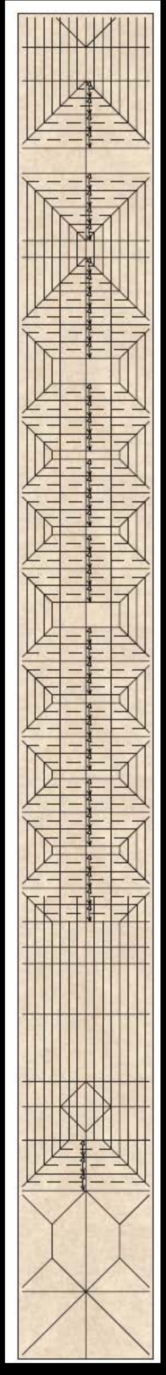
Crease pattern of Mooser's Train removed due to copyright restrictions.

Refer to: Fig. 12.4 from Lang, Robert J. *Origami Design Secrets: Mathematical Methods for an Ancient Art*. 2nd ed. A K Peters / CRC Press, 2011.

folding by Robert Lang

Crease pattern of Mooser's Train removed due to copyright restrictions.
Refer to: Fig. 12.4 from Lang, Robert J. *Origami Design Secrets: Mathematical Methods for an Ancient Art*. 2nd ed. A K Peters / CRC Press, 2011.

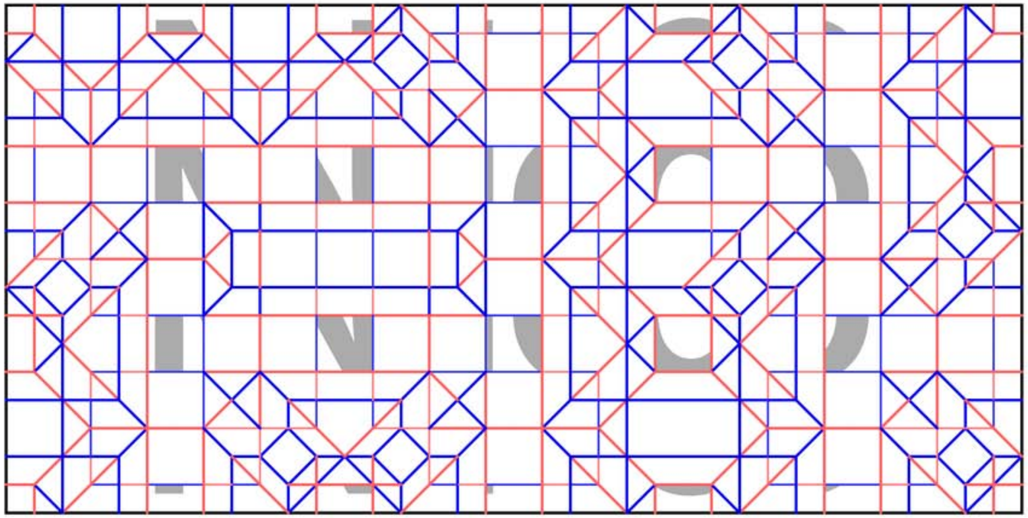


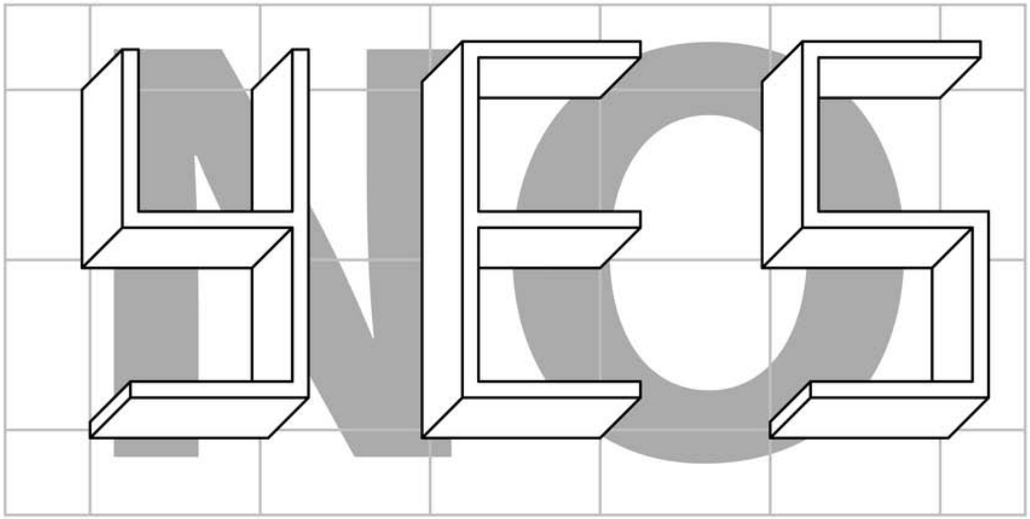
Black Forest Cuckoo Clock,
opus 182

Robert Lang, 1987

Are there known universal hinge patterns to build poly-some-other-shapes-that-are-not-cubes?

Folded state of box-please gadget removed due to copyright restrictions.

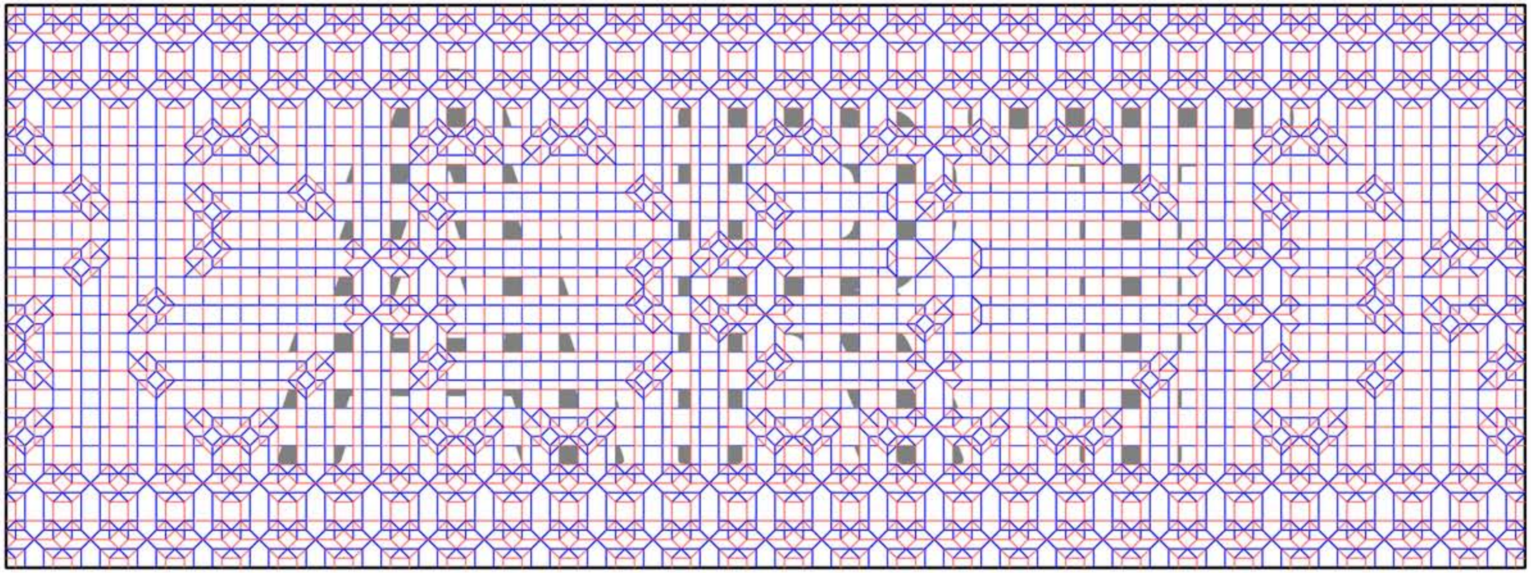


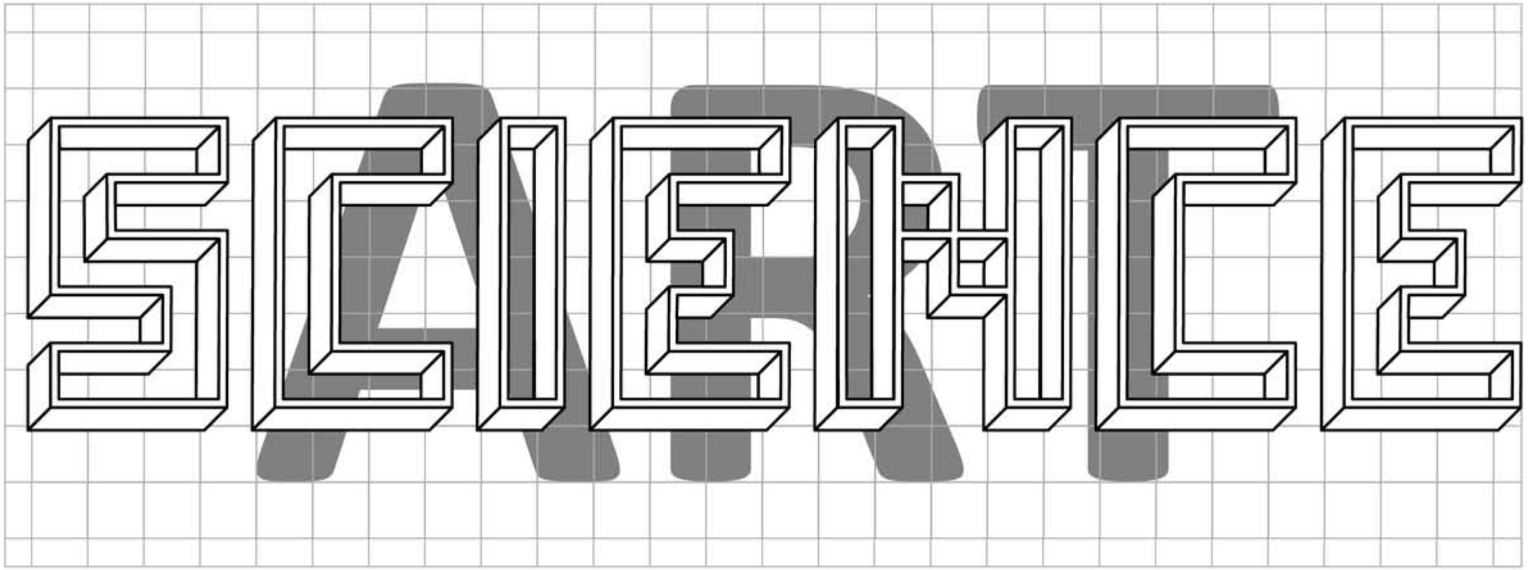


Courtesy of Erik Demaine, Martin Demaine, and Sarah Stengle. Used with permission.

