AJ Ganesh -   (1+1 hr)
Epidemics on networks: thresholds and control strategies:

The talk will provide a brief survey of the contact process on networks, starting from early work on infinite lattices, and going on to finite networks. A key concept will be that of the epidemic threshold, which defines a phase transition between two different regimes on infinite graphs. While there can be no phase transition on finite graphs, we will see that it might still be possible to define a threshold for a sequence of growing graphs. We will look at thresholds for some widely used random graph models. The last part of the talk will discuss strategies for control of epidemics on networks.

Debmalya Panigrahi -   (1+1 hr)
Routing in cost-shared networks: equilibria and dynamics:

This tutorial will discuss how a network administrator/designer can efficiently route traffic from multiple strategic users if the routing cost is shared equally by them. I will talk about both static and dynamic settings, based on whether the set of users is fixed or users can join/leave the network over time. In both settings, I will discuss how the quality of the solution is affected by the degree of control available to the administrator. The first part of the tutorial will illustrate this by showing a sharp distinction between the price of anarchy and the price of stability of the resulting network game. This will lead us to the question of determining which of the corresponding equilibria are attainable via natural game dynamics; this will be our topic of discussion in the second part of the tutorial. The tutorial will touch upon a large body of work in the last 15 years in this area including recent developments, highlighting the main techniques developed and their shortcomings in trying to address the many outstanding questions in this domain.

Sitabhra Sinha -   (1+1 hr)
Strong community organization of populations can promote long-term recurrence of epidemic diseases:

Spread of directly transmitted infectious diseases, such as influenza, measles, etc., is strongly influenced by the structure of human contact networks. As empirical data on the networks of social contacts exhibits evidence for strong community or modular organization, it is natural to ask how do such structures affect the course of an epidemic - particularly in the long term. We report our investigations into the dynamics of models of epidemic spreading in modular networks, where individuals within a community tend to have a much higher degree of connectivity compared to the connectivity between different communities, that may provide clues for designing efficient methods of controlling human/animal pandemics. In particular, we consider the persistence of epidemic diseases for which individuals after having recovered from an infection can again become susceptible with a certain probability - modeled using SIRS (susceptible-infected-recovered-susceptible) dynamics at the agent level. We show that the disease can become recurrent depending on the mesoscopic organization of the social network. In particular, highly contagious diseases which would have become extinct in homogeneous contact networks may survive indefinitely when there is a strong community organization in the population. This suggests that introducing quarantine (or otherwise, isolating different segments of a population) for diseases with a high reproduction number may, counter-intuitively, sometimes have a negative effect in the long run.

Marcos Kiwi - **(30min)**
Adaptive Rumor Spreading:

Rumor spreading is a basic model for information dissemination in a social network. In this setting a central concern for an entity, say the service provider, is to find ways to speed up the dissemination process and to maximize the overall information spread. However, a central issue absent in this setting is that of adaptivity. How can the service provider use information about the current state of the network to cost effectively speed up the process. Motivated by the recent emergence of the so-called opportunistic communication networks, we take a novel approach by considering the issue of adaptivity in the most basic continuous time (asynchronous) rumor spreading process. In our setting a rumor has to be spread to a population and the service provider can push it at any time to any node in the network and has unit cost for doing this. On the other hand, as usual in rumor spreading, upon meeting, nodes share the rumor and this imposes no cost on the service provider. We consider the cost version of the problem with a fixed deadline and ask for a minimum cost strategy that spreads the rumor to every node. A non-adaptive strategy can only intervene at the beginning and at the end, while an adaptive strategy has full knowledge and intervention capabilities. Our main result is that in the homogeneous case (where every pair of nodes randomly meet at the same rate) the benefit of adaptivity is bounded by a constant. This requires a subtle analysis of the underlying random process that is of interest in its own right. Joint work with J.R. Correa (U. Chile), N. Olver (VU University Amsterdam; and CWI, Amsterdam), and A. Vera (U. Chile).

