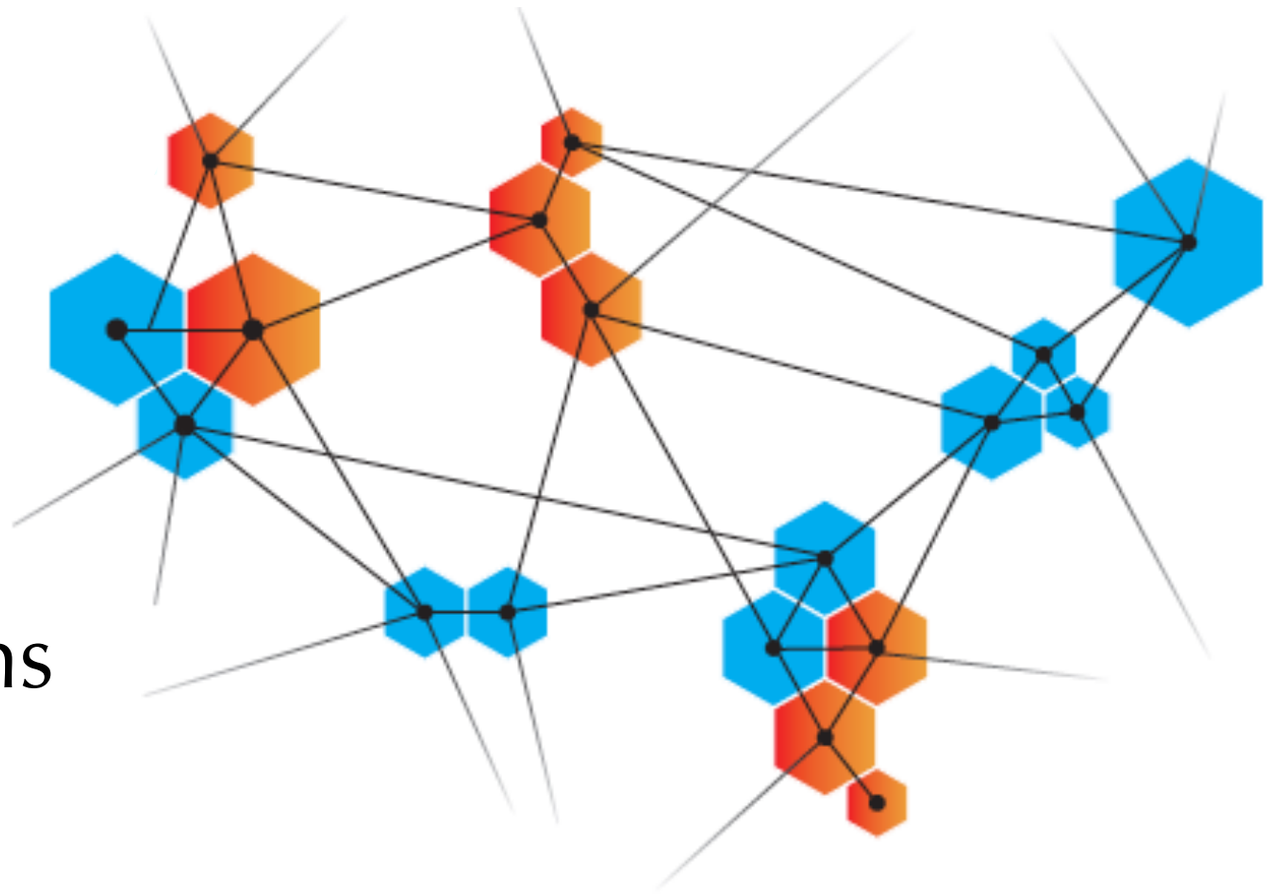
...



Networked Dynamic Systems

Why is this hard?

- large-scale
- complexity & scalability
- variety of interconnections
- delays, bandwidth, etc…



We need a new and dedicated approach for studying these systems!

Networked Dynamic Systems