

# Problem sheet 9

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## 1.) Runtime of BFS

What is the running time of BFS if its input is represented by an adjacency matrix and the algorithm is modified to handle this form of input? (1P)

## 2.) Colors in DFS

Make a 3-by-3 chart with row and column labels WHITE, GRAY and BLACK. In each cell  $(i, j)$ , indicate whether, at any point during a depth-first search of a directed graph, there can be an edge from a vertex of color  $i$  to a vertex of color  $j$ . For each possible edge, indicate what type it can be. Make a second chart for DFS on an undirected graph. (2p)

## 3.) Cycles in undirected graphs

Give an algorithm that determines whether or not a given undirected graph  $G = (V, E)$  contains a cycle. Your algorithm should run in  $O(V)$  time, independent of  $|E|$ . (3p)

## 4.) Number of SCCs

How can the number of SCCs of a graph change if a new edge is added? Explain why. (1P)

## 5.) Component graphs

Give an  $O(V + E)$ -time algorithm to compute the component graph of a directed graph  $G = (V, E)$ . Make sure that there is at most one edge between two vertices in the component graph your algorithm produces. (3p)