Rajsekar Manokaran - **(30min)**
Average case analysis of RBMs:

Restricted Boltzmannian machines are a simple class of Bayesian networks that have found wide use as a model of information in machine learning. Training or tuning the parameters from observed data is a hard problem in the worst case for these models. We study training algorithms based on spectral algorithms that perform well on certain natural class of such networks where the parameters involved are independent and random. Based on work with Aditi Raghunathan.

Prithwish Basu - **(30min)**
Network design games in presence of strategic adversaries:

I will talk about our recent work on topology design games between a network designer and a strategic adversary. While the designer aims to defend the network or grow it to an optimal topology with respect to a network property, the adversary simultaneously counters and tries to force the designer to operate in a suboptimal topology. I will characterize some key structural properties of the mixed strategy equilibriums of this one-shot game, and then describe the effect of parameters, such as probability of a successful attack, on the topology dynamics in a repeated game setting. I will also describe a multi-stage game in which the designer is not just interested in the instantaneous network property costs but a discounted sum of costs over a period of time; and will examine whether defense/growth strategies here result in better benefits for the designer compared to the strategies resulting from the one-shot game.

Parongama Sen - **(30min)**
Some aspects of epidemic and information spreading:

We will discuss some general aspects of spreading processes in the context of epidemic and information flow. Some recent models and results will be discussed.

Auroop Ganguly - **(30min)**
Climate Change Impacts on Public Health and Hazards: A Networks and Behavioral Perspective:

Climate variability and change, including exacerbated weather and hydrologic extremes, can perturb or damage critical lifelines such as water, energy and transportation, and lead to long term changes in coupled natural-engineered-human systems. We discuss the challenges faced by the resource rich community of Brookline in Massachusetts, USA, as they develop adaptation and mitigation measures for public health impacts of climate-induced weather extremes in the decadal to century scales. The introduction of epidemics in a globalized world and scenarios of rapid spread are discussed. Generalizing from Brookline, we discuss the methods and tools, ranging from the data science in climate, water and epidemiology, to the science and engineering of interdependent networks for critical lifelines, to infrastructural risk and resilience models, and finally to agent-based social and behavioral models, which can be brought to bear to address the complex challenge. The hard problems of nonstationarity and deep uncertainty, together with complex dependence patterns and possible cascading failures of essential services, as well as the vulnerability of infrastructures and peoples under stress, are discussed. The challenges and opportunities for developing research products and end-to-end systems are discussed.

Joydeep Chandra - **(30min)**
Social Interaction in the Flickr Social Network:

Online social networking sites such as Facebook, Twitter and Flickr are among the most popular sites on the Web, providing platforms for sharing information and interacting with a large number of people. The different ways for users to interact, such as liking, retweeting and favoriting user-generated content, are among the defining and extremely popular features of these sites. While empirical studies have been done to learn about the network growth processes in these sites, few studies have focused on social interaction behaviour and the effect of social interaction on network growth. In this paper, we analyze large-scale data collected from the Flickr social network to learn about individual favoriting behaviour and examine the occurrence of link formation after a favorite is created. We do this using a systematic formulation of Flickr as a two-layer temporal multiplex network: the first layer describes the follow relationship between users and the second layer describes the social interaction between users in the form of favorite markings to photos uploaded by them. Our investigation reveals that (a) favoriting is well-described by preferential attachment, (b) over 50% of favorites are reciprocated within 10 days if at all they are reciprocated, (c) different kinds of favorites differ in how fast they are reciprocated, and (d) after a favorite is created, multiplex triangles are closed by the creation of follow links by the favoriter's followers to the favorite receiver.

Dinesh Garg - **(30min)**
Incentivizing Crowd Networks for Rapid Geospatial Sensing to Prevent Epidemics Outbreak:

Advances in the Internet and communication technologies have made it possible to harness the wisdom and efforts from a sizable portion of the society towards accomplishing tasks which are otherwise herculean. This phenomenon is popularly known as crowdsourcing. Further, an explosive growth in online social media has given a novel twist to crowdsourcing applications where participants can exploit the underlying social network for inviting their friends to help executing the task.

