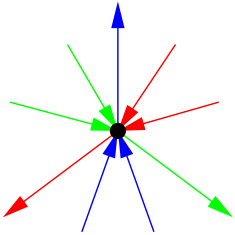
Toroidal Schnyder woods

Benjamin Lévêque

CNRS, LIRMM, Montpellier, France

Schnyder woods (planar triangulations)

Schnyder (1989)



For every inner vertex

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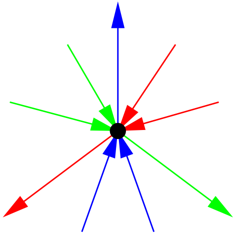

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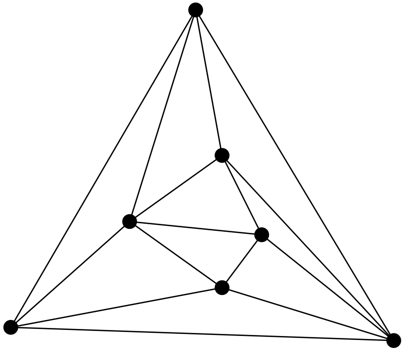

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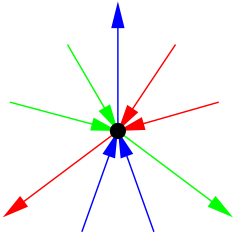

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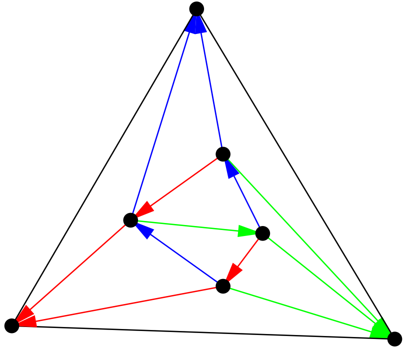

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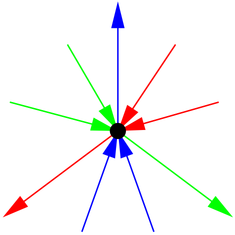

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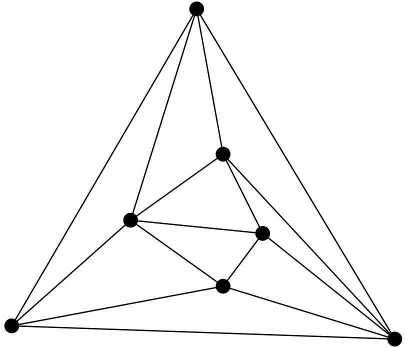

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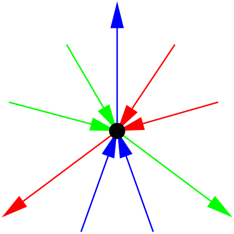

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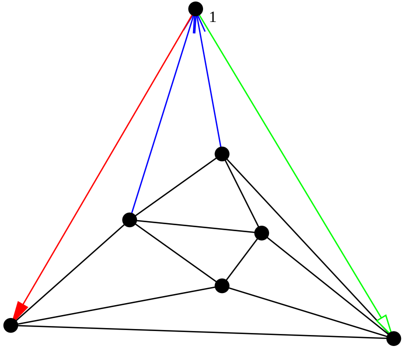

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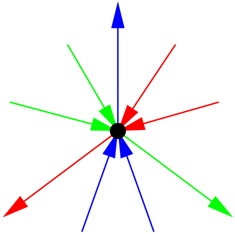

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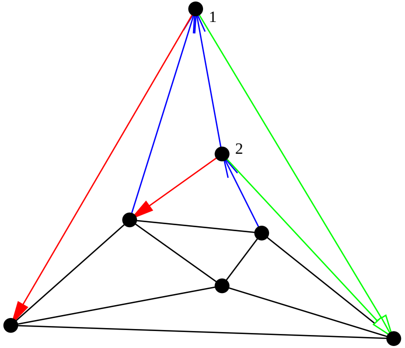

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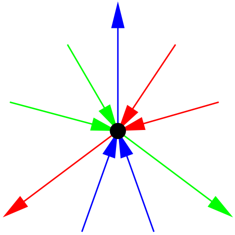

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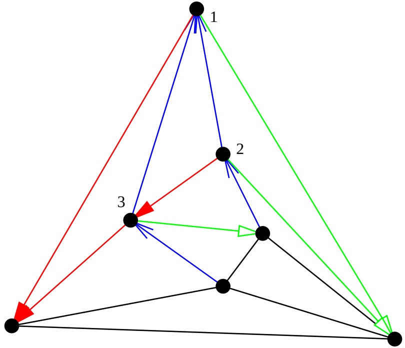

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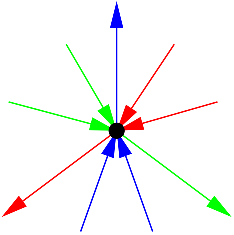

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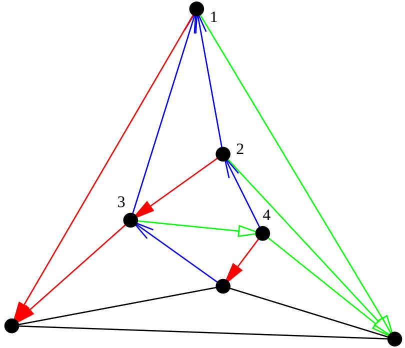

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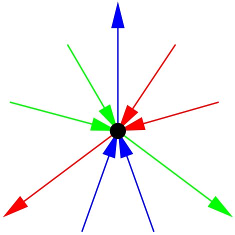

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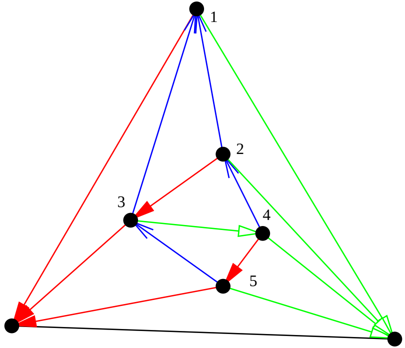

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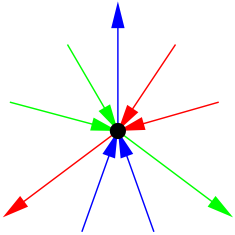

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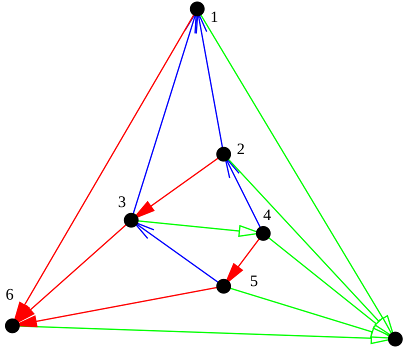

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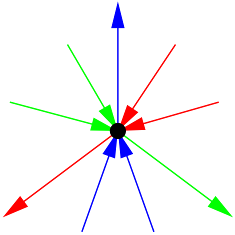

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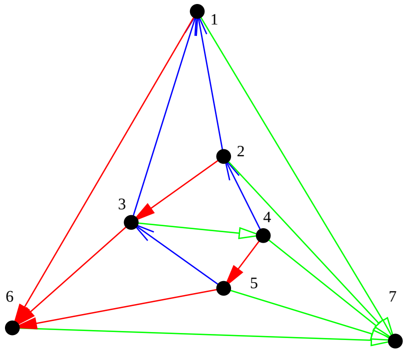

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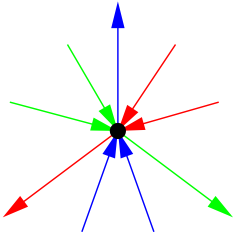

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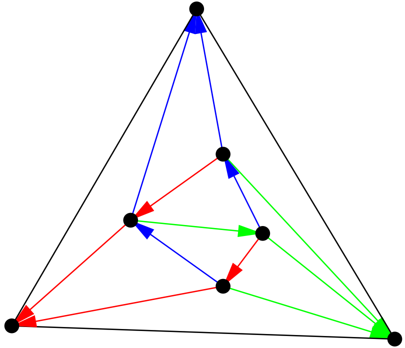

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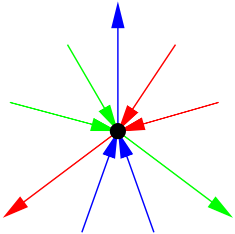

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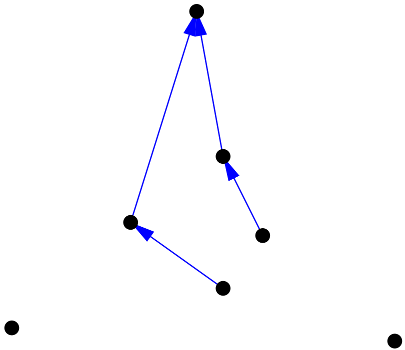

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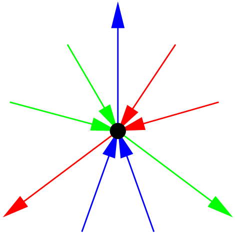

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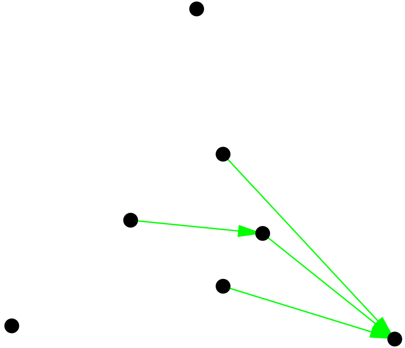

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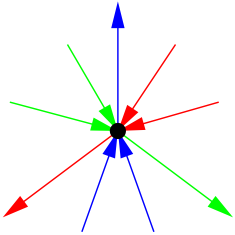

