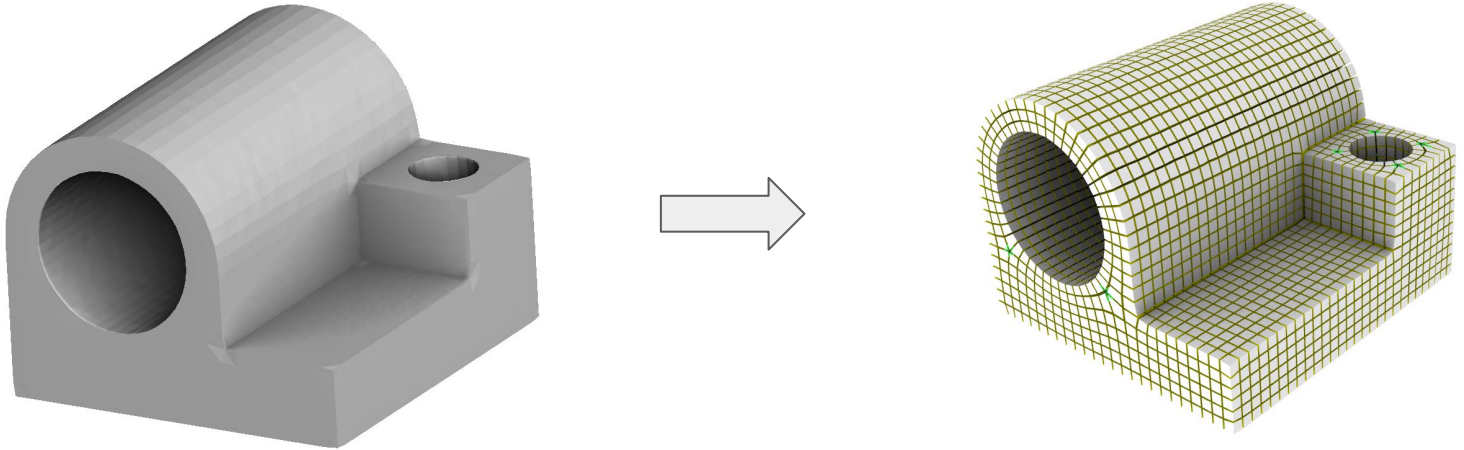
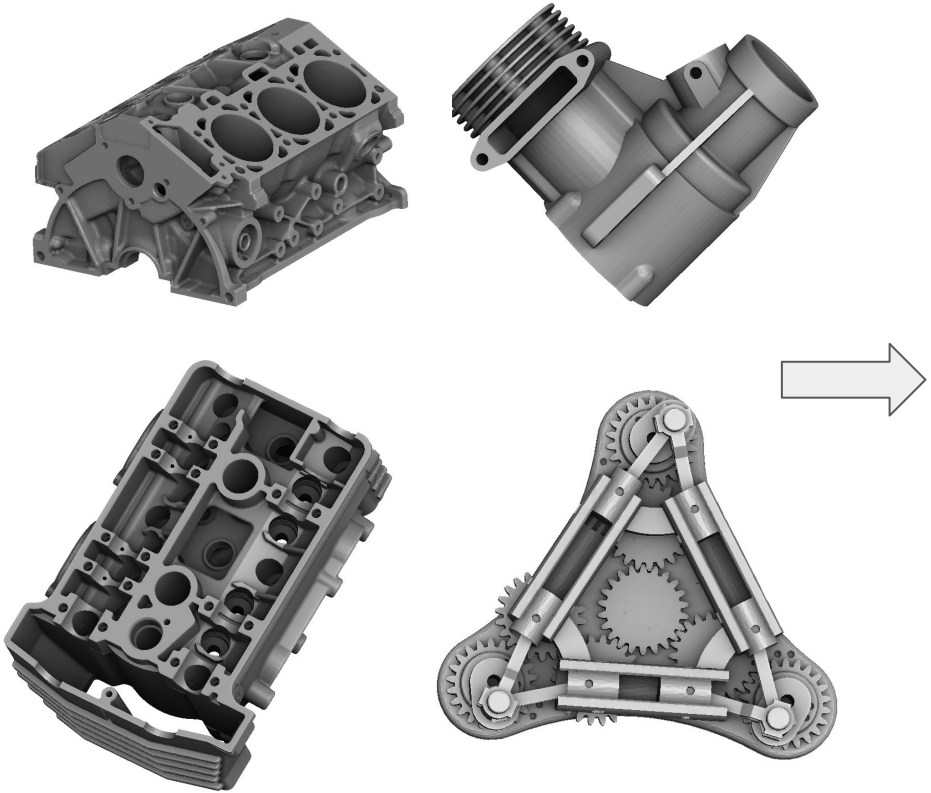
On the bijectivity of polycube maps

Finding a good grid parameterization

Principle



Our dream



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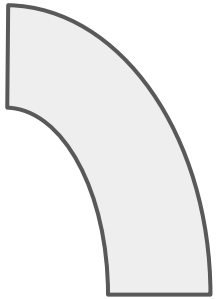
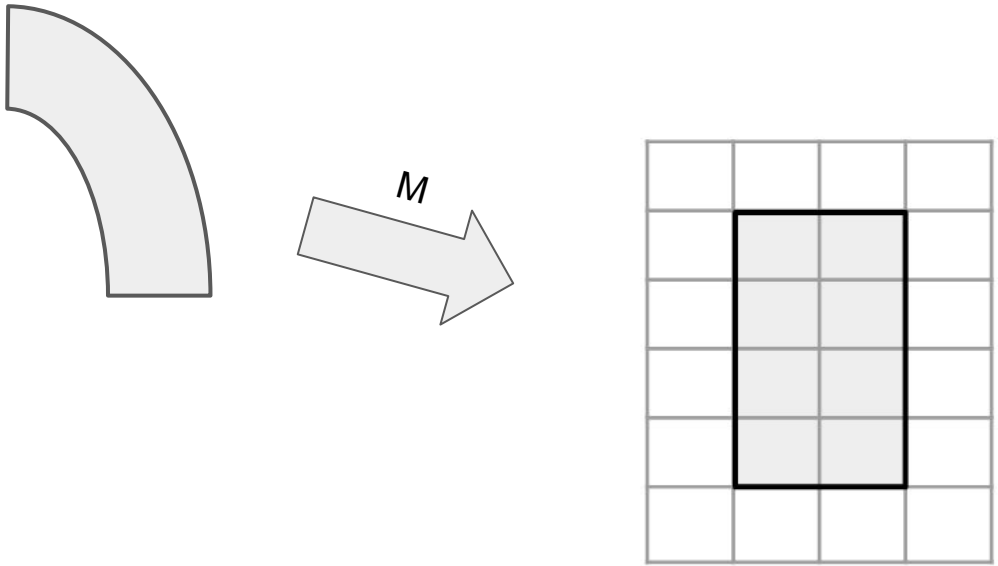
Basic introduction



Basic introduction



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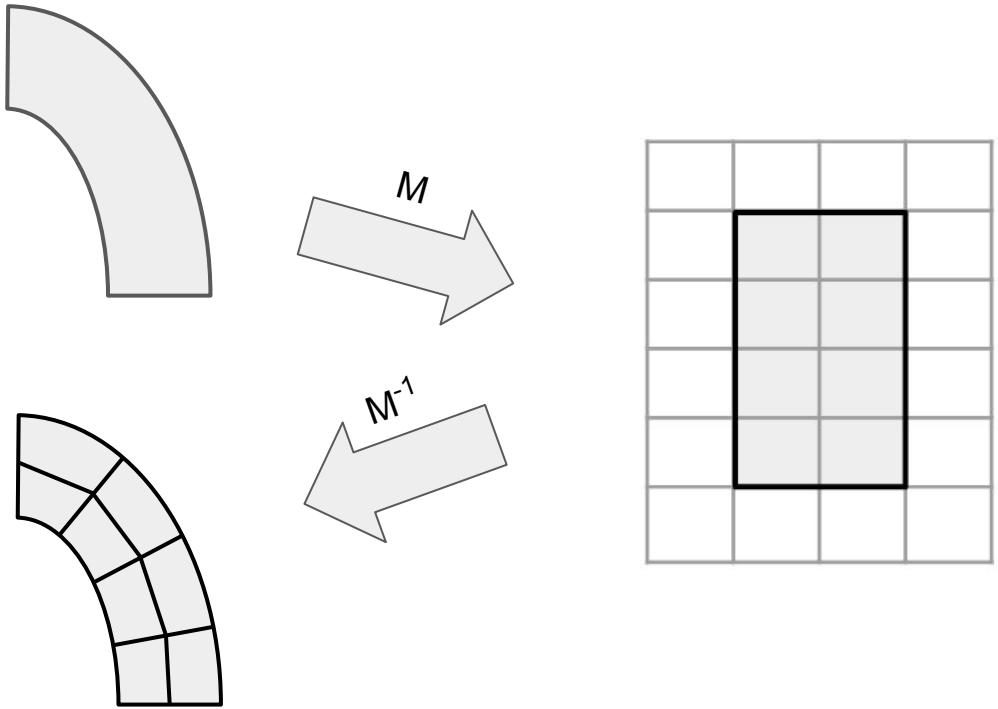
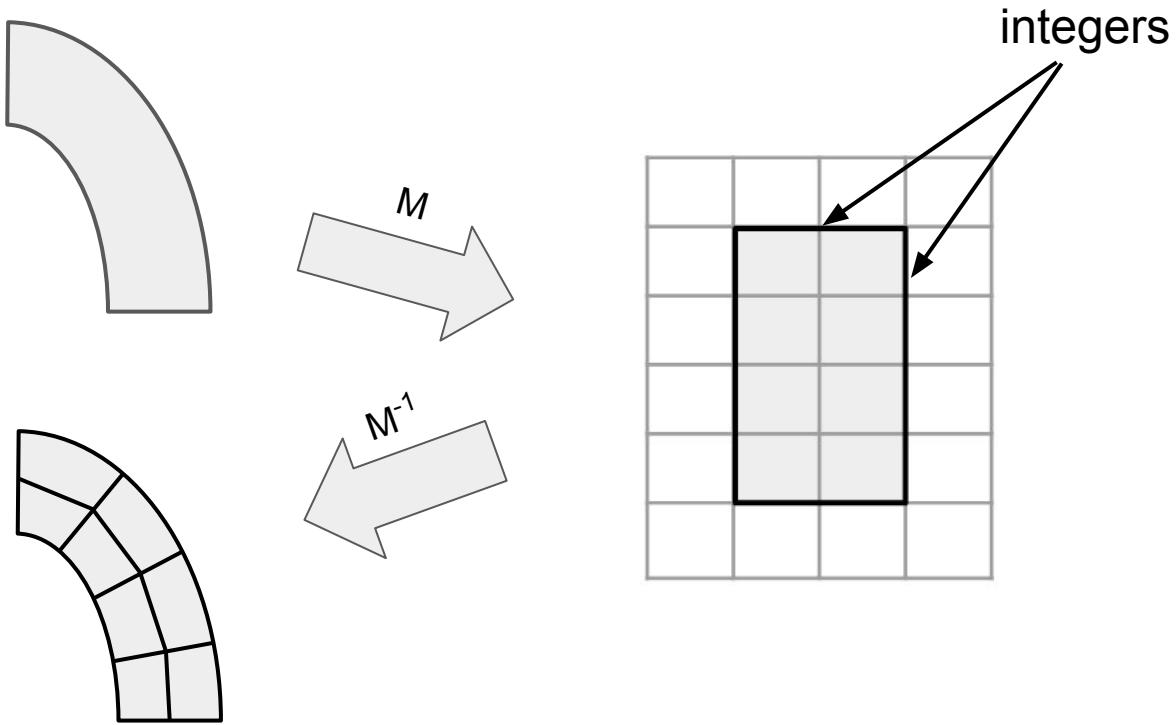
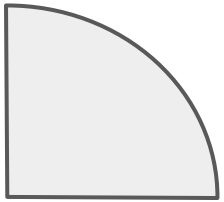


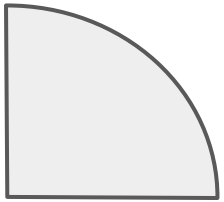
Basic introduction

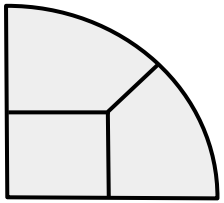


More complicated domains

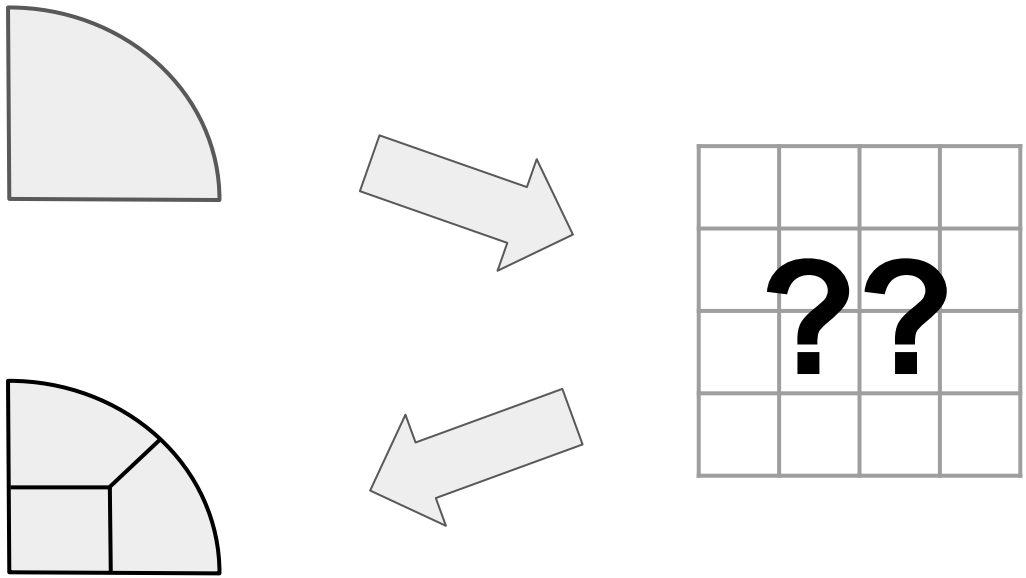


More complicated domains





More complicated domains



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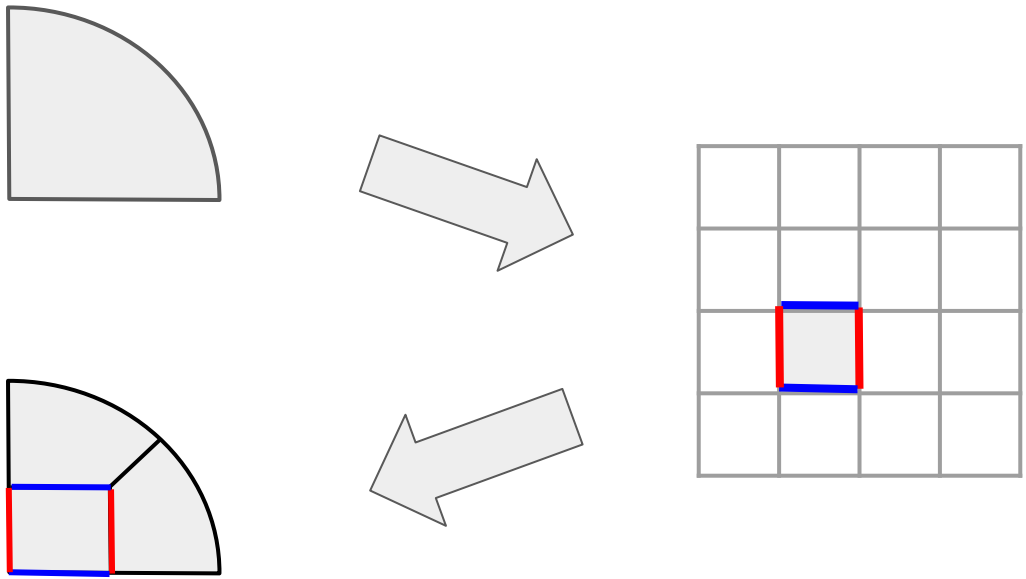

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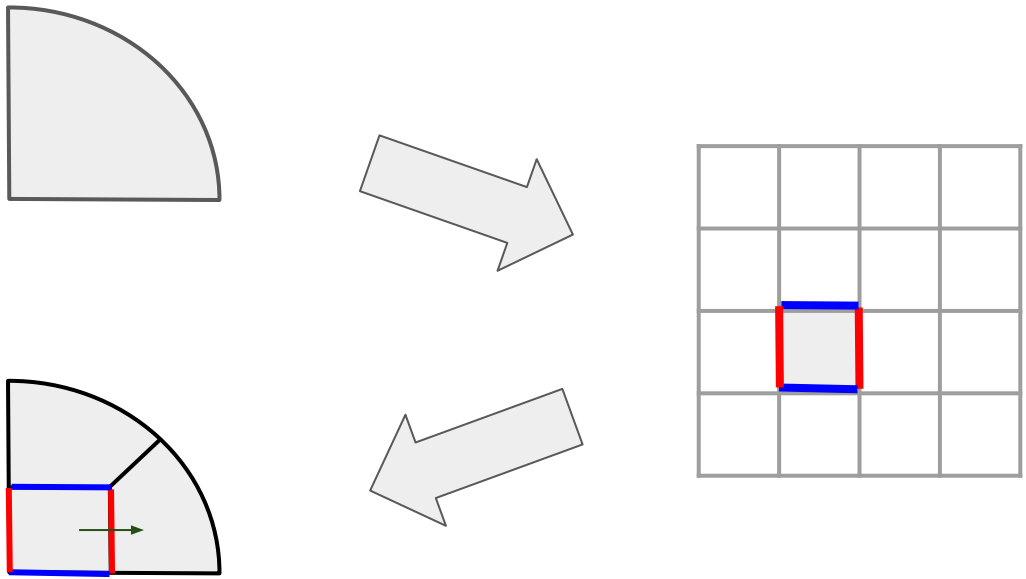

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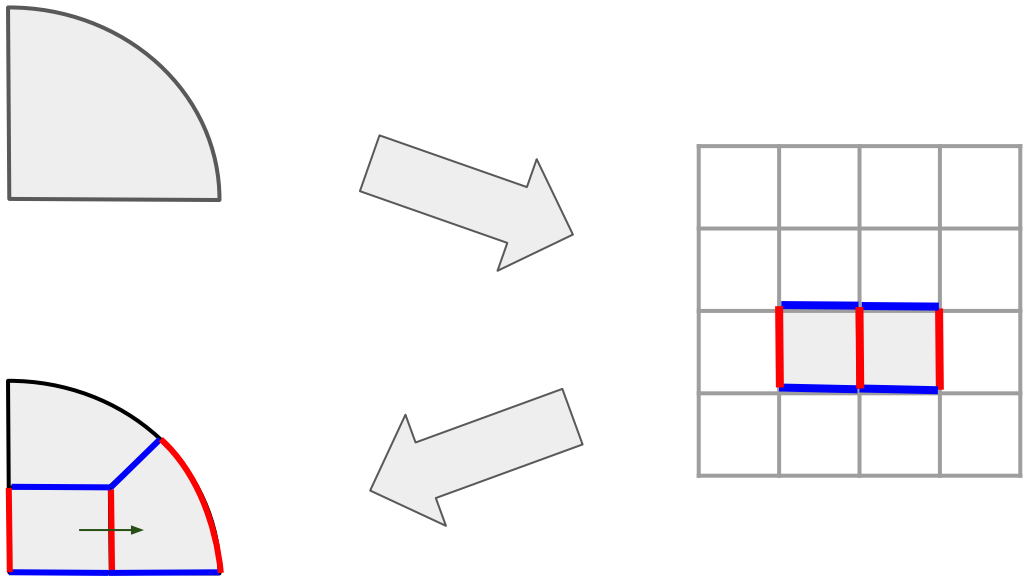
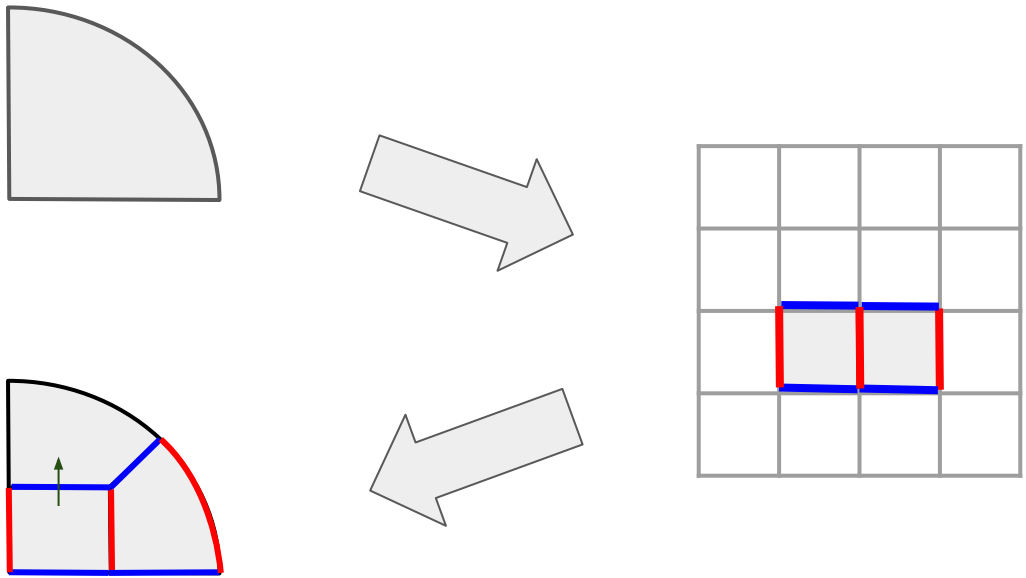


More complicated domains



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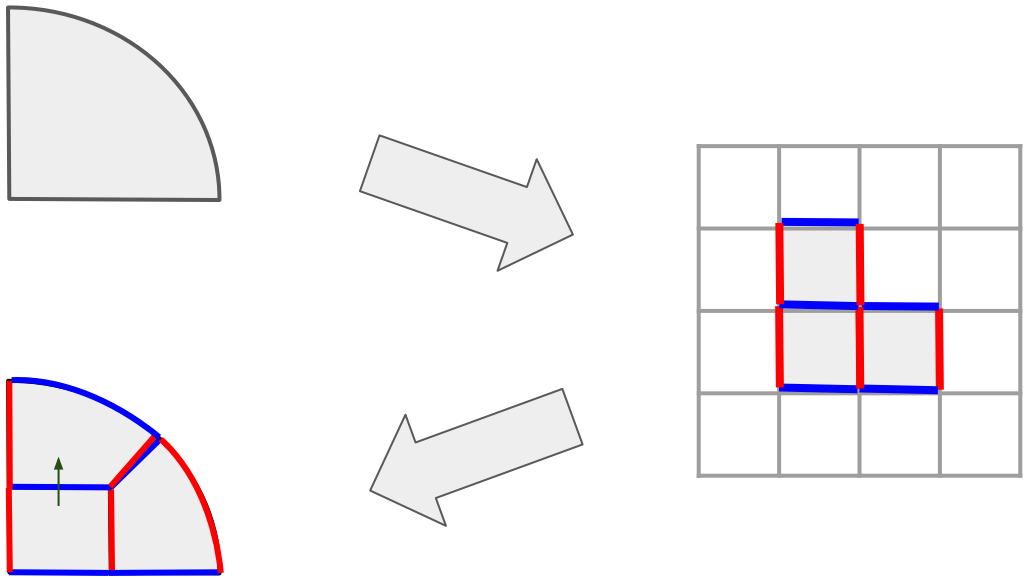
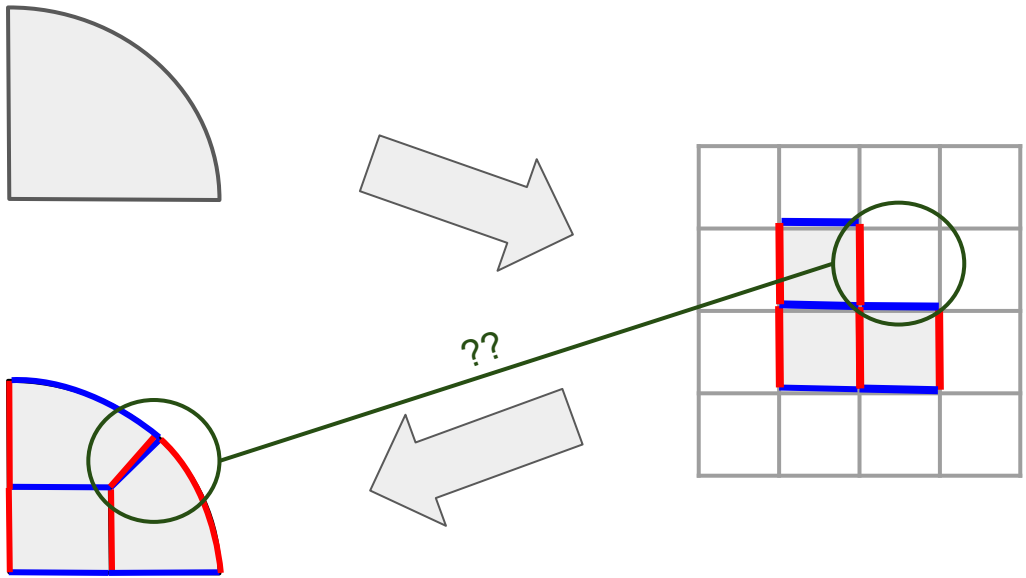


