# Lab #4

COMP6925: Applied Operations Research

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# Network Optimisation

- Many optimisation problems can be defined upon a network/graph
- Graphs comprise:
  - Set of actors, agents, sub-units
  - Set of interactions/relationships
  - Power representation over many scenarios
- Some problems/circumstances can easily be framed as a problem defined on a graph
  - E.g. Finding the lowest cost route from point A to point B
- Graph more implicit in some other scenarios
  - E.g. assigning lab demonstrators to lab sessions

# Network Optimisation

- Many, though not all, optimisation problems defined on graphs/networks can be expressed a linear or integer programming problems
- However, even when LP is a viable prism, specialised algorithms can yield better performance, handle larger instances, and lend themselves to more robust deployment
- Several good libraries exists for solving network programming problems:
  - LightGraphs and LightGraphsFlows in Julia
  - NetworkX in Python
  - Both implement graph type(s) for storing data
  - Both provide algorithms that operate on said ADTs
  - NetworkX API easier to use, so for network optimisation, we will consider NetworkX

# Shortest-Path Problem Example

**At a small but growing airport, the local airline company is purchasing a new tractor for a tractor-trailer train to bring luggage**
**to and from the airplanes. A new mechanized luggage system will be installed in 3 years, so the tractor will not be needed after that. However, because it will receive heavy use, so that the running and maintenance costs will increase rapidly as the tractor ages, it may still be more economical to replace the tractor after 1 or 2 years. The following table gives the total net discounted cost associated with purchasing a tractor (purchase price minus trade-in allowance, plus running and maintenance costs) at the end of year i and trading it in at the end of year j (where year 0 is now).**

| | | *j* | | |
|---|---|---|---|---|
| | | **1** | **2** | **3** |
| | 0 | \$8,000 | \$18,000 | \$31,000 |
| *i* | 1 | | 10,000 | 21,000 |
| | 2 | | | 12,000 |

# Max-Flow Problem Example

Four factories are engaged in the production of four types of toys. The following table lists the toys that can be produced by each factory.

| Factory | Toys productions mix |
|---|---|
| 1 | 1, 2, 3 |
| 2 | 2, 3 |
| 3 | 1, 3, 4 |
| 4 | 1, 3, 4 |

All toys require approximately the same per-unit labor and material. The daily capacities of the four factories are 250, 180, 300, and 200 toys, respectively. The daily demands for the four toys are 200, 150, 350, and 100 units, respectively. Determine the factories' production schedules that will most satisfy the demands for the four toys.