

Consensus and Synchronization of Autonomous Agents on Lie Groups

Ravi N. Banavar

The workshop has the following schedule:

9³⁰-10⁴⁵ Multi-agent systems on Euclidean Spaces and Oscillators on a circle: A Survey in a unified framework

Speaker: **Ravi Banavar**

In this lecture, the Laplacian flow (based on inter-agent errors) for consensus on Euclidean spaces and oscillator synchronization in the Kuramoto framework (based on sine of the inter-agent errors) are both reviewed and are cast in a common framework by considering the Euclidean Space and the Circle as Abelian Lie Groups. Mechanical analogs based on springs and their potential energies are presented and behavior of these systems is cast in this intuitive framework. An introduction to graph theory is also presented.

10⁴⁵- 11⁰⁰ Coffee break

11⁰⁰-12³⁰ Lie Groups, Left/Right-Invariant Errors, the adjoint map and Potential Functions

Speaker: **Arun D Mahindrakar**

This lecture is an introduction to the essential mathematical machinery of differential geometry, Lie groups and potential functions. After being introduced to the concepts of group, manifold and Riemannian metric with examples, important geometrical properties of Lie groups are presented and a special class of potential functions relevant for consensus are presented. This lecture is self-contained and does not presuppose any previous knowledge of group theory or differential geometry. The group theoretic concept of left/right-invariant error on a Lie group and how this enables one to convert a tracking problem to a regulation problem on a Lie group is introduced. The adjoint relations between left and right invariant errors, and the relative velocity of agents separated by a constant error is also presented.

12³⁰-13³⁰ **Lunch**

13³⁰- 14³⁰ **Consensus on Lie groups**

Speakers: **Ravi N Banavar, Rama Seshan**

In this lecture, the first and second order dynamical systems for consensus on Lie groups are constructed by putting together all the machinery presented so far.

14⁴⁵-15⁴⁵ **Synchronization on Lie groups**

Speaker: **Ravi N Banavar**

In this lecture, the first and second order dynamical systems for synchronization on Lie groups are constructed. Stability analysis is done and an energy based intuition of the phenomenon is also given.

16⁰⁰ -17⁰⁰ **Numerical Demonstration and possibilities for further work**

Speakers: **Arun Mahindrakar, Rama Seshan**

In this lecture, simulations are presented with plots and animations. Further, other applications to other problems in Lie groups like distributed optimization and computing are presented.