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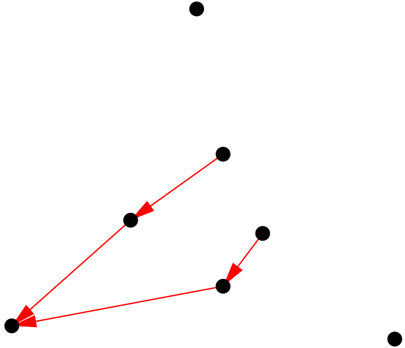

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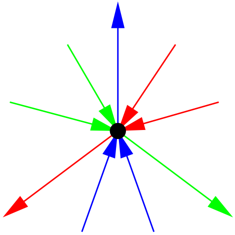

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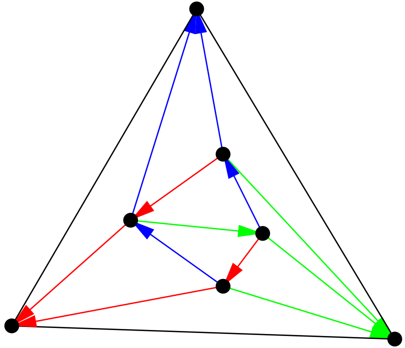

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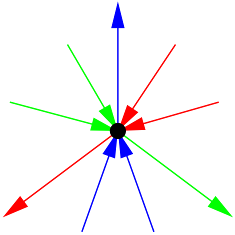

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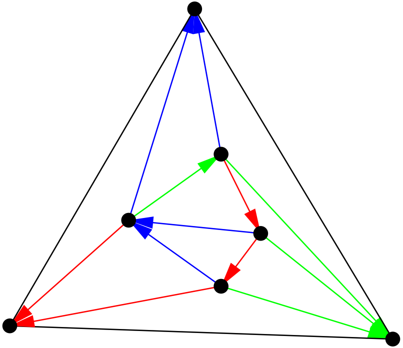

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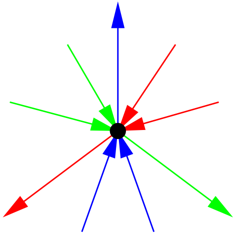

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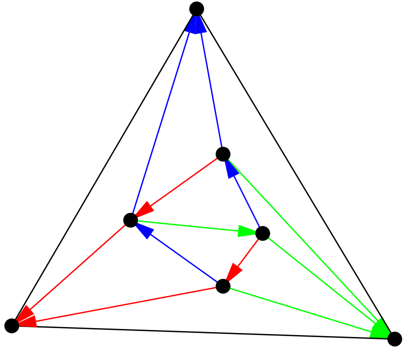

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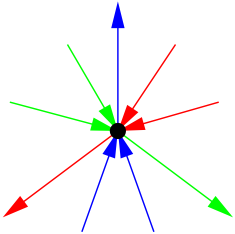

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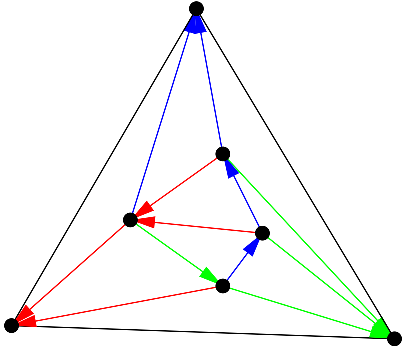

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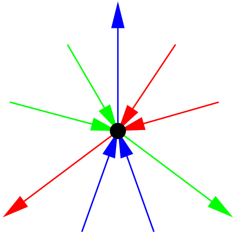

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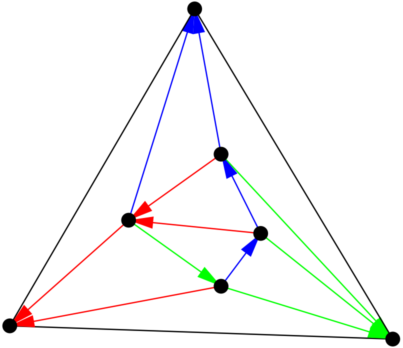
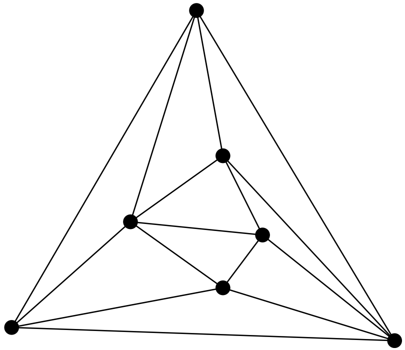


Planar graph $\iff$ Incident poset has DM-dimension ≤ 3

Optimal encoding

Poulalhon and Schaeffer (2003)



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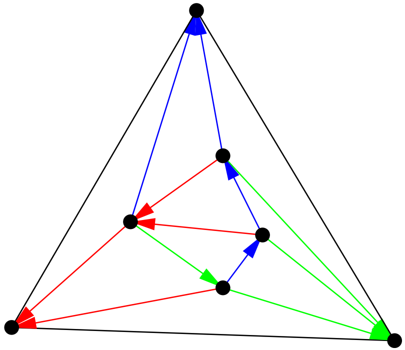

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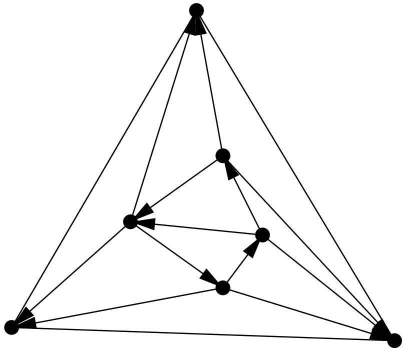

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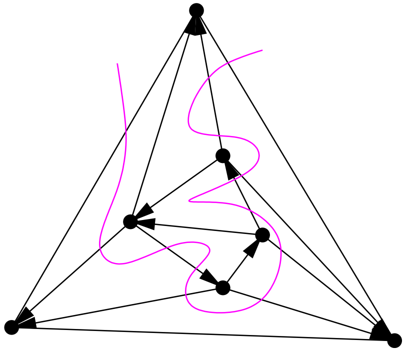

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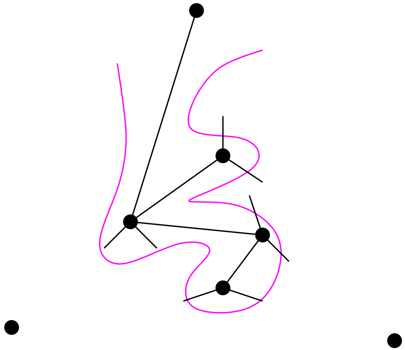

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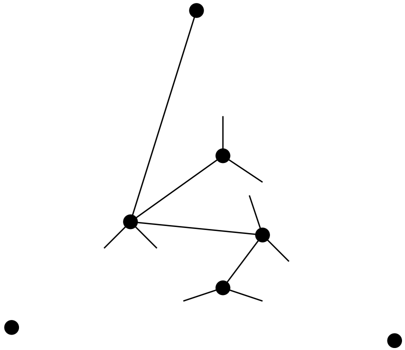

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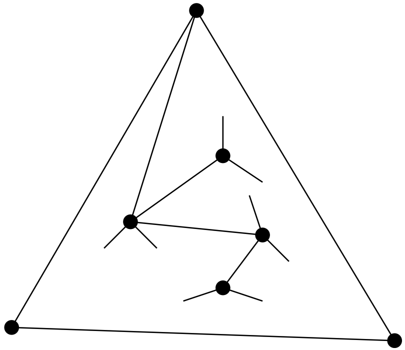

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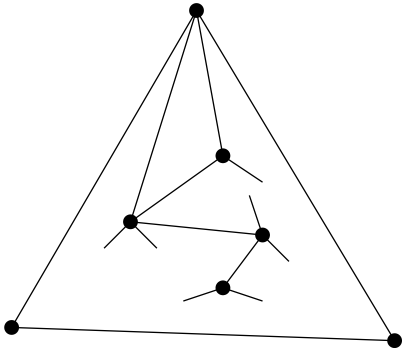

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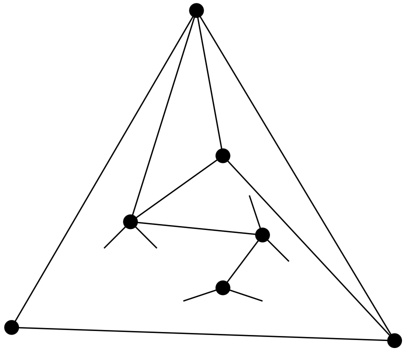

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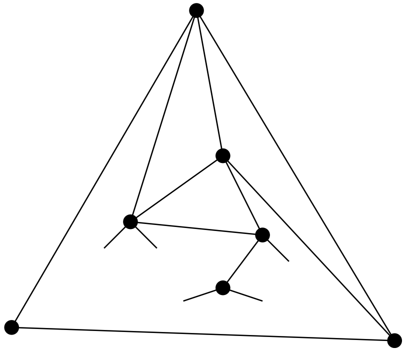

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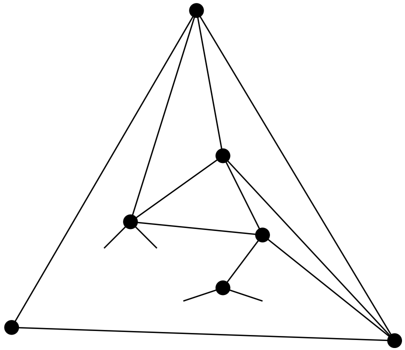