More complicated domains



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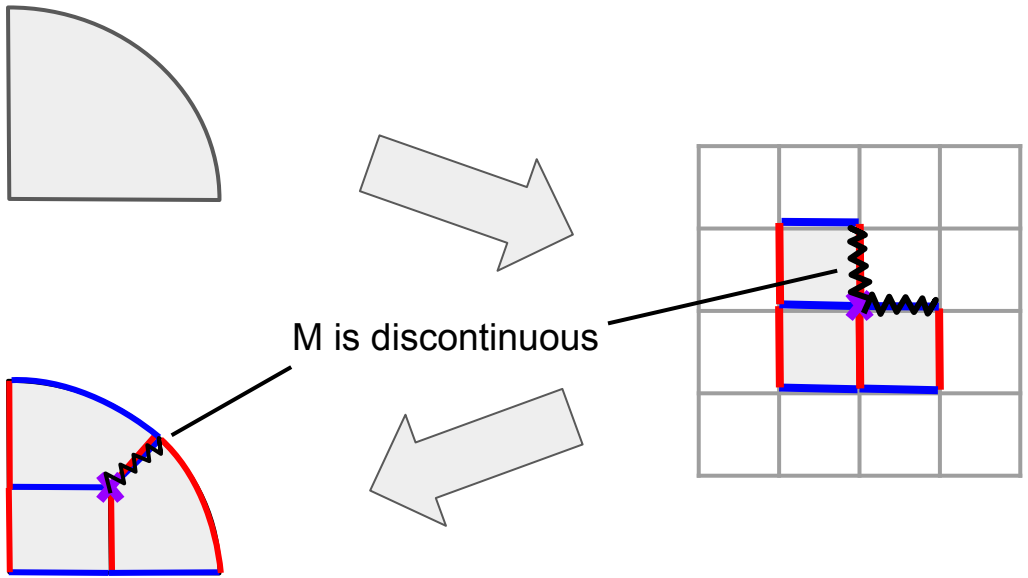

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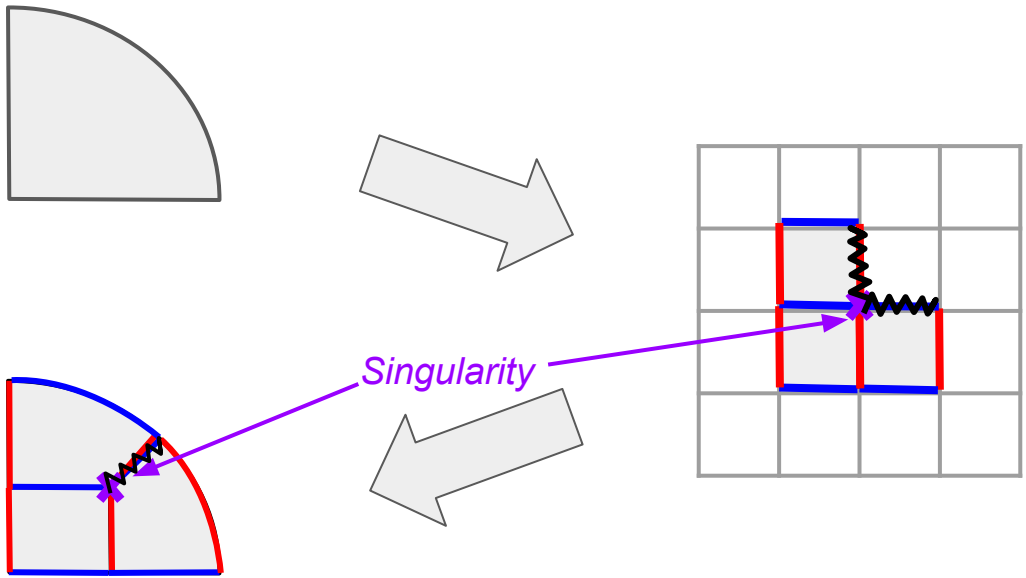

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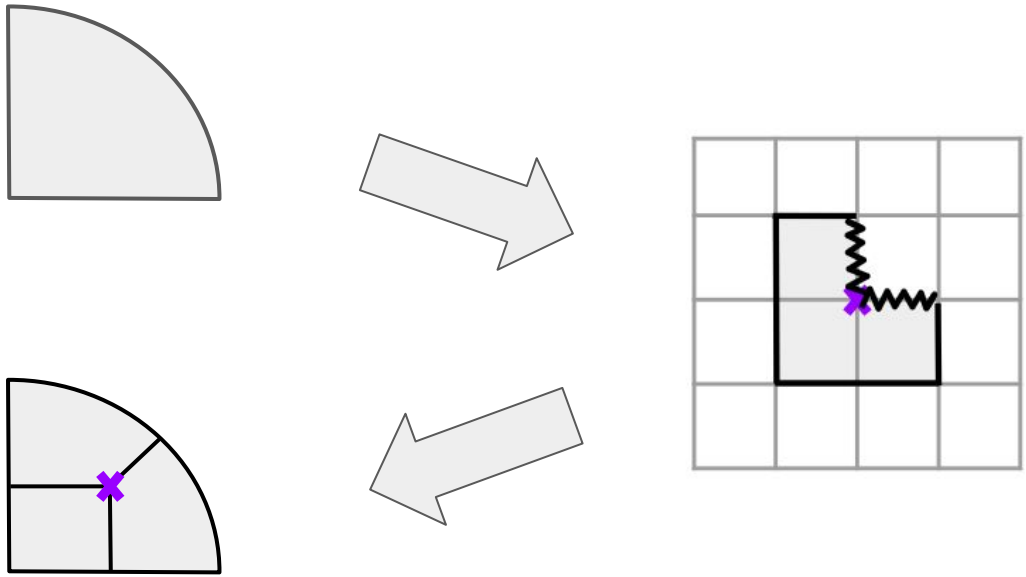

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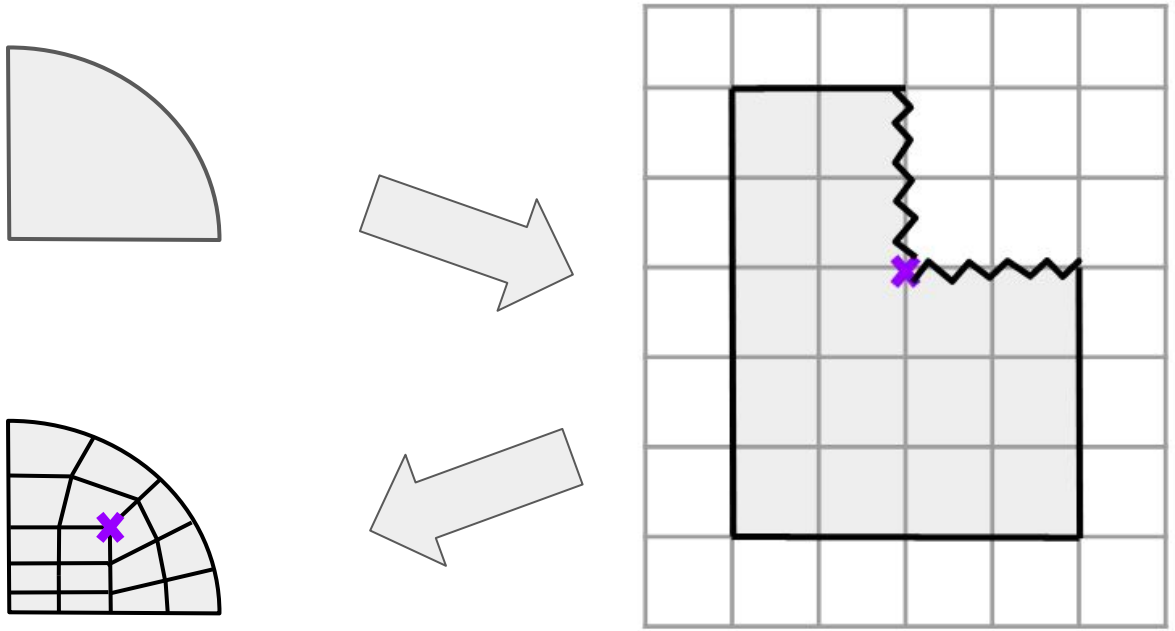
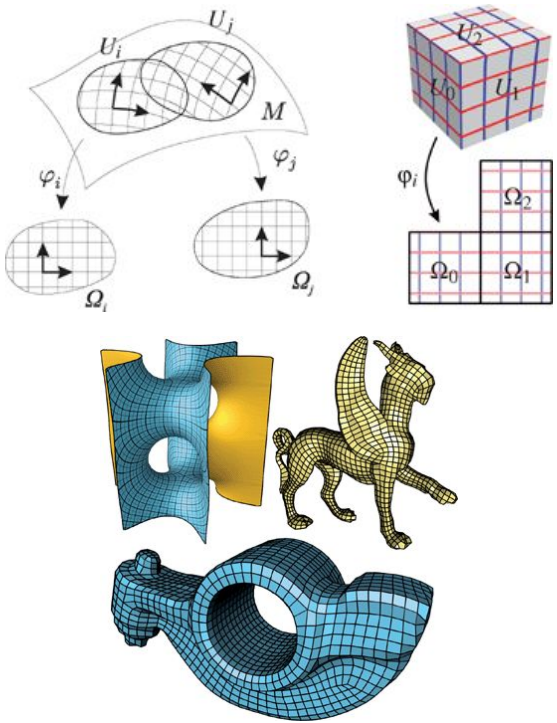
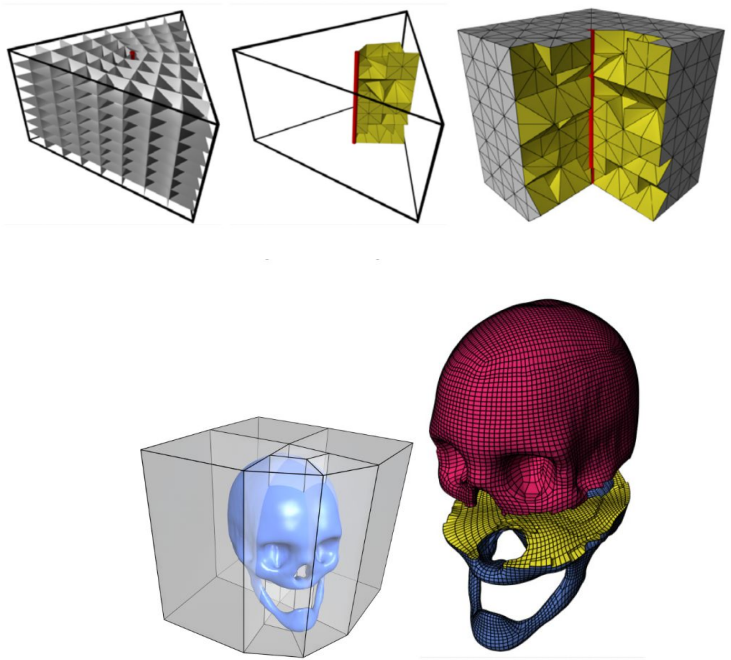


First implemations



[PGP, quadcover, mixed-Integer quadrangulation]

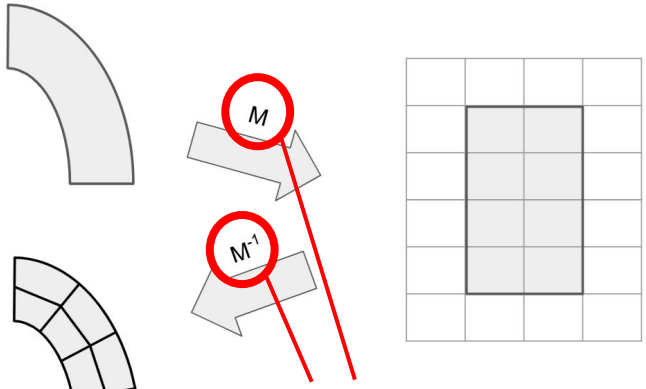


[Nieser et al, 2011]

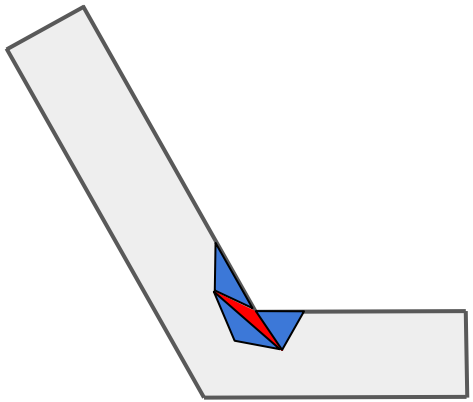
Mapping bijectivity problems

2 reasons :

1. Interpolation of boundary constraints
2. Definition of boundary constraints



Introducing 1st problem



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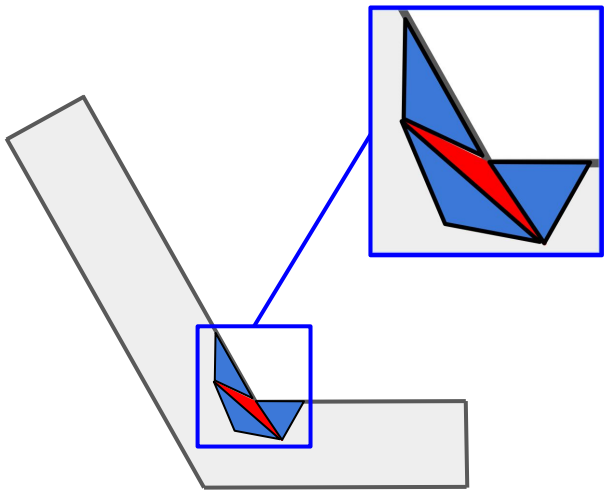

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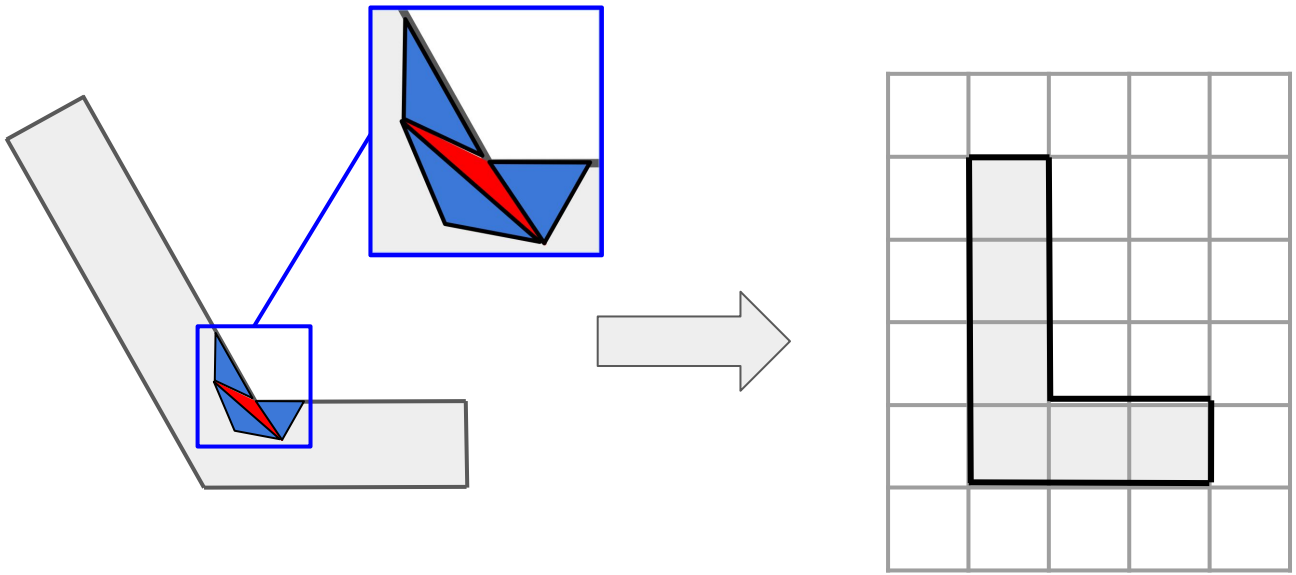

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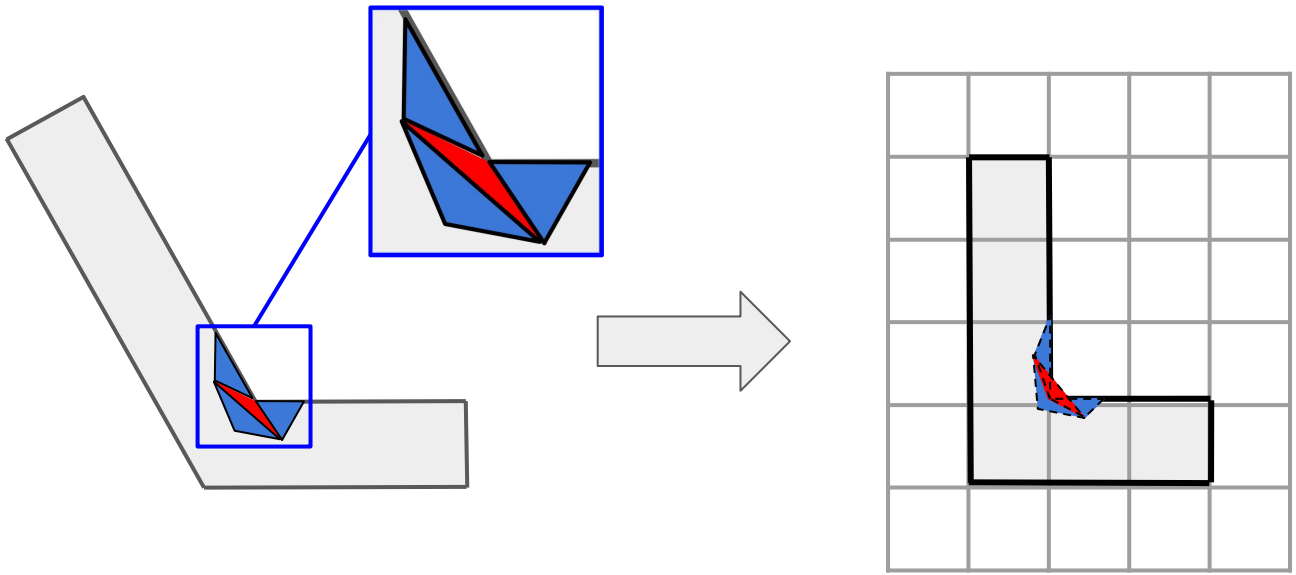

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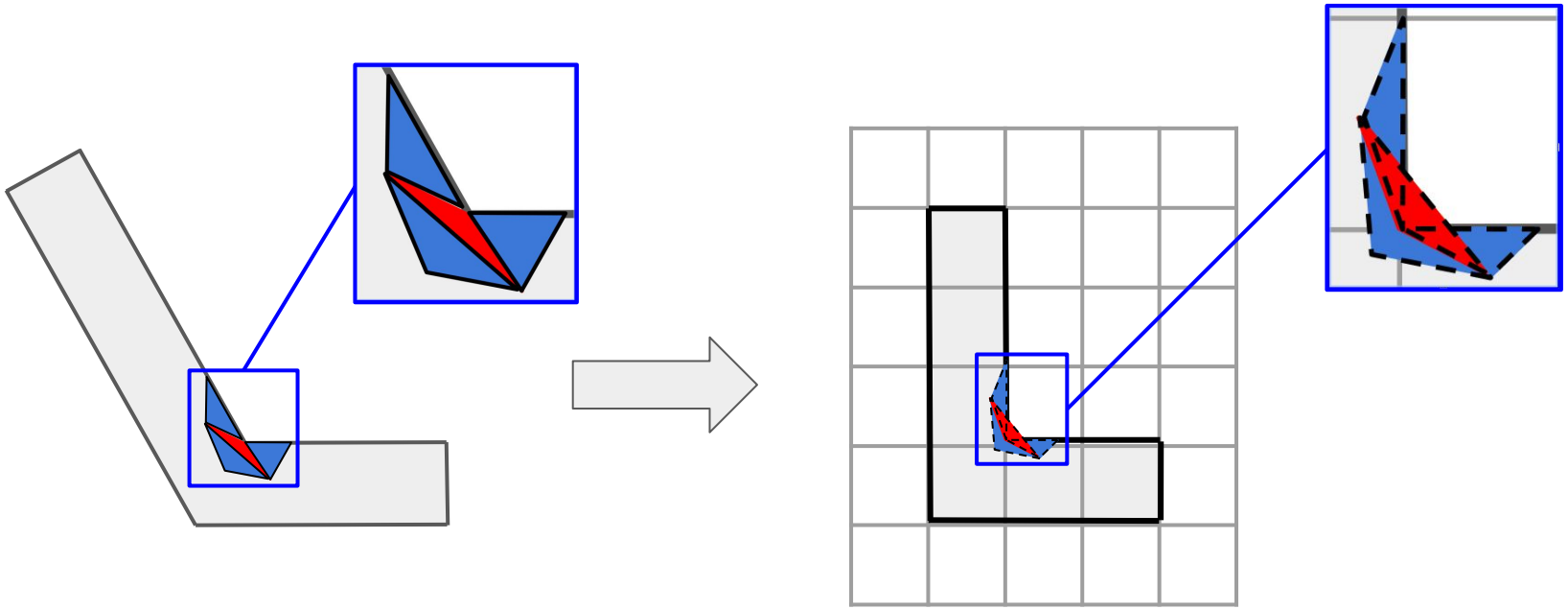

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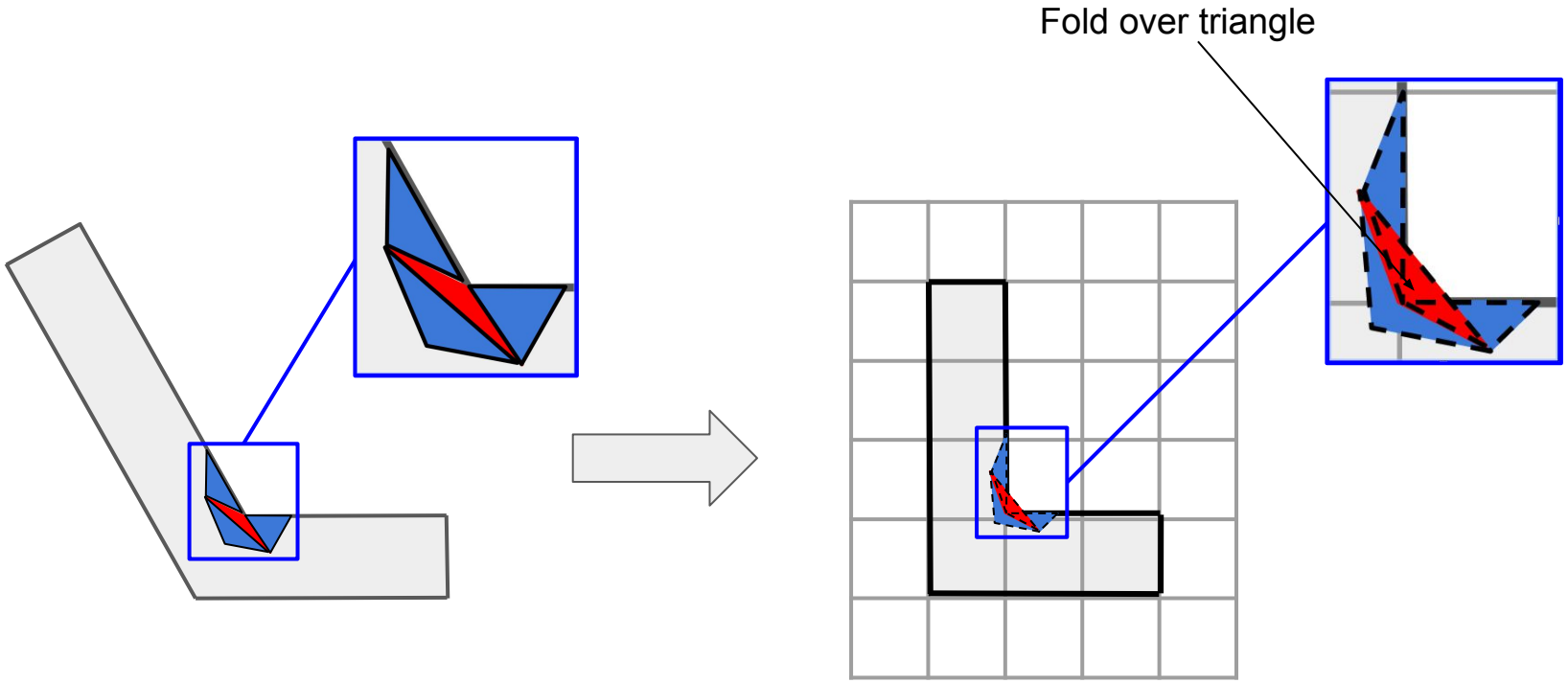

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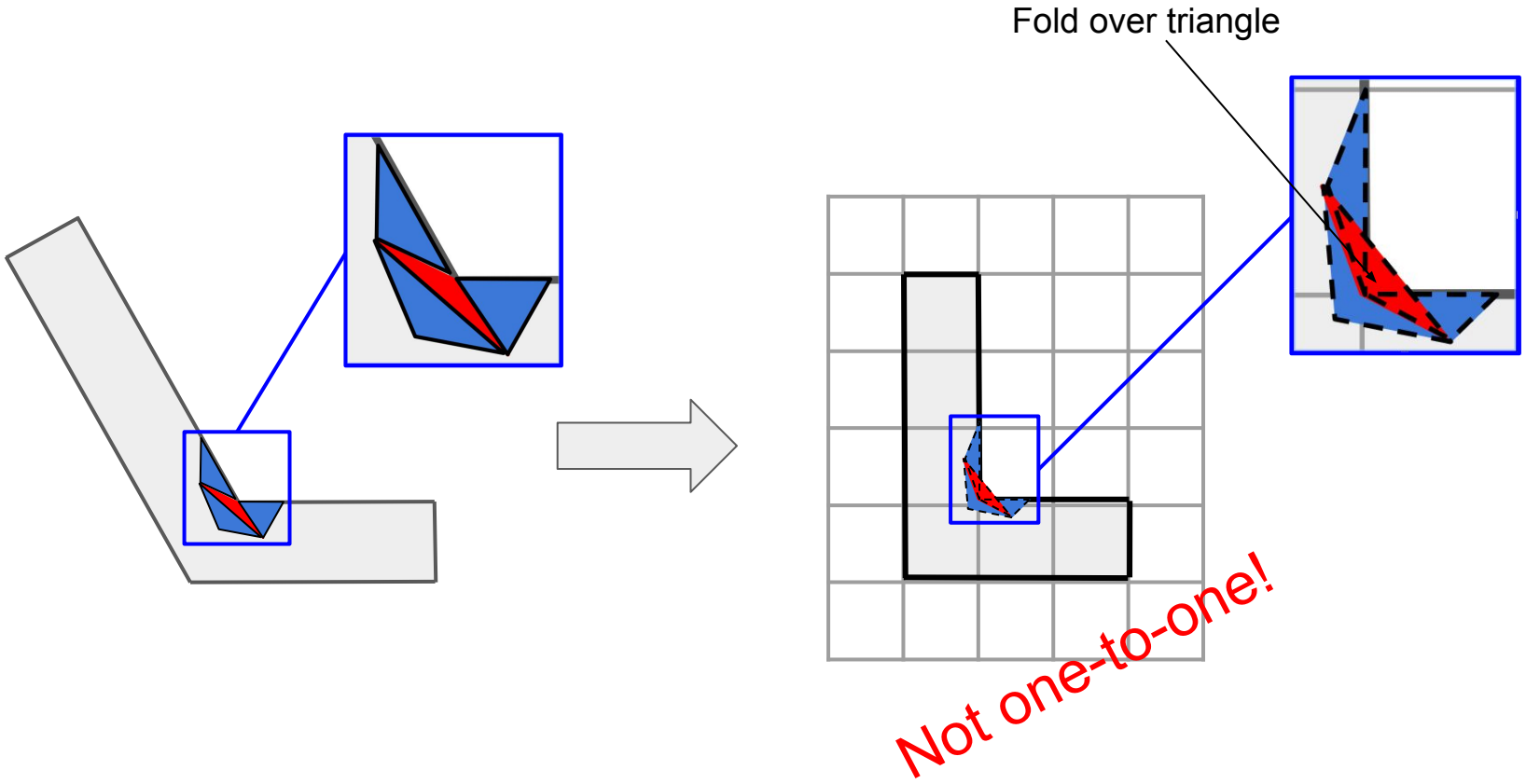
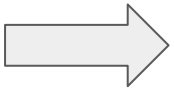


