

Complex Networks (MTH6142) Solutions of Formative Assignment 1

- **1. Adjacency matrix.**

Consider the following adjacency matrix of a network

$$\mathbf{A} = \begin{pmatrix} 0 & 0 & 1 & 1 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 & 0 \end{pmatrix} \quad (1)$$

- a) Is the network directed or undirected? (*Explain why*).
- b) Draw the network.
- c) List the in-degree sequence and the out-degree sequence of the network
- d) Determine the in-degree distribution and the out-degree distribution

- **Solution of question 1.**

- a) The network is directed because the adjacency matrix is asymmetric.
- b) The network is drawn in figure 1
- c) The in-degree sequence is given by $\{2, 1, 2, 0, 2\}$.
The out-degree sequence is given by $\{2, 1, 2, 2, 0\}$.
- d) The in degree distribution is given by $P(0) = 1/5, P(1) = 1/5, P(2) = 3/5$, and $P(k) = 0$ for $k > 2$.
The out-degree distribution is given by $P(0) = 1/5, P(1) = 1/5, P(2) = 3/5$, and $P(k) = 0$ for $k > 2$.

- **2. Number network.**

Given the set of nodes V , with $|V| = 6$, in which each node i is labelled by a natural number between 1 and 6, $i = 1, 2, 3, 4, 5, 6$, consider the directed network $G = (V, E)$ where each link from node j to node i indicates that j is a multiple of i .

- a) Draw the network.
- b) Write down the adjacency matrix of the network.
- c) Are there tadpoles in the network? How many?

- **Solution of question 2.**

- a) The network is drawn in figure 2.
- b) The adjacency matrix of the network is the following

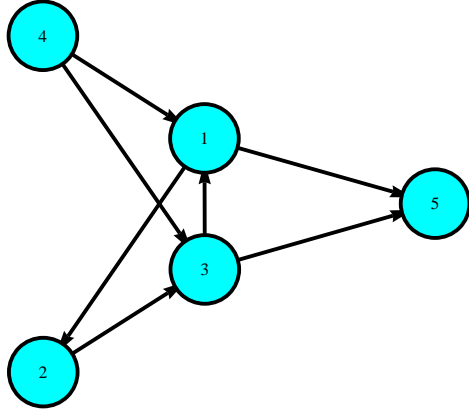


Figure 1: The network described in problem 1.

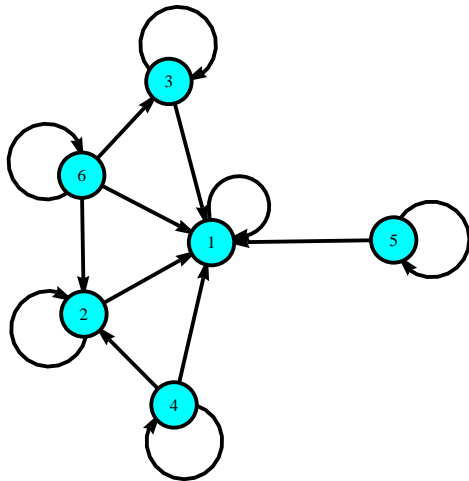


Figure 2: The network described in problem 2.

$$\mathbf{A} = \begin{pmatrix} 1 & 1 & 1 & 1 & 1 & 1 \\ 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix}$$

c) In the network there are 6 tadpoles.