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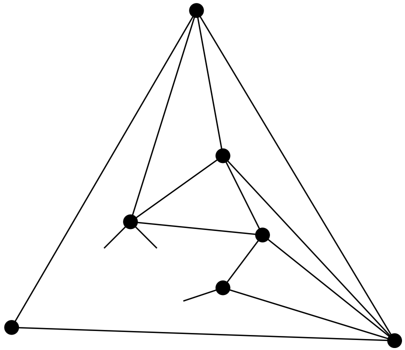

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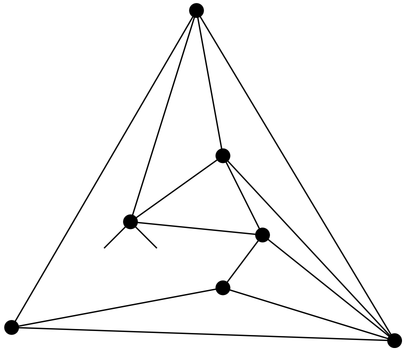

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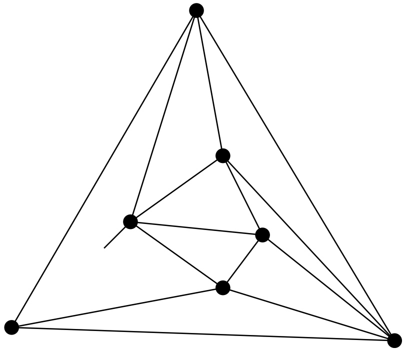

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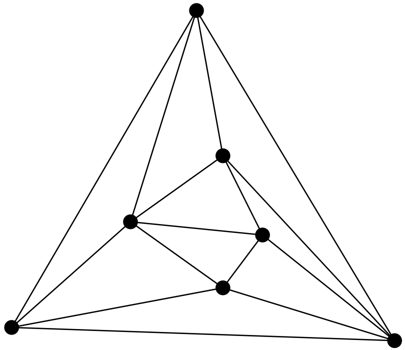

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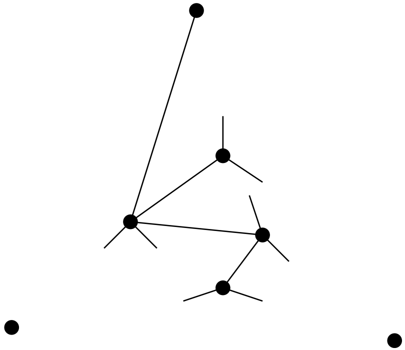

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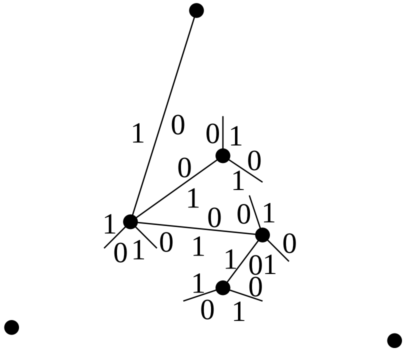

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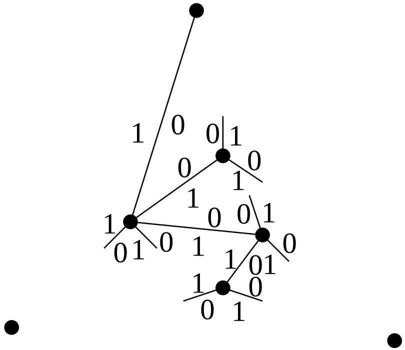

110101110100101001101000

Optimal encoding

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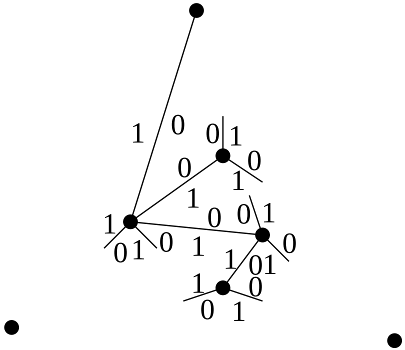
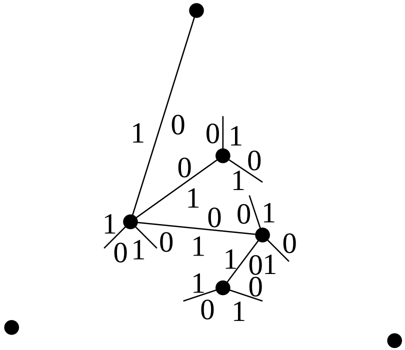


110101110100101001101000 $\rightsquigarrow$ 6n bits

Optimal encoding

Poulalhon and Schaeffer (2003)

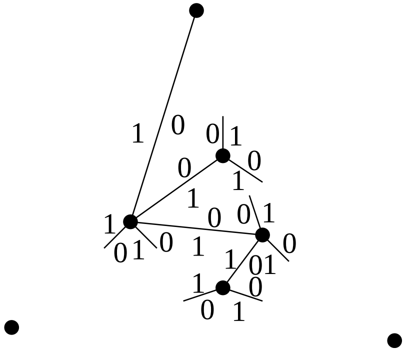


1101011101001010011010000 $\rightsquigarrow$ 6n bits

...1w10w10w0...

Optimal encoding

Poulalhon and Schaeffer (2003)



110101110100101001101000 $\rightsquigarrow$ 6n bits

...1w10w10w0...

Optimal encoding

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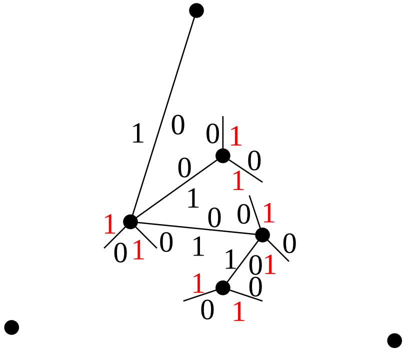
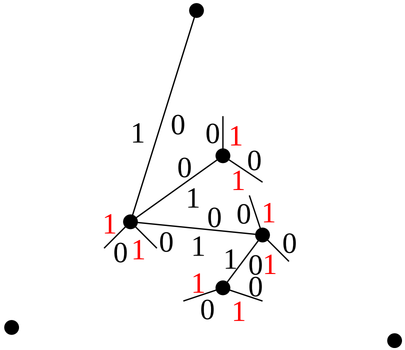


11010111010010100110100 ⇝ 6n bits

...1w10w10w0...

Optimal encoding

Poulalhon and Schaeffer (2003)

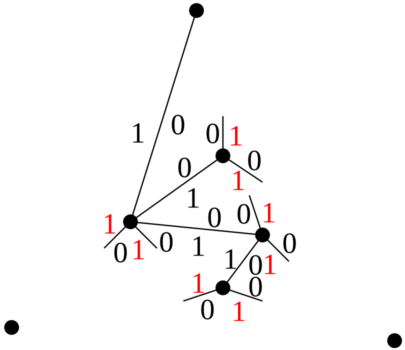


110101110100101001101000

...1w10w10w0...

Optimal encoding

Poulalhon and Schaeffer (2003)

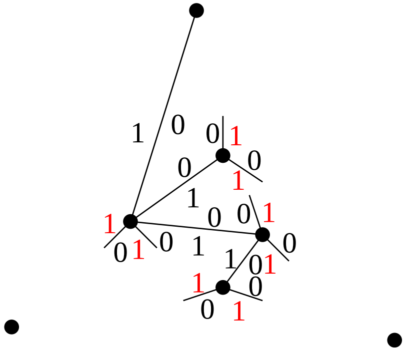


1001100000010000

...1w10w10w0...

Optimal encoding

Poulalhon and Schaeffer (2003)

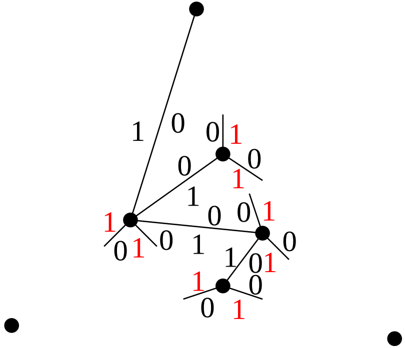


1001100000010000 $\rightsquigarrow$ 4n bits

...1w10w10w0...

Optimal encoding

Poulalhon and Schaeffer (2003)

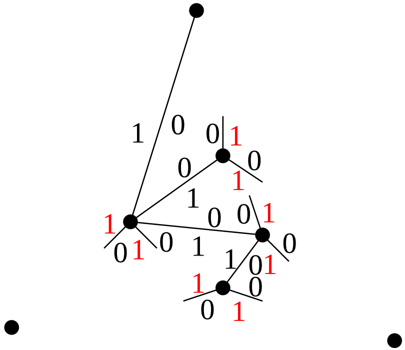


100110000010000 $\rightsquigarrow$ 4n bits (n bits 1)

...1w10w10w0...

Optimal encoding

Poulalhon and Schaeffer (2003)

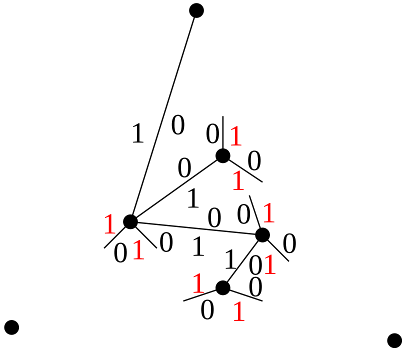


100110000010000 $\rightsquigarrow$ 4n bits (n bits 1) $\rightsquigarrow$ 3,25n bits

...1w10w10w0...

