# Unit III - Generative Models

- Network properties to be modelled

  Properties observed in real world networks -

  1. Power law distribution
  2. High clustering coefficient
  3. Small average path length

- Random graph models

  - G(n,p) model - likely to contain none or all possible edges
  - G(n, m) model - contains a fixed number of edges

  At p = 0 - No giant component is observed, diameter is small, there are small isolated components

  At larger values of p - Giant component starts to appear, isolated components become connected, diameter value increases

  The point where the diameter value starts to shrink in a random graph is called the phase transition. p = 1/(n-1). The giant component that just started to appear starts to grow and then the diameter that just reached it's maximum value starts decreasing.

- Barabasi Albert preferential model

  - Growth element
  - Preferential attachment element
  - Average path length increases logarithmically
  - Clustering coefficient is a function of time

- Watts and Strogatz Small world model

  - Egalitarian assumption about the same number of connections

- Built on a low dimensional regular lattice and then adding or moving random edges to create a low density of shortcuts.
- Rewiring of links - replaces an existing edge with a nonexisting edge between two nodes with probability b
- 0 < b < 1 where b = 0 implies the model is a regular lattice and b = 1 implies the model is a random graph

▼ Myopic/Decentralized search

Milgram's experiment

Randomly chosen individuals forward a letter

The network distances between people are typically small - small world model

Diameter scales logarithmically

**Decentralized search** - people acting without any sort of global map are effective at colletively finding short paths.

Each node knowns only his set of local contacts of subsequent nodes.

Current message holder chooses the target closest to it.

This works recursively until target is reached.

> 💡 Inverse square distribution of links with distance makes for effective myopic search

▼ Herd behaviour

▼ Diffusion

Awareness - Interest - Evaluation - Trial - Adoption

Innovators - Early adopters - Early majority - Late majority - Laggards

**Bass model**

1. Innovators
2. Imitators

3. Innovation coefficient p - represents the extent to which the adopters emulate other members of the same population

- S shaped adoption curve
- q<p - innovation effects dominate
- q>p - imitation effects dominate

▼ Epidemics

Infection probability - p

Branching factor - k

Base reproductive number, R0 = pk

▼ SI model

One way flow

Fixed rates, fixed population

eg: Herpes, CMV

- Can be written using an ODE.

▼ SIR model

Process of epidemic is controlled by a) network structure b) length of infection t1

Dynamic SIR process can be converted into a static percolation model

▼ SIS model

▼ SIRS model

| **Model** | **Average path length** | **Degree distribution** | **Clustering Coefficient** |
|---|---|---|---|
| Random graph model (Erdos Renyi) | can model properly | Poisson - NOT power law | Underestimates CC |
| Barabasi’s preferential attachment model | Small average path length (increases logarithmically) | Most known for power law distribution | Fails to exhibit high clustering coefficient |
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|---|---|---|---|
| Watts and Strogatz small world model | Short average path length | Incapable of following power law | High clustering coefficient |