Yes/No

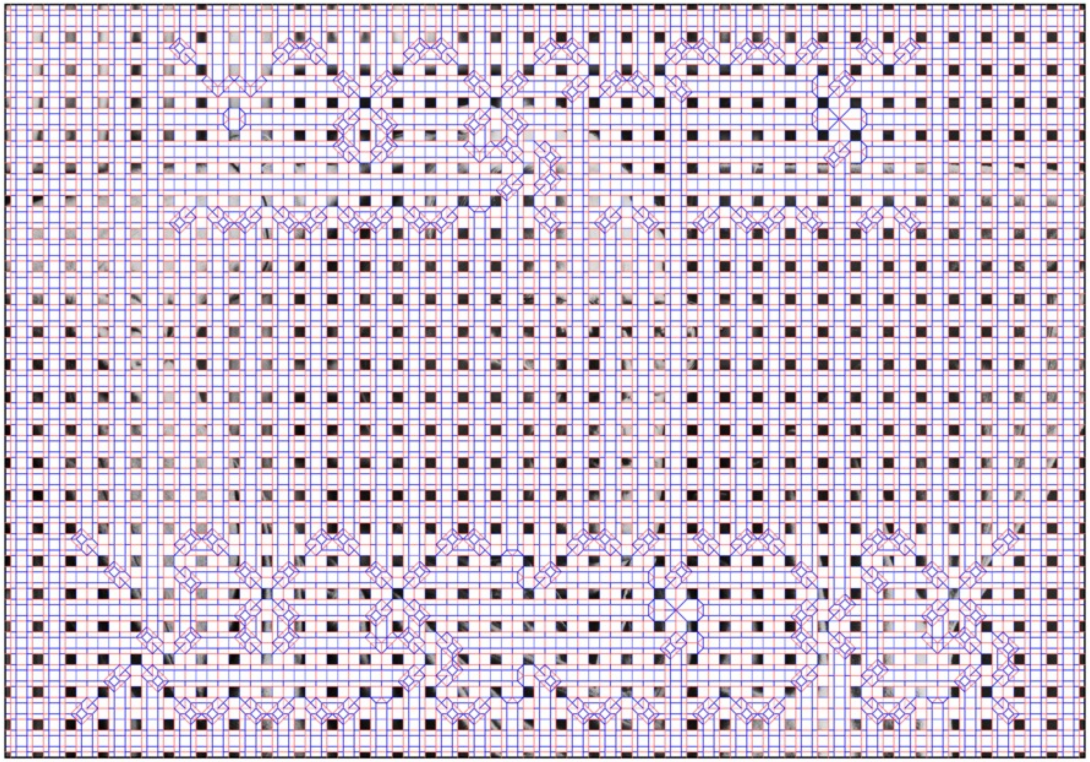
Demaine, Demaine, Stengle 2011

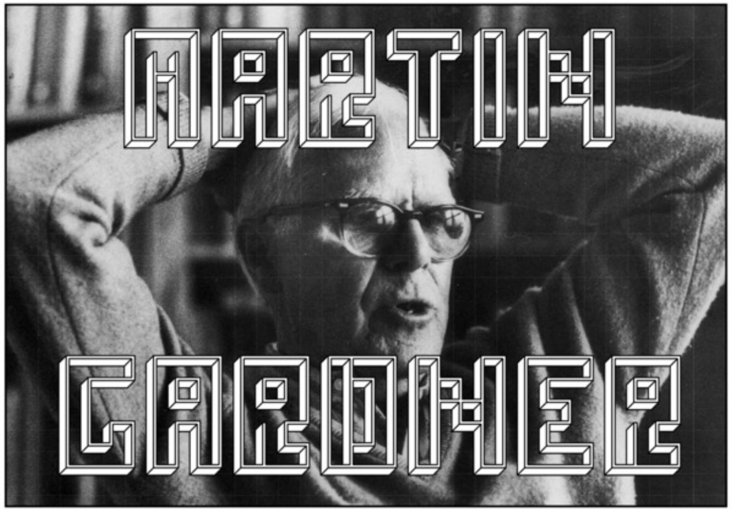




Science/Art

Demaine & Demaine, 2011

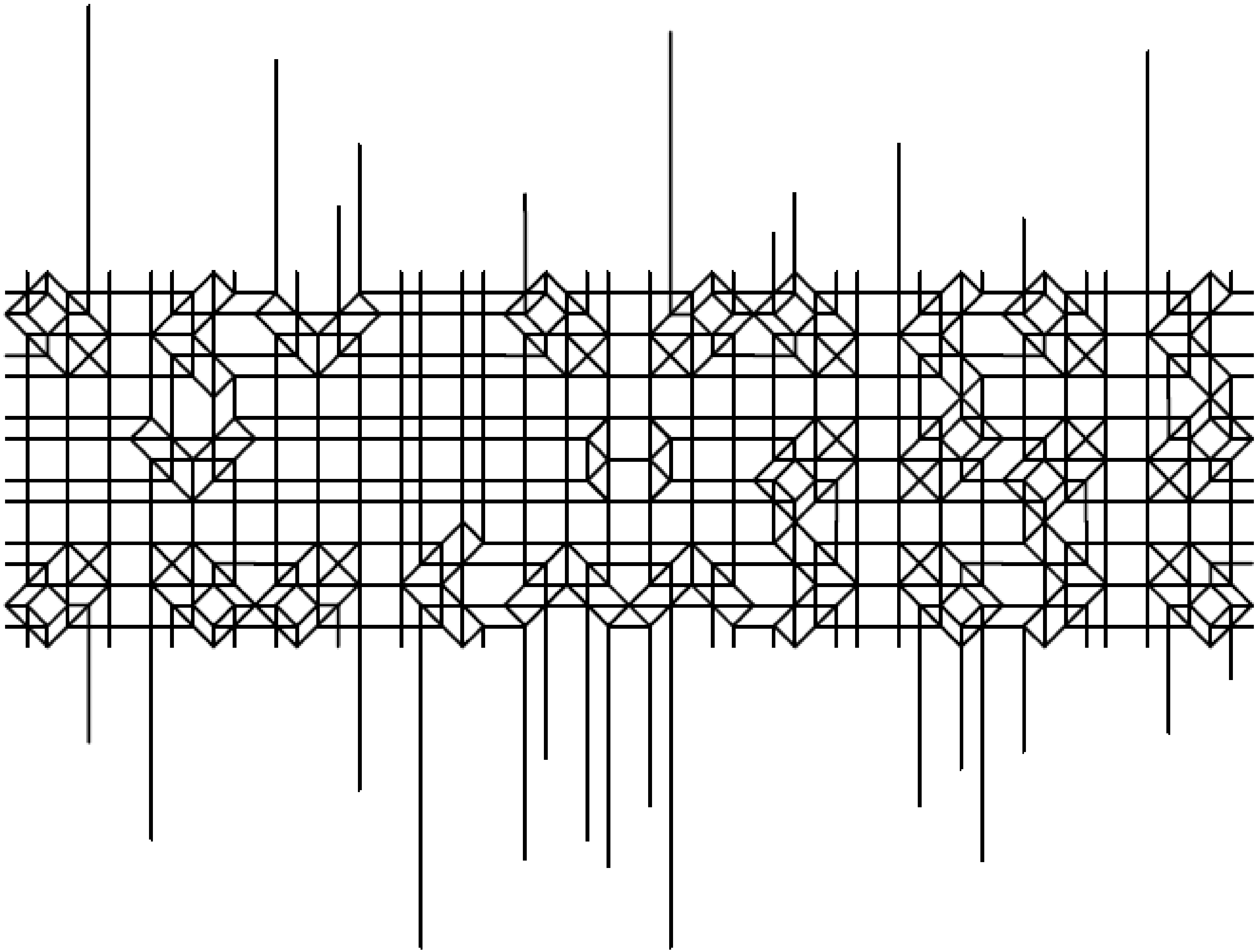




Courtesy of Erik Demaine, and Martin Demaine. Used with permission.

Martin Gardner

Demaine, Demaine 2012



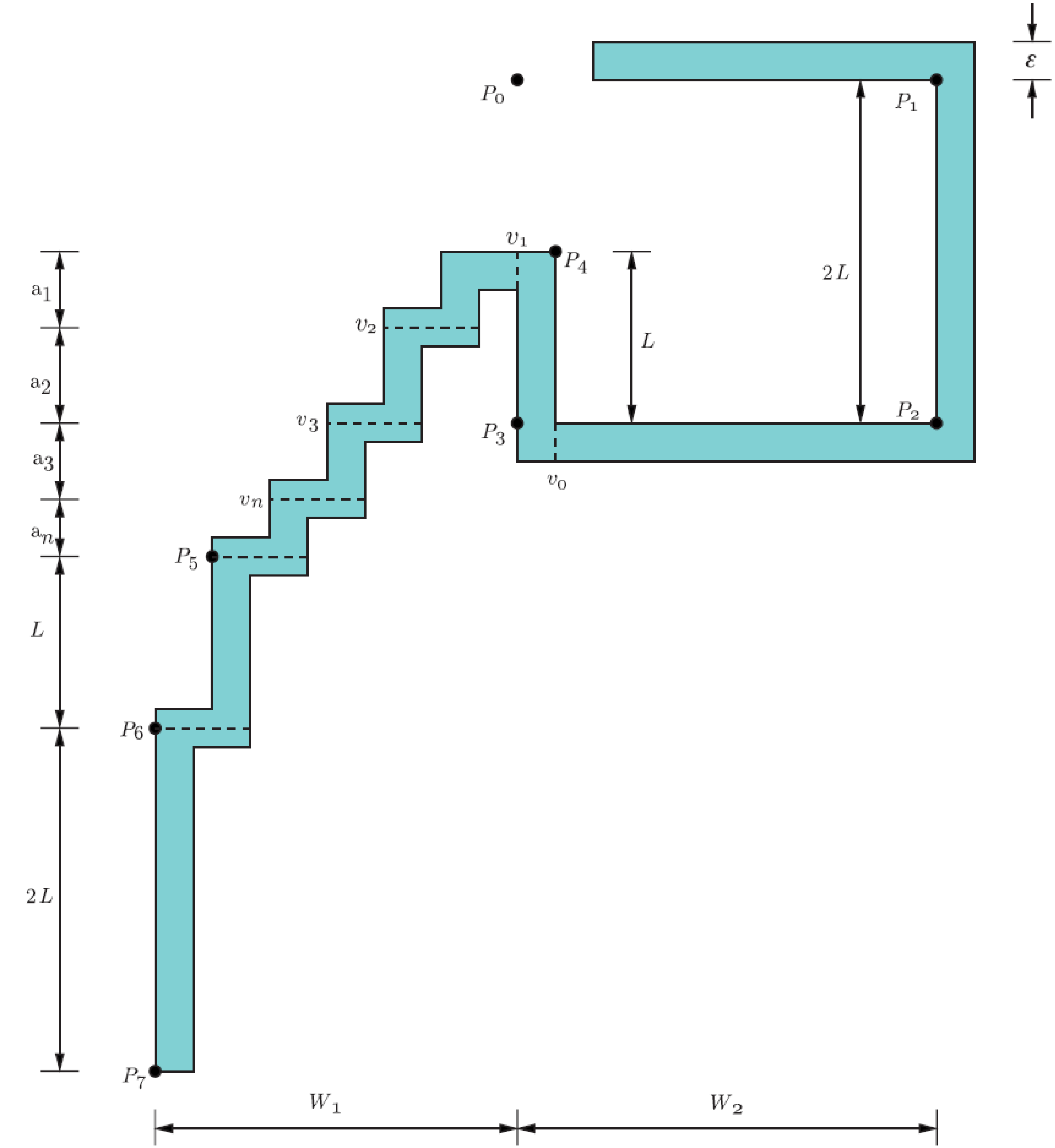
Courtesy of Erik Demaine, and Martin Demaine. Used with permission.

