















## Network algorithms

### Dijkstra's algorithm

START with a graph  $G$ . At each vertex draw a box, the lower area for temporary labels, the upper left hand area for the order of becoming permanent and the upper right hand area for the permanent label.

STEP 1 Make the given start vertex permanent by giving it permanent label 0 and order label 1.

STEP 2 For each vertex that is not permanent and is connected by an arc to the vertex that has just been made permanent (with permanent label =  $P$ ), add the arc weight to  $P$ . If this is smaller than the best temporary label at the vertex, write this value as the new best temporary label.

STEP 3 Choose the vertex that is not yet permanent which has the smallest best temporary label. If there is more than one such vertex, choose any one of them. Make this vertex permanent and assign it the next order label.

STEP 4 If every vertex is now permanent, or if the target vertex is permanent, use 'trace back' to find the routes or route, then STOP; otherwise return to STEP 2.

### Prim's algorithm (graphical version)

START with an arbitrary vertex of  $G$ .

STEP 1 Add an edge of minimum weight joining a vertex already included to a vertex not already included.

STEP 2 If a spanning tree is obtained STOP; otherwise return to STEP 1.

### Prim's algorithm (tabular version)

START with a table (or matrix) of weights for a connected weighted graph.

STEP 1 Cross through the entries in an arbitrary row, and mark the corresponding column.

STEP 2 Choose a minimum entry from the uncircled entries in the marked column(s).

STEP 3 If no such entry exists STOP; otherwise go to STEP 4.

STEP 4 Circle the weight  $w_{ij}$  found in STEP 2; mark column  $j$ ; cross through row  $i$ .

STEP 5 Return to STEP 2.

### Kruskal's algorithm

START with all the vertices of  $G$ , but no edges; list the edges in increasing order of weight.

STEP 1 Add an edge of  $G$  of minimum weight in such a way that no cycles are created.

STEP 2 If a spanning tree is obtained STOP; otherwise return to STEP 1.

## Additional Pure

### Vector product

$\mathbf{a} \times \mathbf{b} = |\mathbf{a}||\mathbf{b}|\sin \theta \hat{\mathbf{n}}$ , where  $\mathbf{a}, \mathbf{b}, \hat{\mathbf{n}}$ , in that order form a right-handed triple.