# ECE 559 — Project #4

## DUE: February 26

**Problem instance:** A graph $G = (V, E)$ where $V = \{1, 2, \ldots, n\}$ is the set of vertices and $E \subseteq V \times V$ the set of edges. An edge between vertices $i$ , $j$ is denoted by the pair $\langle i\ , j \rangle \in E$, and we define the *adjacency matrix* $(e_{ij})$ according to

$$e_{ij} \;=\; \begin{cases} 1 & \text{if } \langle i\ , j \rangle \in E \\ 0 & \text{otherwise} \end{cases}$$

**Feasible solution:** A set $V'$ of nodes such that $\forall\ i\ , j \in V' : \langle i\ , j \rangle \notin E$ (i.e., $e_{ij} = 0$).

**Objective function:** The size $|V'|$ of the independent set $V'$.

**Optimal solution:** An independent set $V'$ that maximizes $|V'|$ (i.e., the max cardinality independent set).

An example of an independent set problem is shown in Figure 1.

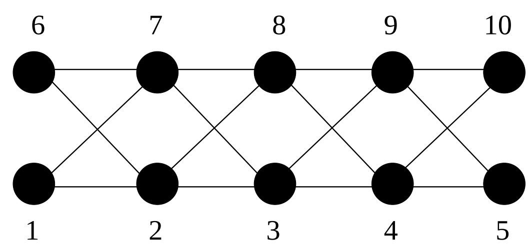


Figure 1: The independent set $\{2, 4, 7, 9\}$ is a feasible solution but not globally optimum.

The easiest form of genotype is to represent a candidate solution as the bit string $(b_1, b_2, \ldots, b_n) : b_i = 1 \Leftrightarrow i \in V'$. This way, the $i$-th bit indicates the presence ($b_i = 1$) or absence ($b_i = 0$) of vertex $i$ in the candidate solution. Note that $\sum_i b_i = |V'|$. A natural evaluation of an individual $\mathbf{x}$ is thus

$$\text{eval}(\mathbf{x}) \;=\; \sum_{i=1}^{n} b_i + \text{penalty}(\mathbf{x})$$

where the penalty reduces the evaluation of individual $\mathbf{x}$ for infeasibility.

You are to construct a genetic algorithm that solves an instance of the independent set problem. The graph itself is shown in Figure 2. Use a population of size $\mu = 20$ and run your GA for 100 generations. You will have to define an appropriate penalty function. Plot the best of 20 independent runs[1].

[1]In independent runs, there is no requirement that all runs have the same initial population.

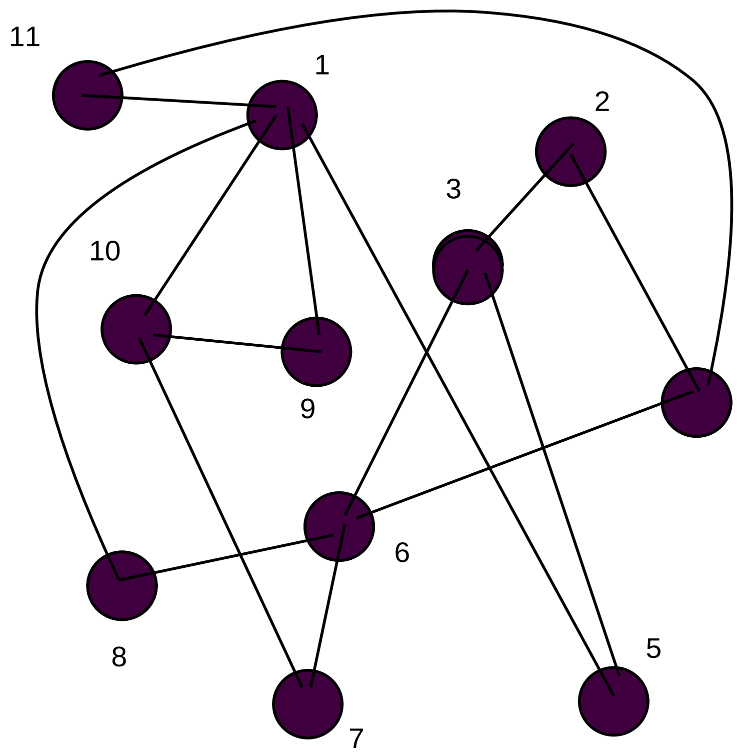


Figure 2: Test graph for the independent set GA problem.