Reality example

Reality example

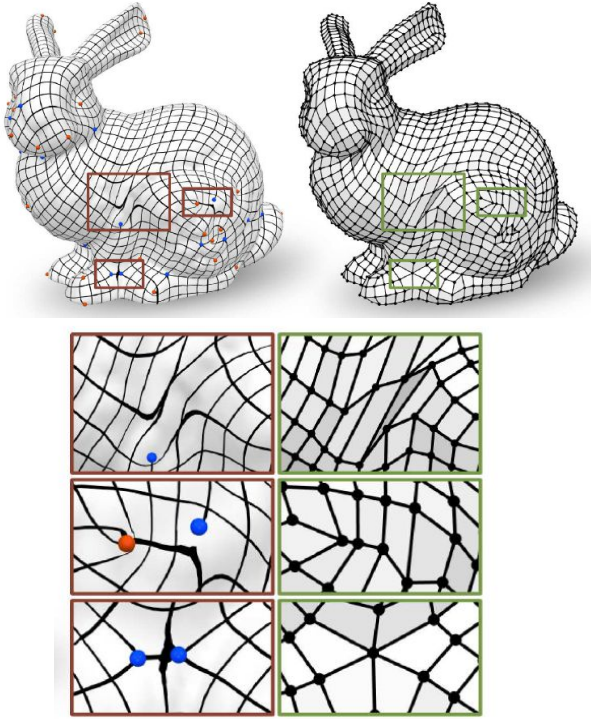


Reality example

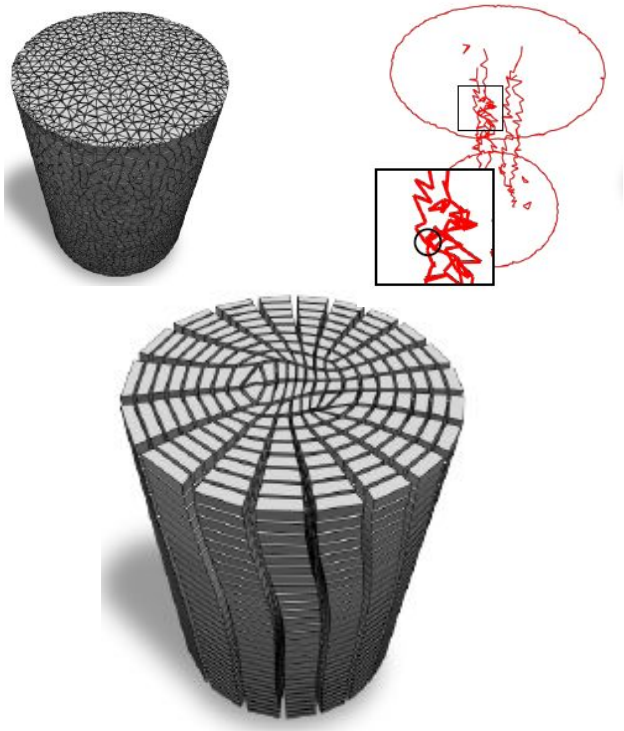
Solution

Allowing local non-bijectiviy

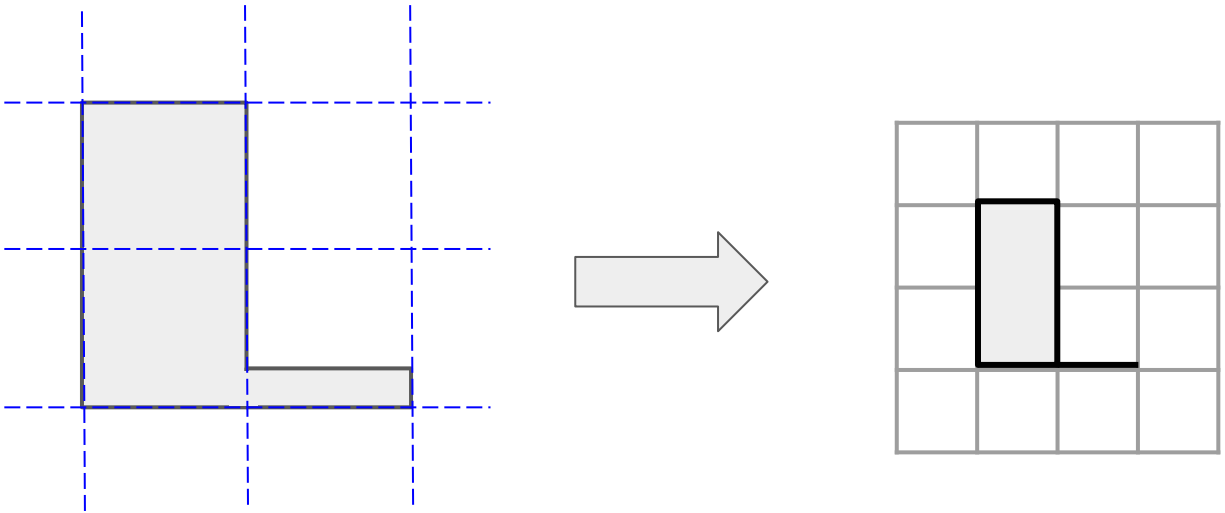
[Ebke et al, 2013]



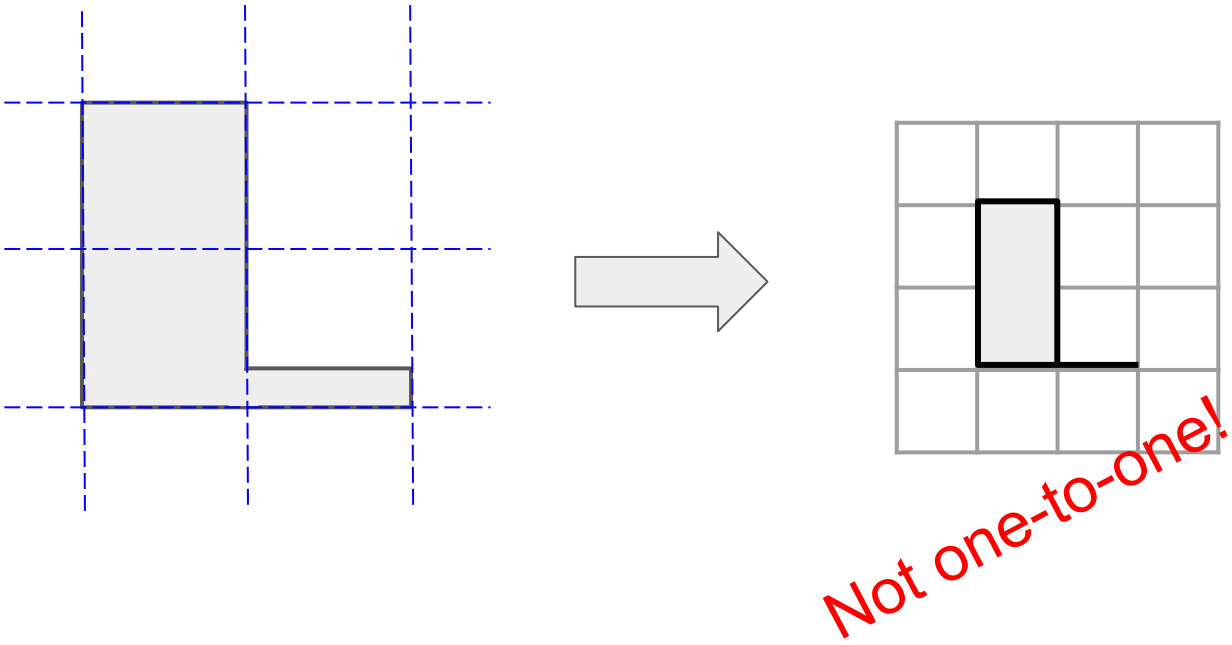
[Lyon et al, 2016]



Introducing 2nd problem



Introducing 2nd problem



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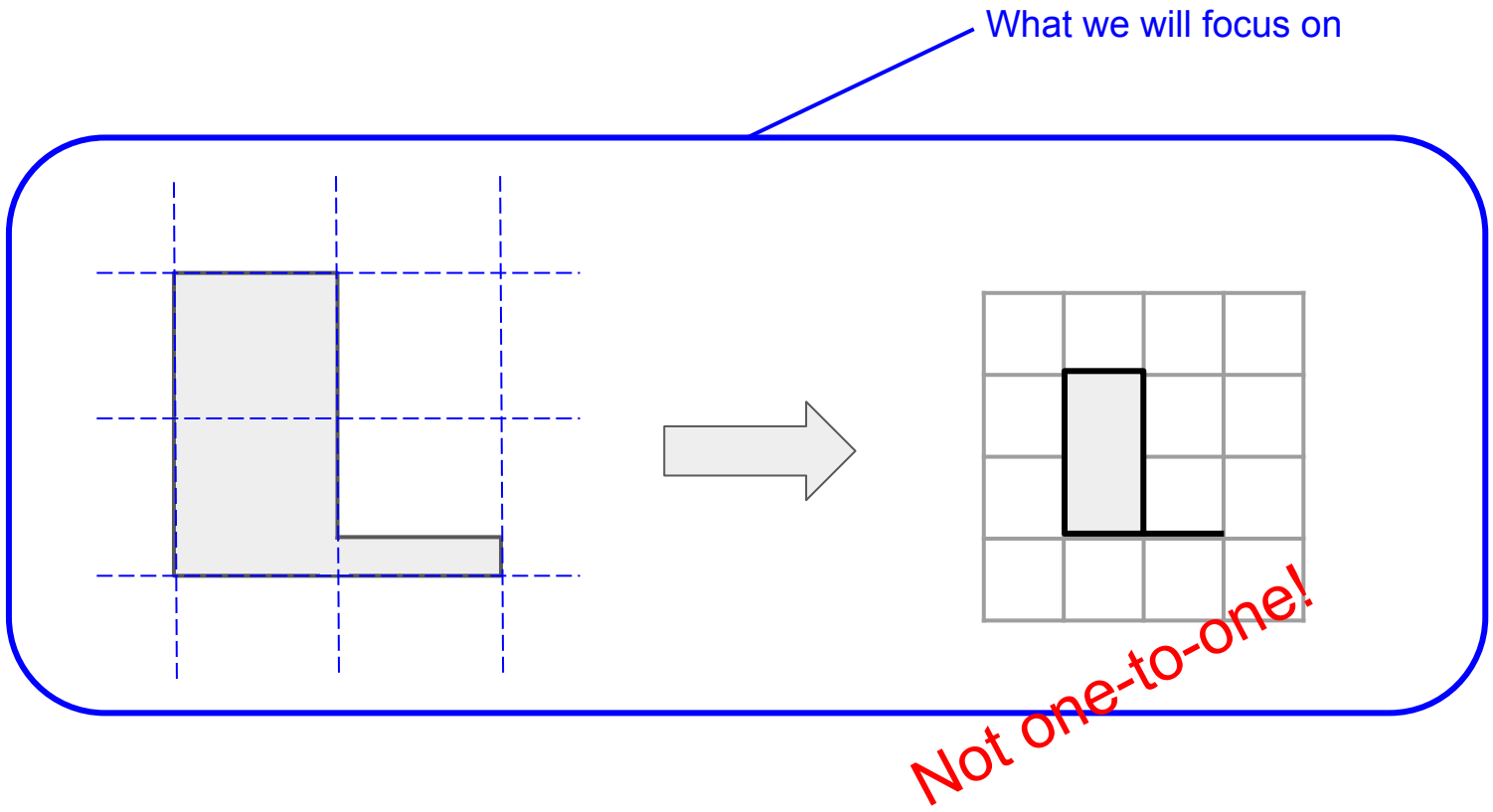
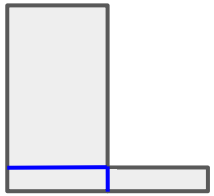
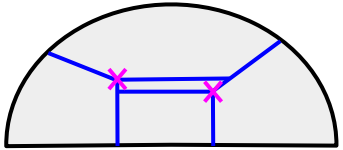
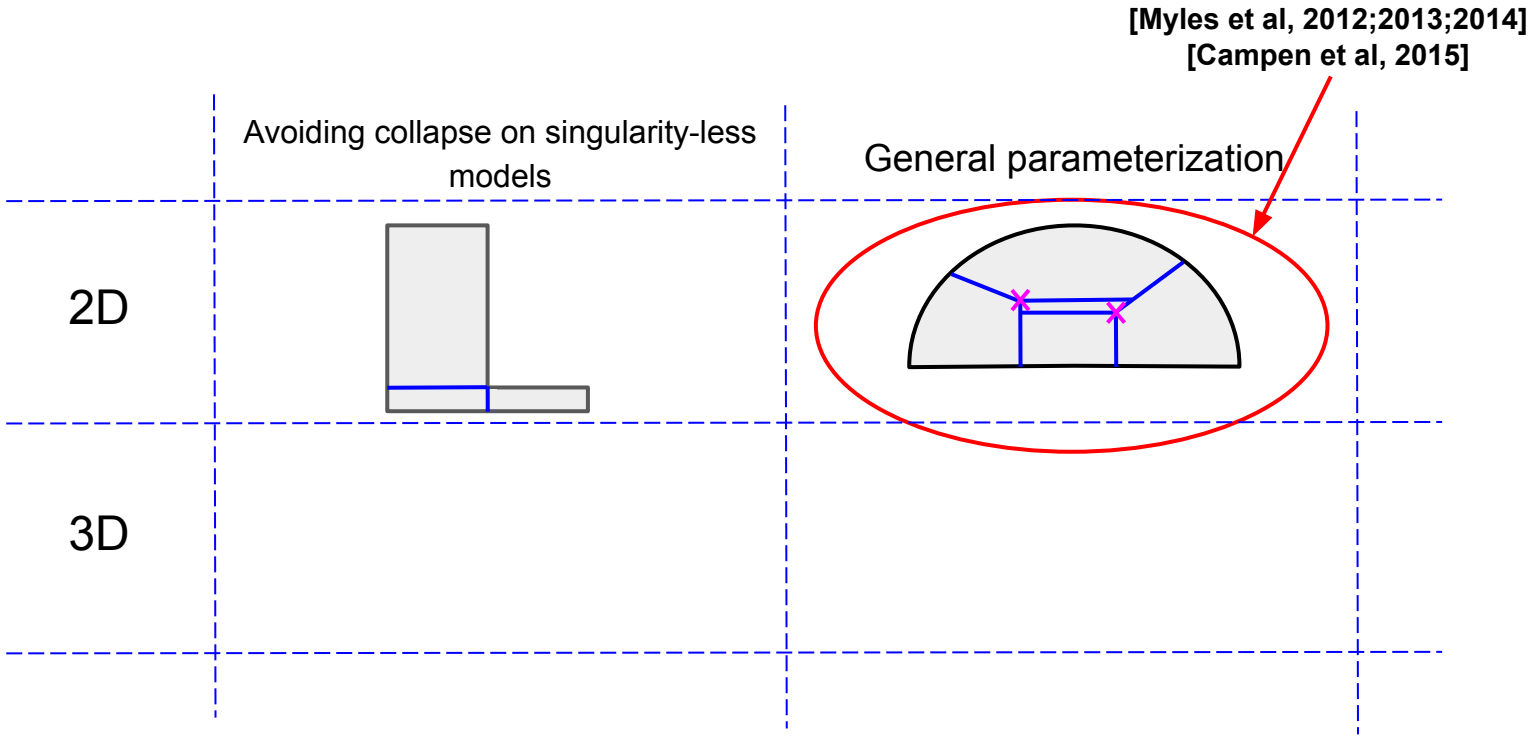


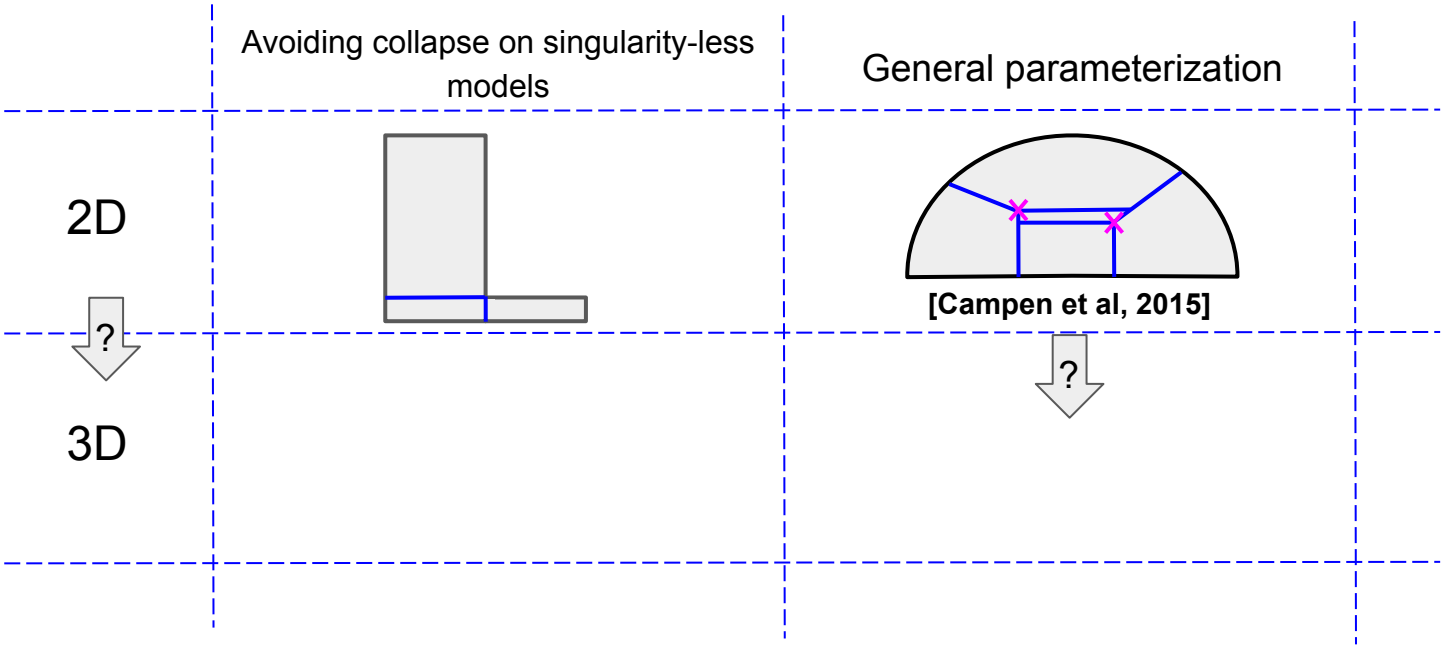
Solutions

	Avoiding collapse on singularity-less models	General parameterization
2D		
3D		

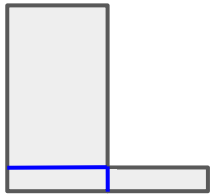
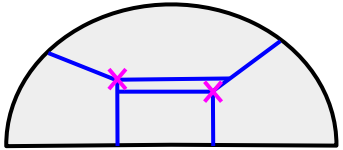
Solutions


[Myles et al, 2012;2013;2014]
[Campen et al, 2015]
Avoiding collapse on singularity-less models
General parameterization
2D
3D

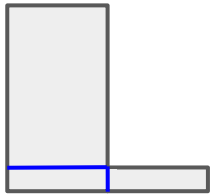
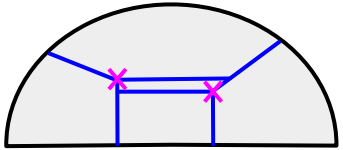
Solutions


Avoiding collapse on singularity-less models
General parameterization
2D
?
3D
[Campen et al, 2015]
?

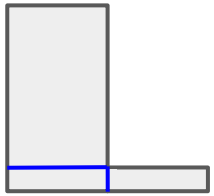
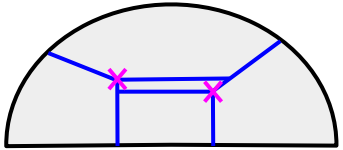
Solutions

	Avoiding collapse on singularity-less models	General parameterization
2D		
?		[Campen et al, 2015]
3D		?
		[Kowalski et al, 2014;2016] ?

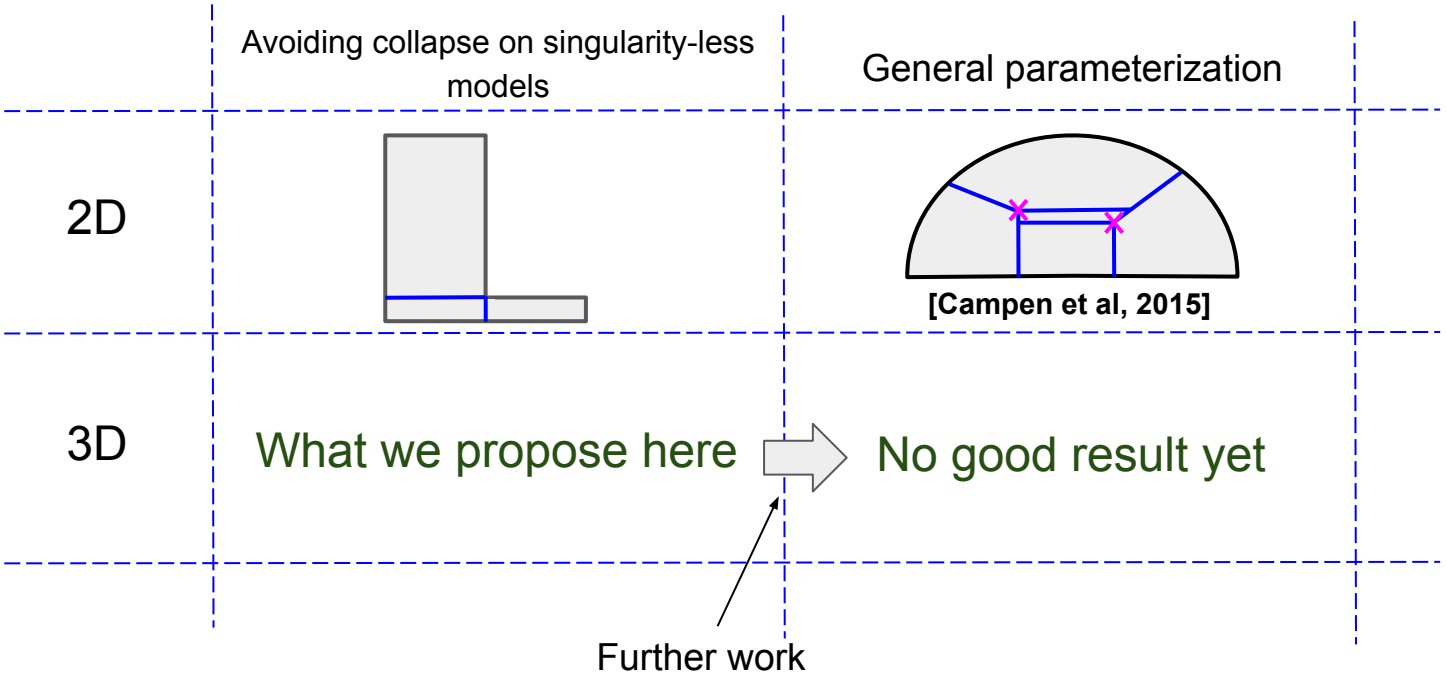
Solutions

	Avoiding collapse on singularity-less models	General parameterization
2D		 [Campen et al, 2015]
3D		No good result yet

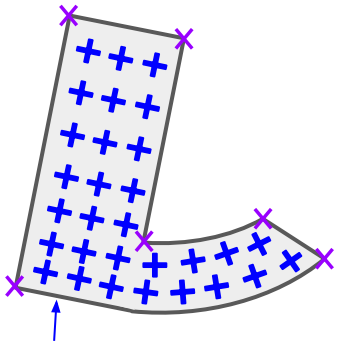
Solutions

	Avoiding collapse on singularity-less models	General parameterization
2D		 [Campen et al, 2015]
3D	What we propose here	⇐ No good result yet

Solutions

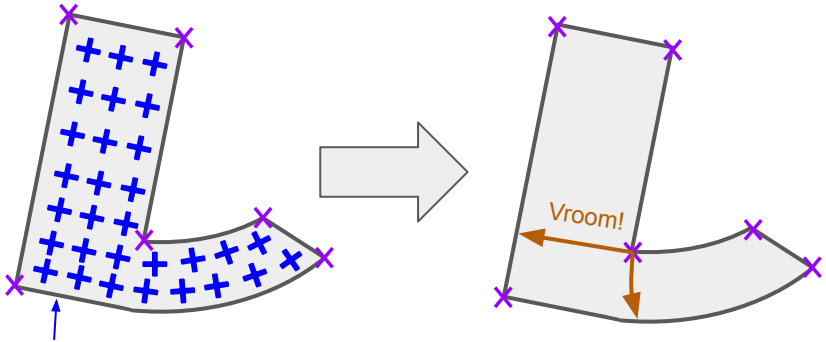

Avoiding collapse on singularity-less models
General parameterization
2D
3D
[Campen et al, 2015]
What we propose here
No good result yet
Further work