GLASS

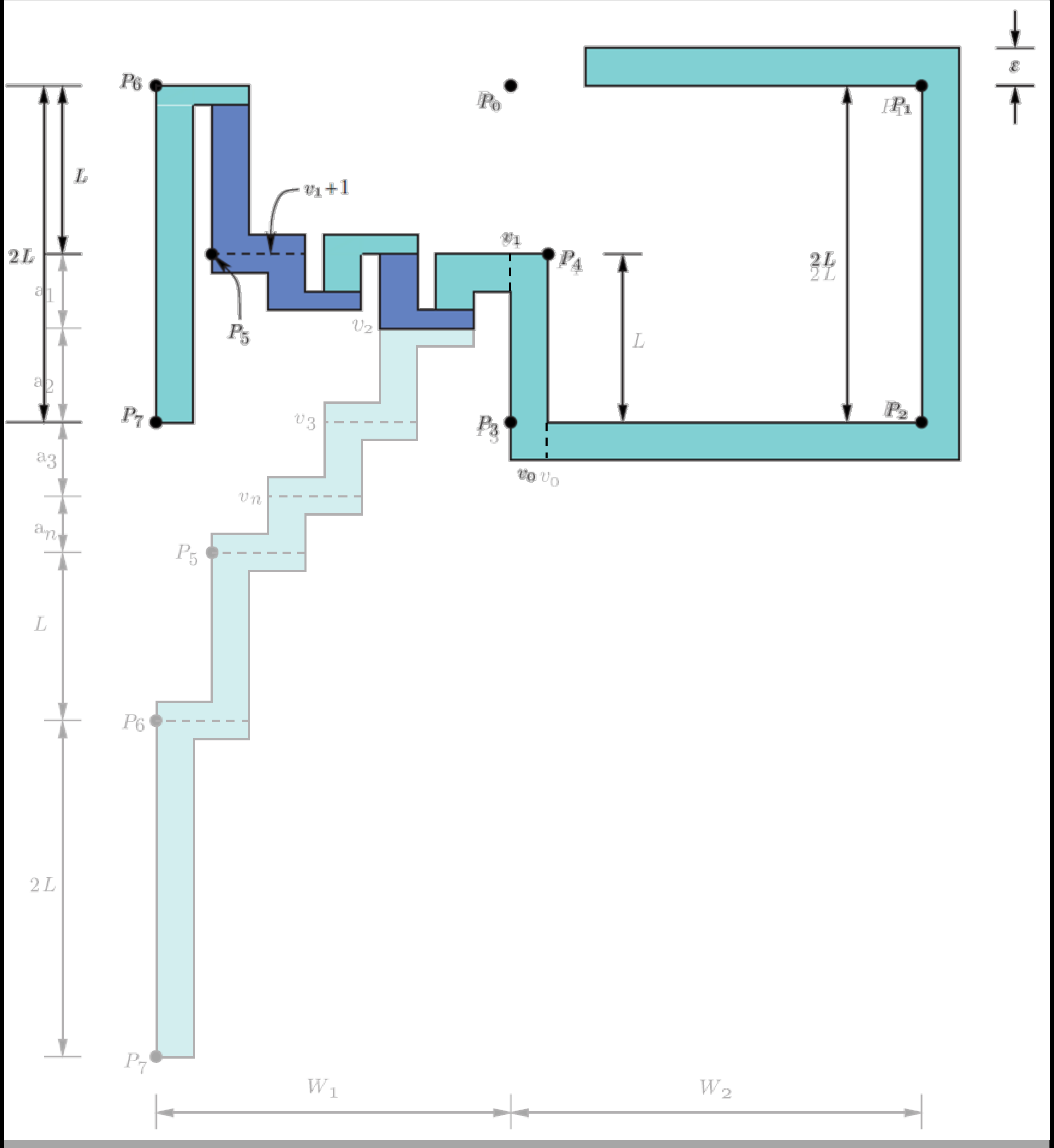
Demaine & Demaine, 2012

I didn’t understand the point of NP-hardness. Are there examples of actual problems that can't be calculated?

Could we go through one of the NP proofs with a little less hand waving?



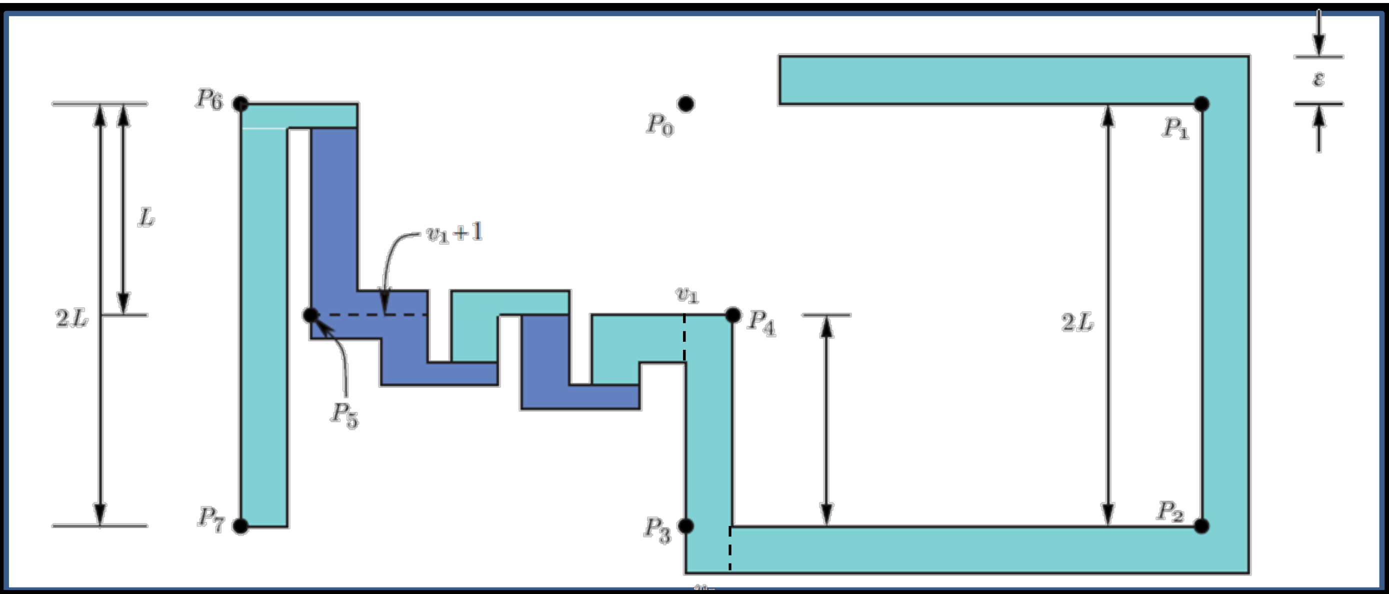
[Arkin, Bender, Demaine, Demaine, Mitchell, Sethia, Skiena 2000]



Courtesy of Elsevier, Inc., http://www.sciencedirect.com. Used with permission.

[Arkin, Bender, Demaine, Demaine, Mitchell, Sethia, Skiena 2000]

Minor question: in the orthogonal paper reduction, doesn't this require not folding some of the creases, if we want to make 2 consecutive strips the same direction?



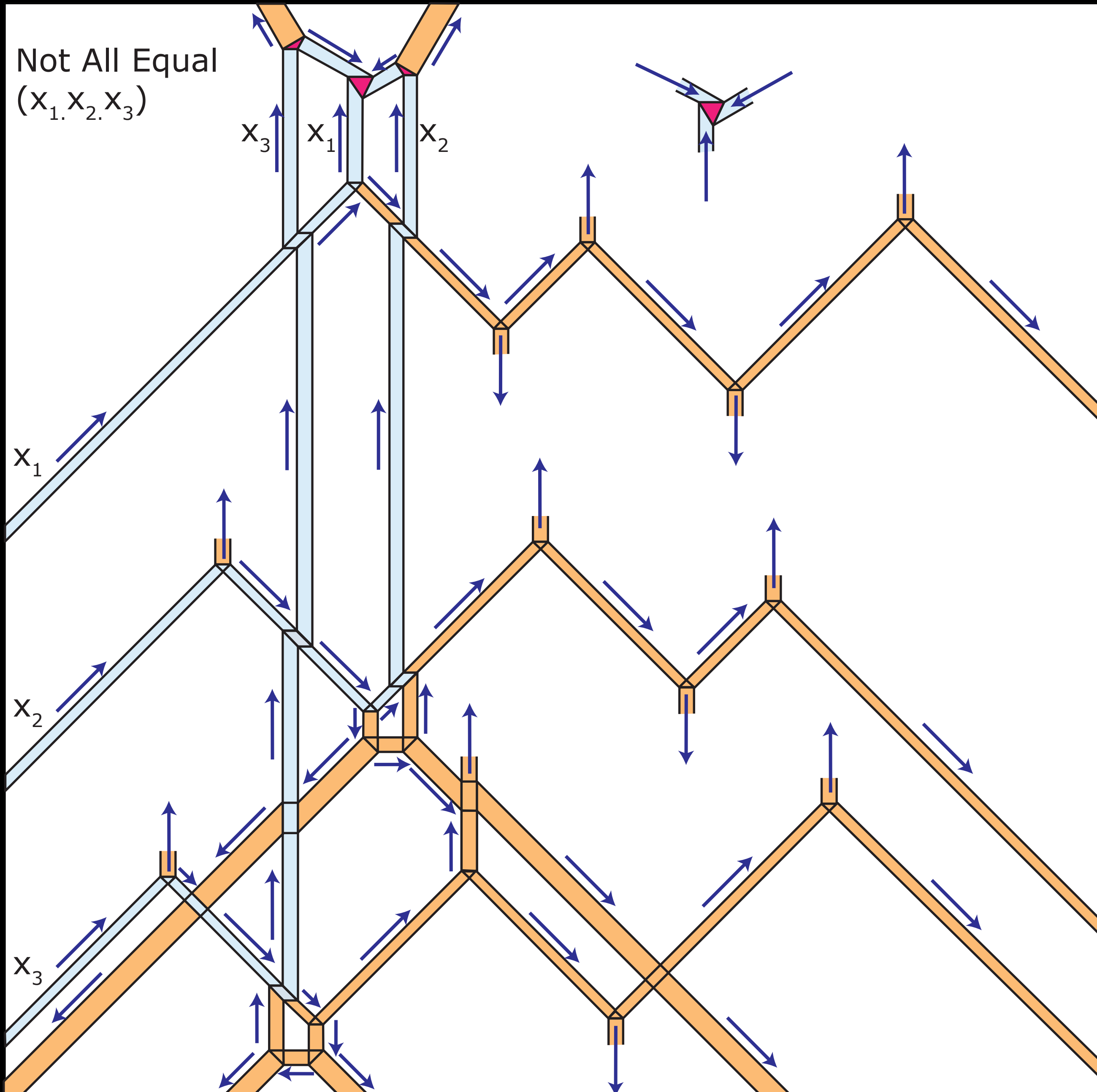


Image by MIT OpenCourseWare.