Optimal encoding

Poulalhon and Schaeffer (2003)

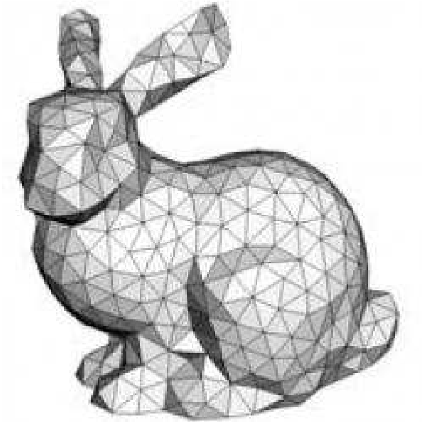


1001100000010000 $\rightsquigarrow$ 4n bits (n bits 1) $\rightsquigarrow$ 3,25n bits

...1w10w10w0... OPTIMAL !

Optimal encoding

Poulalhon and Schaeffer (2003)



100110000001000 $\rightsquigarrow$ 4n bits (n bits 1) $\rightsquigarrow$ 3,25n bits

...1w10w10w0... OPTIMAL !

Generalization to 3-connected planar map

Felsner (2001), Miller (2002)

Generalization to 3-connected planar map

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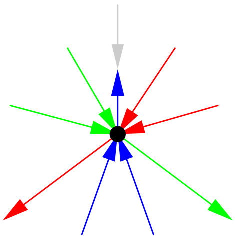
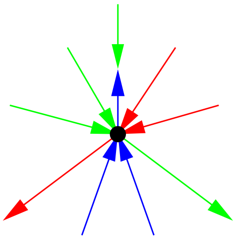


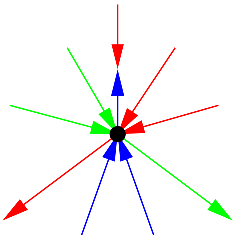
Generalization to 3-connected planar map

Felsner (2001), Miller (2002)



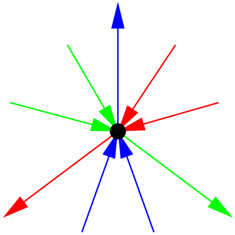
Generalization to 3-connected planar map

Felsner (2001), Miller (2002)



Generalization to 3-connected planar map

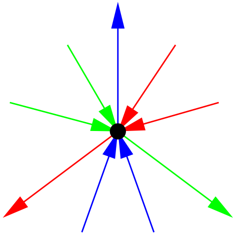
Felsner (2001), Miller (2002)



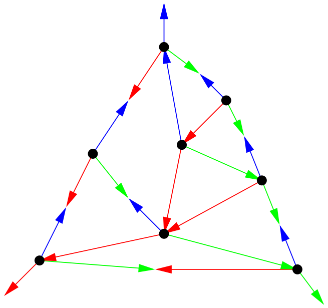
For every vertex

Generalization to 3-connected planar map

Felsner (2001), Miller (2002)

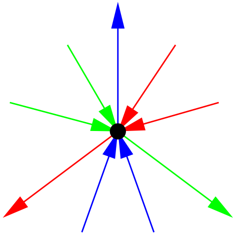


For every vertex



Generalization to 3-connected planar map

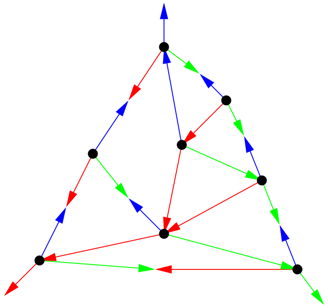
Felsner (2001), Miller (2002)



For every vertex

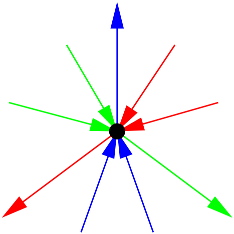
AND

No monochromatic cycles



Generalization to (internally) 3-connected planar map

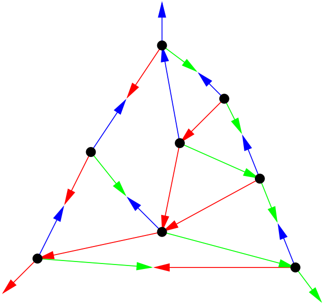
Felsner (2001), Miller (2002)



For every vertex

AND

No monochromatic cycles



Generalization to (internally) 3-connected planar map

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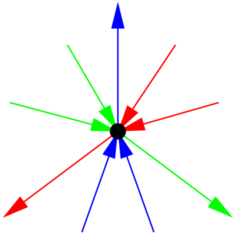

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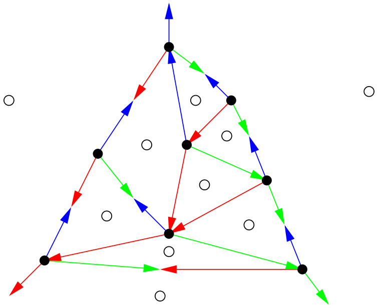

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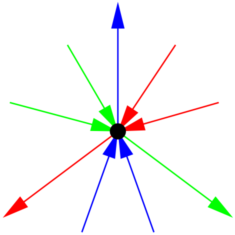

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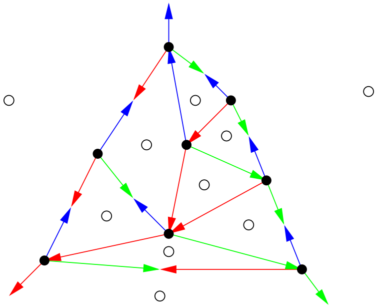
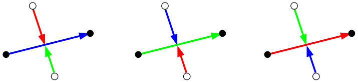
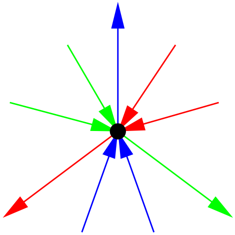




Dual rules

Generalization to (internally) 3-connected planar map

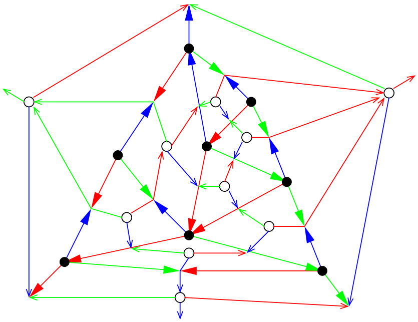
Felsner (2001), Miller (2002)

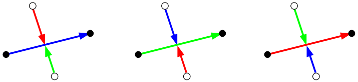


For every vertex

AND

No monochromatic cycles





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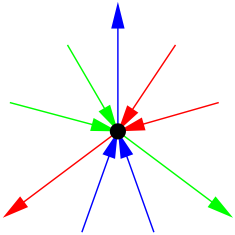

For every vertex

AND

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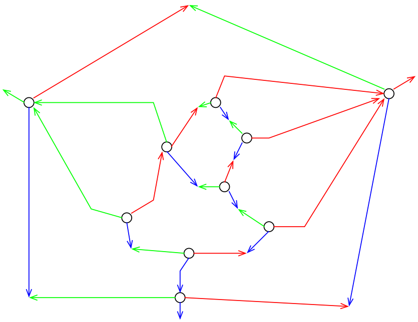
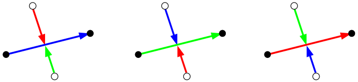
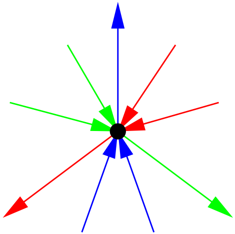




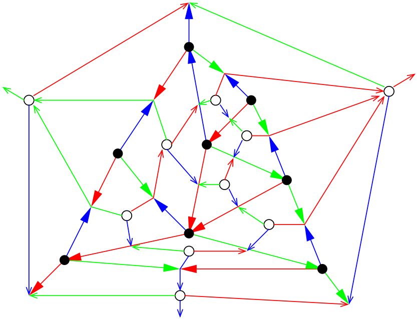
Dual rules

Generalization to (internally) 3-connected planar map

Felsner (2001), Miller (2002)

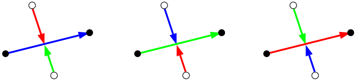


For every vertex



AND

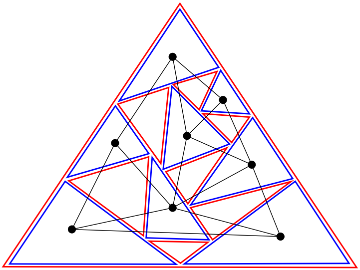
No monochromatic cycles

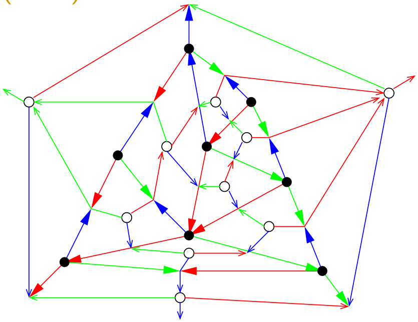


Dual rules

Generalization to (internally) 3-connected planar map

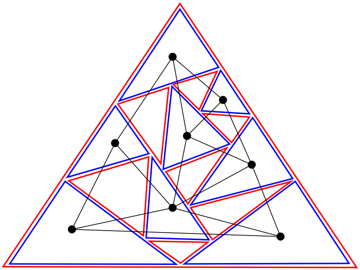
Gonçalves, Lévêque, Pinlou (2010)

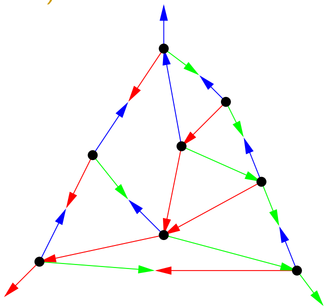




Generalization to (internally) 3-connected planar map

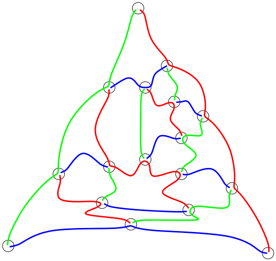
Gonçalves, Lévêque, Pinlou (2010)