2d solution: motorcycles



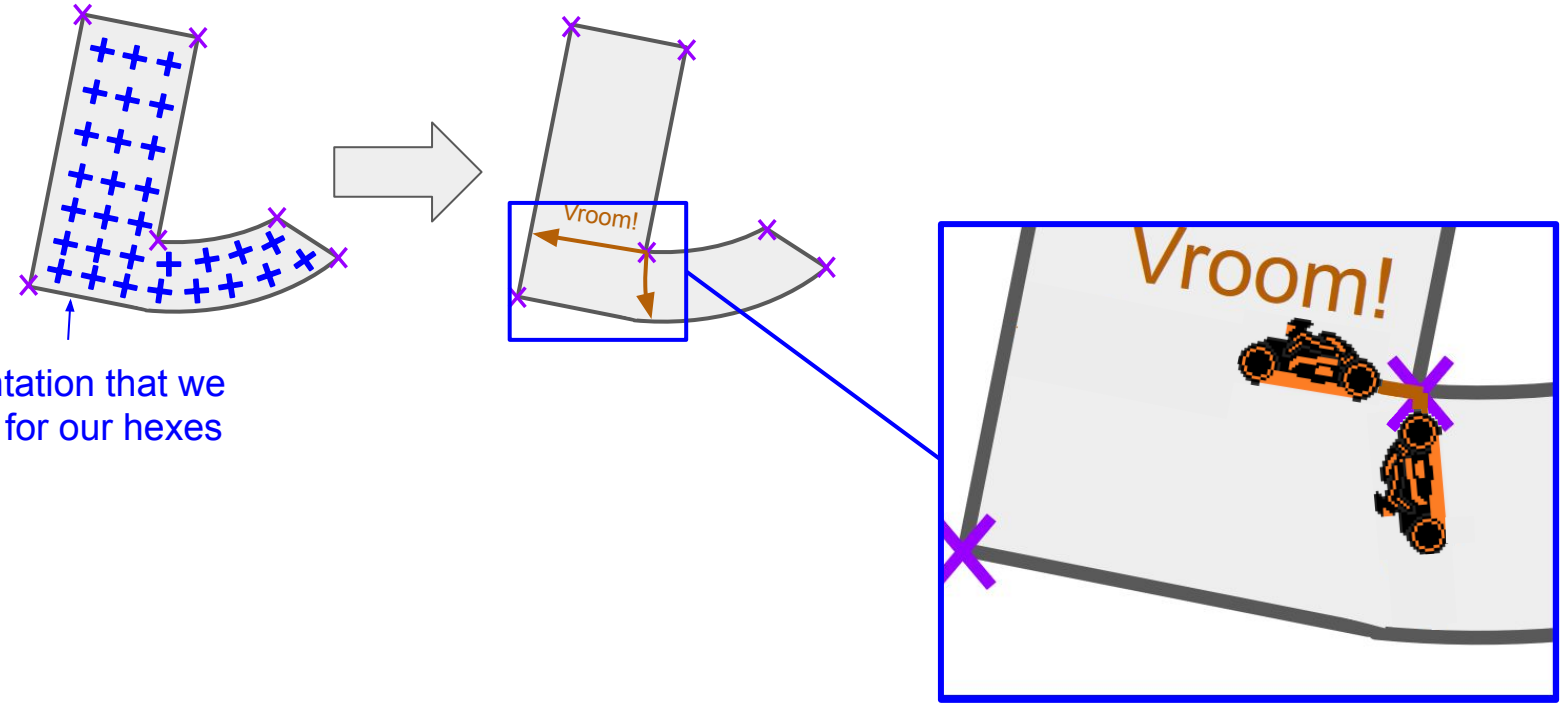
Orientation that we want for our hexes

2d solution: motorcycles

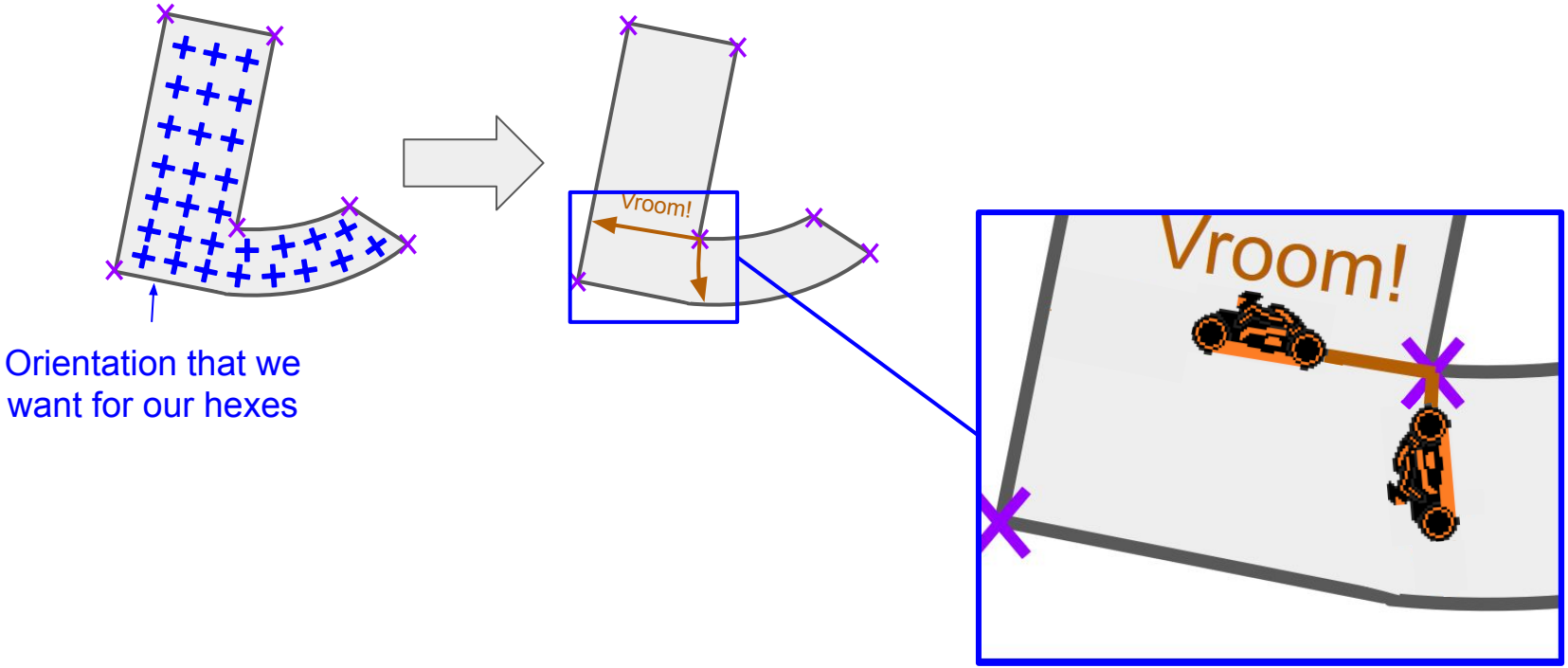


Orientation that we want for our hexes

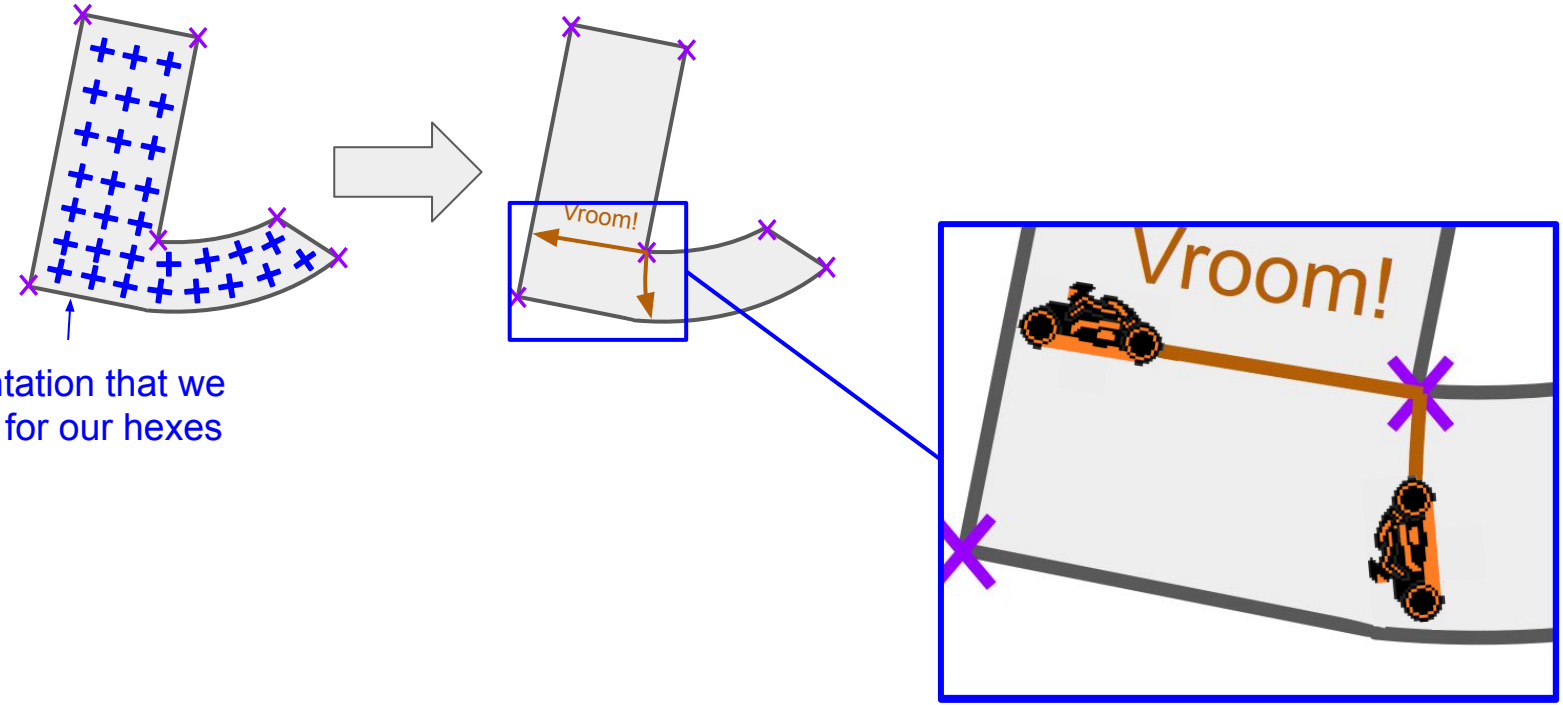
2d solution: motorcycles



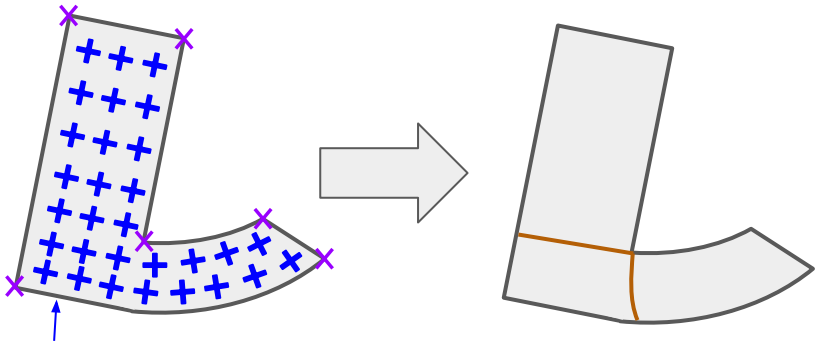
2d solution: motorcycles



2d solution: motorcycles

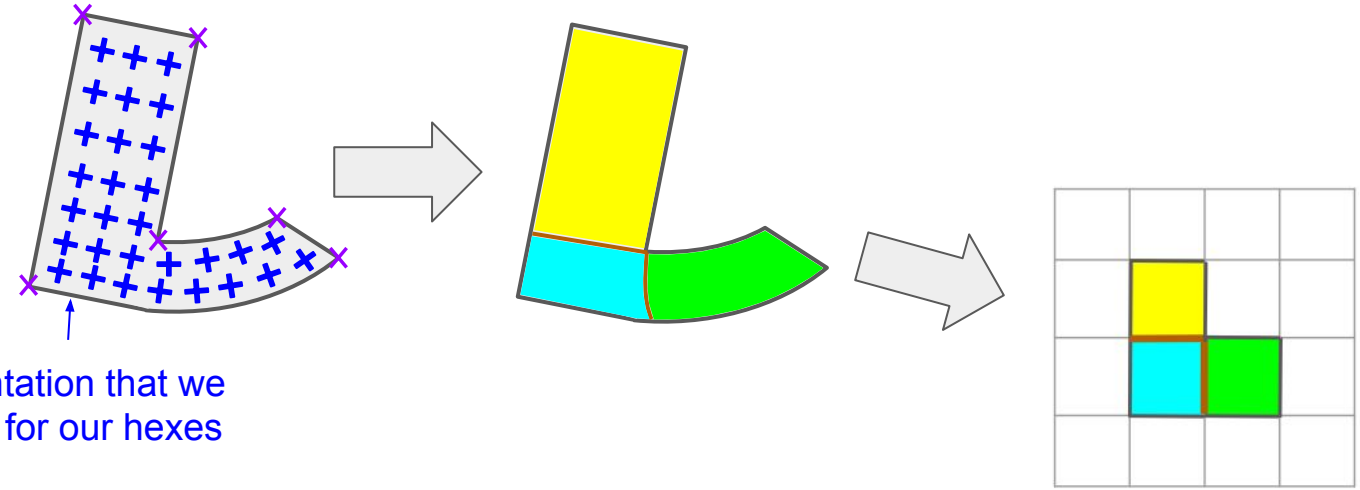


2d solution: motorcycles



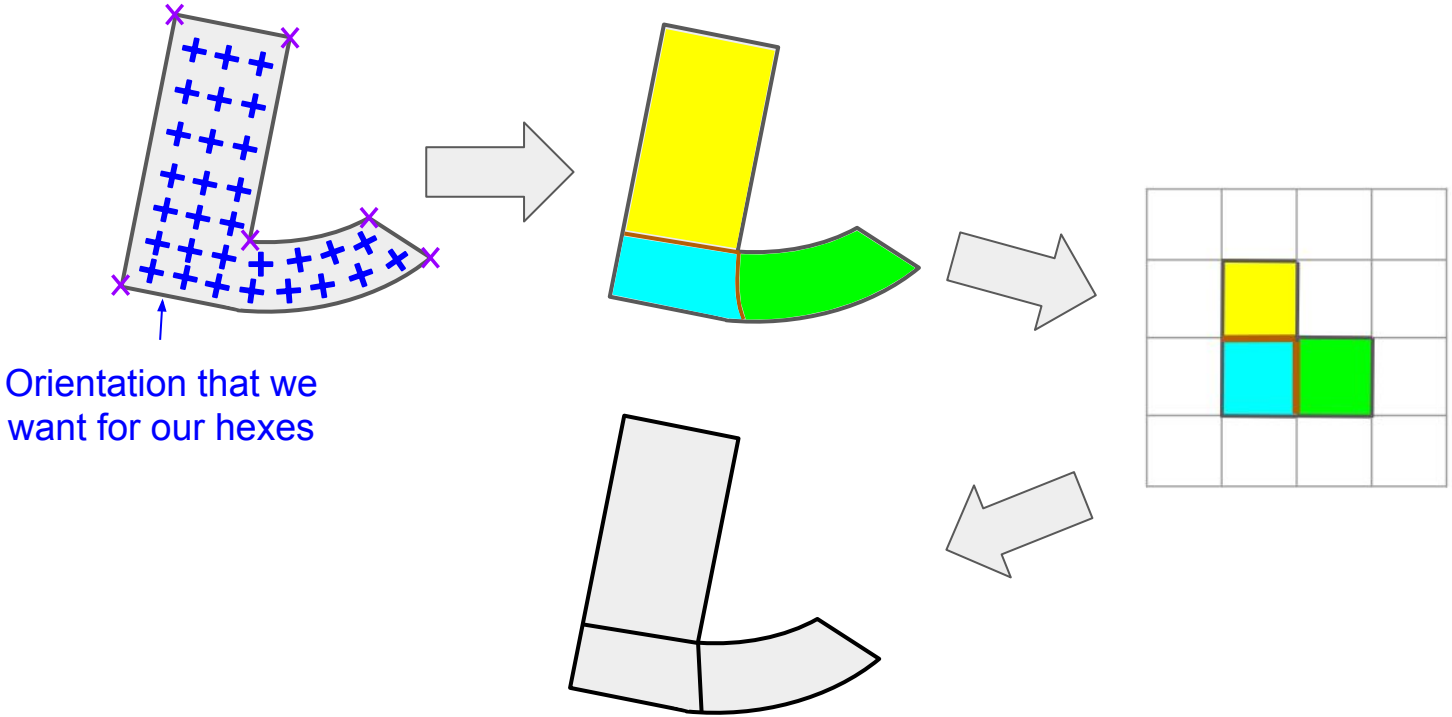
Orientation that we want for our hexes

2d solution: motorcycles

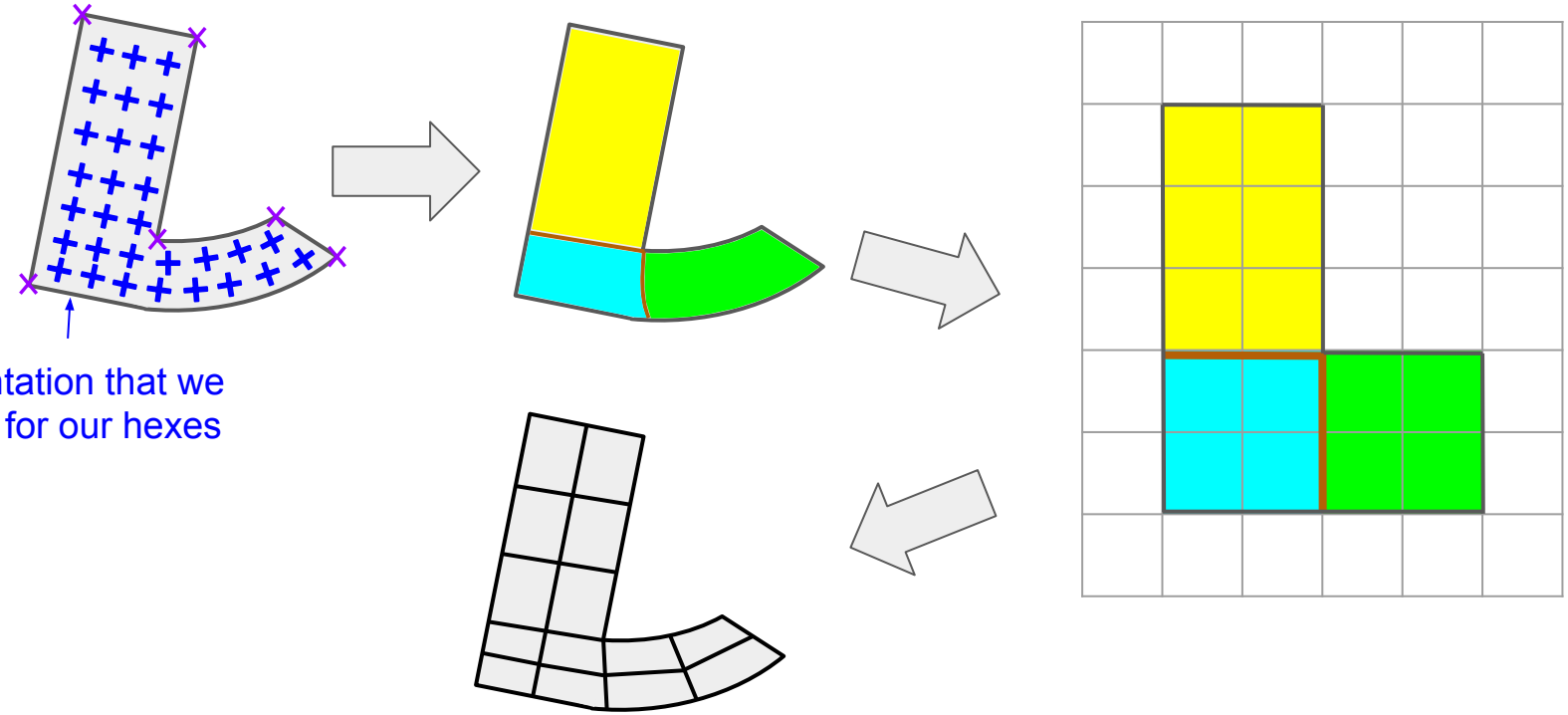


Orientation that we want for our hexes

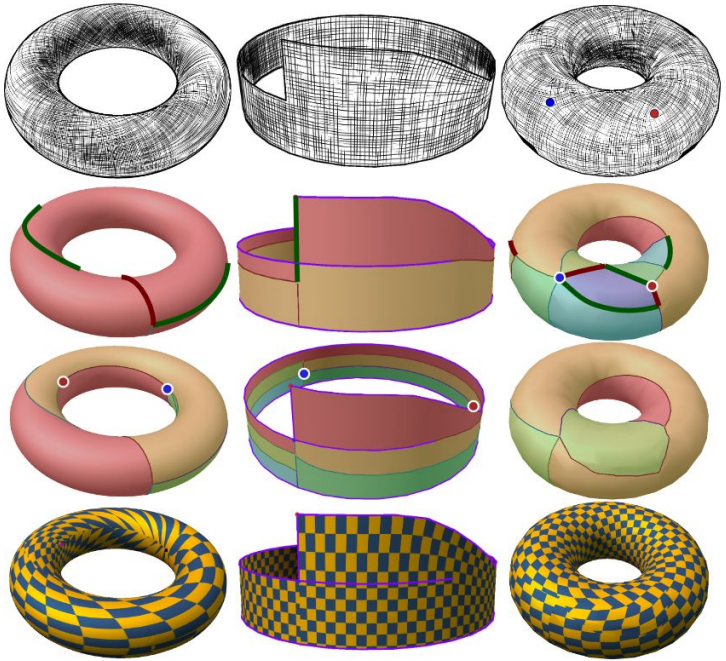
2d solution: motorcycles



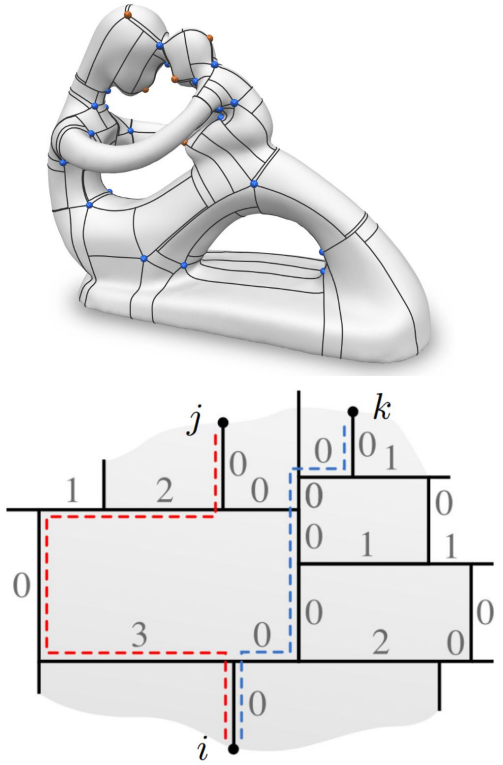
2d solution: motorcycles



2d solution: T-junctions and no boundary

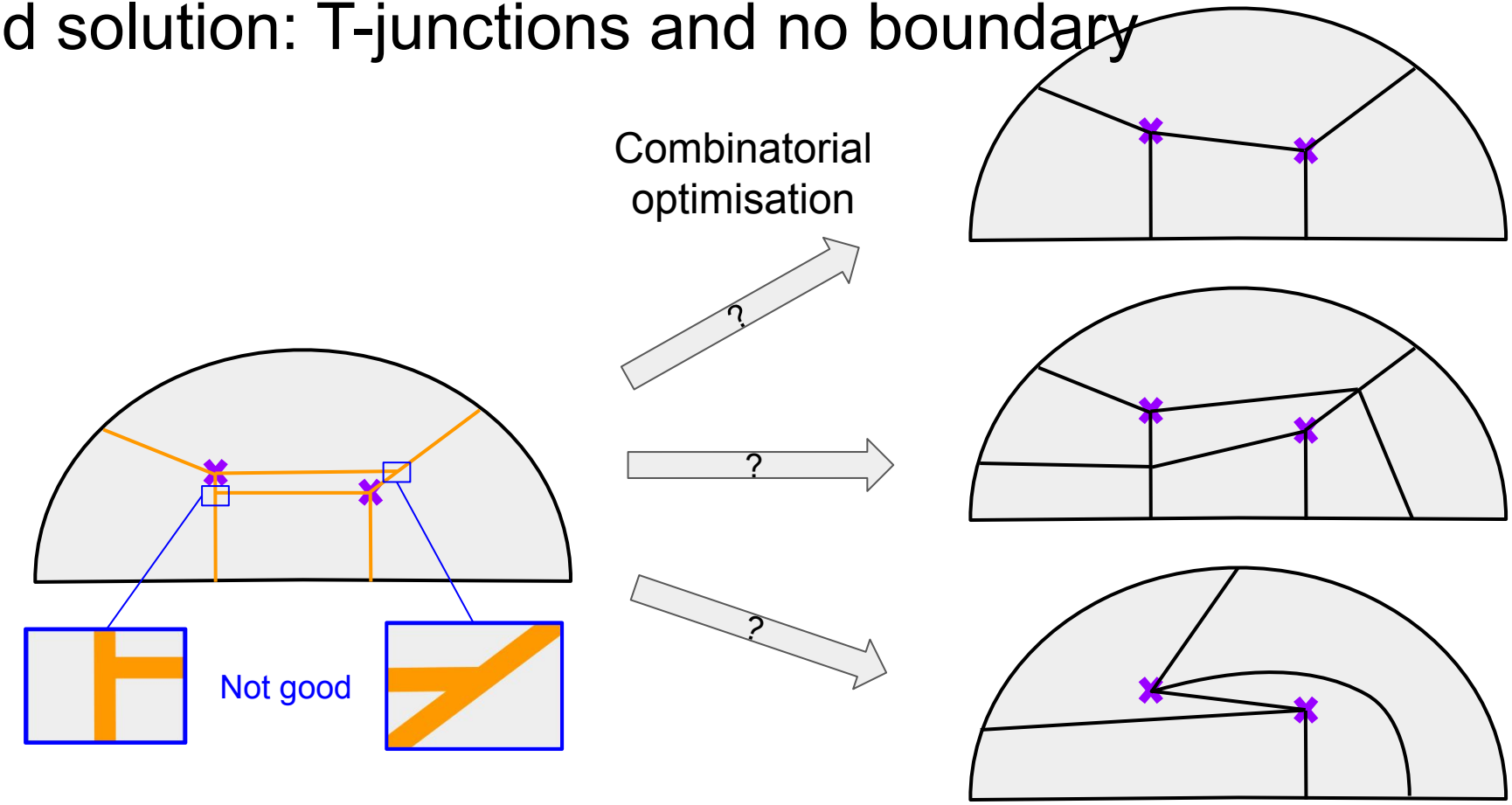


[Myles et al, 2012;2013;2014]

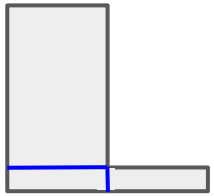
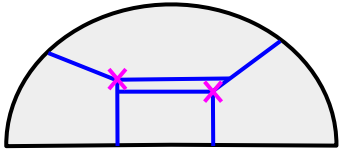


[Campen et al, 2015]

2d solution: T-junctions and no boundary

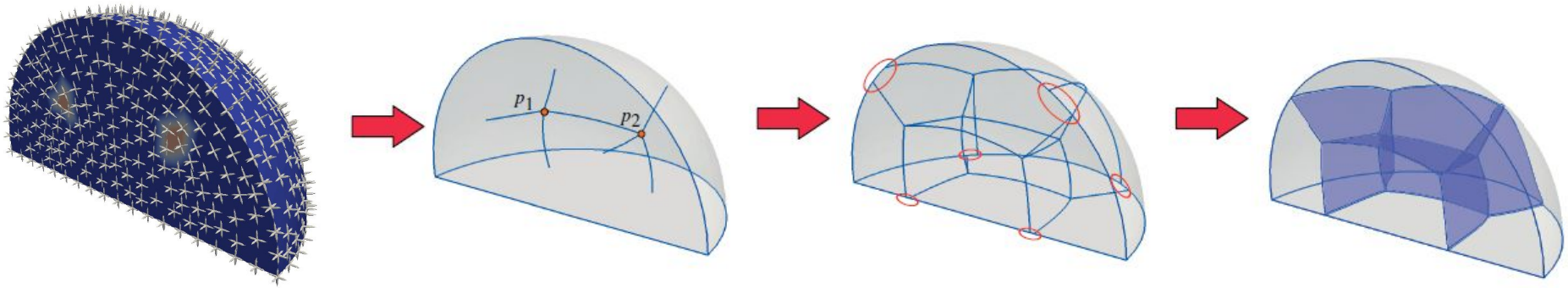


3d solution: ?

