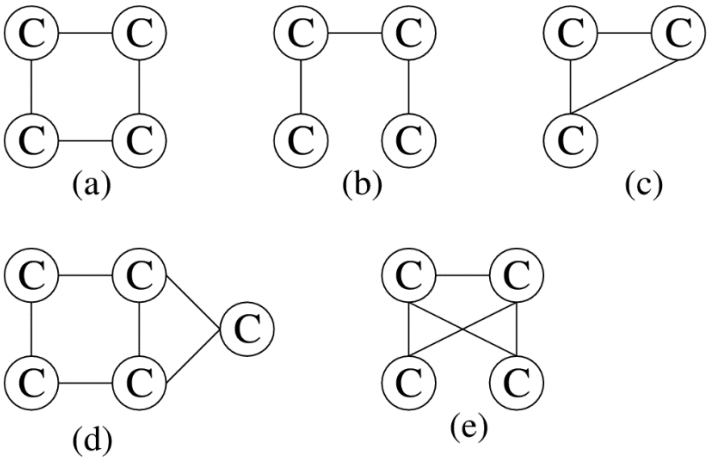
Assignment 3

The deadline of assignment 3 is:

Fri 25 May, 5:00 pm

Question 1 (5 marks)

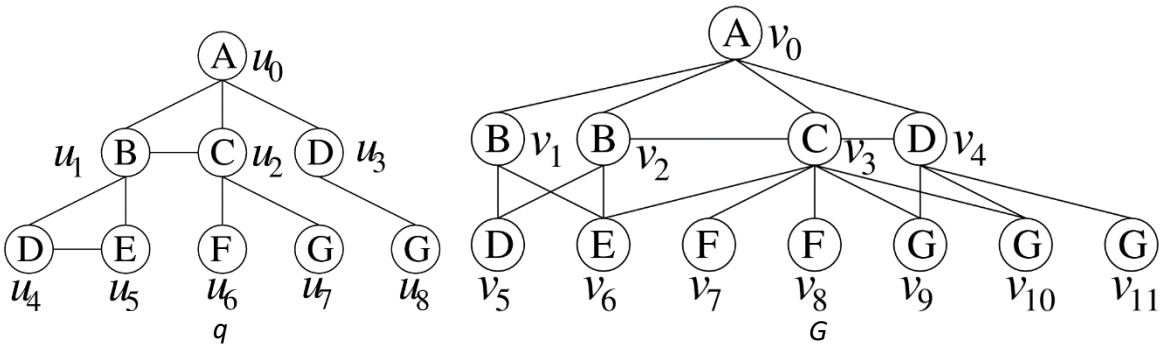
Given a graph database *D* containing following graphs:



1) Suppose *minFreq* = 3, draw at least 4 frequent patterns/fragments in the graph database *D*. A graph/pattern *g* is frequent if its occurrence frequency is no less than *minFreq*. (5 marks)

Question 2 (10 marks)

Given the following query *q* and data graph *G*.



1) Please draw a Neighborhood Equivalence Class tree (NEC tree) of query *q*. (5 marks)

The Neighborhood Equivalence Class(NEC) of a query vertex u is a set of query vertices, which are equivalent to u. The equivalence is defined as follows:
Let $\cong$ be an equivalence relation over all query vertices in q such that,
$u_i (\in V(q)) \cong u_j (\in V(q))$ if for every embedding m that contains (u_i, v_x) and (u_j, v_y) $(v_x, v_y \in V(g))$, there exists an embedding m' such that $m' = m - \{(u_i, v_x), (u_j, v_y)\} \cup \{(u_i, v_y), (u_j, v_x)\}$.

Please read the following paper for more detail:

Han, W. S., Lee, J., & Lee, J. H. (2013, June). Turbo iso: towards ultrafast and robust subgraph isomorphism search in large graph databases. In Proceedings of the 2013 ACM SIGMOD International Conference on Management of Data (pp. 337-348). ACM.

2) Please decompose the vertex set of query q according to Core-Forest-Leaf decomposition. That is, decompose the vertex set of q into three sets including the core-set, the forest-set and the leaf-set. (5 marks)

Given a query q, the Core-Forest-Leaf decomposition consists of core-forest decomposition and forest-leaf decomposition.