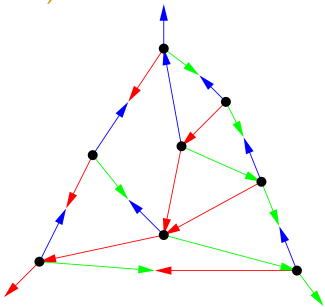




Generalization to (internally) 3-connected planar map

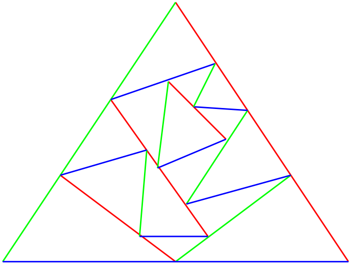
Gonçalves, Lévêque, Pinlou (2010)

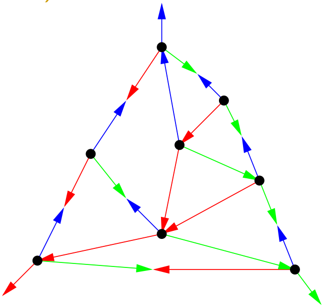




Generalization to (internally) 3-connected planar map

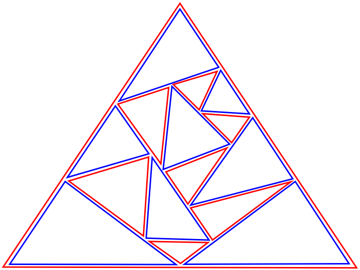
Gonçalves, Lévêque, Pinlou (2010)

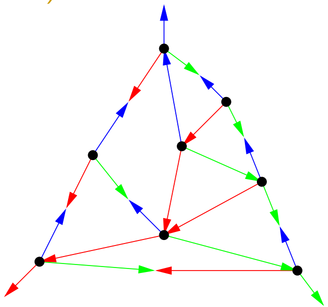




Generalization to (internally) 3-connected planar map

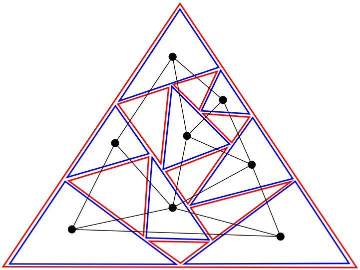
Gonçalves, Lévêque, Pinlou (2010)

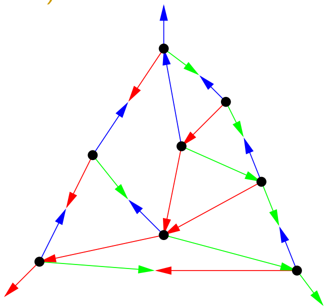




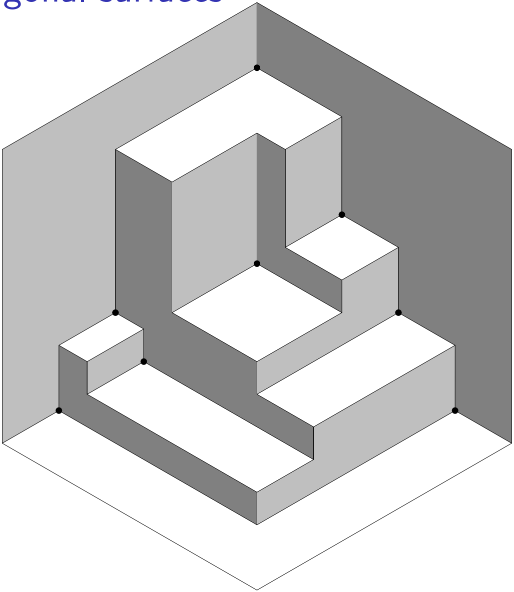
Generalization to (internally) 3-connected planar map

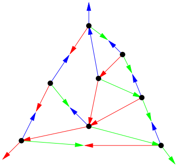
Gonçalves, Lévêque, Pinlou (2010)