	Avoiding collapse on singularity-less models	General parameterization
2D		 [Campen et al, 2015]
3D	What we propose here	No good result yet

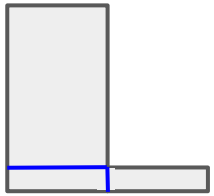
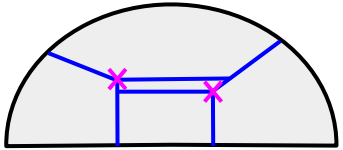
2.2 Bijectivity problems: 2nd problem

3d solution: ?

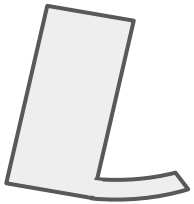


[Kowalski et al, 2014;2016]

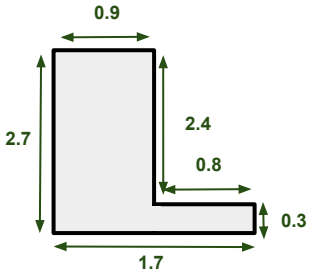
3d solution: solving a sub-problem

	Avoiding collapse on singularity-free models	General parameterization
2D		 [Campen et al, 2015]
3D	What we propose here	No good result yet

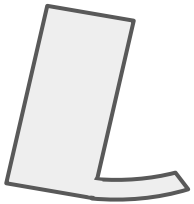
Naive polycube approach



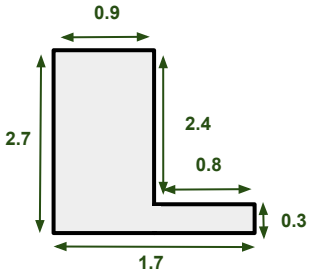
Deformation



Naive polycube approach

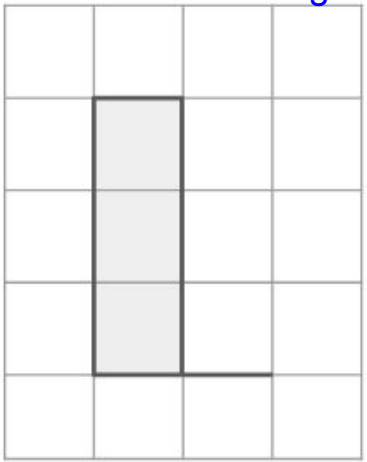


Deformation

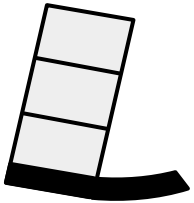


Snapping

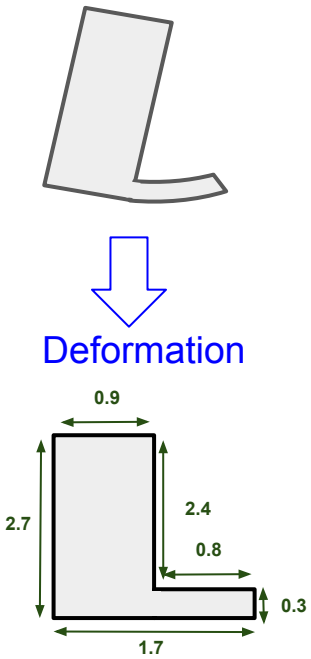
Deformation on a grid

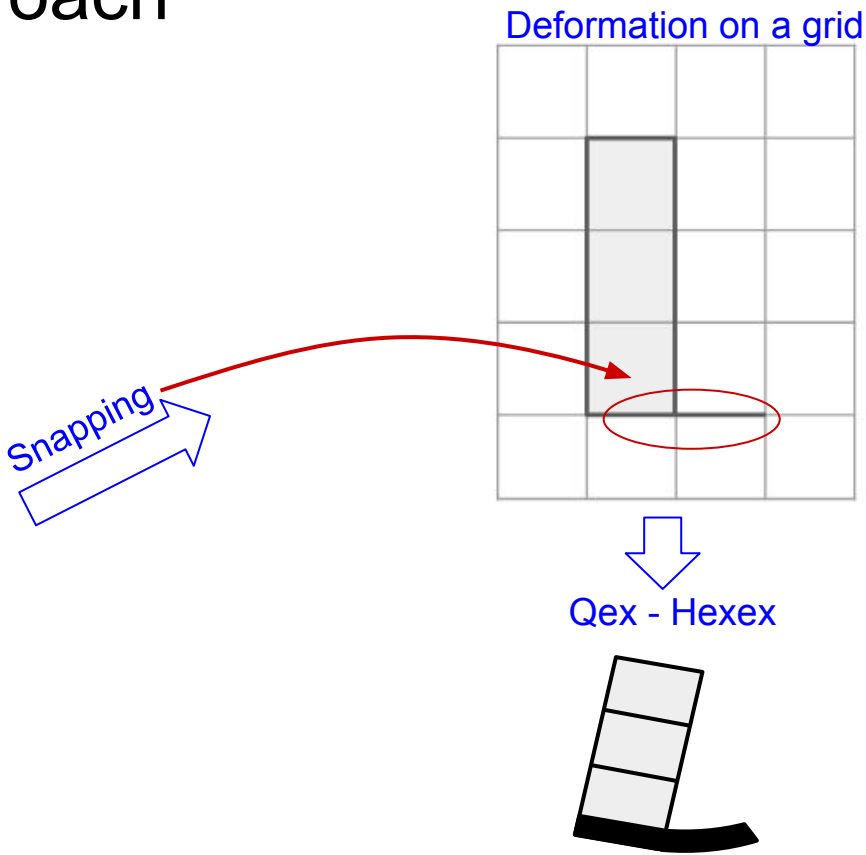


Qex - Hexex

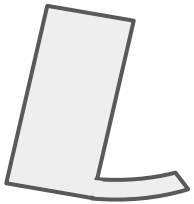


Naive polycube approach

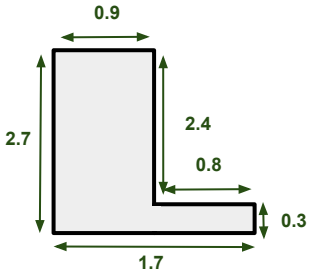




Naive polycube approach



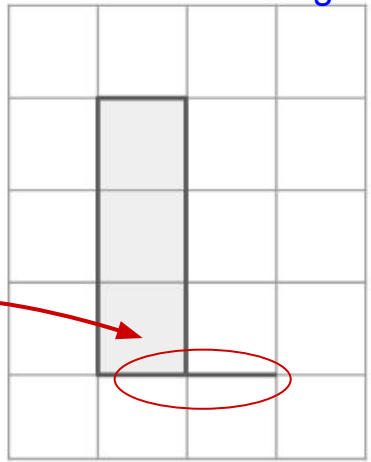
Deformation



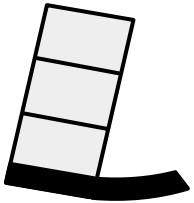
Snapping

2nd problem

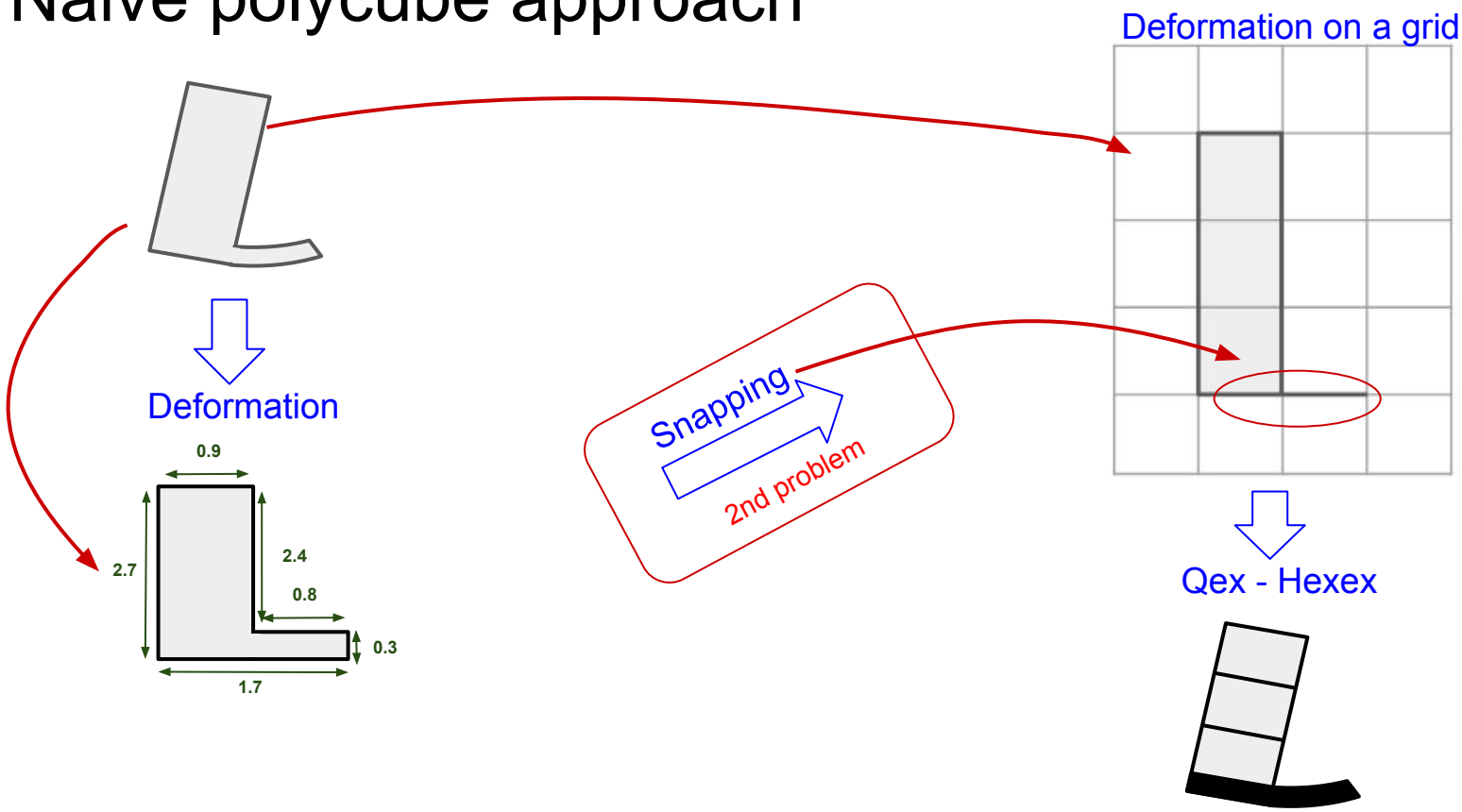
Deformation on a grid



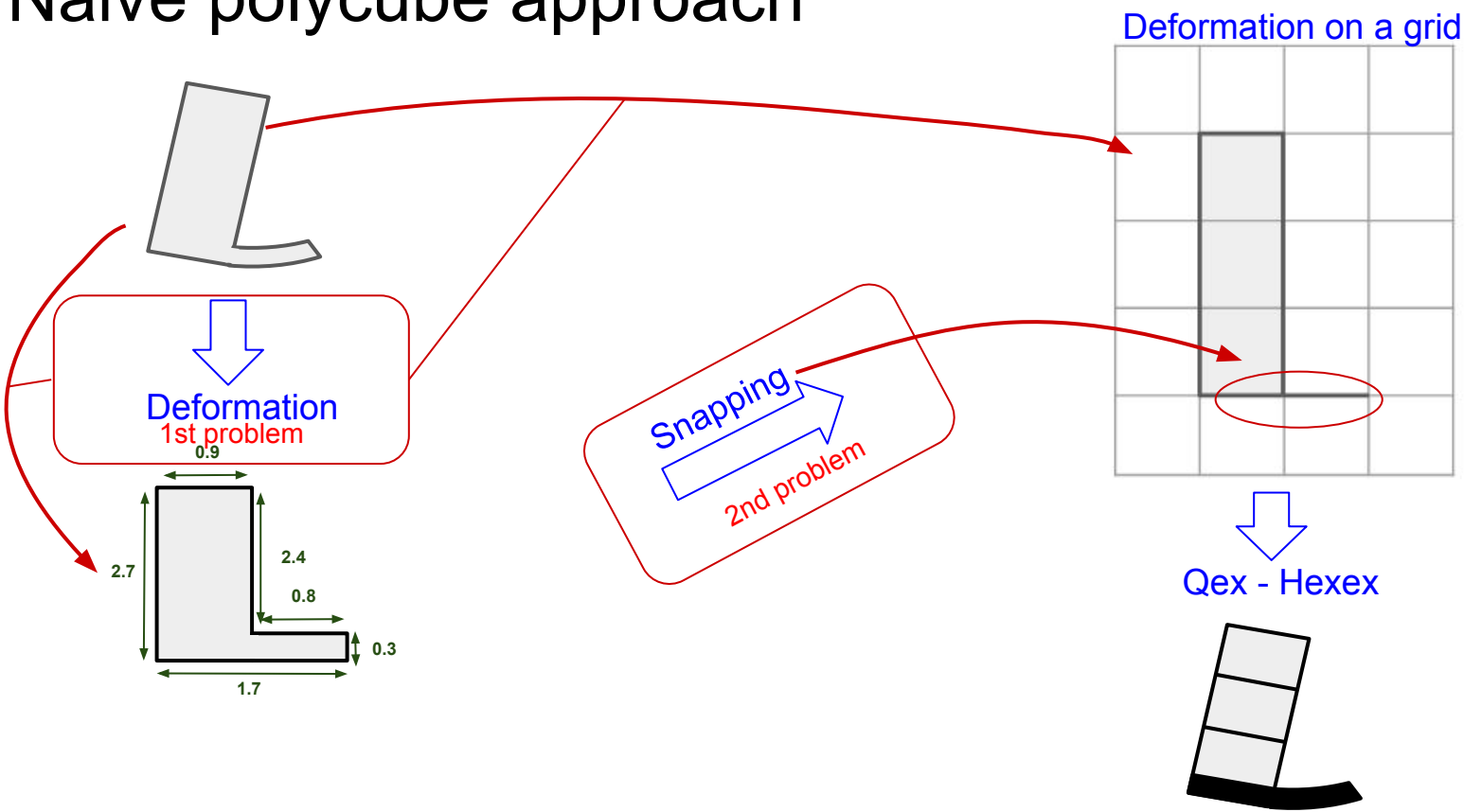
Qex - Hexex



Naive polycube approach

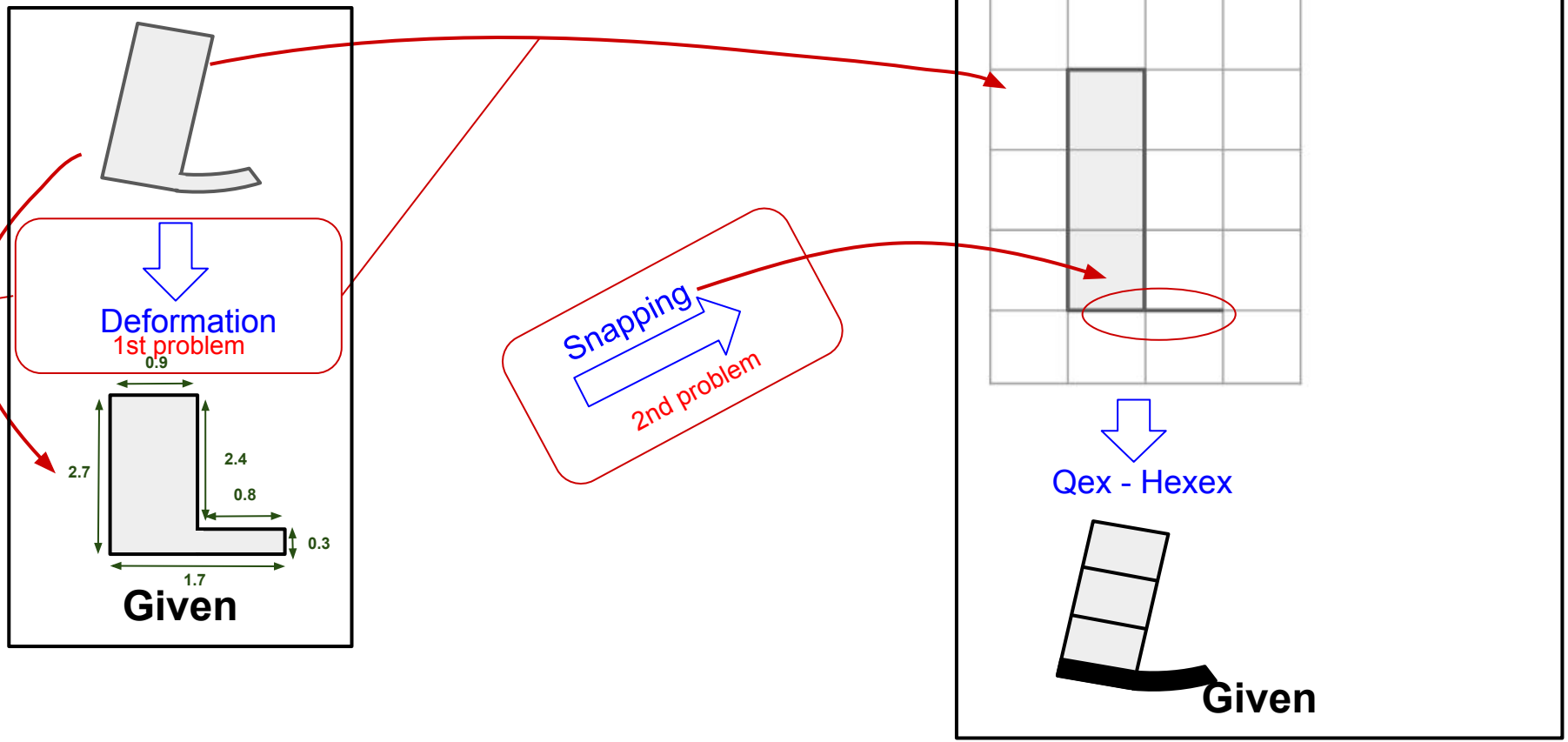


Naive polycube approach



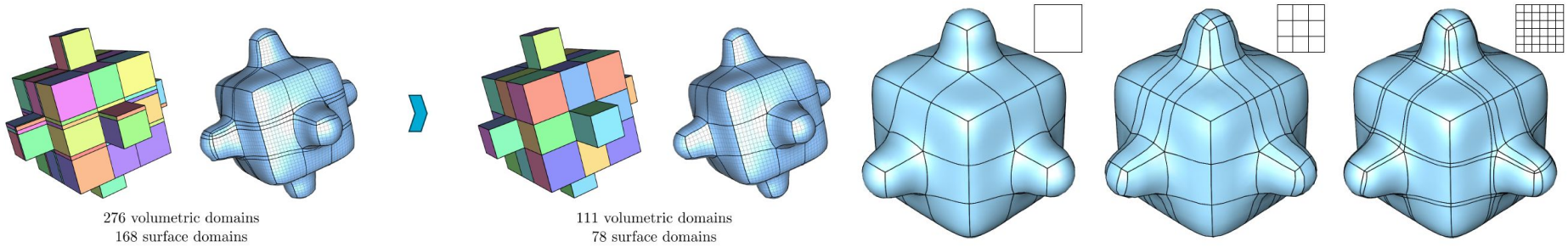
3.1 Studying a sub-problem: Introducing

Naive polycube approach



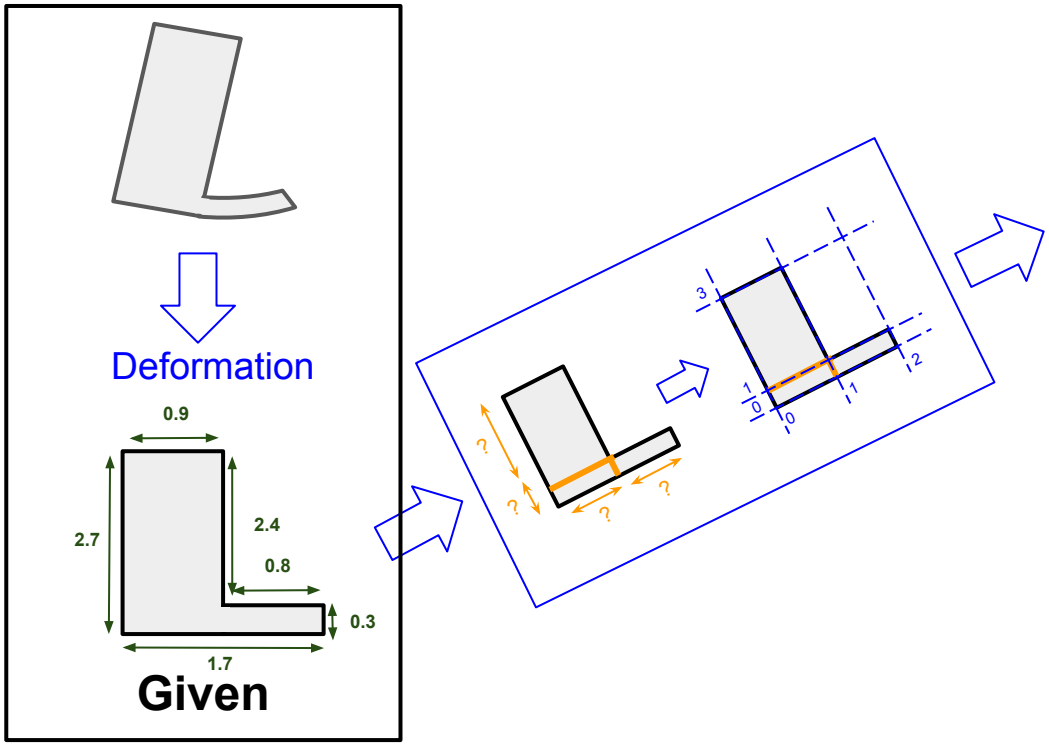
Related work

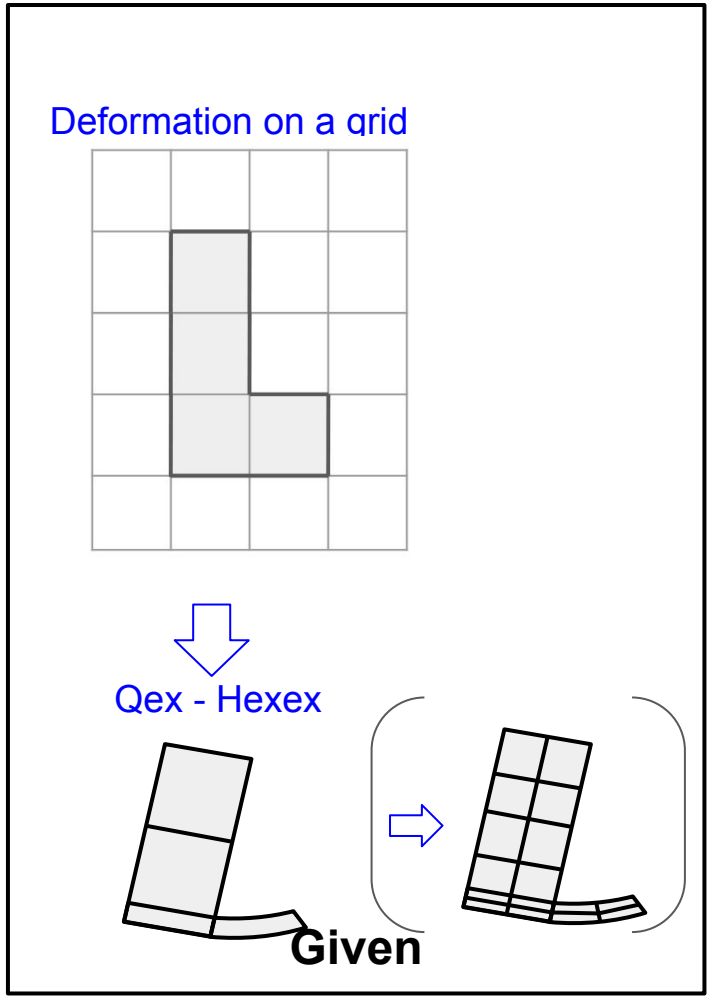
- **[Kowalski et al, 2014;2016]**
- **[Cherchi et al., 2016]** : Improve a given polycube by focusing on corner pairing to improve edge alignment :



