Karlsruher Institut für Technologie

Exercise Sheet 4

Discussion: 20. December 2017

Exercise 1: Forces ⋆

In the following we consider force-based layout methods.

(a) Define forces that ensure that

(i) vertices closely stay to pre-defined positions,

(ii) vertices are closely placed to the x-axis,

(iii) edges are aligned parallel to the y-axis,

(iv) directed edges are drawn upwards (similar to layered drawings).

(b) Let $G = (V, E)$ be a graph and assume that we are given a clustering $\mathcal{C}$ for G, i.e., a partition of V in pairwise disjoint subsets $C_1, \ldots, C_k$ with $\bigcup_{C \in \mathcal{C}} C = V$. Define forces that make sure that vertices of the same cluster lie closely together, while vertices of different clusters lie apart from each other.

(c) So far we have assumed for the spring-embedder algorithm that vertices are represented by points. How can the approach be adapted if the vertices are represented by circles that should not overlap? What about rectangles?

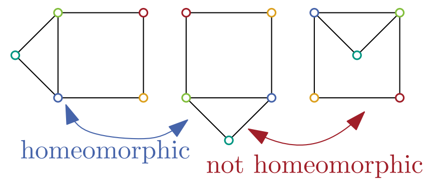
Exercise 2: Feedback Arc Set ⋆⋆

In the lecture we introduced the Minimum Feedback Arc Set and the Minimum Feedback Set problems. Let $D = (V, A)$ be a directed graph and A' be a subset of A. The set A' is a *feedback arc set of* D if $D_f = (V, A \setminus A')$ is acyclic. If $D_r = (V, (A \setminus A') \cup \{vu \mid uv \in A'\})$ is acyclic, then A' is a *feedback set of* D. Every feedback set is a feedback arc set, the reverse is not necessarily true. Prove the following.

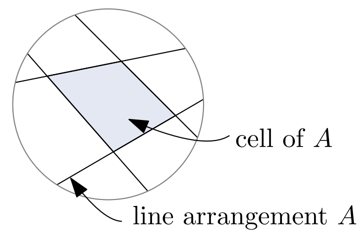
Lemma 1 *A set $A' \subset A$ is a minimum feedback arc set of D if and only if A' is a minimum feedback set of D.*

Exercise 3: Homeomorphic Drawings ⋆⋆

Let Γ be planar straight-line drawing of a graph $G = (V, E)$. For our purposes we say that two drawings Γ an Γ′ are *homeomorphic* if for every $v \in V$ there is a continuous movement of v starting from its position in Γ and ending at its position in Γ′, such that during the movement no vertex passes over an edge.



Lemma 2 *There is an arrangement A of lines with respect to Γ such that moving a vertex $v \in V$ within a cell of A yields a drawing Γ′ homeomorphic to Γ.*



Use this Lemma to design a spring-embedder that computes a drawing homeomorphic to a given input drawing.