**Abstract**

We present an overview of the first combinatorial results for the so-called geometric RAC simultaneous drawing problem, i.e., a combination of problems on geometric RAC drawings [3] and geometric simultaneous graph drawings [1].

**The GRACSim Problem**

The geometric RAC simultaneous drawing problem (or GRACSim, for short) is stated as follows: Given two planar graphs $G_1 = (V, E_1)$ and $G_2 = (V, E_2)$ with $E_1 \cap E_2 = \emptyset$, place their vertices on the plane so that, when the edges are drawn as straight-lines:

i. each graph is drawn planar
ii. there are no edge overlaps
iii. crossings between edges in $E_1$ and $E_2$ occur at right-angles.

**A Cycle and a Matching: A Positive Result**

**Theorem.** A cycle $C$ and a matching $M$ always admit a GRACSim drawing on an $(n + 2) \times (n + 2)$ integer grid. Moreover, the drawing can be computed in linear time.

If we remove an edge from $C$, the remaining graph is a path $P$.

Identify in $P \cup M$ a cycle collection that contains half of $P$'s edges and all of $M$'s edges and draw it in a snake-like fashion.

Add the remaining edges of $P$ and move each even-indexed vertex of $P$ one unit to the right.

Merge consecutive columns that do not interfere in $y$-direction into a common column.

Add the removed edge of $C$.

**A Wheel and a Cycle: A Negative Result**

Since Cabello et al. [2] have shown that a geometric simultaneous drawing of a wheel and a cycle always exists, the theorem mentioned above implies that if two graphs always admit a geometric simultaneous drawing, it is not necessary that they also admit a GRACSim drawing.

According to the GDual-GRACSim drawing problem, we are given a planar embedded graph $G$ and the main task is to determine a geometric drawing of $G$ and its dual $G^∗$ (without the face-vertex corresponding to the external face) such that:

i. $G$ and $G^∗$ are drawn planar
ii. each vertex of $G^∗$ is drawn inside its corresponding face of $G$
iii. the primal-dual edge crossings form right-angles.

**Theorem.** Given a planar embedded graph $G$, a GDual-GRACSim drawing of $G$ and its dual $G^∗$ does not always exist.

A graph that is a subdivision of a triconnected graph and it has two planar combinatorial embeddings.

In order to have a RAC drawing of $G$ and $G^∗$ both $uvvw$ and $uvv’x$ must be convex, which is impossible.

**Theorem.** Given an outerplane embedding of an outerplanar graph $G$, it is always possible to determine a GDual-GRACSim drawing of $G$ and its dual $G^∗$.

**References**


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