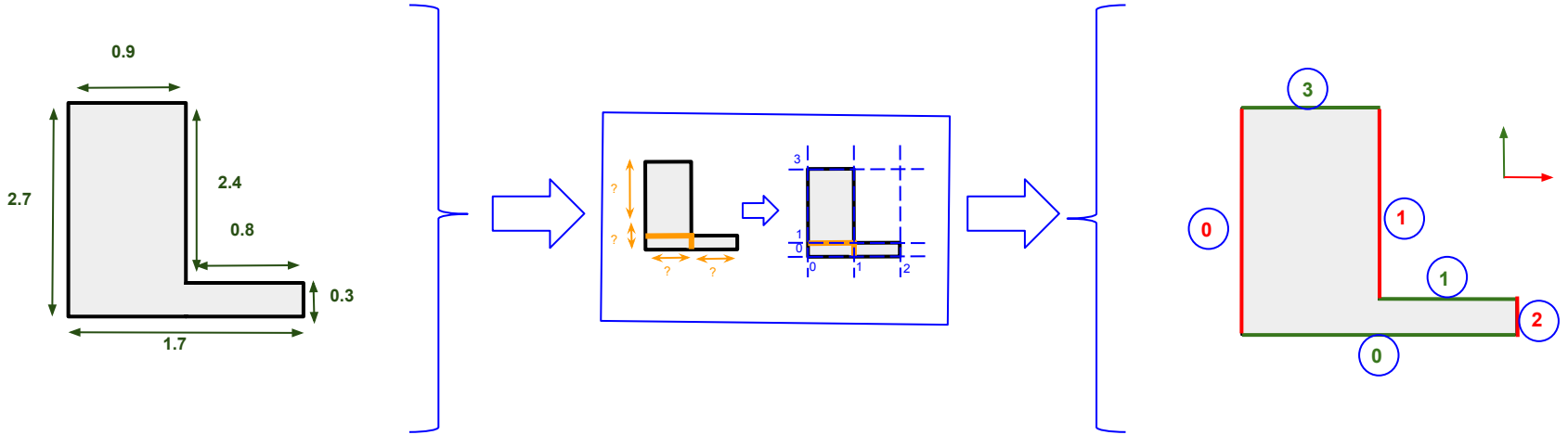
- **[Chen et al, 2019]** : constraint to no collapse edges of the polycubes

Our improvement



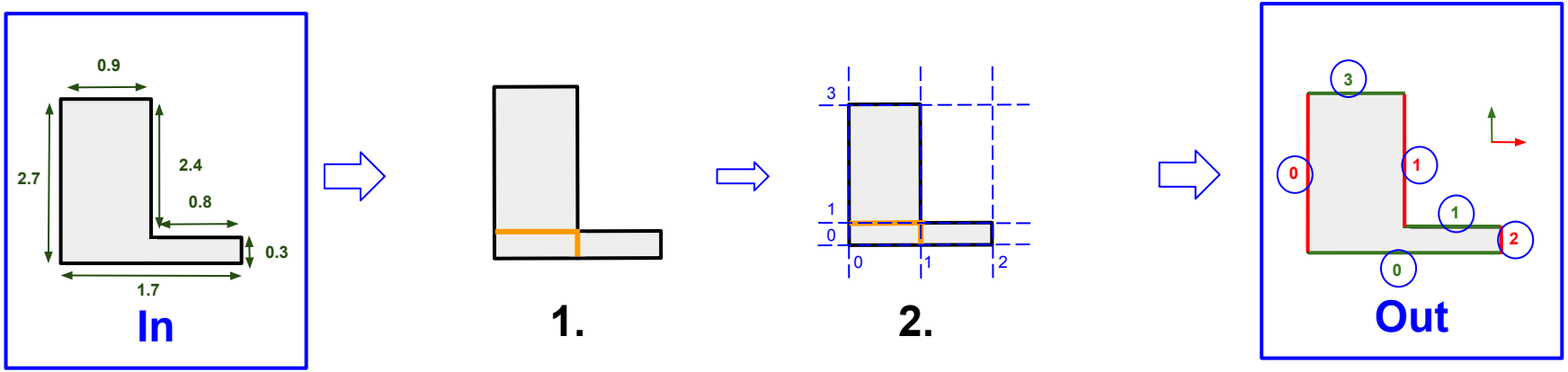


Our improvement

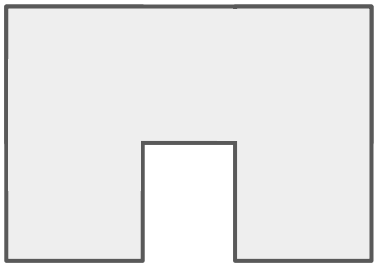


Our method

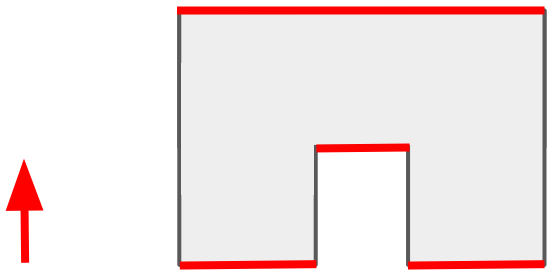
1. Generate combinatorial information with a motorcycle-like method
2. Finding the best set of integers respecting the combinatorics



