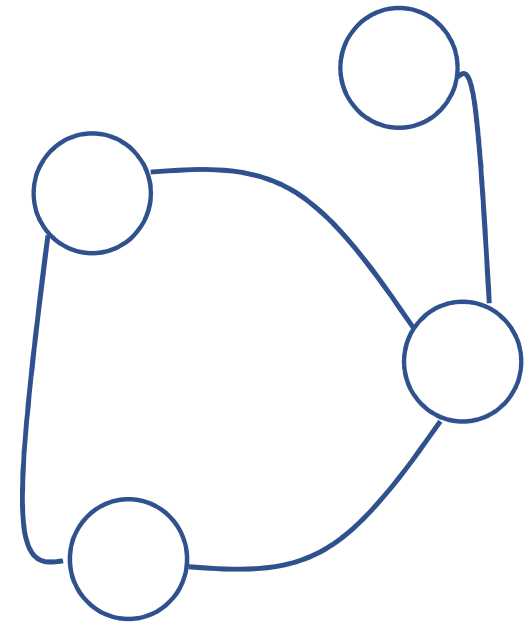# Module II: Graph Basics

10:30 am - 11:30 am

Why

- Importance of graph

Understanding Graph

- Graph representation
- Nodes, edges and structure
- Temporal and spatial dynamics

Lab 2 – Graph properties in *MAG*

- Degree centrality & Clustering coefficient
- Temporal and spatial dynamics – AI trends comparison between US and China
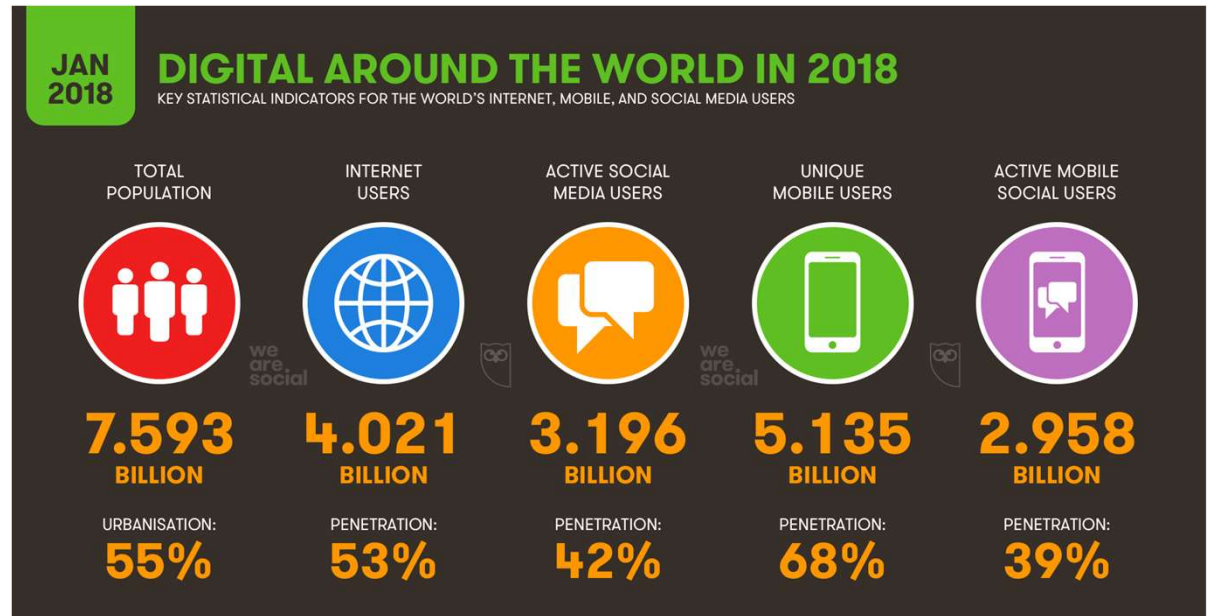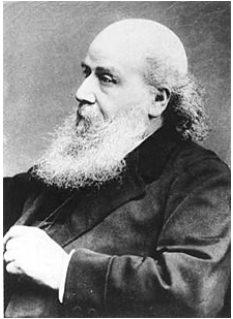
Module 2 Overview

Graph basics

THE ERA OF (DIGITALLY)
   CONNECTED WORLD

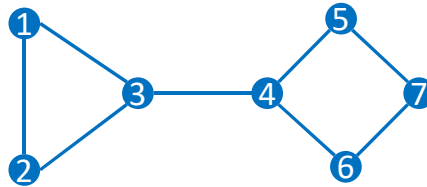- Computer
- People
- IoT (things / devices)

Why is Graph Important

The graph G can be represented as a matrix!

The term "graph" (1878)
The term "matrix" (1850)

James J Sylvester

(1814--1897)

$G = (V, E)$, where V is the node set and E denotes the edge set.

- V: $v_1, v_2, v_3, v_4, v_5, v_6, v_7$
- E: $e_{12}, e_{13}, e_{23}, e_{34}, e_{45}, e_{46}, e_{57}, e_{67}$
- $E \subseteq V \times V$

Adjacency matrix $A = \{a_{ij}\}_{n \times n}$

- $a_{ij} = \begin{cases} 1 & if\ e_{ij} \in E \\ 0 & otherwise \end{cases}$

$$\begin{bmatrix} 0 & 1 & 1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 & 0 & 0 & 0 \\ 1 & 1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 1 & 1 & 0 \end{bmatrix}$$

Graph Representation

- Importance of nodes
  - Degree centrality
  - Clustering coefficient centrality
  - Eigenvector centrality
  - HITS centrality

- Similarity of nodes
  - Node label classification
  - Node clustering / community detection

Understanding nodes

- Edges – missing link prediction
  - in homogeneous networks
  - in heterogeneous networks

- Structure
  - Network similarity (structural similarity)

Understanding edges and structure

- Temporal dynamics

  - When node / edge has a birthdate

- Spatial dynamics

  - When node has a geo-location

Understanding the graph evolution

- Task 1: Degree Centrality

- Task 2: Clustering coefficient

- Task 3: Temporal and spatial stats

Lab 2: Graph properties in MAG