[Bern & Hayes 1996]

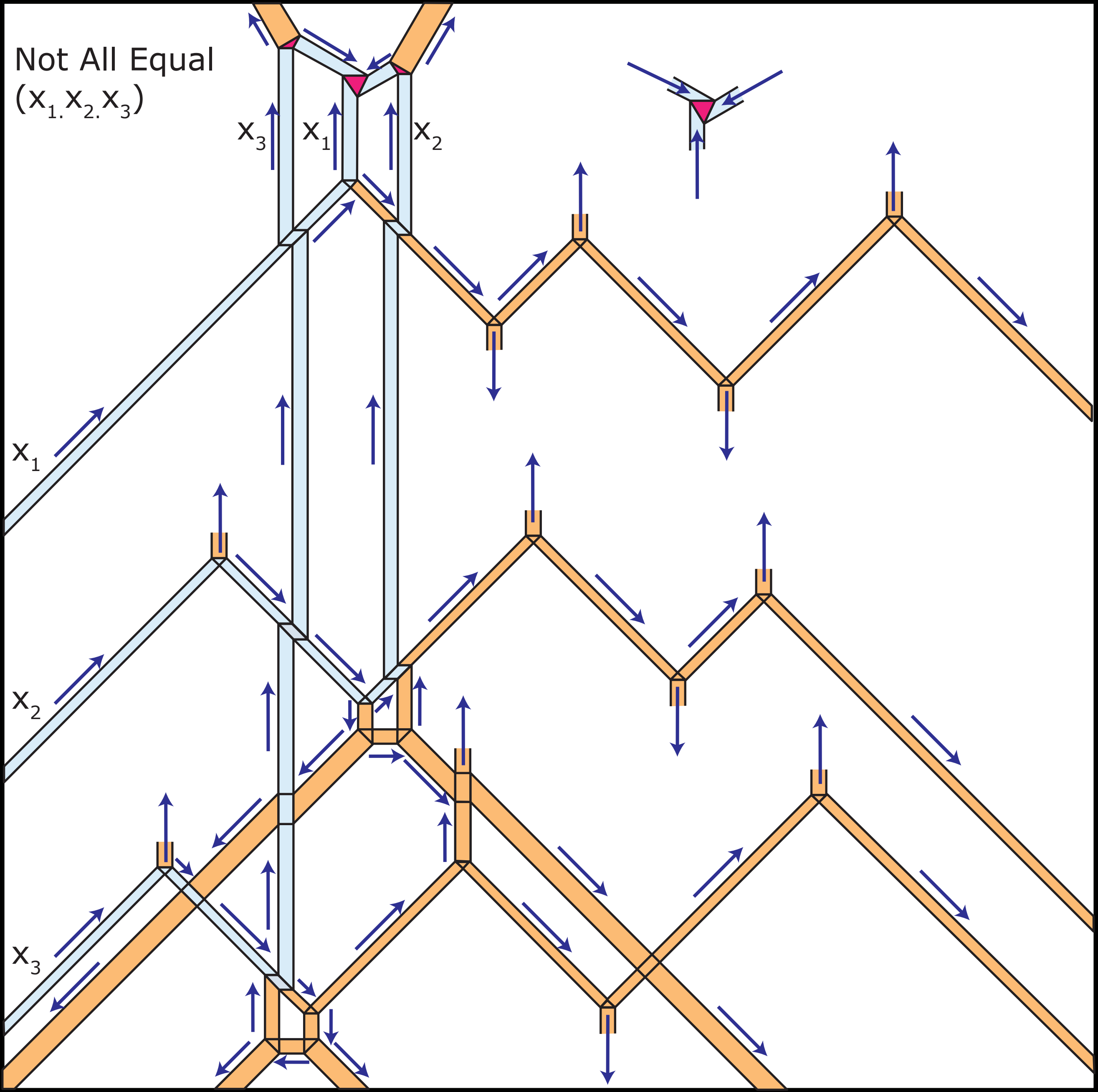


Image by MIT OpenCourseWare.

[Bern & Hayes 1996]

In the reflector gadget, it looks like all the left sides of the wires, where left is taken relative to the free end of the wire, are equal. How does the reflector negate one of them, then?

[Bern & Hayes 1996]

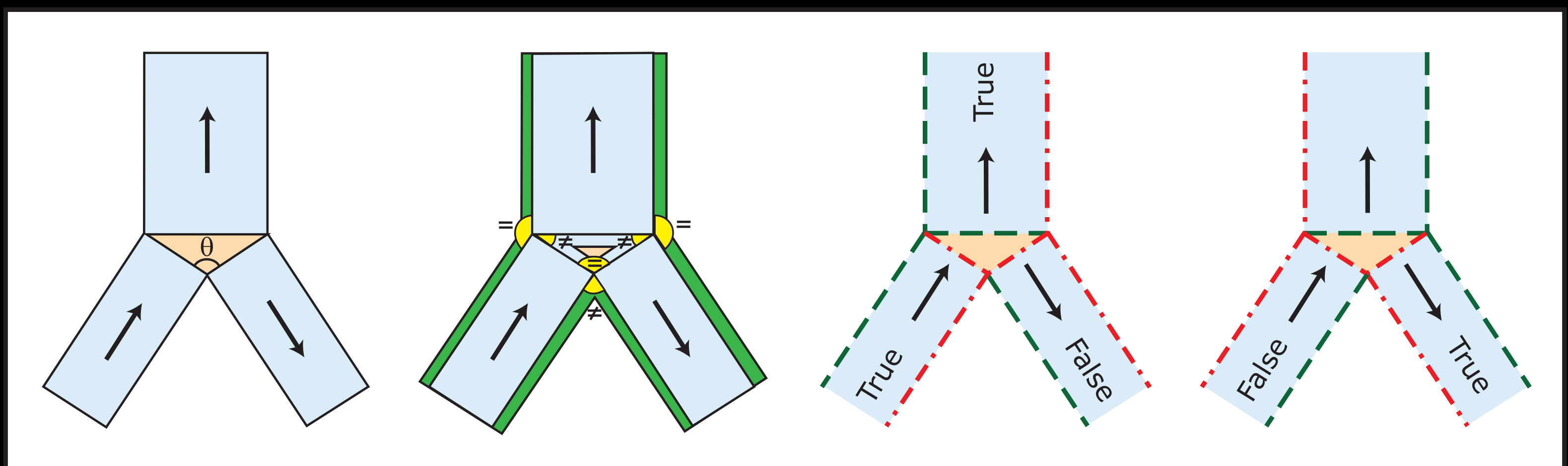


Image by MIT OpenCourseWare.

It looks like the global flat foldability proof proves that

globally flat-foldable
$\Rightarrow$ NAE satisfiability
$\Rightarrow$ locally flat-foldable,

but I don't see where

NAE satisfiability
$\Rightarrow$ globally flat-foldable.

(It looks like all that matters is the order of sheets, though, and that those all work out.)

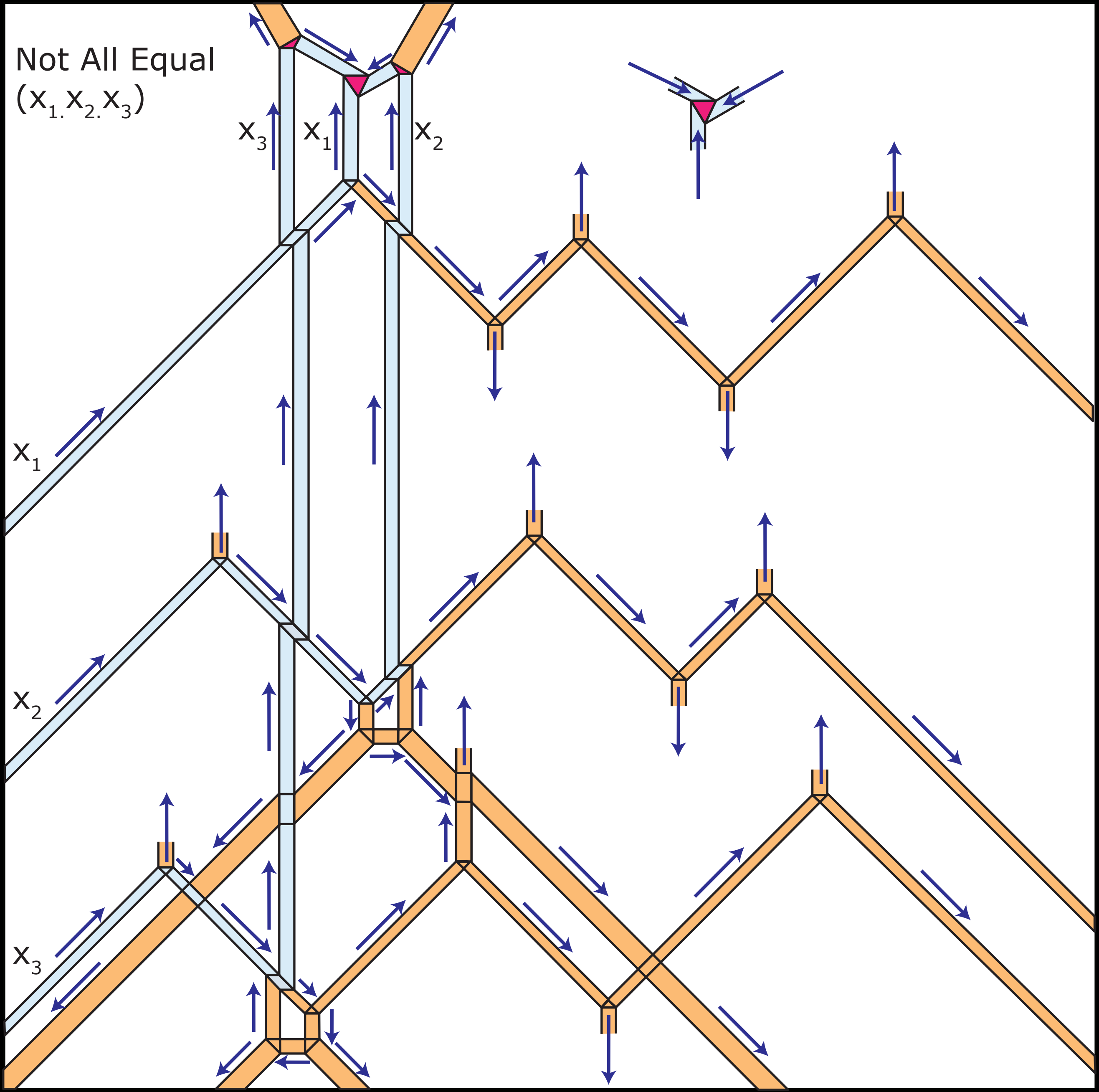


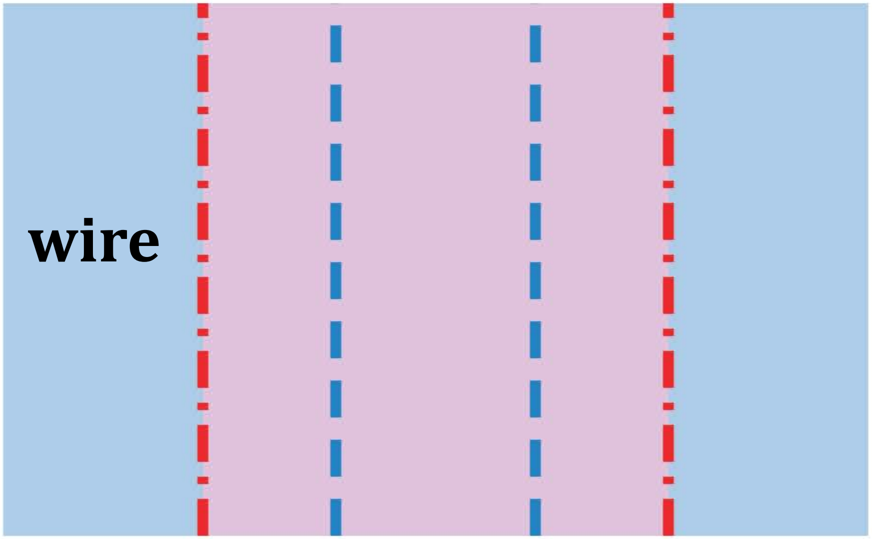
Image by MIT OpenCourseWare.