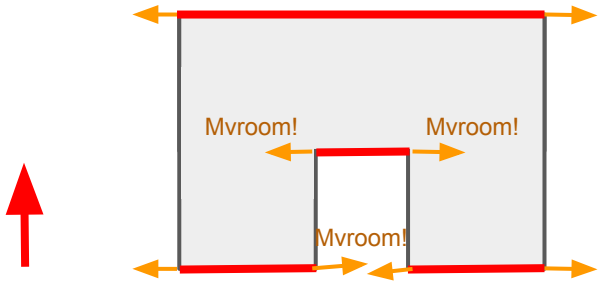
Using motorcycles



Using motorcycles

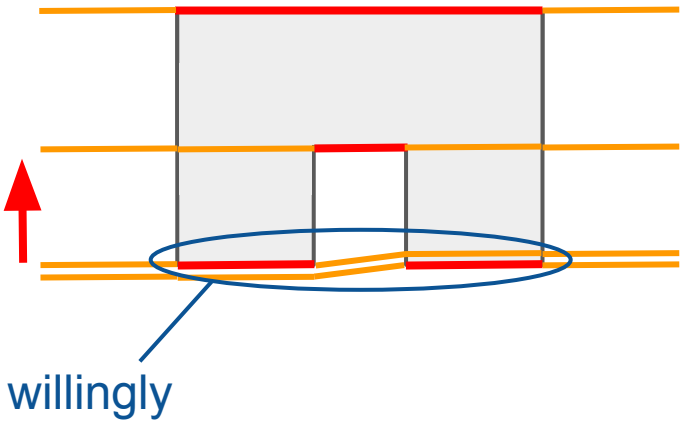


Using motorcycles

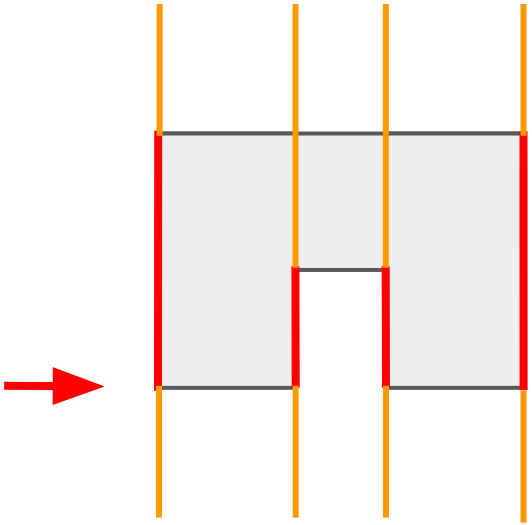


Using motorcycles

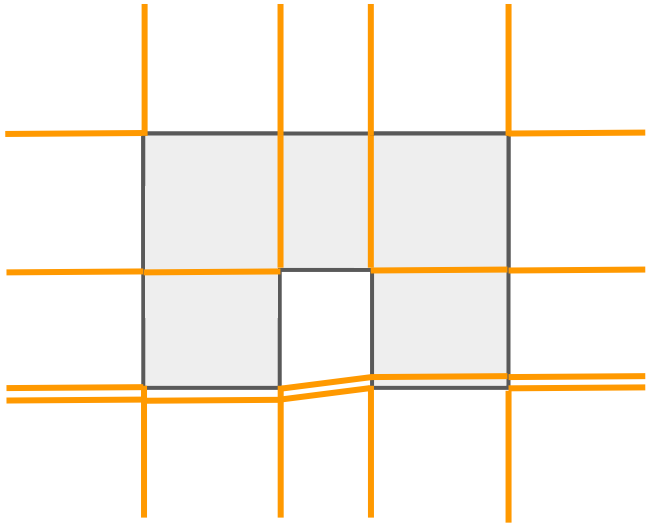
Using motorcycles



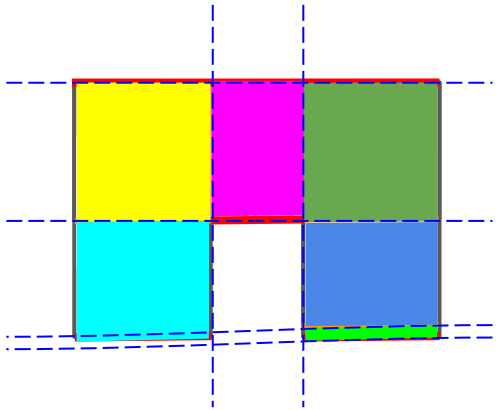
Using motorcycles



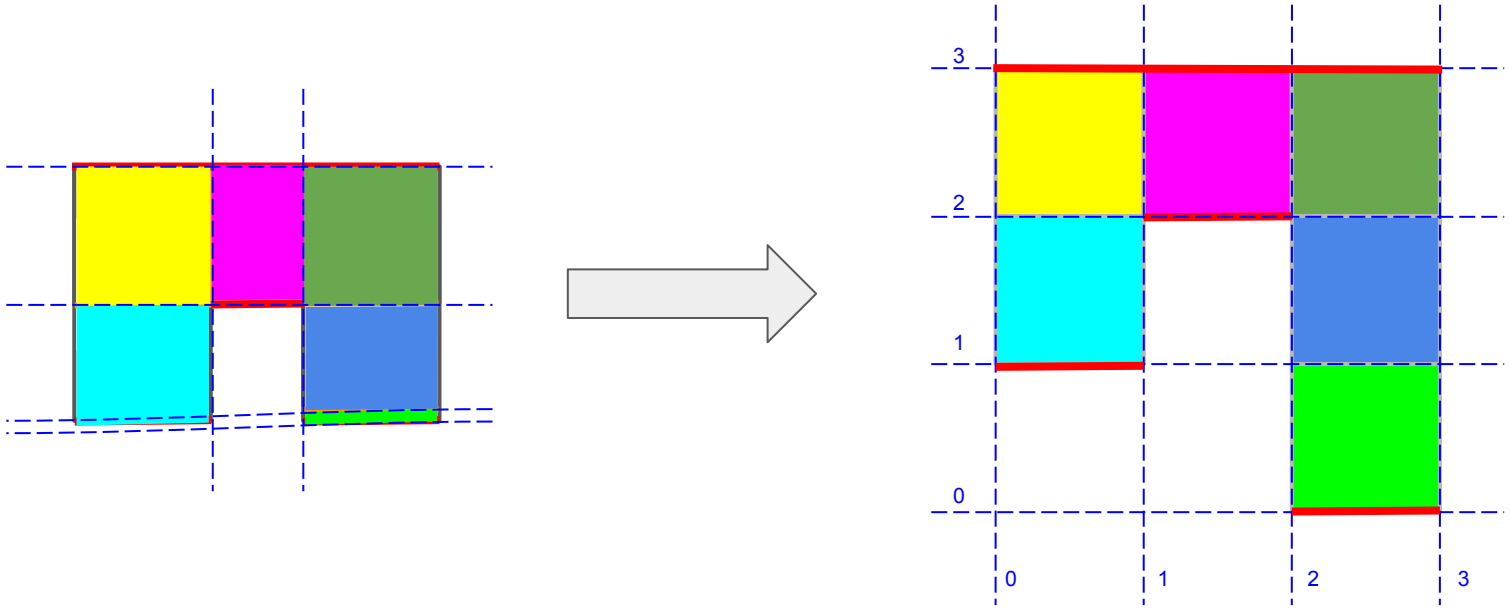
Using motorcycles



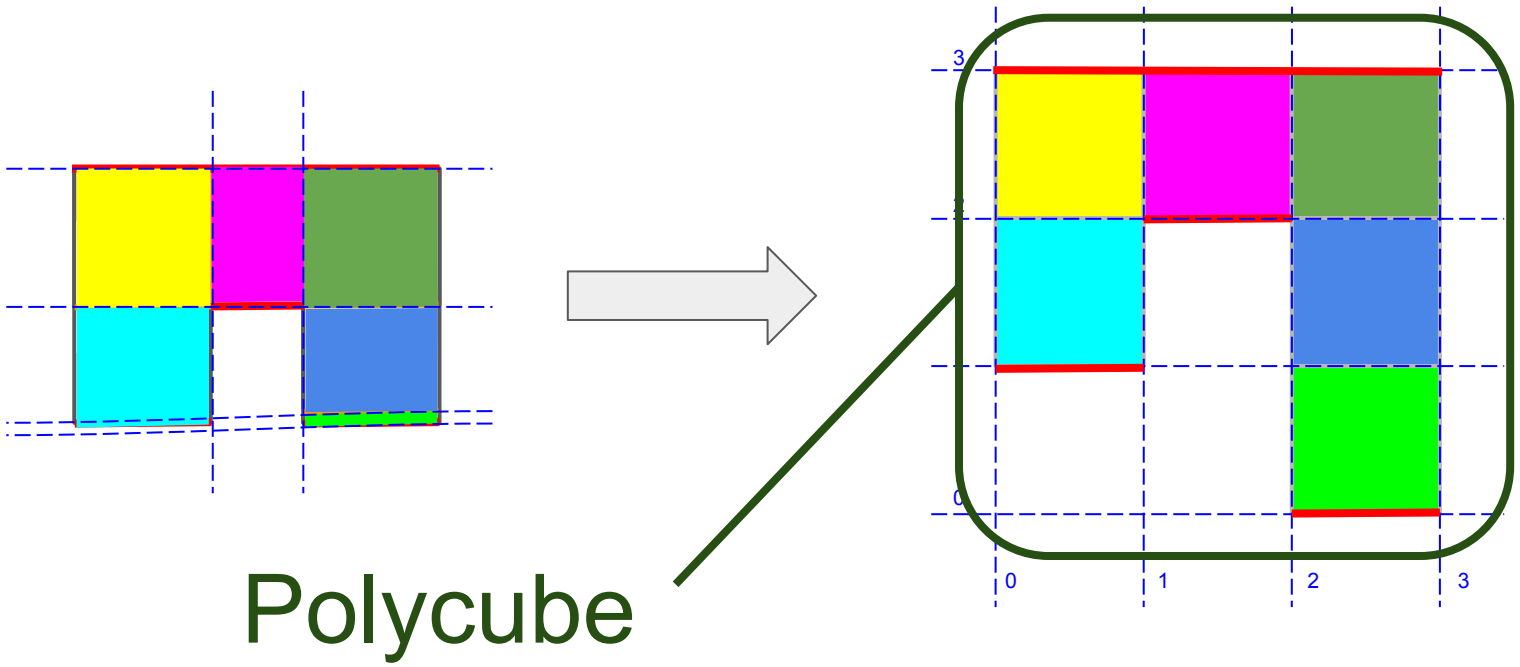
Using motorcycles



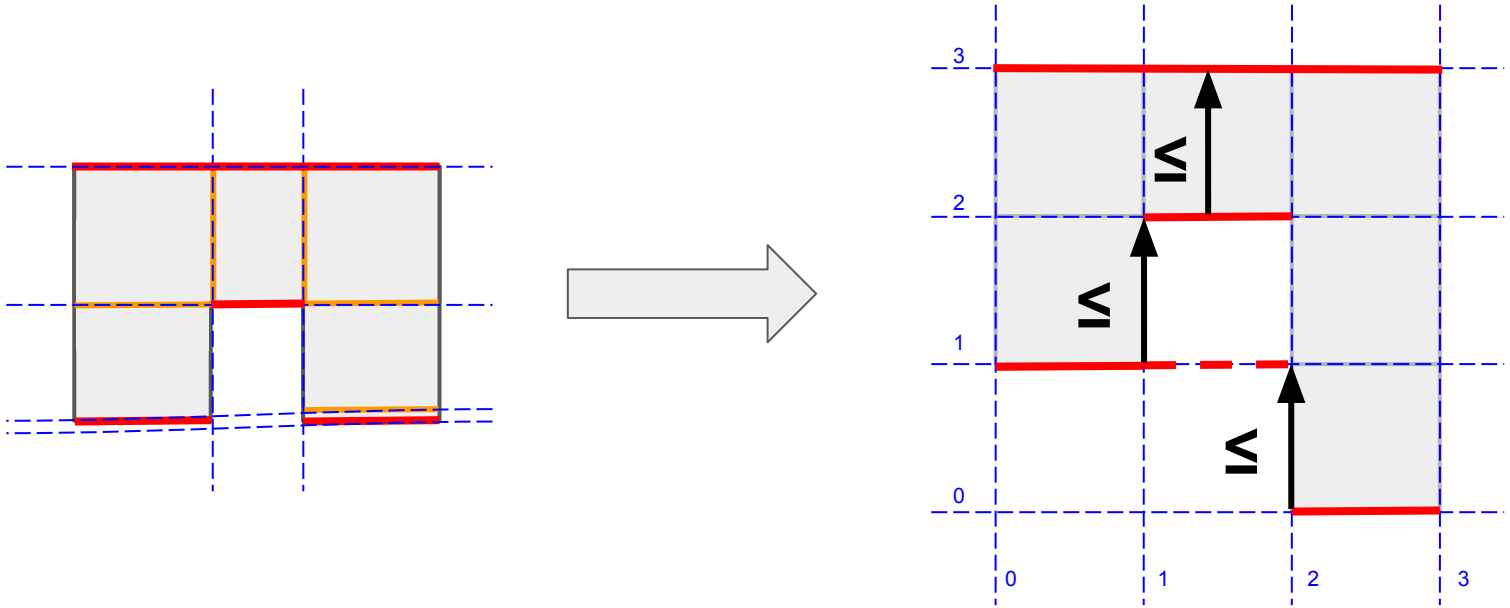
Using motorcycles



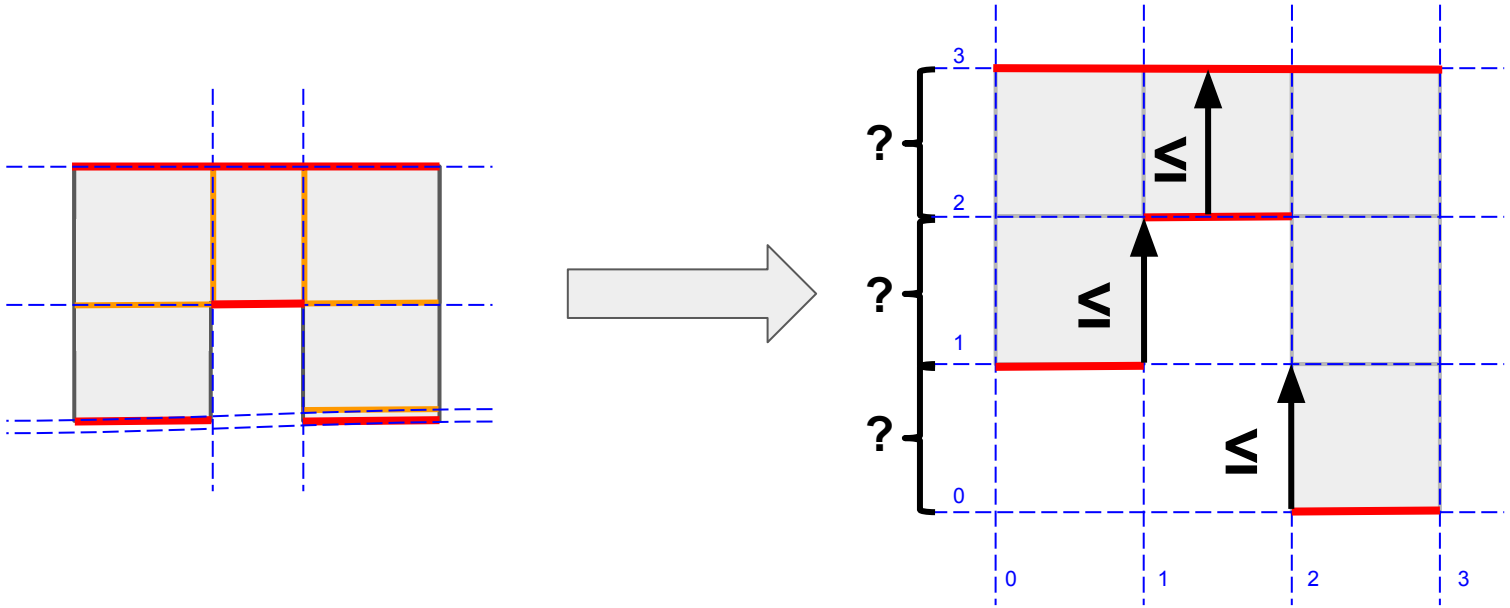
Using motorcycles



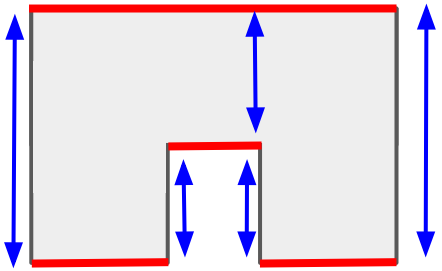
Total order

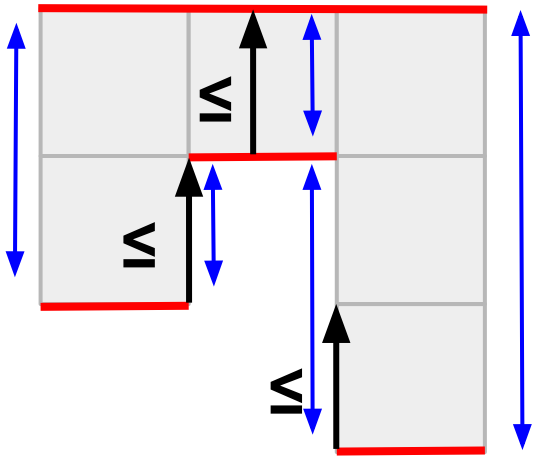


Total order

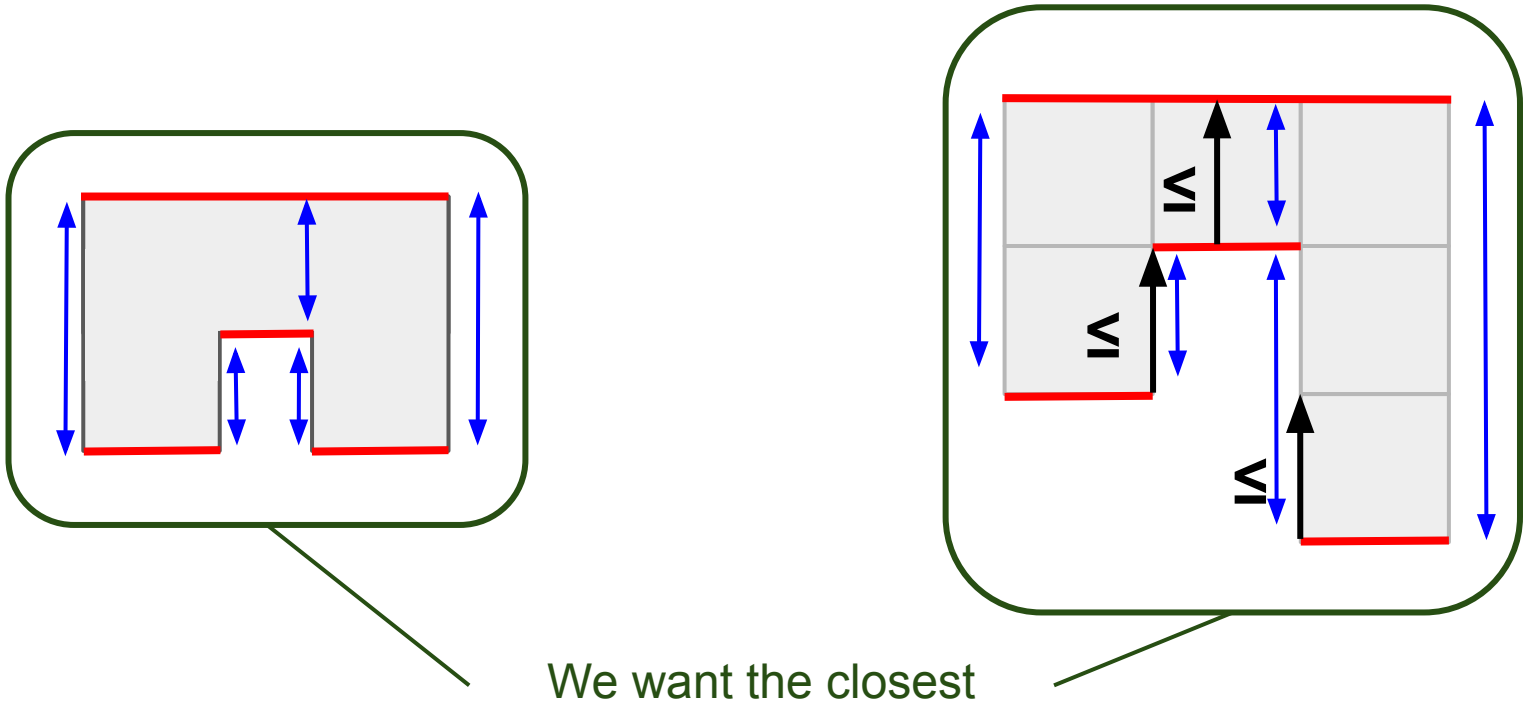


Defining our energy

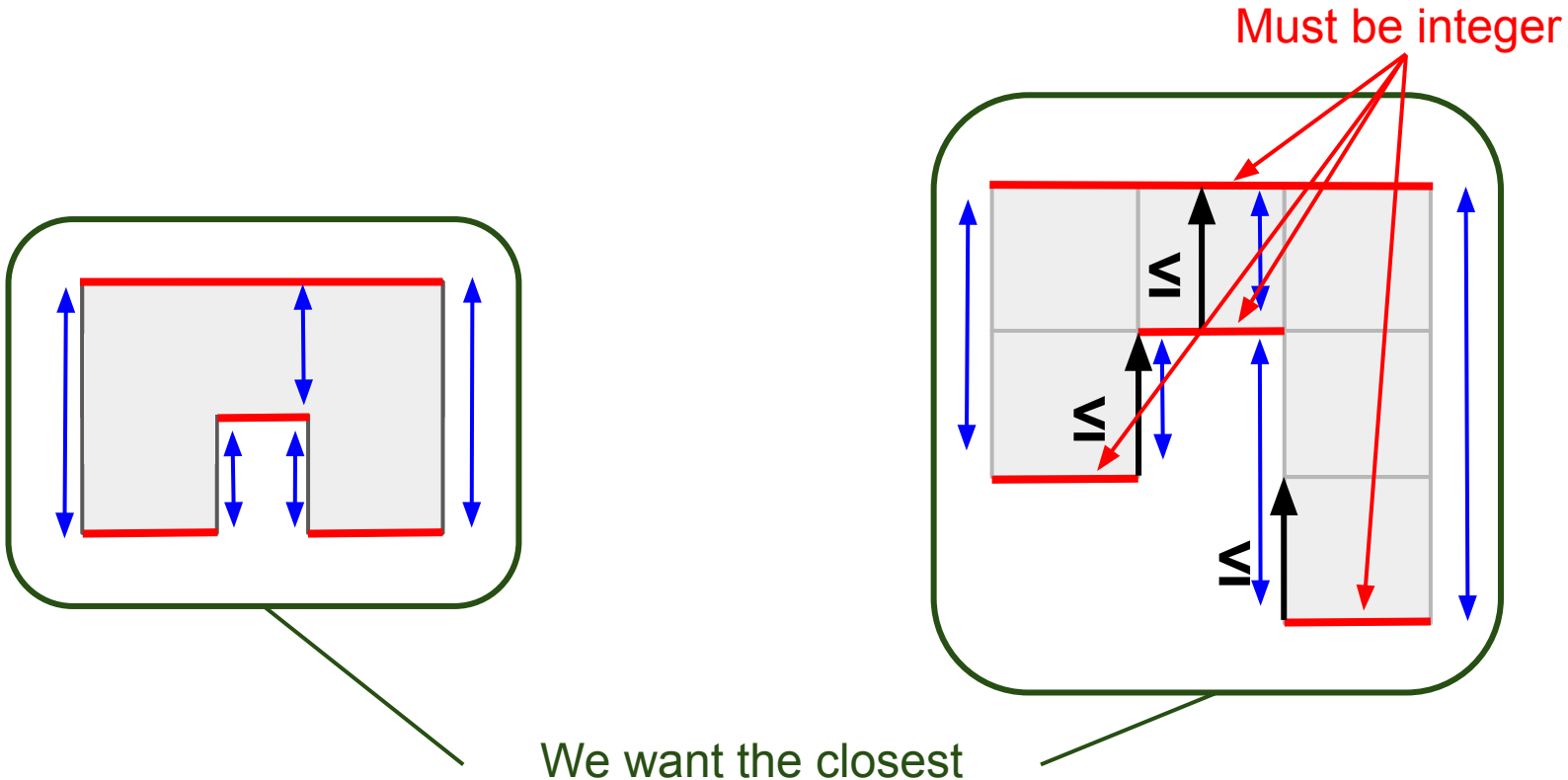




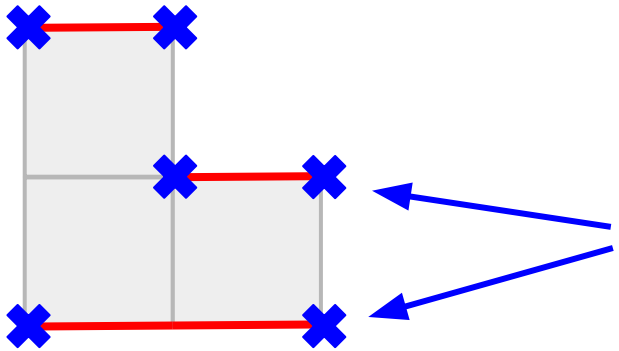
Defining our energy



Defining our energy

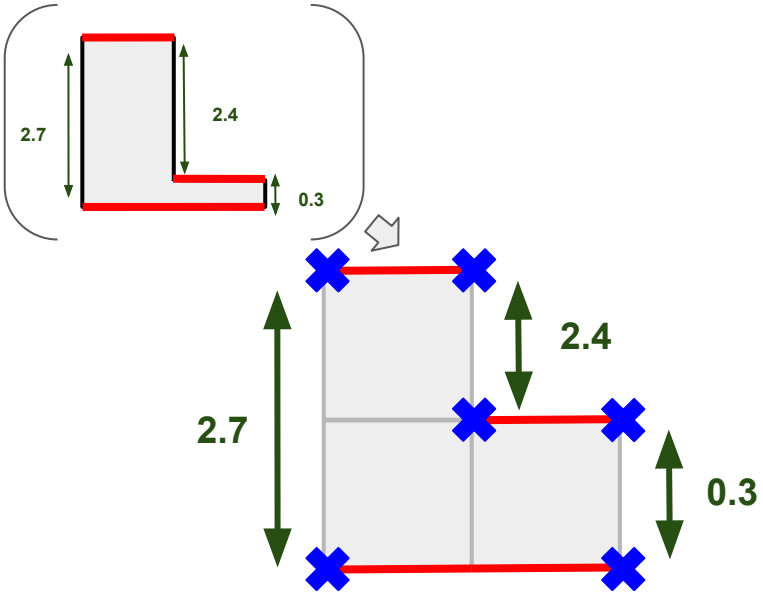


Expliciting constraints

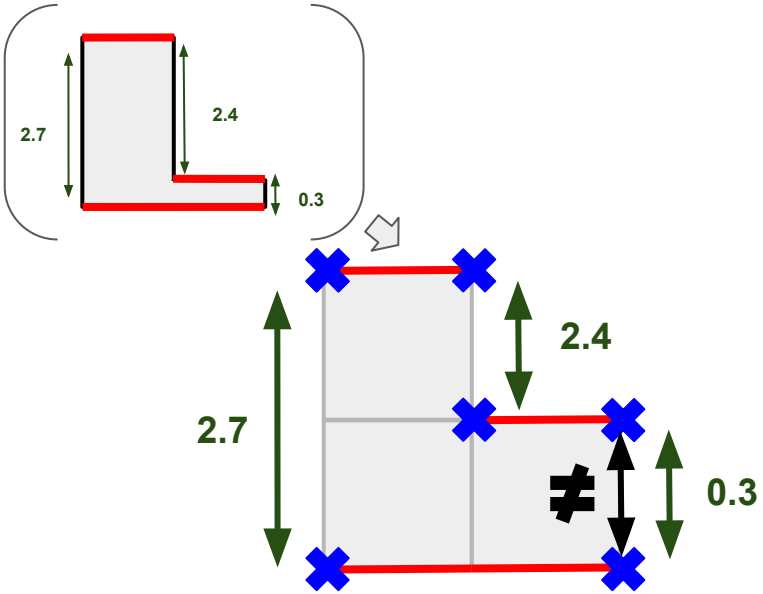


A point of chart shall not be merged to a point of another charts of the same axis

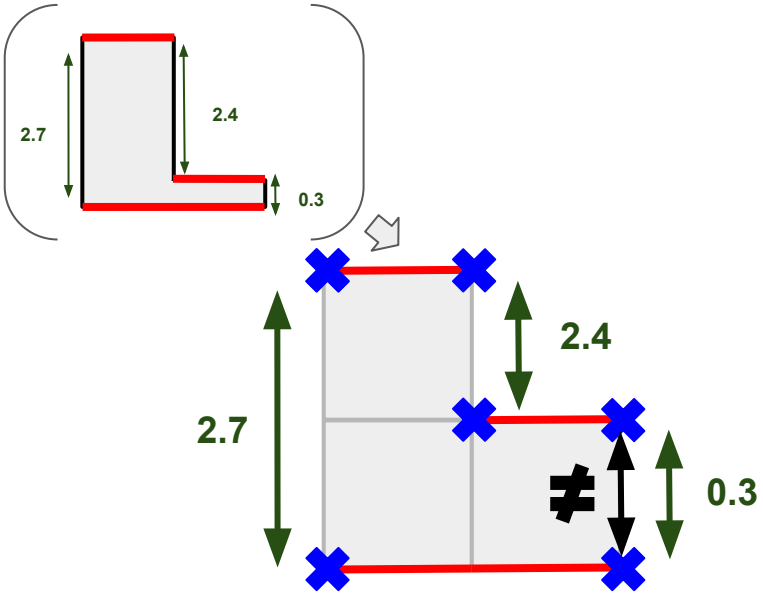
Expliciting constraints: example 1



Expliciting constraints: example 1

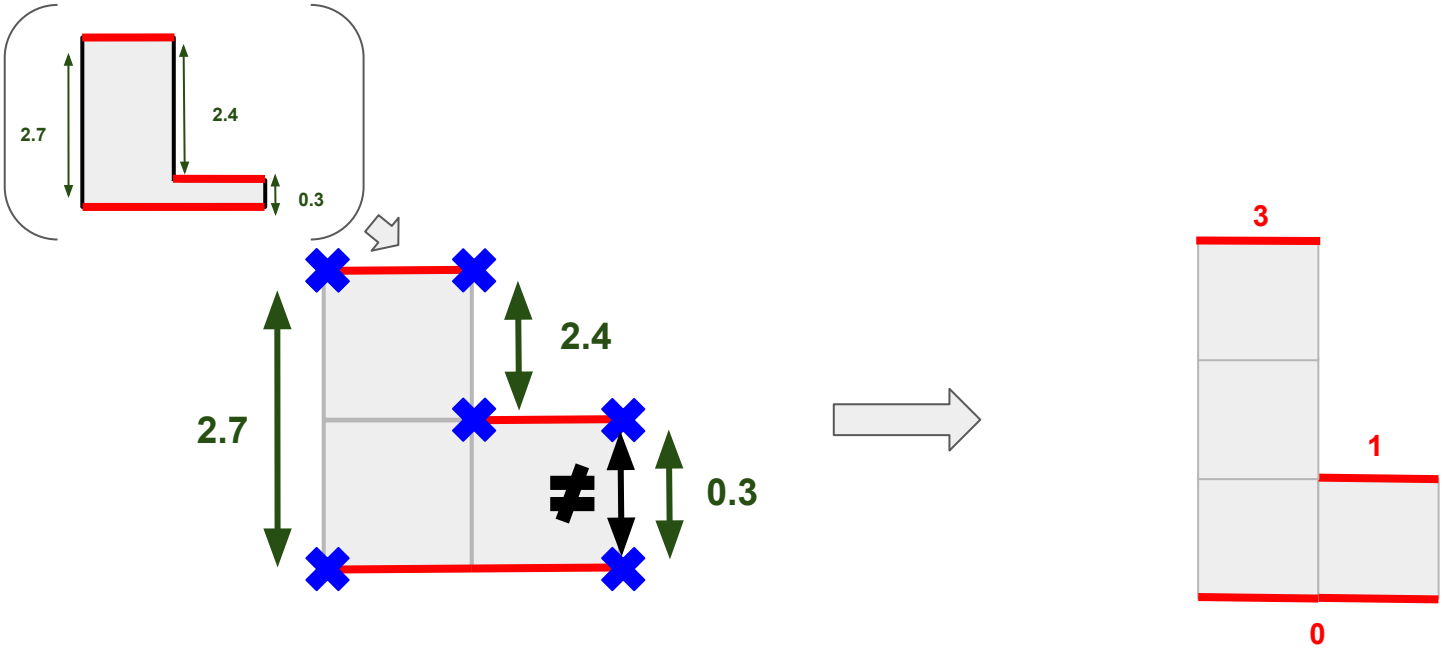


Expliciting constraints: example 1

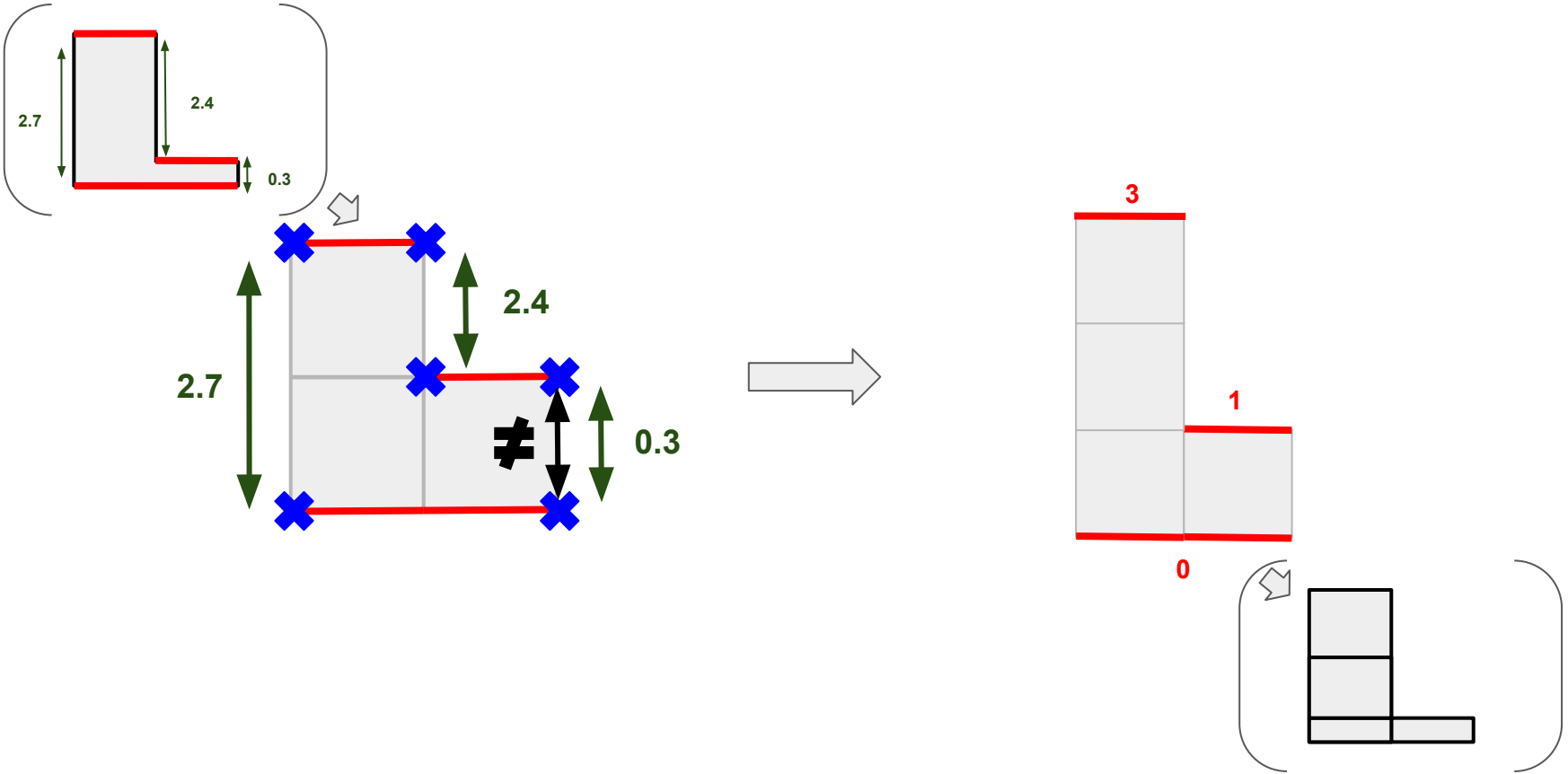


([Chen et al, 2019])

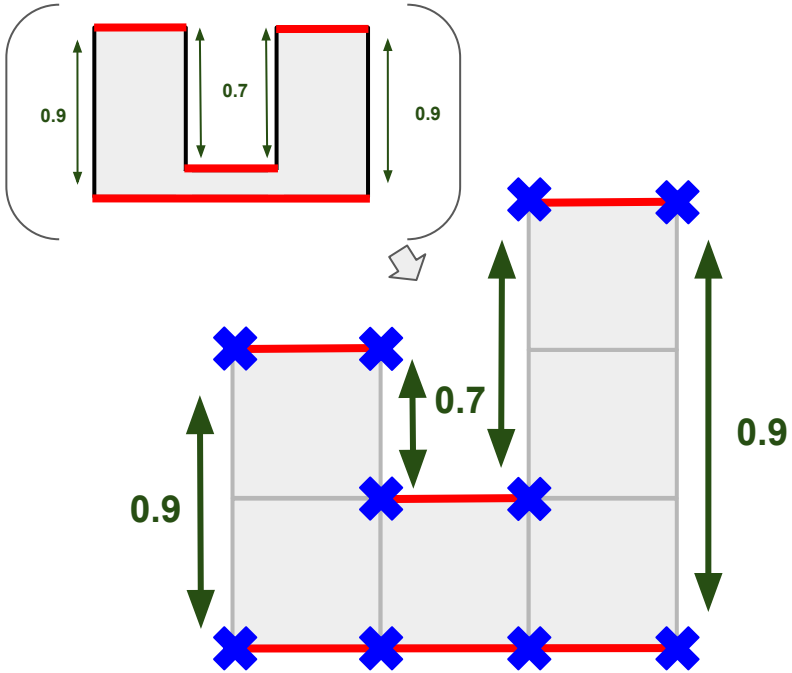
Expliciting constraints: example 1



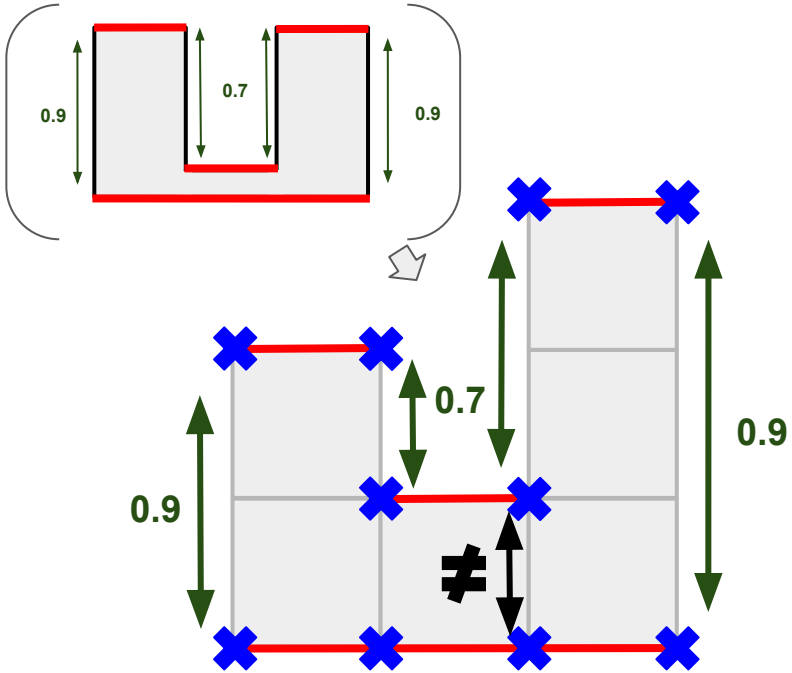
Expliciting constraints: example 1



Expliciting constraints: example 2



Expliciting constraints: example 2



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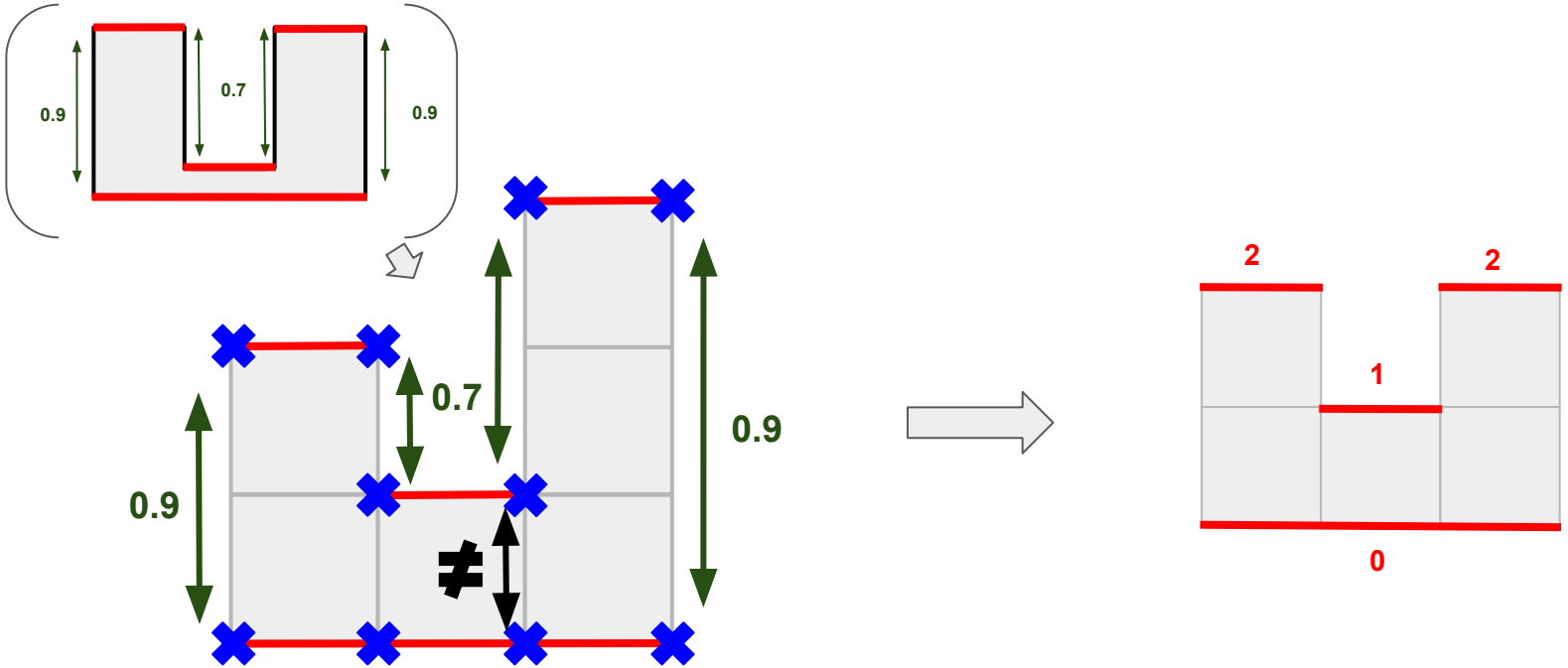
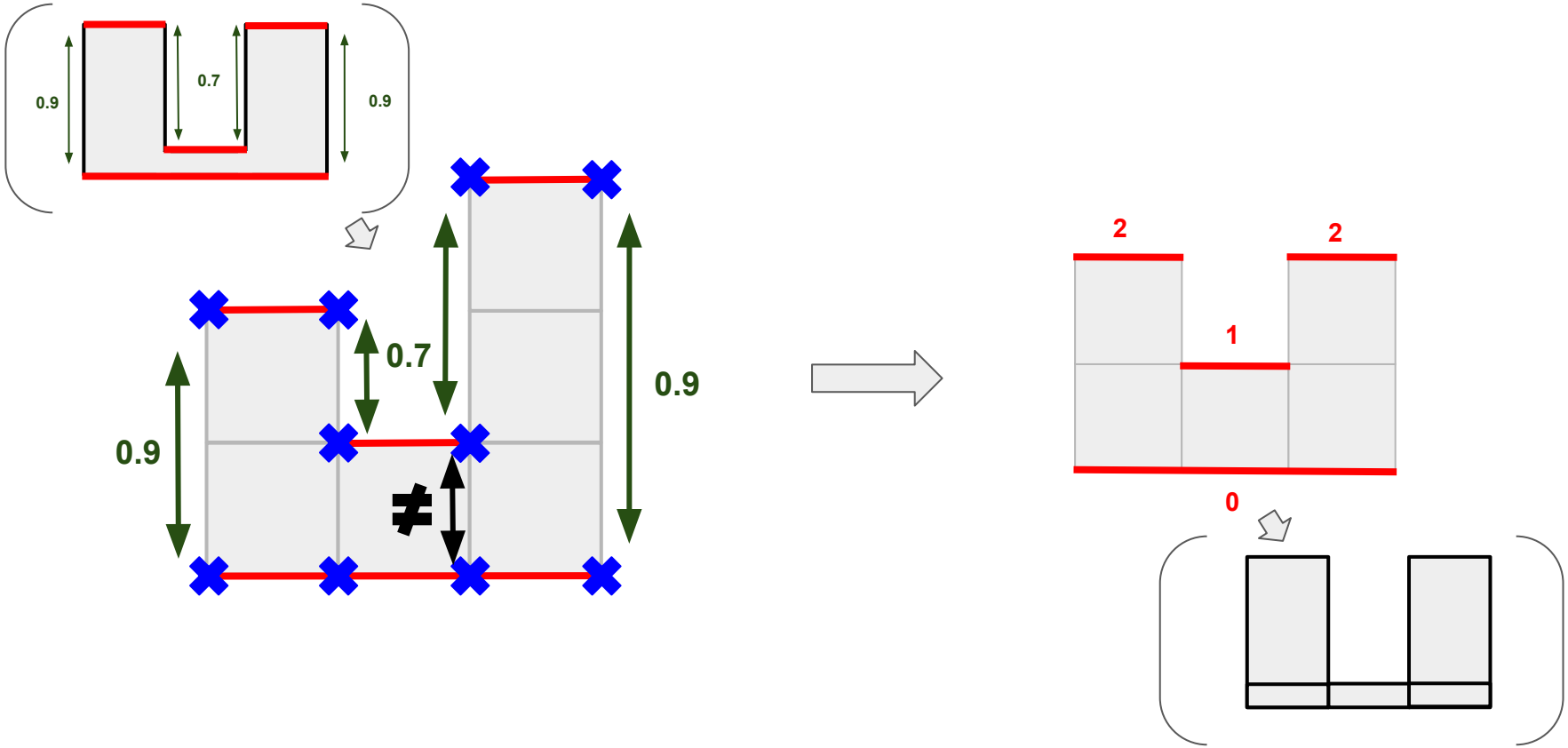
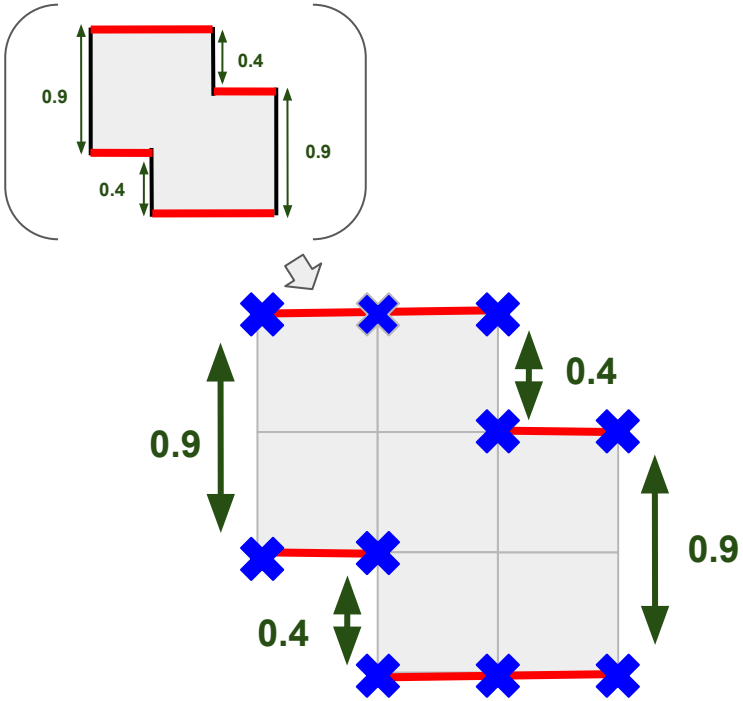


