Planar Configuration Spaces

of Disk Arrangements and Hinged Polygons

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Protein Folding

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* Proteins in an organism fold into a specific geometric pattern (sometimes referred as its *native state*).
* Geometric patterns can determine a protein's function and behavior.

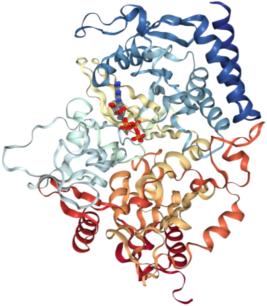

Figure: The structure of rat cytosolic PEPCK variant E89A in complex with oxalic acid and GTP [**?**].

Hinged Dissections

* asdf
* asdfasd

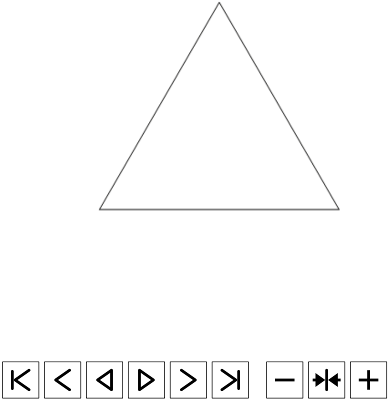

Figure: blah

Problem

Consider three realizability problems when the union of the polygons (resp., disks) in the desired configuration is simply connected (i.e., contractible). That is, the contact graph of the disks is a tree, or the "hinge graph" of the polygonal linkage is a tree (the vertices in the *hinge graph* are the polygons in $\mathcal{P}$, and edges represent a hinge between two polygons). Our main result is that realizability remains NP-hard when restricted to simply connected structures.

Problem 1

Theorem

It is strongly NP-hard to decide whether a polygonal linkage whose hinge graph is a tree can be realized.

Problem 2

A bit more information about this

Theorem

It is strongly NP-hard to decide whether a polygonal linkage whose hinge graph is a tree can be realized with counter-clockwise orientation.

Problem 3

A bit more information about this

Theorem

It is NP-Hard to decide whether a given ordered tree with positive vertex weights is the contact graph of a disk arrangements with specified radii.

Graphs and Drawings

Graph	Vertices	Edges
G_1	$\{a, b, c, d, e\}$	$\{(a, b), (b, c), (c, d), (d, e), (e, a)\}$
G_2	$\{1, 2, 3, 4, 5\}$	$\{(1, 2), (2, 3), (3, 4), (4, 5), (5, 1)\}$

Table: Two graphs that are isomorphic with the alphabetical isomorphism $f(a) = 1$, $f(b) = 2$, $f(c) = 3$, $f(d) = 4$, $f(e) = 5$.

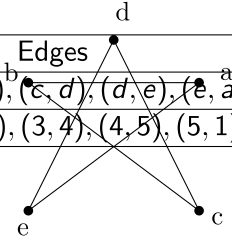

Figure: This figure depicts the graph isomorphism shown in Table 1 between V_1 and V_2.

Boolean Formulas

* Figure 4 is associated to a family of Boolean formulas. One such associated Boolean formula is:

$$(x_1 \vee x_3 \vee \neg x_5) \wedge (\neg x_1 \vee \neg x_2 \vee x_3) \wedge (\neg x_3 \vee x_4 \vee \neg x_5) \wedge (x_2 \vee x_4 \vee \neg x_5) \wedge (\neg x_1 \vee x_2 \vee x_5$$

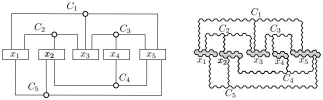

Figure: Left: the associated graph $A(\Phi)$ for a Boolean formula Φ. Right: the schematic layout of the variable, clause, and transmitter gadgets in the auxiliary construction showing in Section **??**

Modified Auxialry Construction

A bit more information about this

Gadgets

A bit more information about this

Transmission Gadget

A bit more information about this

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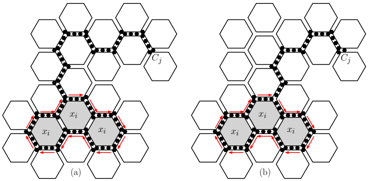

Figure: These two figures depict an example of placing a transmitter gadget corresponding to edge $\{x_i, C_j\}$.

Clause Gadget

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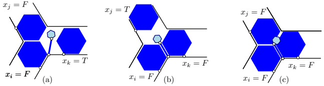

Figure: (a-b) A clause gadget $(x_i \vee x_j \vee x_k)$ is realizable when at least one of the literals is TRUE. (c) The clause gadget cannot be realized when all three literals are FALSE.

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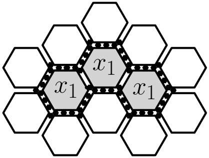

Figure: This depicts a variable gadget with $x_1 = T$. Carefully note that the flags around x_1 are in the state R. Corridors adjacent to two obstacles of a variable in the honeycomb do not have t flags; these corridors simply have the flags at the junctions.

Other Gadgets

A bit more information about this

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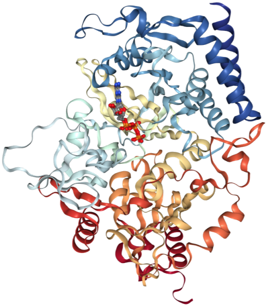

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