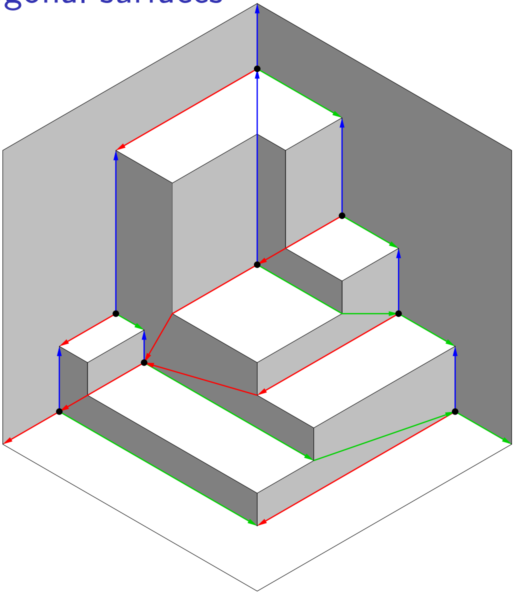


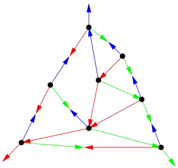
Orthogonal surfaces



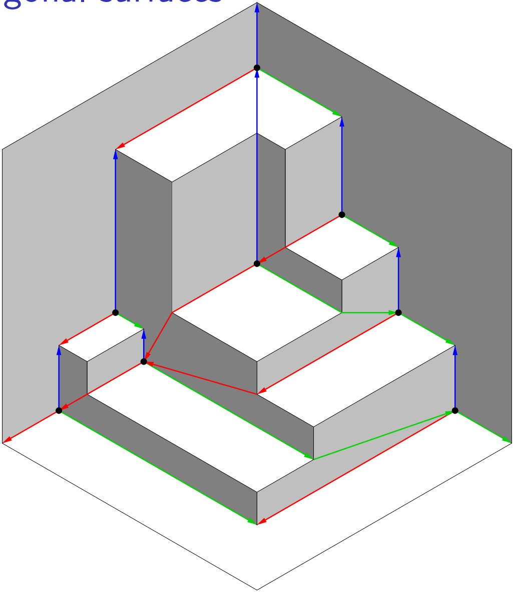


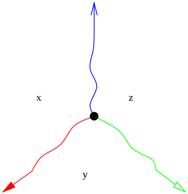
Orthogonal surfaces

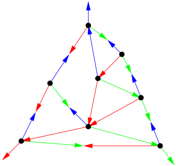




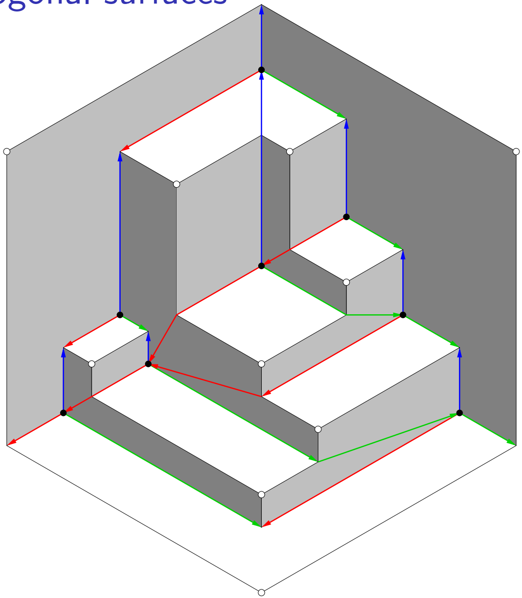
Orthogonal surfaces

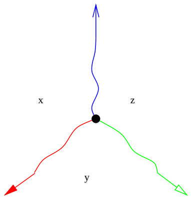


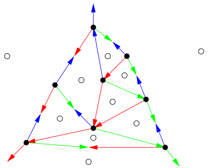




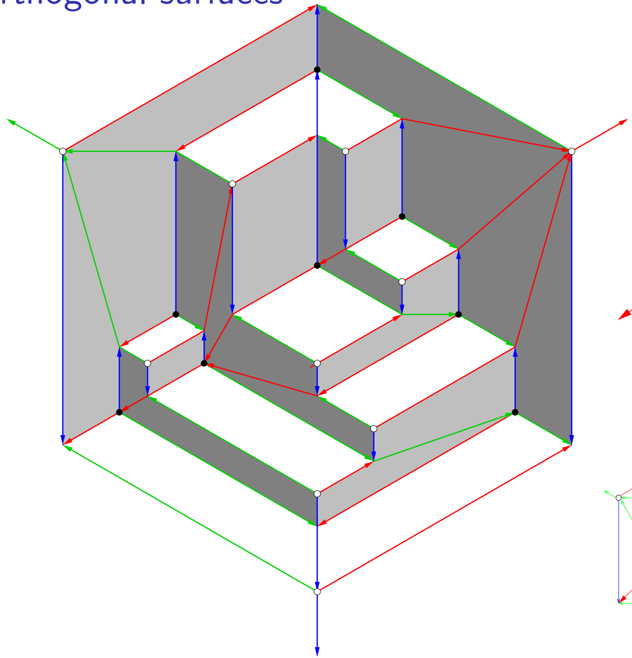
Orthogonal surfaces

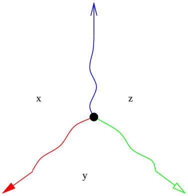


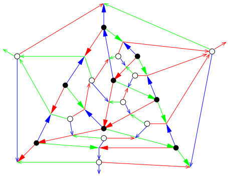




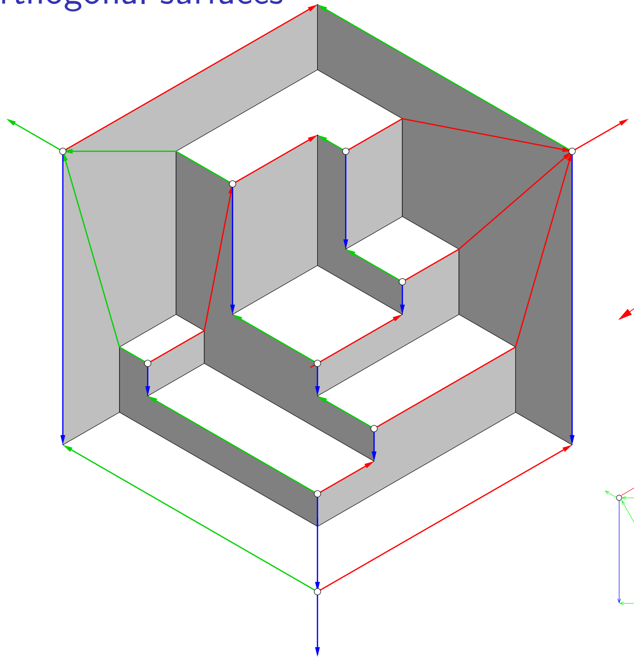
Orthogonal surfaces

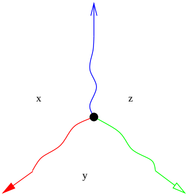


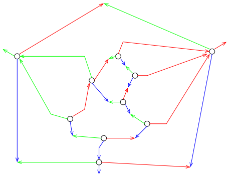




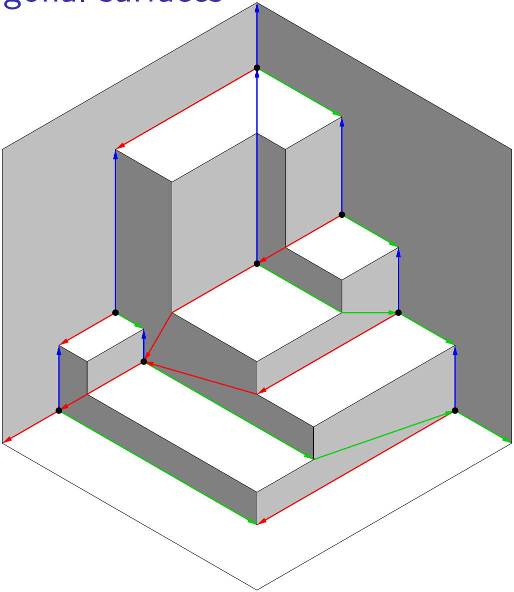
Orthogonal surfaces

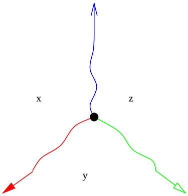


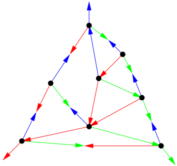




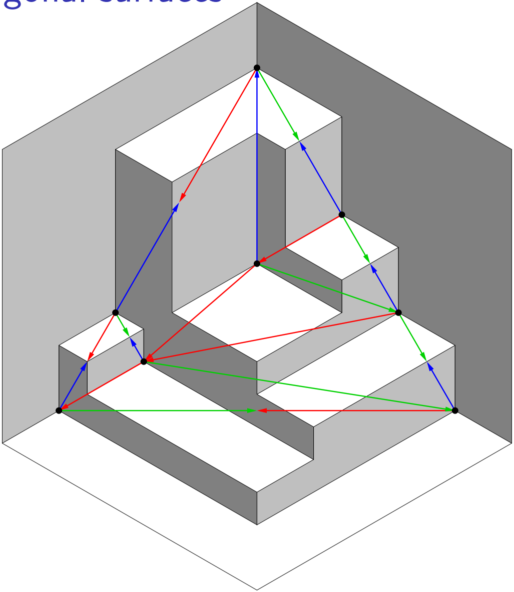
Orthogonal surfaces

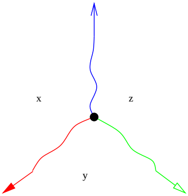


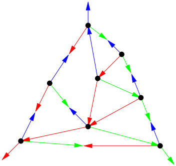




Orthogonal surfaces







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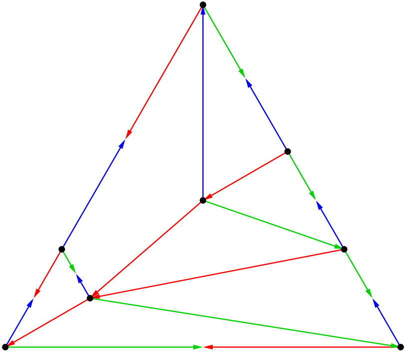
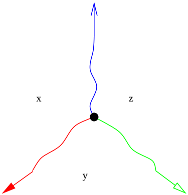
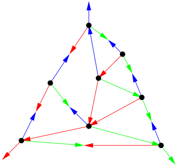
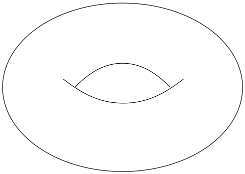


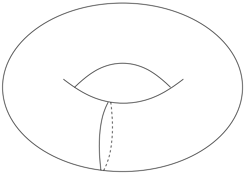




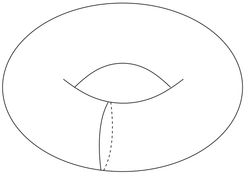
The torus

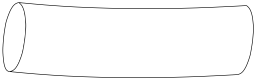


The torus

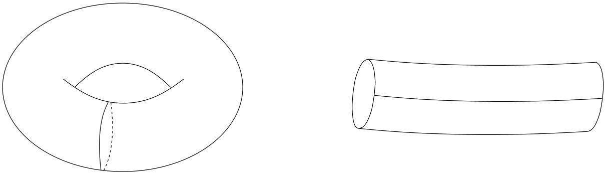


The torus

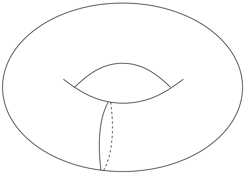


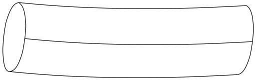


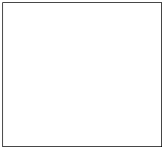
The torus



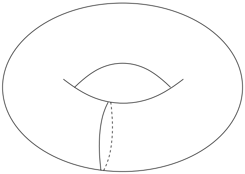
The torus

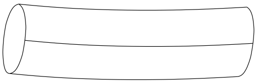


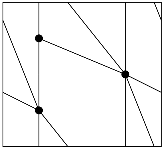




The torus







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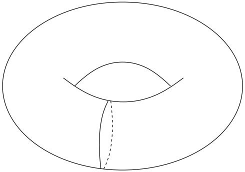
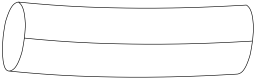
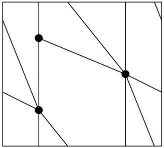




No loop and no multiple edges



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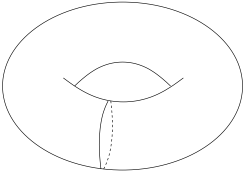
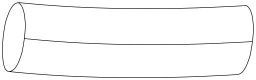
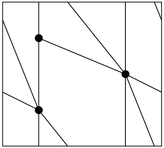




No contractible loop and no multiple edges



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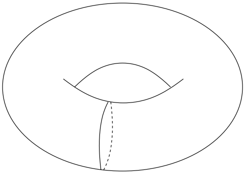
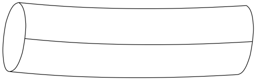
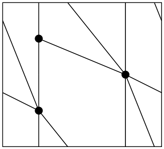




No contractible loop and no homotopic multiple edges



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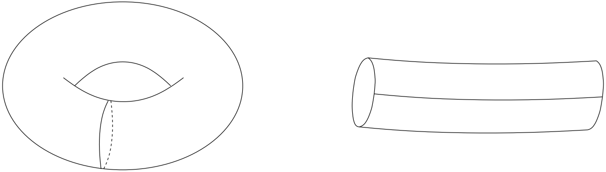

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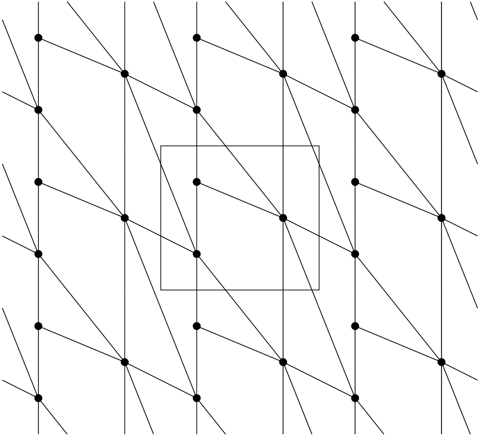

A generalization of Schnyder woods to higher genus

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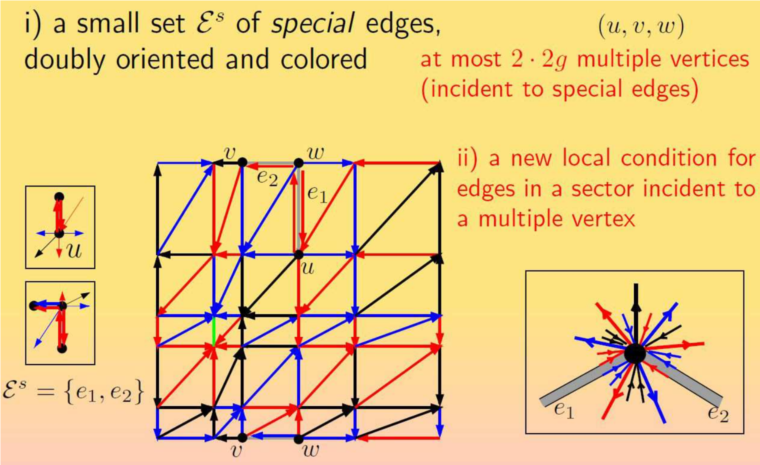
Castelli Aleardi, Fusy, Lewiner (2009) : applications to encoding