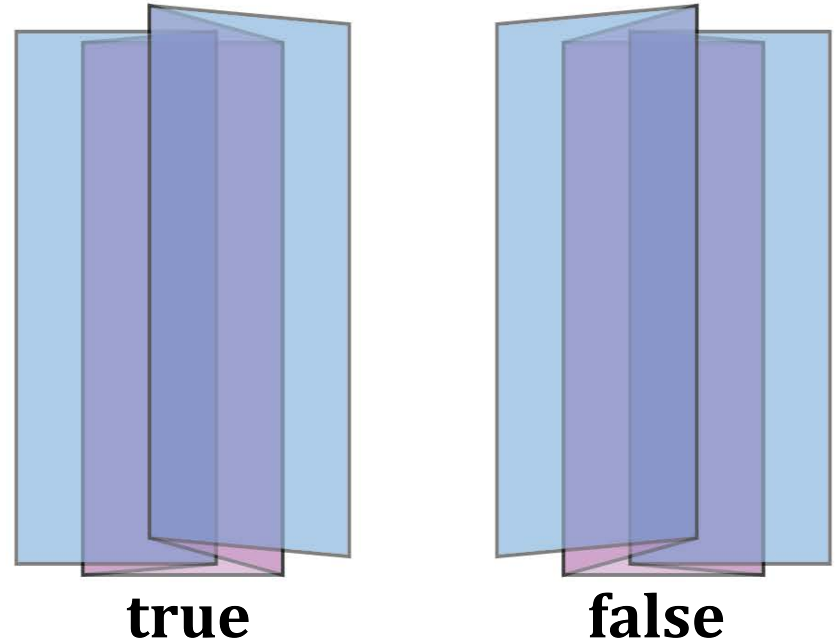
[Bern & Hayes 1996]

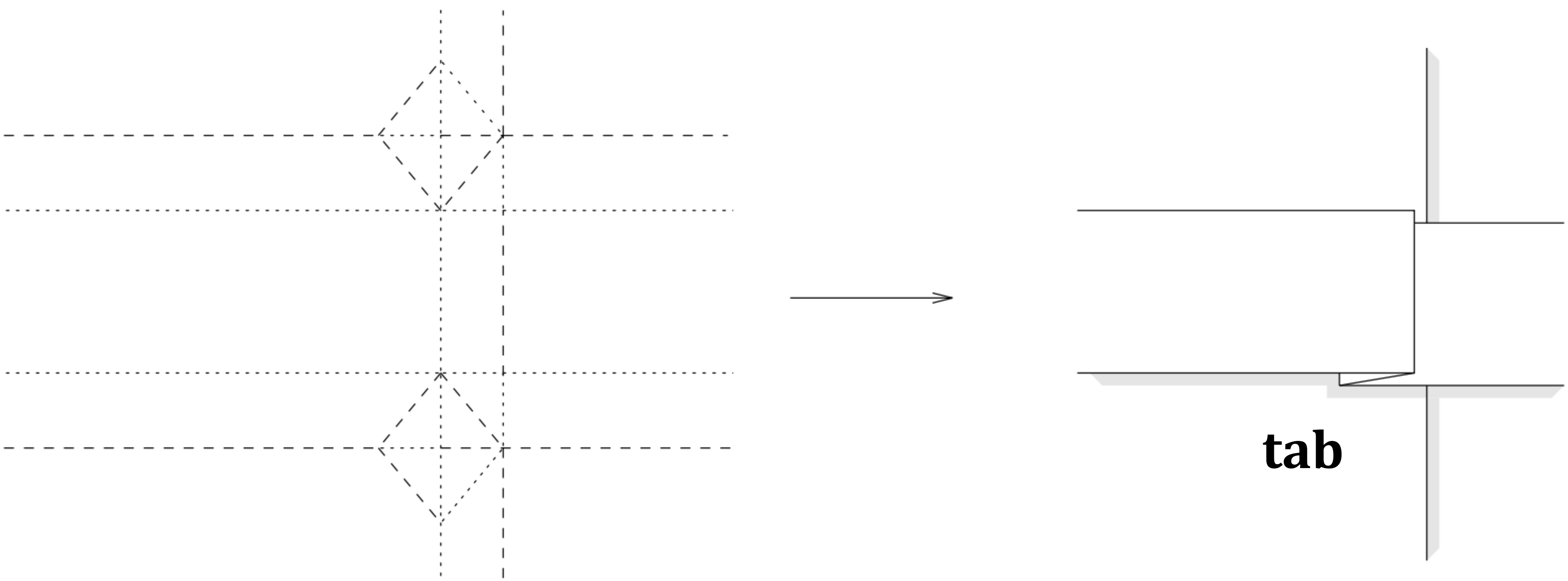
For global flat foldability, I understand how the gadgets prove (1), but how do they prove (2)?

Global flat foldability: [Bern & Hayes 1996]

1. deciding flat foldability of given crease pattern is strongly NP-hard
2. constructing valid layer ordering for given flat-foldable mountain-valley pattern is strongly NP-hard

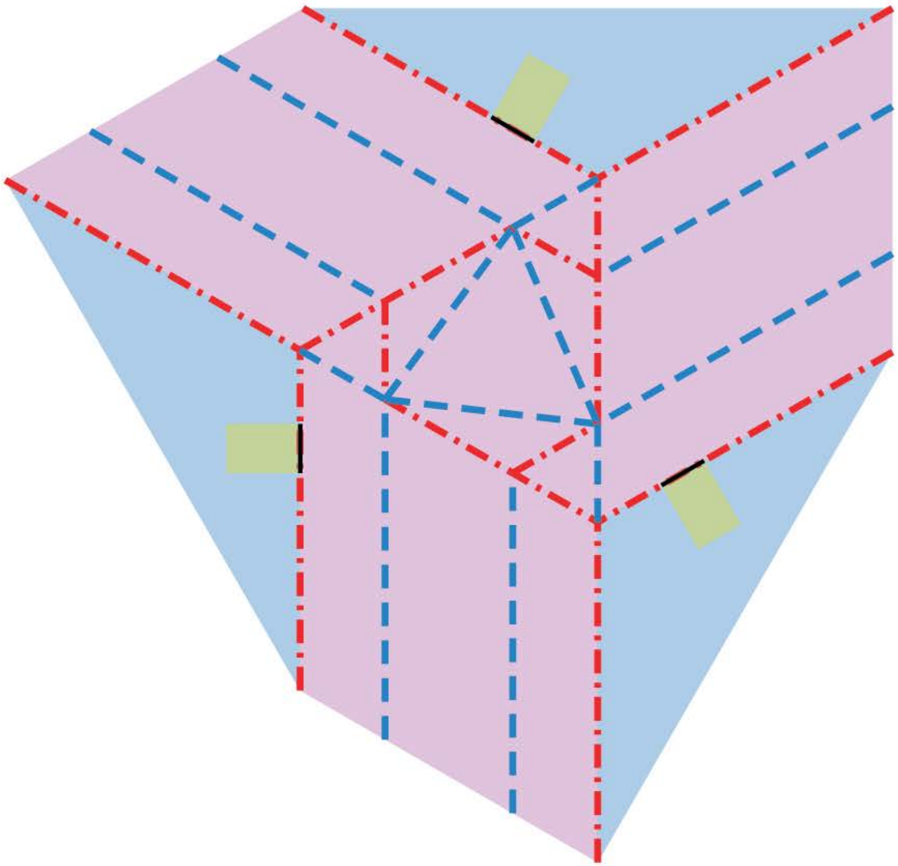


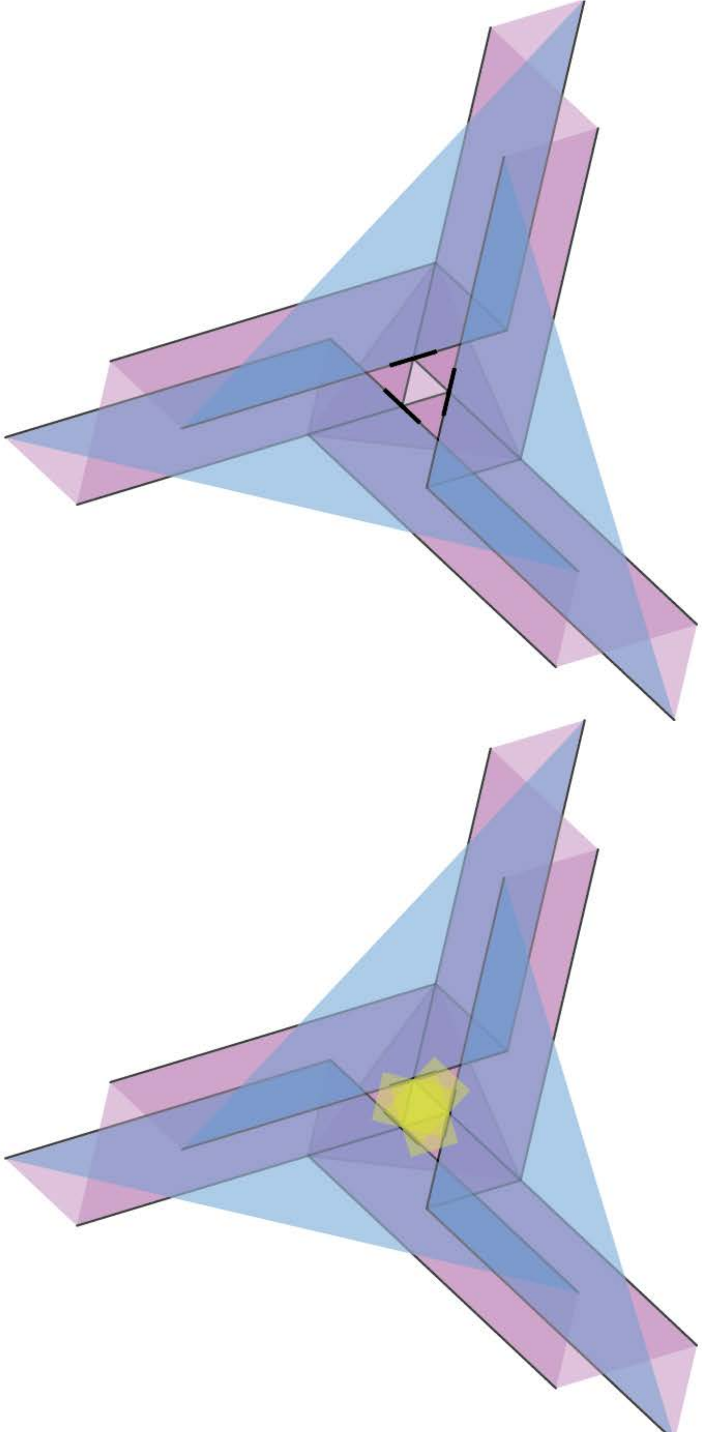




[Bern & Hayes 1996]

NAE clause





[Bern & Hayes 1996]

2D map folding: [Arkin et al 2004]

↳ rectangular paper with axis-parallel creases

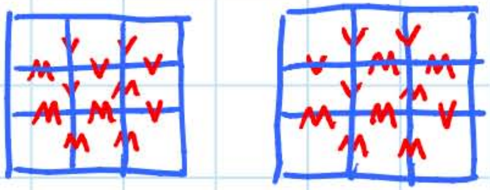
— again every crease pattern is flat foldable:

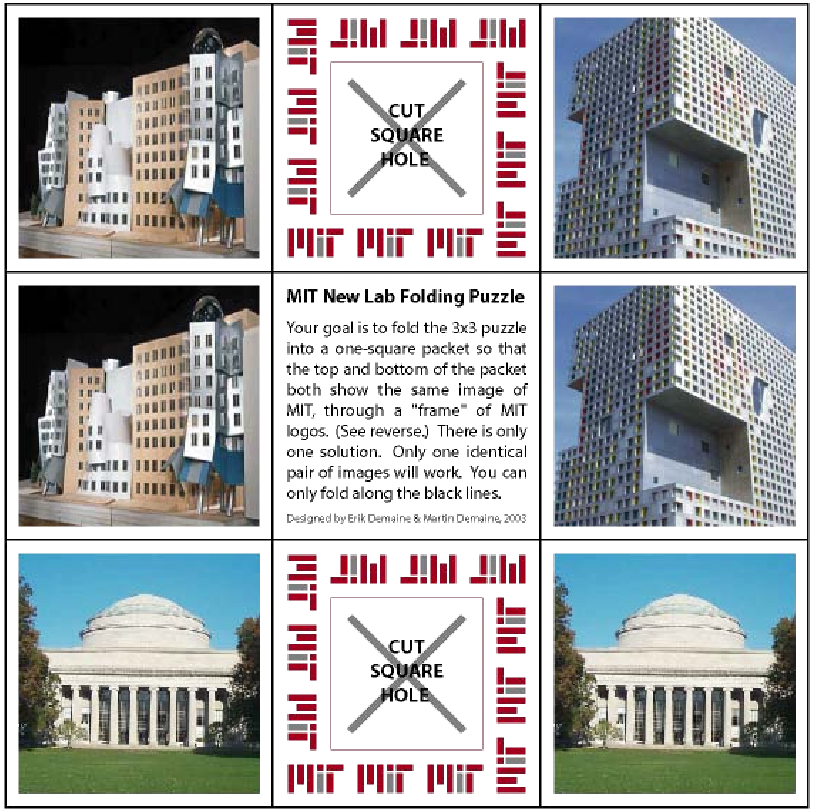
zig-zag in x then y

OPEN: characterize flat-foldable mountain-valley patterns — even $2 \times n$! [Edmonds 1997]

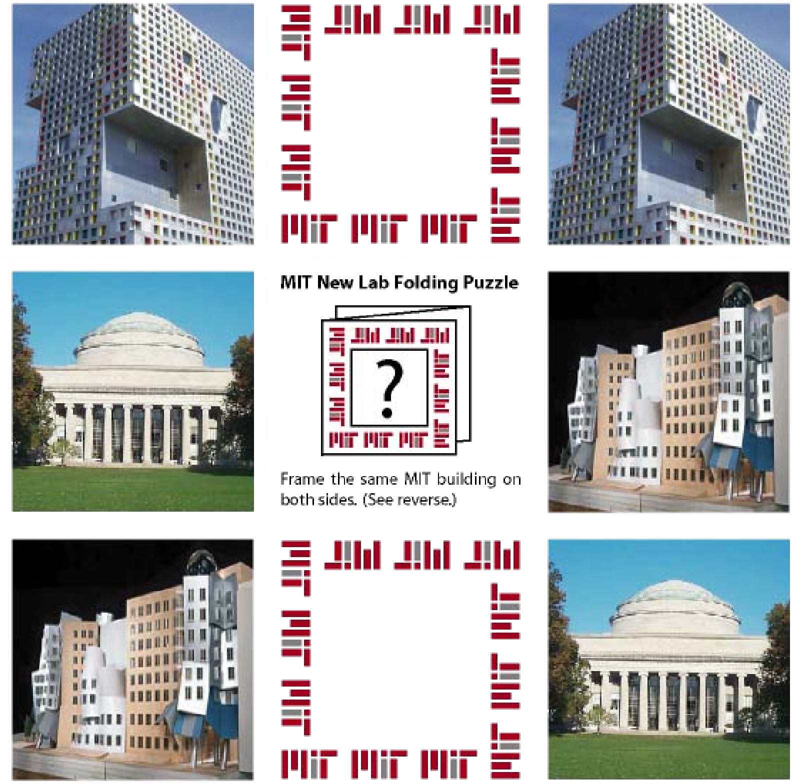
Simple folds are not as powerful in 2D:

(in contrast to 1D, where we can simulate crimp/end folds)

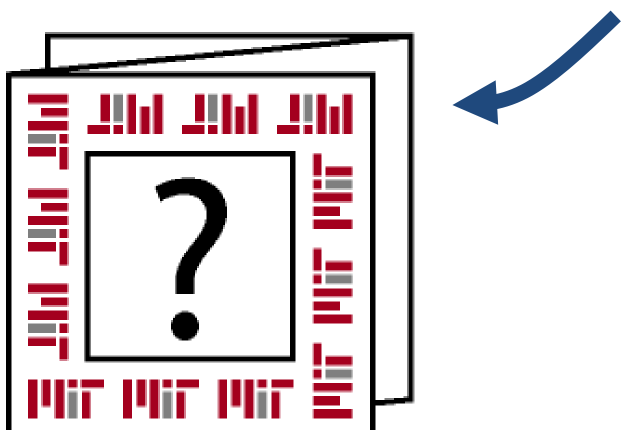




Front

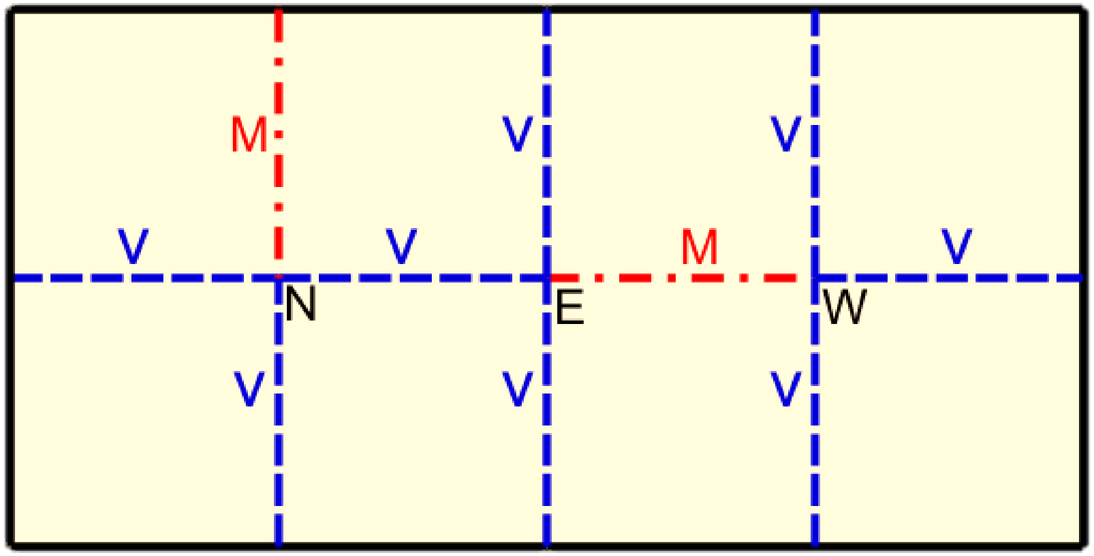


Back



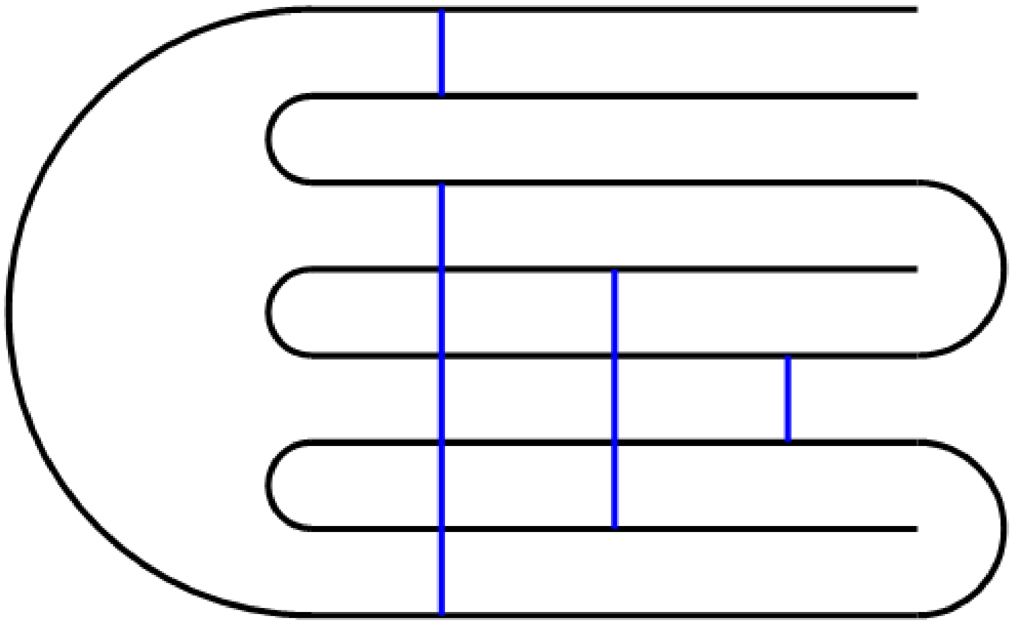
[Demaine & Demaine 2003]

1,368 folded states



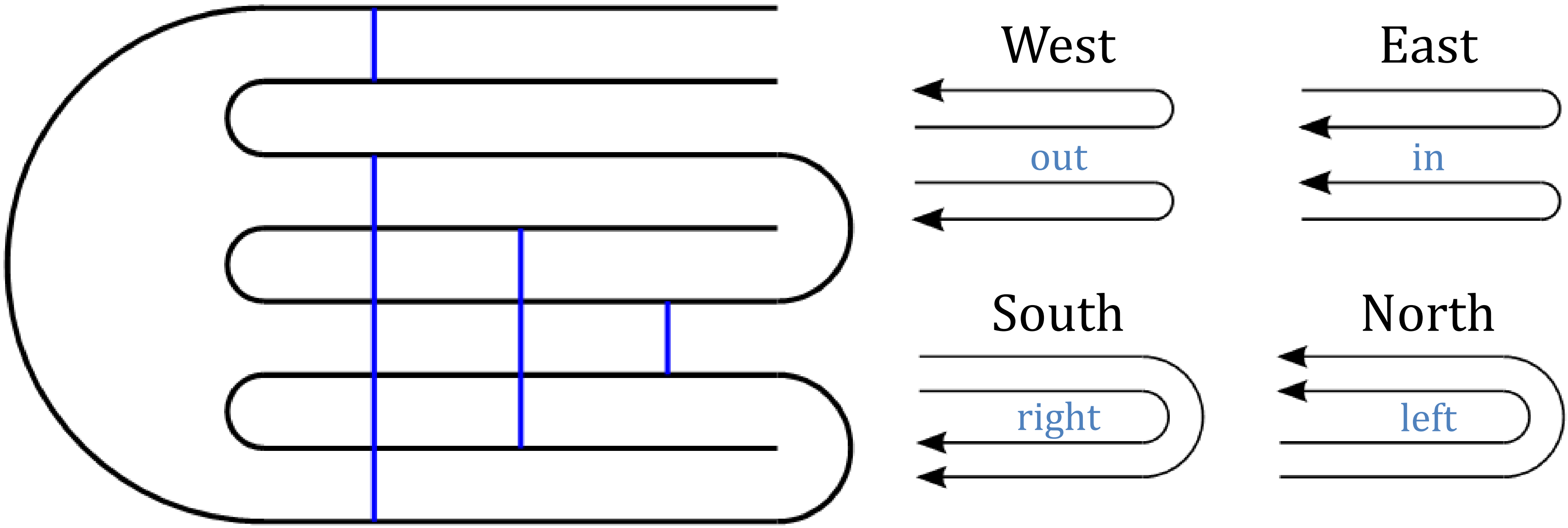
NEWS labeling

[Demaine, Liu, Morgan 2012]