In this talk, we discuss the problem of a planner who needs to incentivize agents within a network in order to seek their help in executing an atomic task as well as in recruiting other agents to execute the task. One key application of this work is related to digital epidemiology, where a public health organization that is responsible for monitoring and controlling the spread of an infectious disease needs to regularly and repeatedly survey, identify, and reduce the intensive sources and epidemics of the disease in a timely manner to avoid any outbreak.

Shashi Thutupalli - **(1+1 hr)**
Active and evolvable matter: A perspective from physics about biology:

Biological systems are a truly unique state of matter - active, adaptive and evolving. Cells, biological tissues, highly coordinated animal groups and interacting populations are a form of complex materials with emergent coherent properties that arise from mechanical and socially-mediated interactions between constituent elements/ individuals. Unlike in purely physical systems, a biological individual is capable of processing information, in addition to tuning dynamically adaptive response. These augmented capabilities of individual units allow a population to exhibit collective organization and behaviour, beyond what is found in traditional materials. Such a perspective naturally suggests two complementary approaches : (i) to distill unifying physical principles that govern biological systems by probing them as a unique state of matter or as a unique class of dynamical systems and (ii) to construct de novo, using traditional materials, systems with functions that are defining features of living matter such as self propulsion, replication etc. and study the resulting emergent collective behavior. In revealing the differences between the different systems, artificial and biological, as well as the underlying commonalities in mathematical features, we hope to better understand the relationship between microscopic and macroscopic emergent collective behaviour in systems far from equilibrium and ultimately, in biology. In this talk I will try to present a panoramic view of these issues through a survey of relevant work and will also touch upon some of our own proposals in this regard.

Vishu Guttal - **(30min)**
Early warning signals of critical events in complex systems:

TBD

Y Narahari -   **(30min)**
Multi-Phase Information Di ffusion in Social Networks:

The problem of maximizing information di ffusion, given a certain budget constraint (the number of seed nodes), is an extensively studied topic in social networks research. Existing literature focuses on single phase diffusion where (a) all seed nodes are selected at the beginning of diffusion and (b) all the selected nodes are activated simultaneously. In this talk, we undertake an investigation of the effect of selecting and activating seed nodes in multiple phases. Specically, we study diffusion in two phases assuming the well-studied independent cascade model. First, we formulate an objective function for two-phase diff usion, investigate its properties, and propose e fficient algorithms for finding the seed nodes in the two phases. Next, we study two associated problems: (1) budget splitting which seeks to optimally split the total budget between the two phases and (2) scheduling which seeks to determine an optimal delay after which to commence the second phase.

Atanu Sinha -   **(30min)**
Market for Information :

We study a market for information in one-of-a-kind services (e.g., home improvement), where an infomediary mediates contact-information between the consumer and providers. This market is a part of online platform-markets for information that have evolved since the advent of the Internet and continue unabated. Unlike online price-information markets for standardized products and services (e.g., automobile and insurance), or, platform markets for advertisements (e.g., ad exchange) and software development (e.g., apps for mobile OS) in one-of-a-kind services the deliverable is non-standardized and in fact, customized for every consumer. This necessitates considerable a priori task-specific information flow between the consumer and potential providers, who vary in cost of performing the task, and thus motivates the consumer to host bid competition among providers. In turn the infomediary may find an incentive to control the information flow between the consumer and the potential providers. Recognizing the bid-competition-based price discovery for the service, the infomediary sets fees to balance own revenue with the need of attracting both providers and consumer. Using game theoretic models, we analyze three platforms that differ in (1) whether providers or the consumer pays for contact-information, and (2) whether brief vs. detailed task-specific information is transmitted to potential providers. In the first two platforms, both high- and low-cost providers obtain contact-information, and infomediary sets a high fee to restrict competition to a deterministic number of providers; thus, its interest can be misaligned with the consumer. In a third platform, which allows detailed task-specific information flow to potential providers, only low-cost providers obtain contact-information, infomediary sets an intermediate fee to attract a probabilistic number of providers, and its interest is partially aligned with the consumer. We further compare the platforms based on infomediary revenue and social cost. In addition, we analyze data obtained from an online infomediary to draw further empirical insights.