A different approach for the torus

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	Plane	Torus
Euler's Formula	$n - m + f = 2$	$n - m + f = 0$

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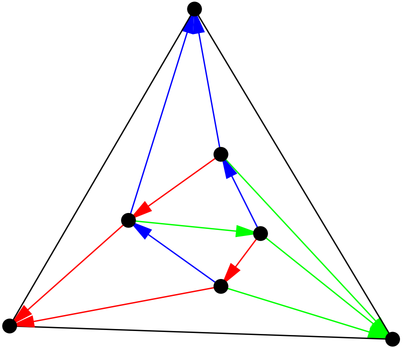

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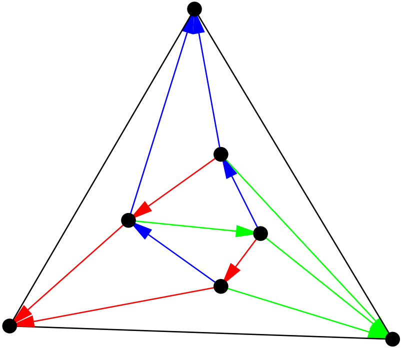

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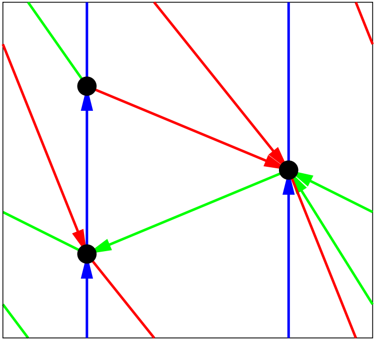

Definition of (generalized) Schnyder wood on the Torus

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Planar Schnyder wood Felsner (2001)

- Schnyder property + half edge.
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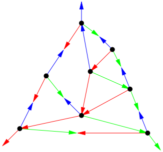

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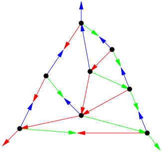

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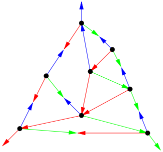

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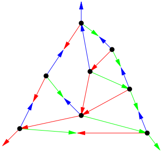

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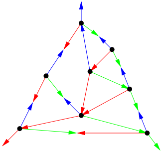

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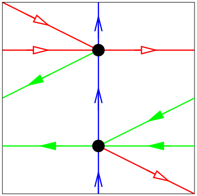

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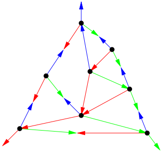

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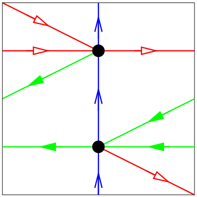

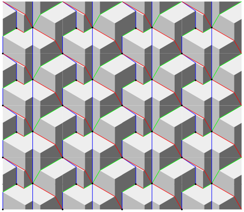

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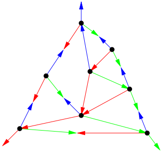

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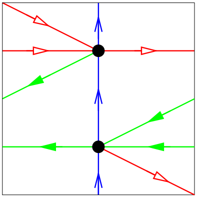

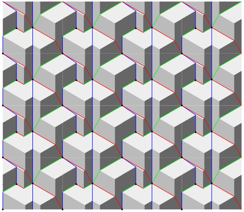

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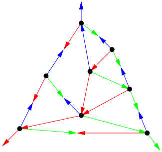

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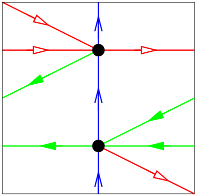

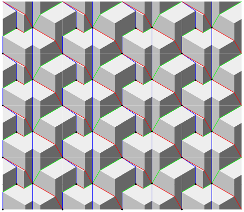

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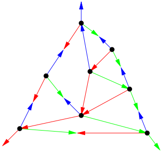

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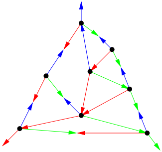

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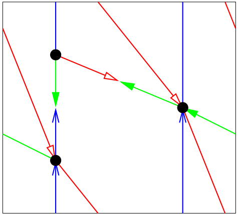

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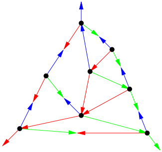

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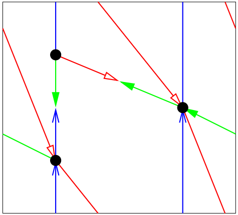

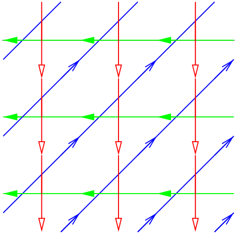

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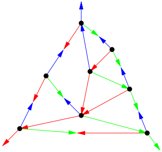

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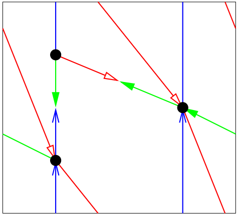

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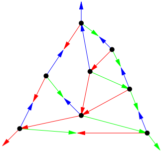

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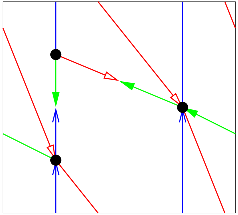

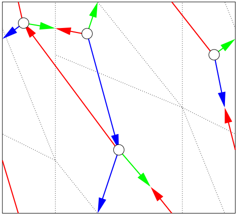

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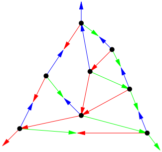

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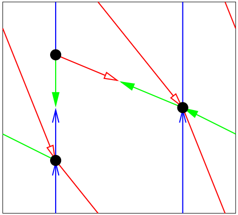

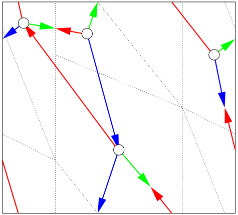

Theorem A toroidal map admits a Schnyder wood if and only if it is essentially 3-connected.

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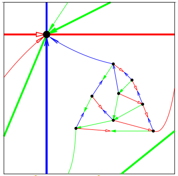

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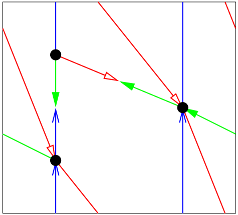

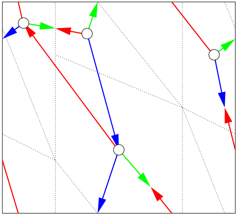

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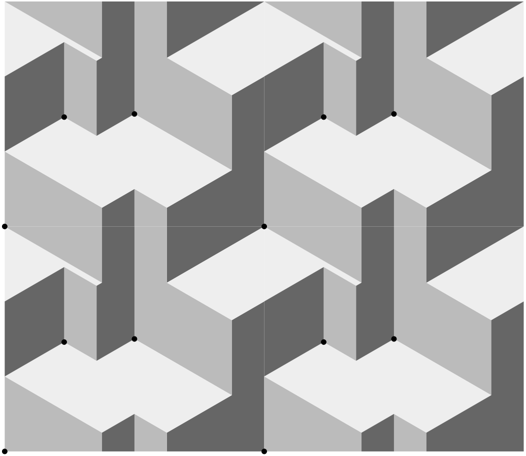
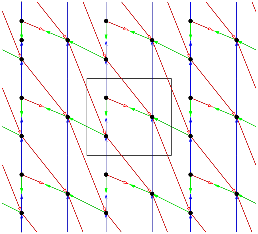
Orthogonal surfaces





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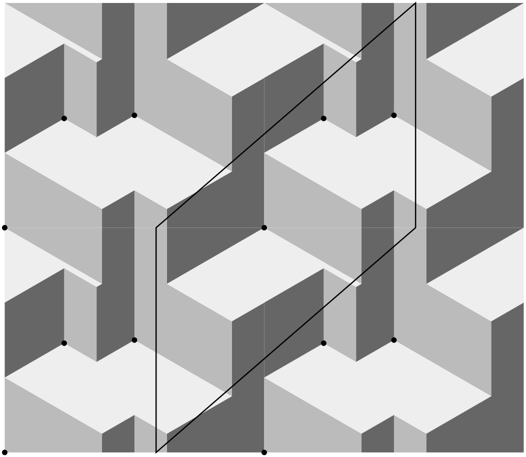