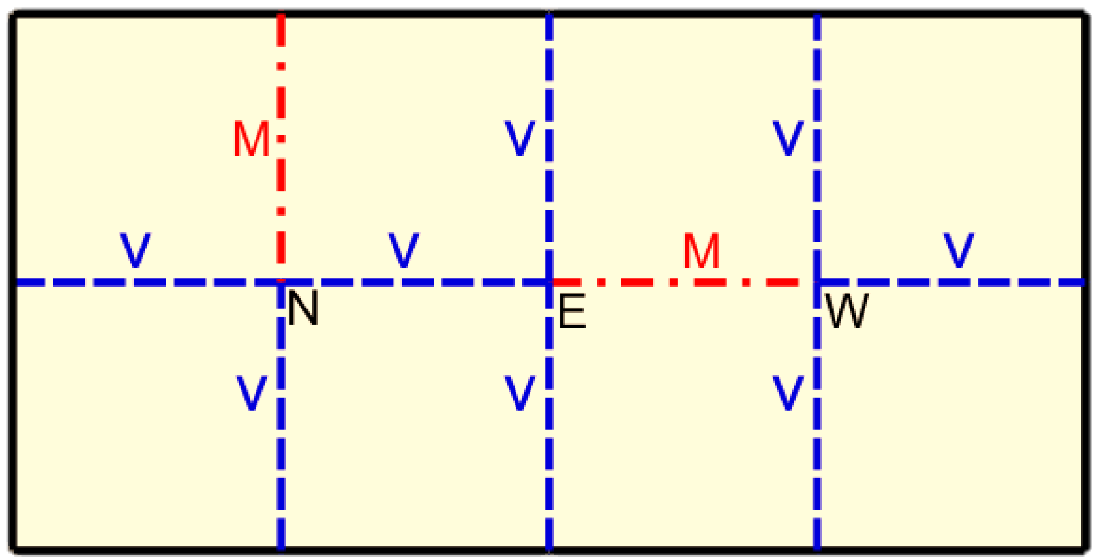


top edge view

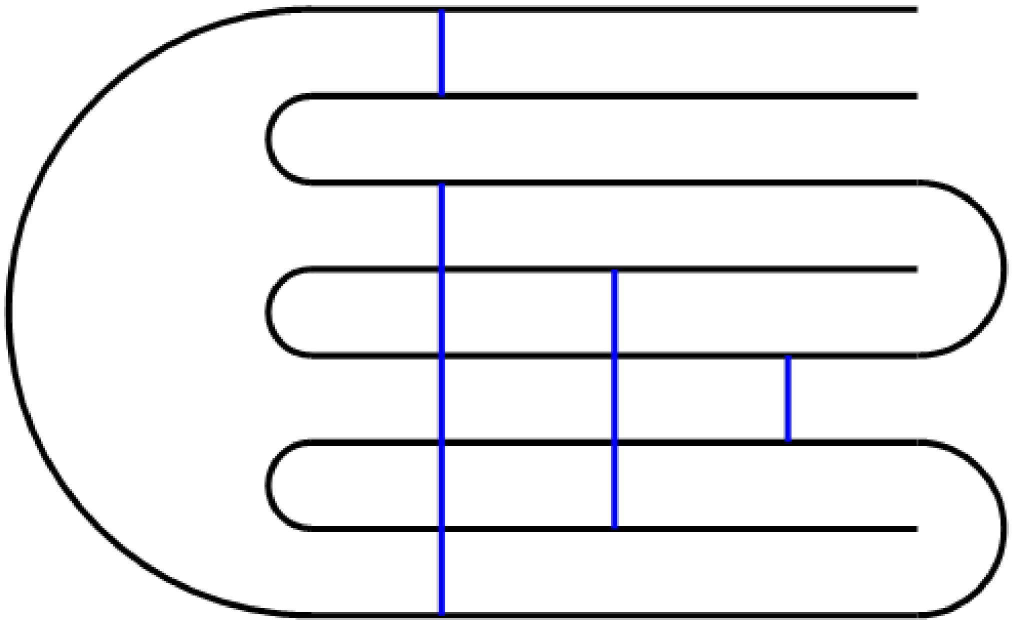
[Demaine, Liu, Morgan 2012]

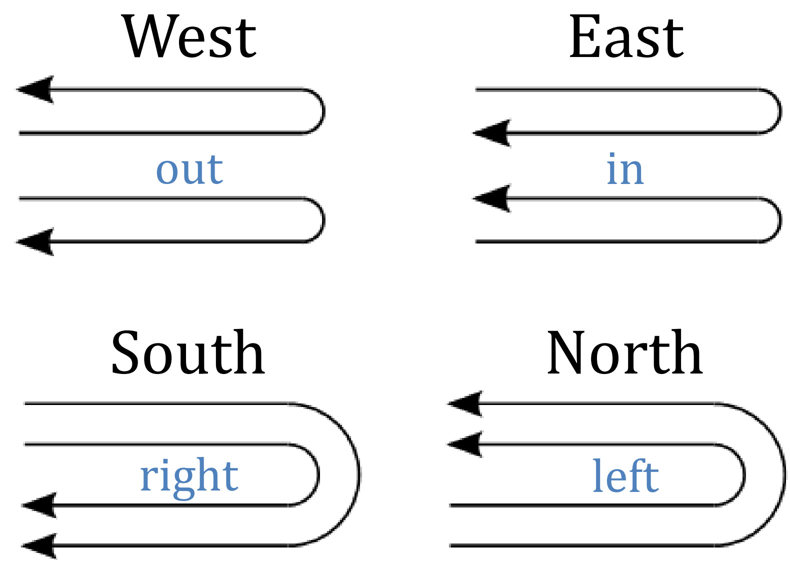


top edge view

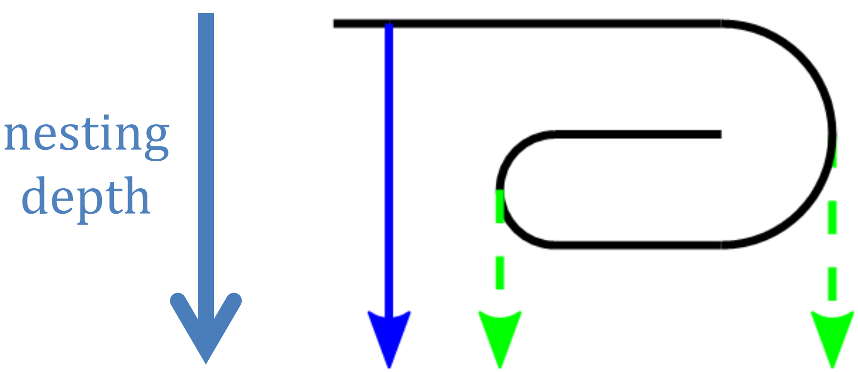


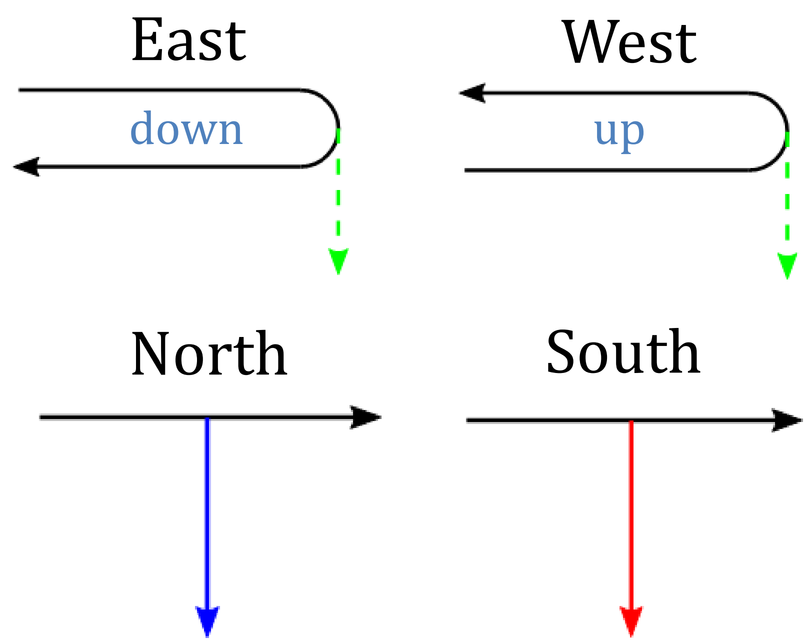
[Demaine, Liu, Morgan 2012]



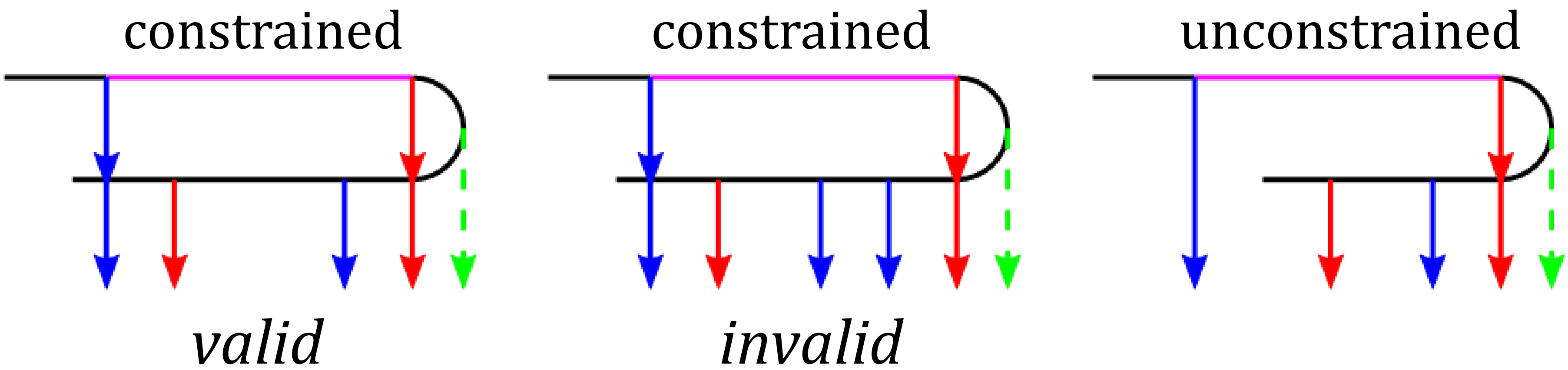


ray diagram

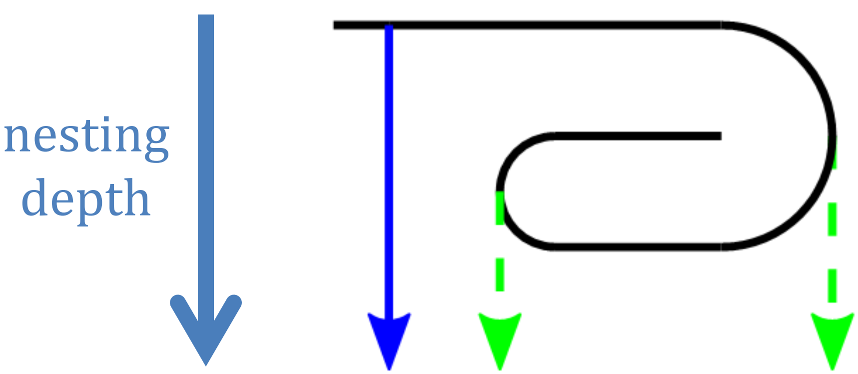


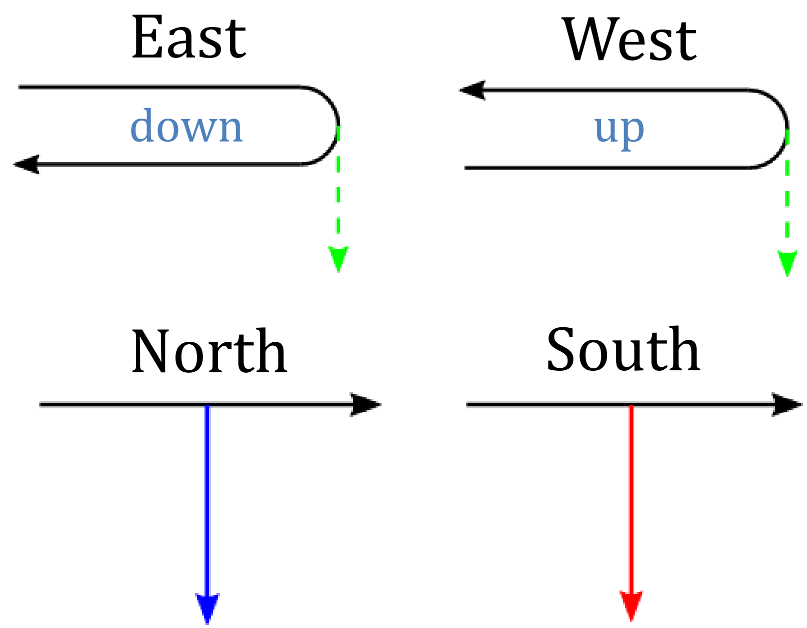


[Demaine, Liu, Morgan 2012]