John Augustine -   **(30min)**
Random Walks on Dynamic Graphs :

Random walks are useful in modeling a variety of natural phenomena. Moreover, they have also found wide application as an algorithmic tool. Quite naturally, they have been studied extensively in the context of static graphs. In this talk, we will present recent results from the last five years that have extended random walks theory to dynamic graphs and show how they can be effectively used to solve a variety of algorithmic problems in dynamic networks.

Shakti Menon -   **(30min)**
The evolution of collective strategies in communities :

Cooperation is one of the fundamental mechanisms underlying the organization of systems as diverse as genomes, multicellular organisms and human societies. The emergence of cooperation in systems of interacting "rational" agents is a nontrivial phenomenon that has long intrigued biologists, sociologists and mathematicians alike. Many previous investigations into the evolution of collective strategies have utilized the paradigm of the iterated spatial Prisoner's Dilemma game, where agents interact with their neighbours on a network of given topology and at each iteration choose their actions (which can either be to cooperate or to defect) using a specified updating scheme. Of particular interest is the nature of collective strategies that arise in modular networks, i.e. networks having a community structure. We consider the joint roles played by modularity and temperature (or "noise") in the updating scheme on the sustenance of cooperation, and connect this to known behaviour of Ising spins on modular networks.

Sudarshan Iyengar -   **(30min)**
Diffusion: Information Cascades, Epidemics and Knowledge Networks.

The tutorial will centre around some of the classical models of diffusion and its limitations. The discussion will range from the standard SIR/SIS model, the branching processes to some of the recent open questions in epidemic modelling. Special emphasis will be on some of the state of the art ideas in knowledge networks where cognitive conflicts trigger information diffusion with incremental improvisations. We will also touch upon modeling collective action and some of the open questions pertaining to knowledge emergence in collaboration networks.

Ramesh Hariharan -   **(30min)**
Using Data to Make Genomic Diagnoses :

A small but not insignificant fraction of individuals suffer from early onset diseases caused by single or few genomic mutations. The task of identifying the genomic cause requires sequencing the genome and then analysing the large amount of data that results. What follows can often be confounding in various ways as this talk will illustrate with real examples -- infants who pass away mysteriously, siblings with misplaced organs, a little boy suffering from bone marrow failure, an infant whose blood can't carry enough oxygen, and my own colorblindness. Some of these are captured in a book called Genomic Quirks.

Rajmohan Rajaraman -
Cobra Walks :

Coalescing-branching random walks, or cobra walks for short, are a natural variant of random walks on graphs that can model the spread of disease through contacts or the spread of information in networks. In a k-cobra walk, at each time step a subset of the vertices are active; each active vertex chooses k random neighbors (sampled independently and uniformly with replacement) that become active at the next step, and these are the only active vertices at the next step. A natural quantity to study for cobra walks is the cover time, which corresponds to the expected time when all nodes have become infected or received the disseminated information. In this talk, we introduce and motivate cobra walks, discuss results on the cover time on expanders, grids, trees, and general graphs, and close with several open problems.

Ananth Grama -
Role of Statistical Significance in Network Analytics :

Problems in network analytics are commonplace in diverse domains, ranging from social interactions to systems biology and spread of infectious diseases. More recently, interactions between distinct networks have attracted considerable attention as well; for e.g., social networks and the spread of disease, drug similarity/ complementarity and its regulatory impact on gene expression, etc. In this talk, I will highlight the importance of statistical analysis, and its role in motivating algorithm development, in network analytics. I will present three specific examples -- statistical significance of dense clusters in random graphs, statistical significance of overlaps of clusters with applications in social networks, and statistical significance of network alignments with applications in biomolecular interaction networks. These results will be used to motivate new problems in derivation of arrival sequences in dynamic networks and tracking lineage of dynamic objects in evolving systems. In each of these problem, I will highlight the role of analytical modeling, design of suitable priors, and their impact on algorithm design.