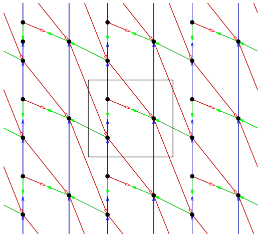

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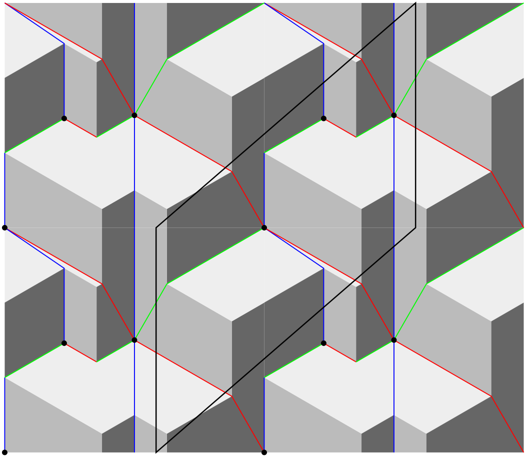
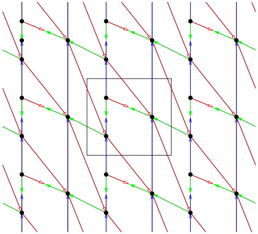
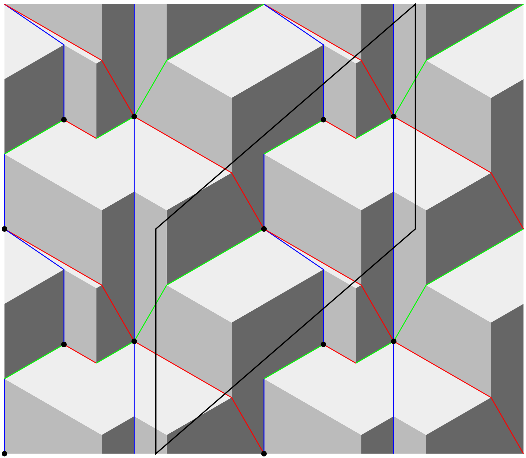
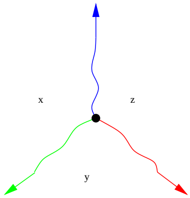
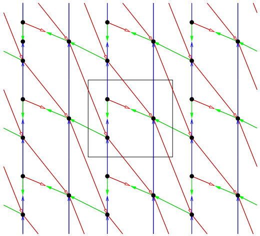




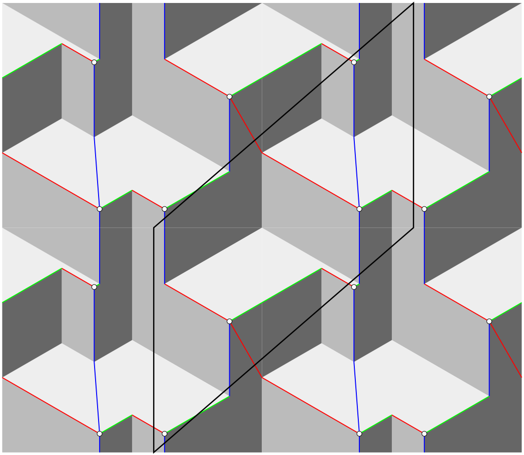
Orthogonal surfaces

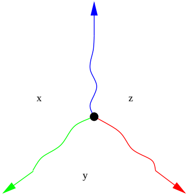


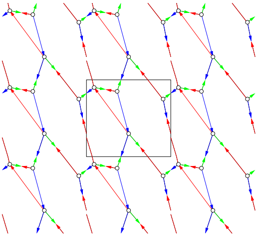




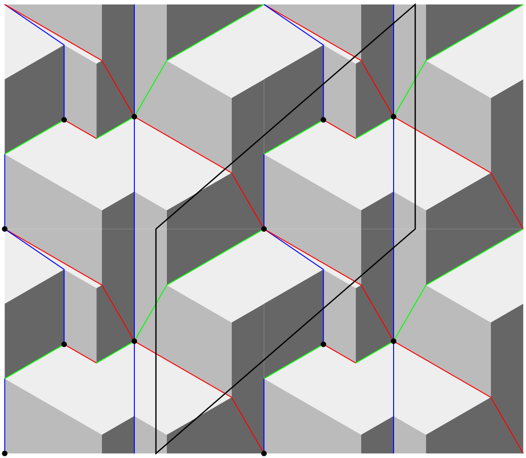
Orthogonal surfaces

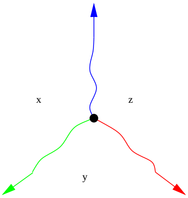


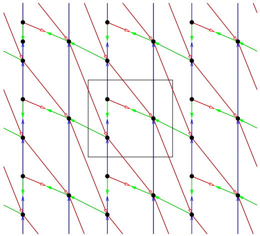




Orthogonal surfaces







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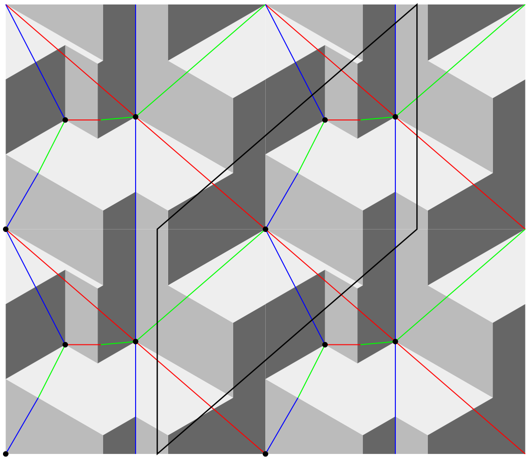
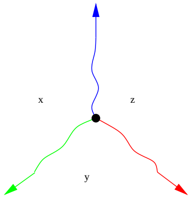
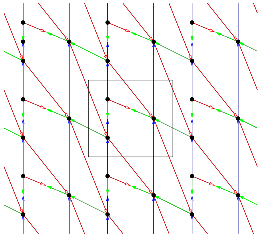
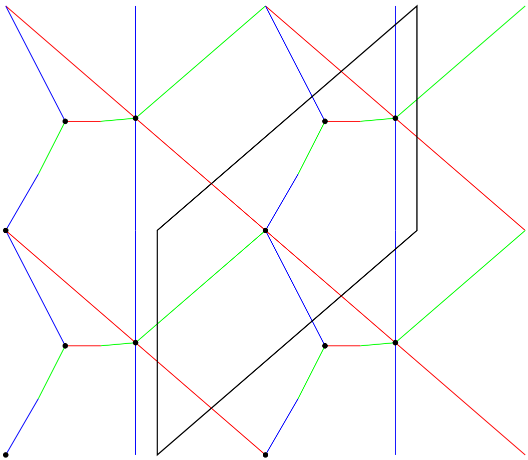
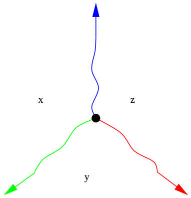


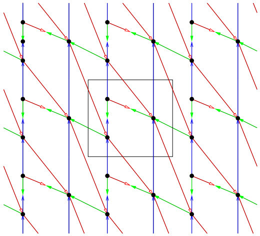




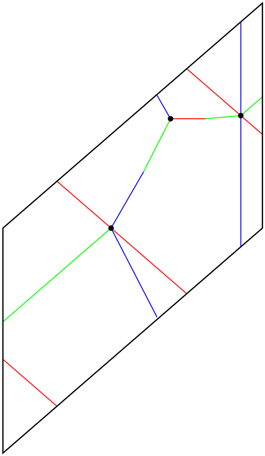
Orthogonal surfaces

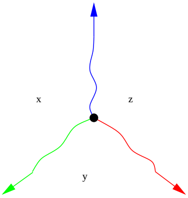


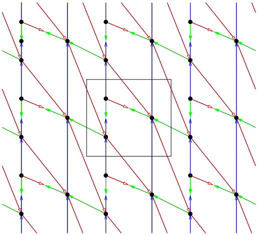




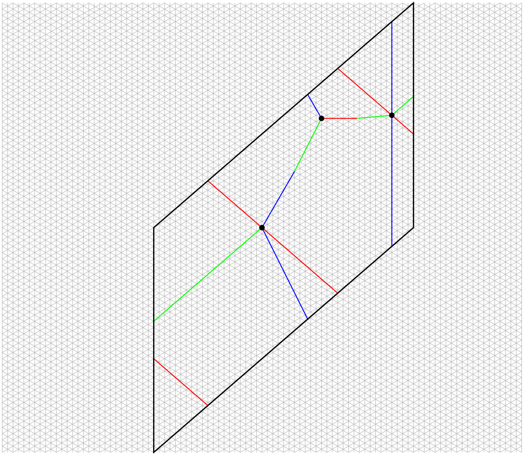
Orthogonal surfaces

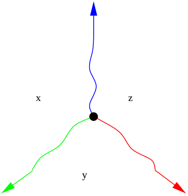


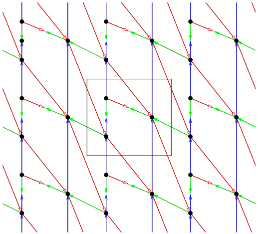




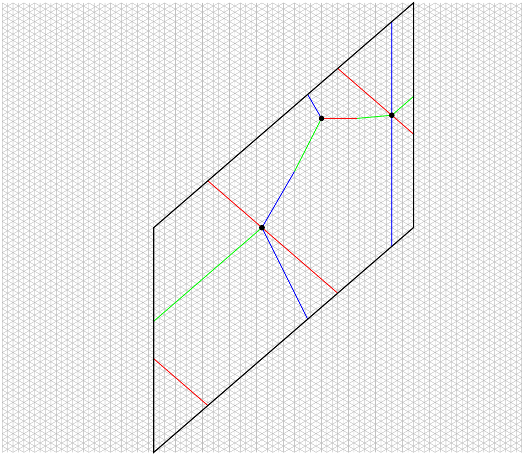
Orthogonal surfaces

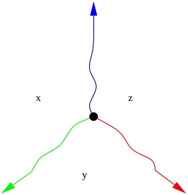


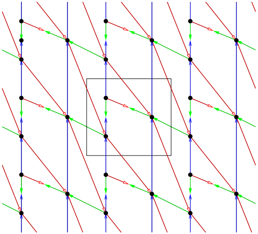




Orthogonal surfaces







Theorem A simple toroidal map admits a straight line representation in a grid of size $\mathcal{O}(n^2) \times \mathcal{O}(n^2)$

Open questions

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- One component for each color ?

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- Lattice structure ?

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- Enumeration, Compression, Spanners,. . .

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- Contact system of triangles ? $\rightsquigarrow$ stretching
- Enumeration, Compression, Spanners,...
- Transversal structures, 2-orientations, ...
- Higher genus, Higher dimension