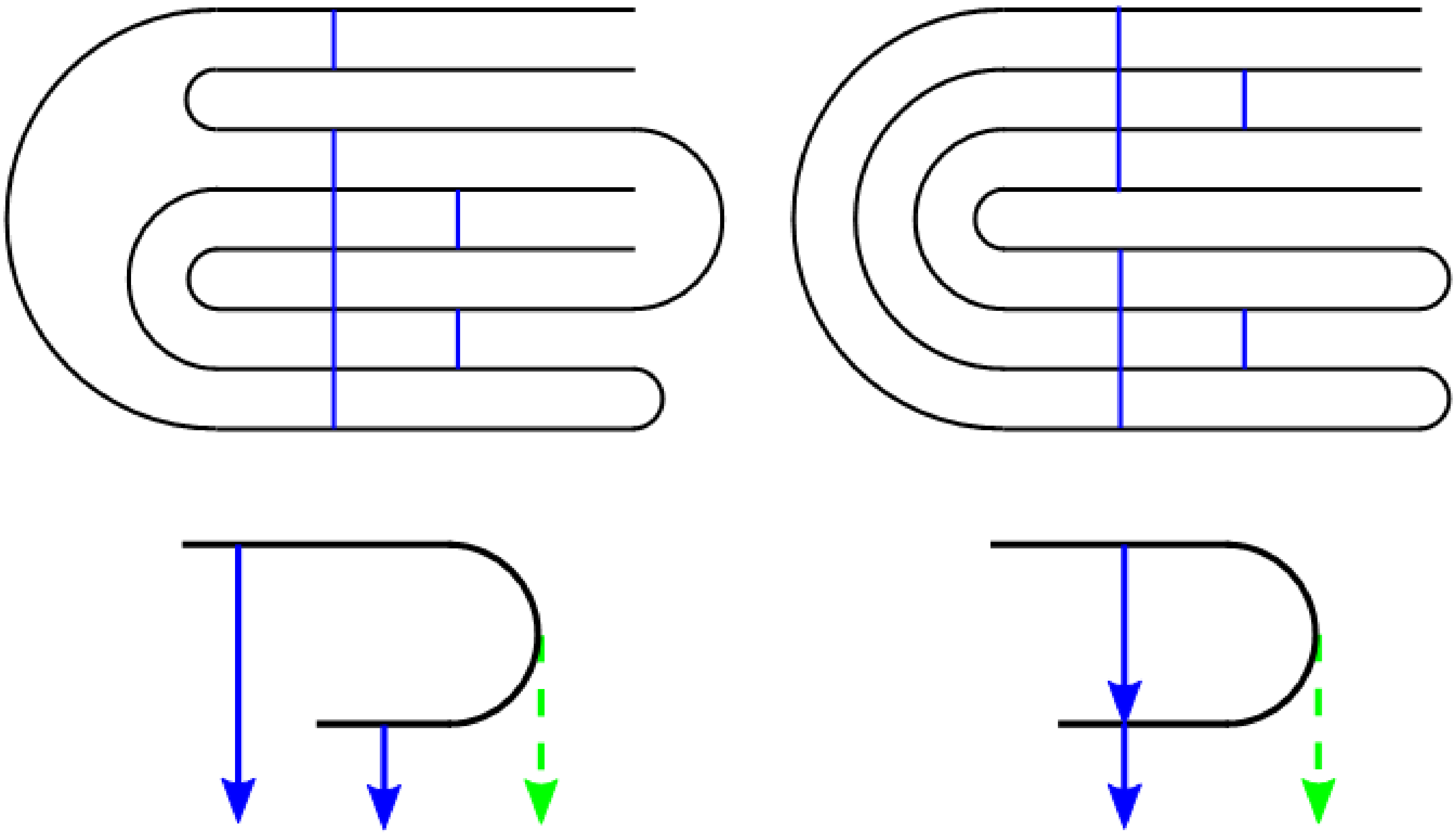


ray diagram



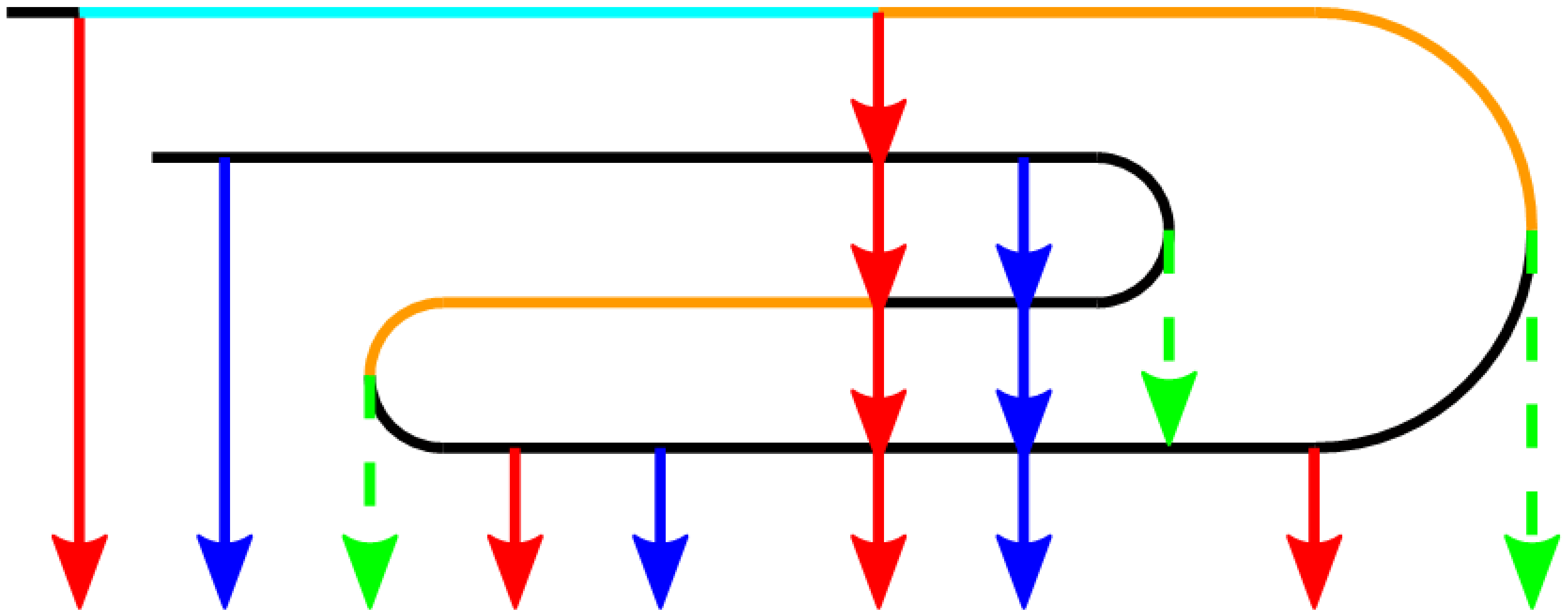


[Demaine, Liu, Morgan 2012]



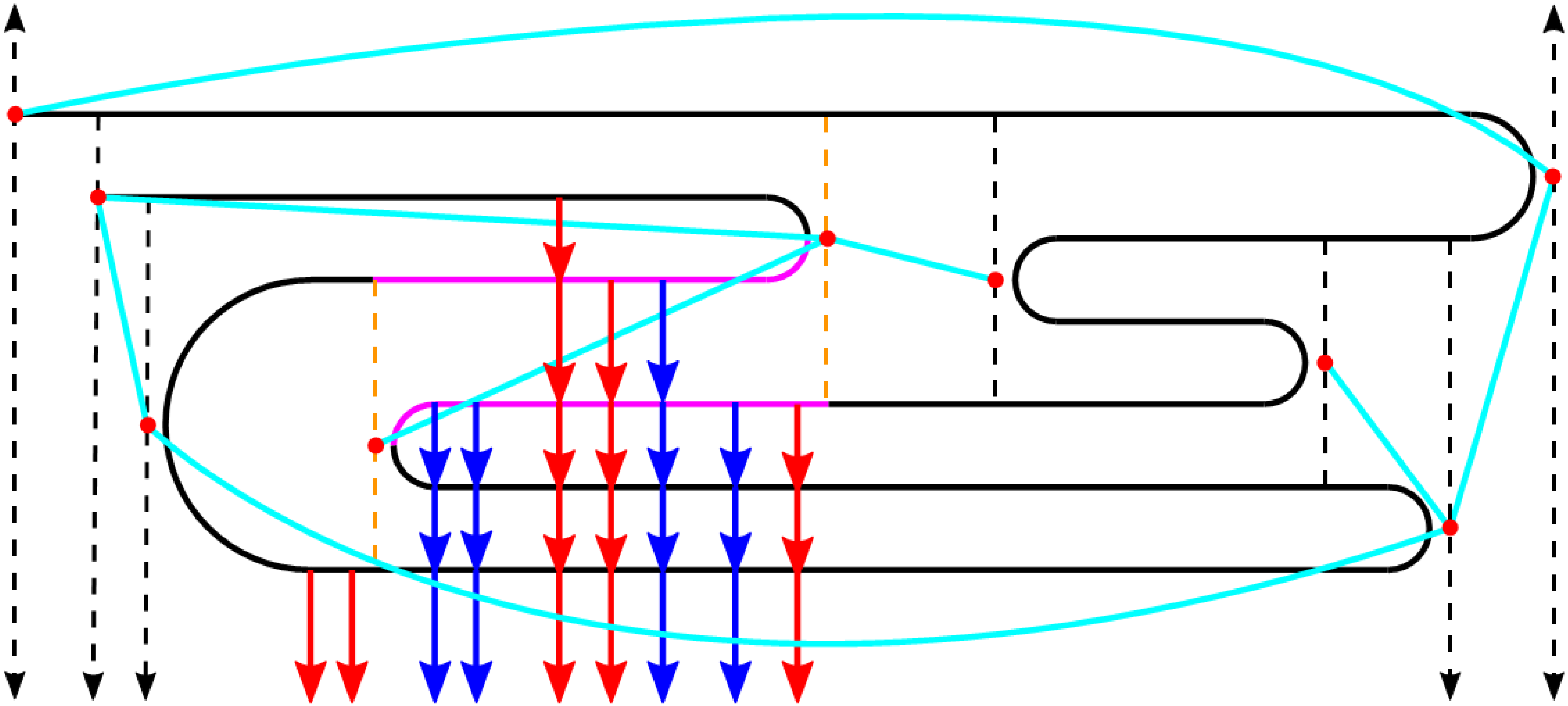
Courtesy of Erik Demaine, Eric Liu, and Thomas Morgan. Used with permission.

[Demaine, Liu, Morgan 2012]



SSESNSNSWSNWNSN

[Demaine, Liu, Morgan 2012]



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[Demaine, Liu, Morgan 2012]