Core-Forest Decomposition

Edges of q can be categorized into two categories regarding a spanning tree q_T of q: edges in q_T are called tree edges while edges of q that are not in q_T are called non-tree edges regarding q_T.

Our core-forest decomposition is to compute a small dense subgraph containing all non-tree edges regarding any spanning tree, which is defined as follows. Given a query q, the core-forest decomposition of q is to compute the minimal connected subgraph g of q that contains all non-tree edges of q regarding any spanning tree of q; g is called the core-structure of q. The subgraph of q consisting of all other edges not in the core-structure called the forest-structure of q, denoted T. We call the vertex set of the core-structure as the core-set $\boldsymbol{V_C}$ and the forest-structure of q doesn't contain any vertices in $\boldsymbol{V_C}$.

Forest-Leaf Decomposition

Given the forest-structure T, rooting each tree in forest-structure at its connection vertex with core-structure. The set $\boldsymbol{V_I}$ is called the leaf set which contains all the degree-one vertices in the trees of forest-structure. The set of vertices not in $\boldsymbol{V_C} \cup \boldsymbol{V_I}$ is called the forest set $\boldsymbol{V_T}$.

Let $V(q)$ denotes the vertex set of q, $V(q) = \boldsymbol{V_C} \cup \boldsymbol{V_T} \cup \boldsymbol{V_I}$ and $\boldsymbol{V_C} \cap \boldsymbol{V_T} = \boldsymbol{V_C} \cap \boldsymbol{V_I} = \boldsymbol{V_T} \cap \boldsymbol{V_I} = \emptyset$.

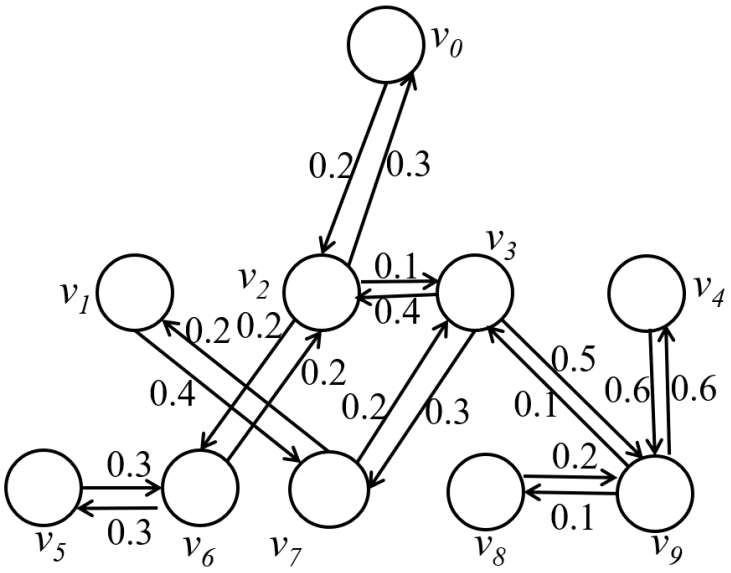
Please read the following paper for more detail:

Bi, F., Chang, L., Lin, X., Qin, L., & Zhang, W. (2016, June). Efficient subgraph matching by postponing cartesian products. In Proceedings of the 2016 International Conference on Management of Data (pp. 1199-1214). ACM.

Considering Figure 4 in the above paper, we can decompose the vertex set of q into:
The core set: u_0, u_1, u_2
The forest set: u_3, u_4, u_5, u_6
The leaf set: u_7, u_8, u_9, u_{10}

Question 3 (5 marks)

Given a social influence graph G_1 as following:



1) Choose one activated seed s from $v_0 \sim v_9$ which can generate the largest influence spreads (i.e., let $w(s) = 1$, maximize $\sum_{i=0}^{9} w(v_i)$). (5 marks)

   Initially, all the vertices are inactivated. We define $w(u)$ as the probability of a vertex u which can be activated. In graph G_1, $p(u, v)$ on a directed link from u to v is the probability that v is activated by u after u is activated (e.g., $p(v_0, v_1) = 0.3$). For example, $w(v_0) = 1$, $w(v_2) = 0.2$, and $w(v_3) = 0.2 * 0.1 = 0.02$ if we choose v_0 as the activated seed.