Expliciting constraints: example 2



Expliciting constraints: example 3



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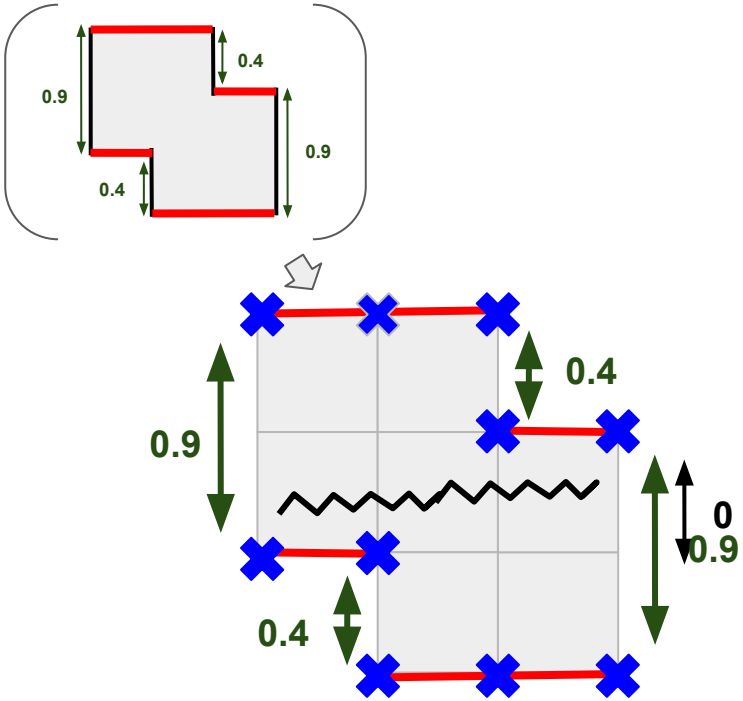

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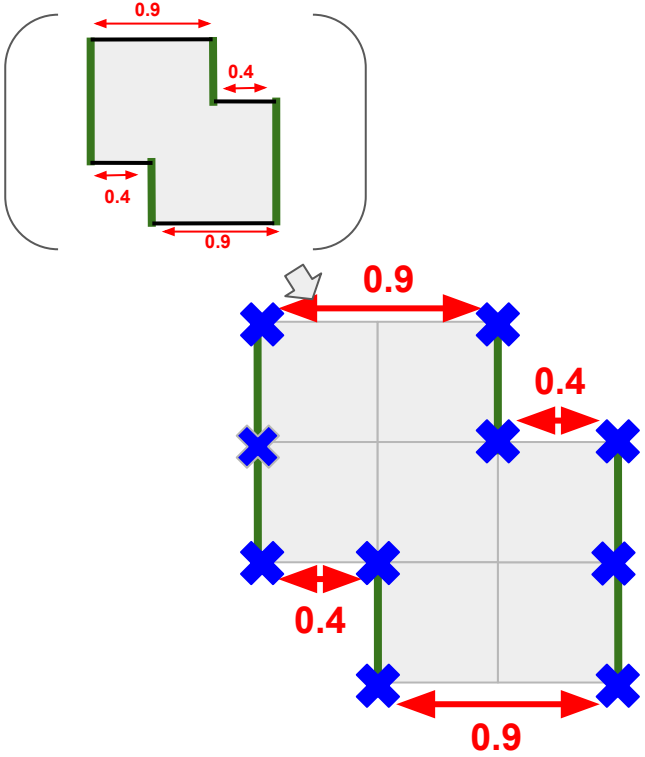

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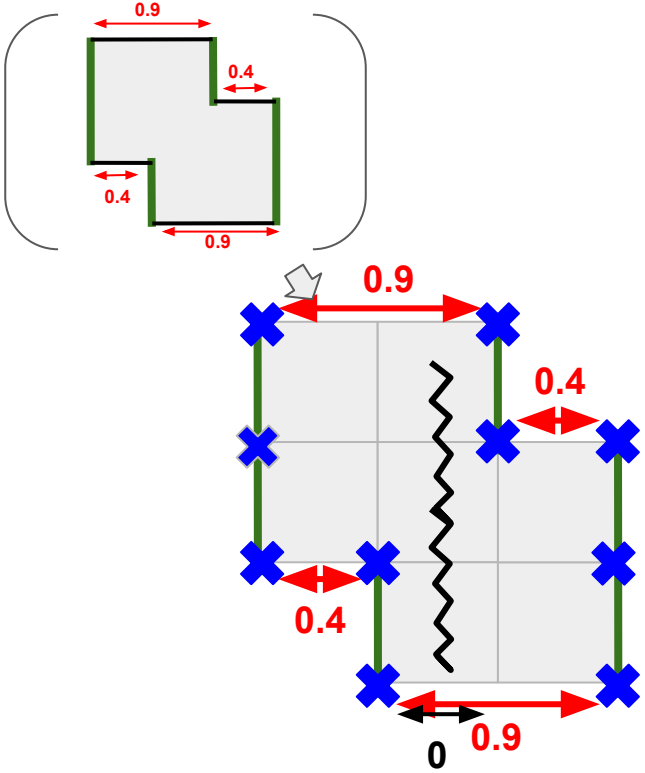

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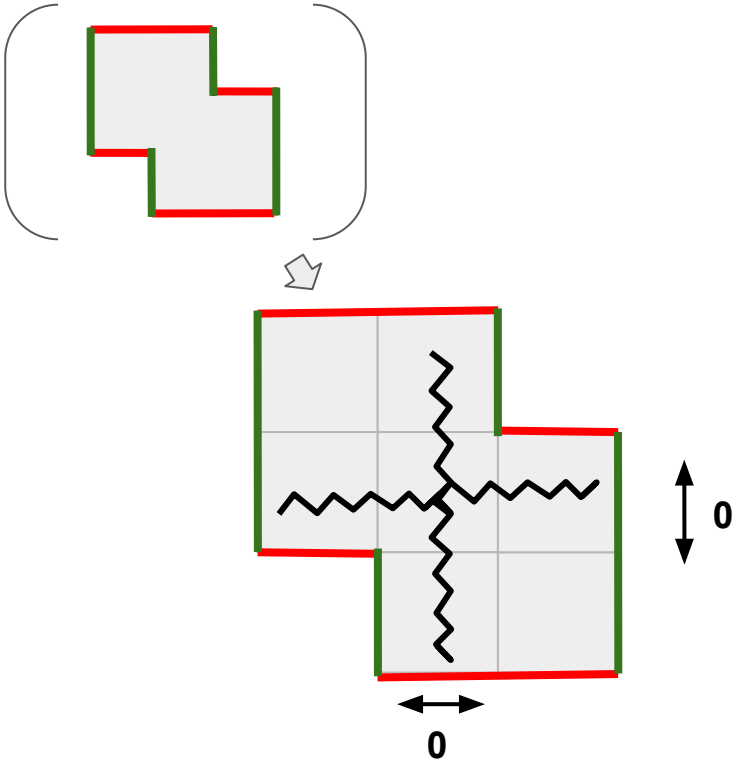

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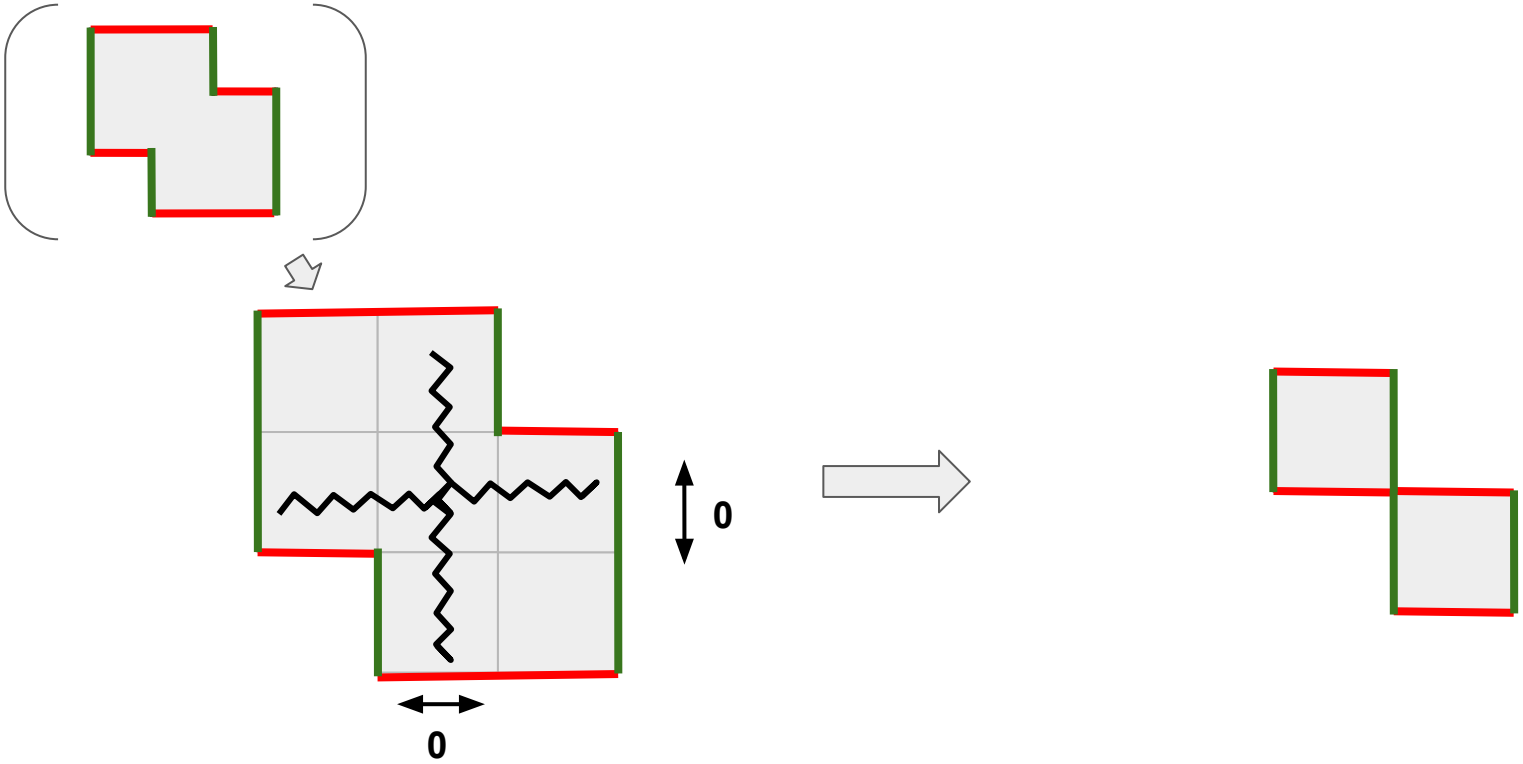

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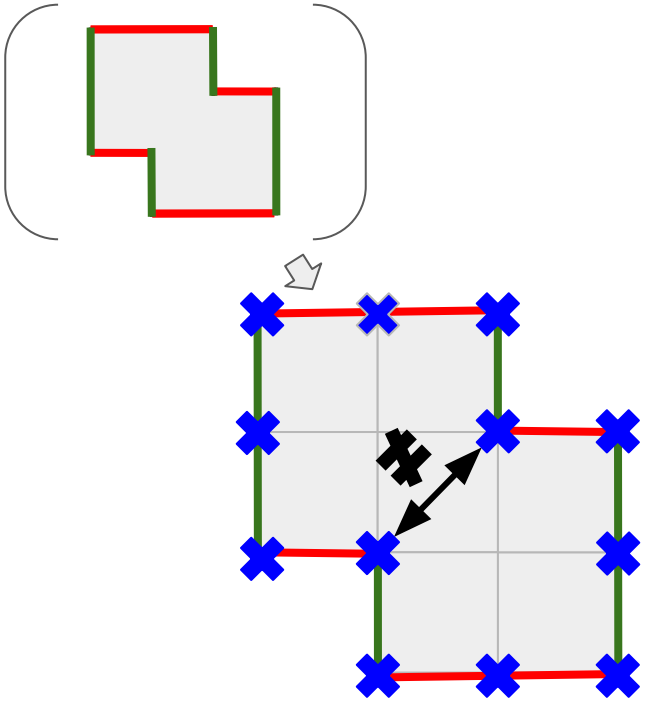

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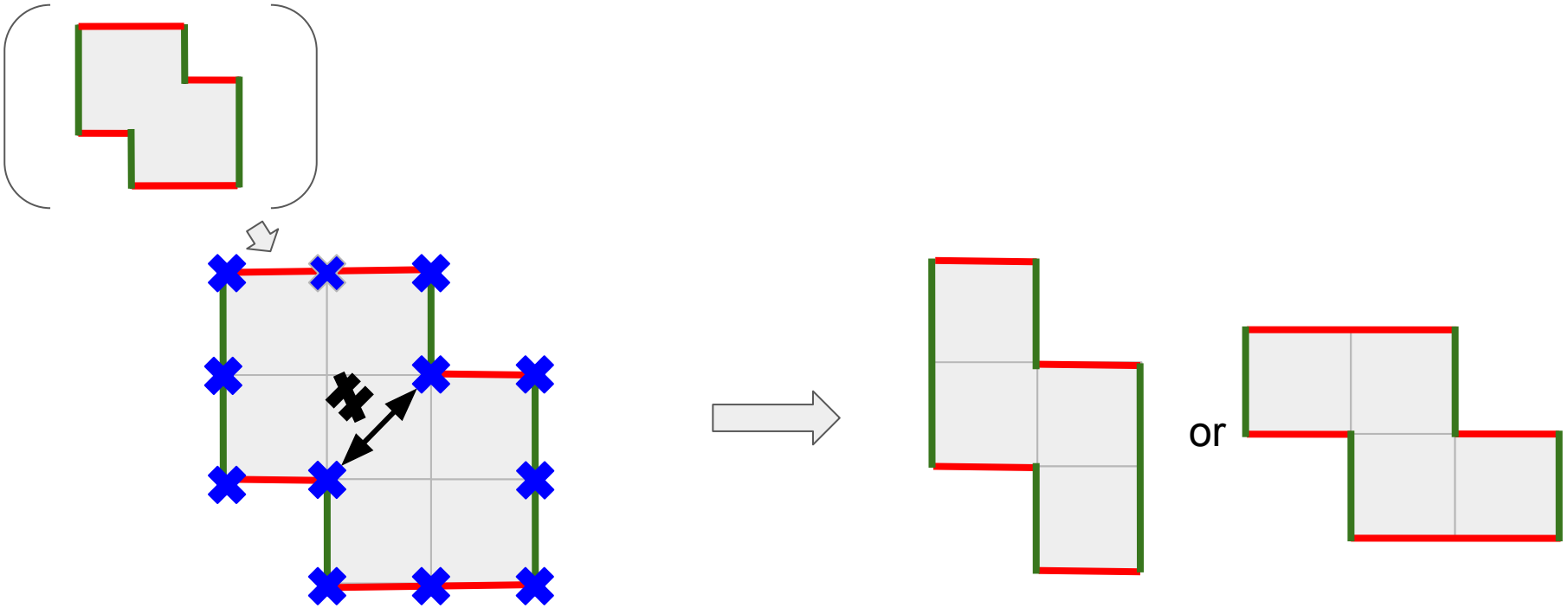

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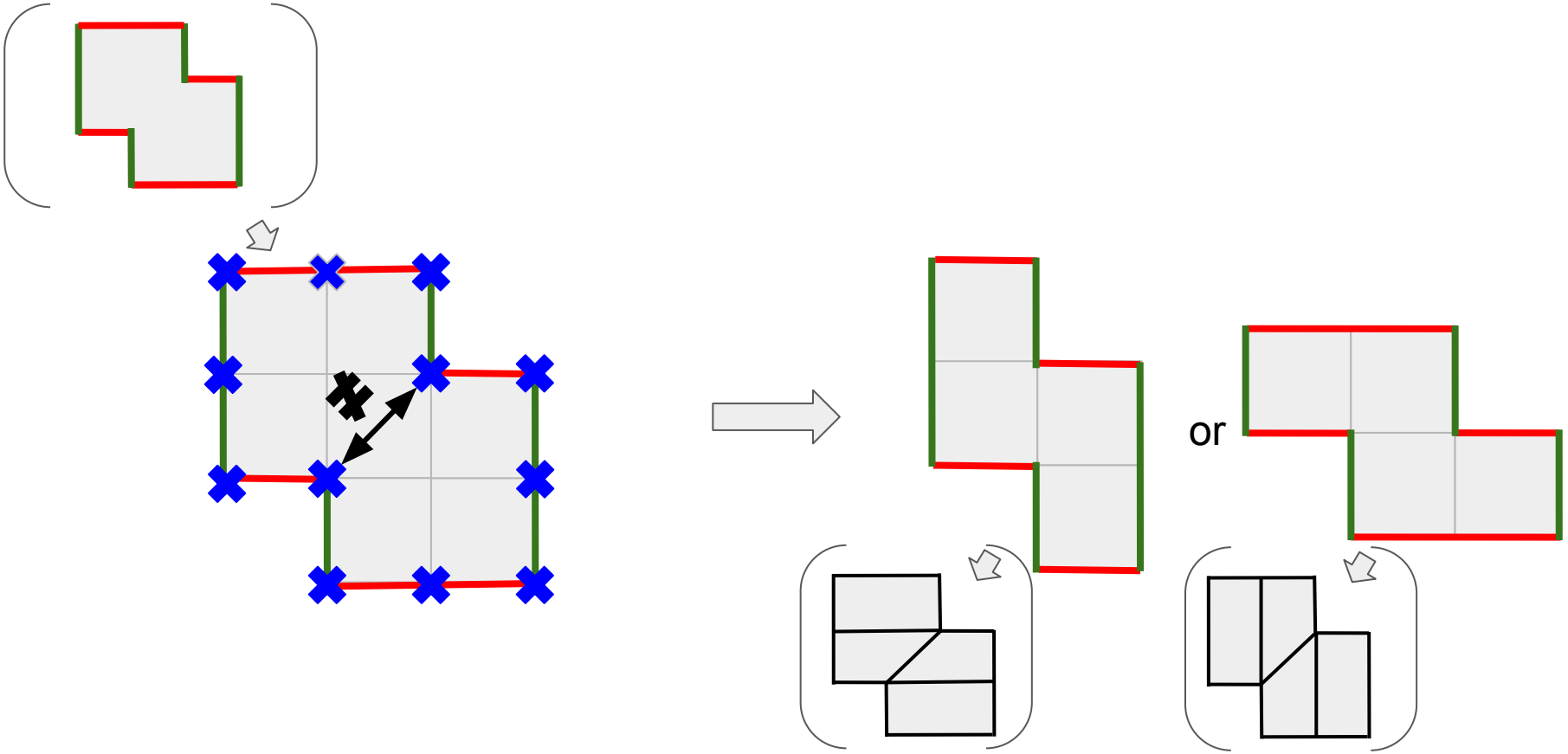

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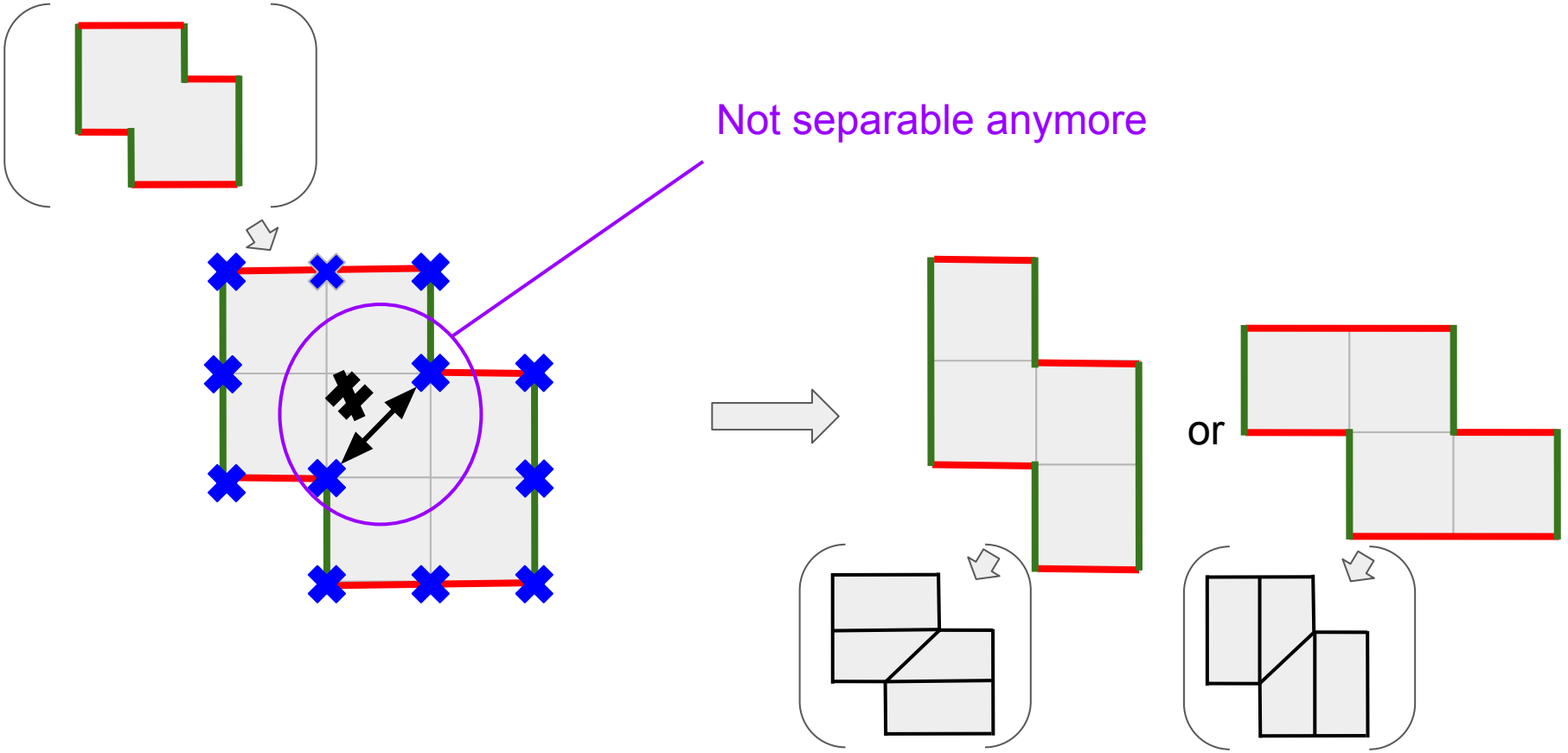

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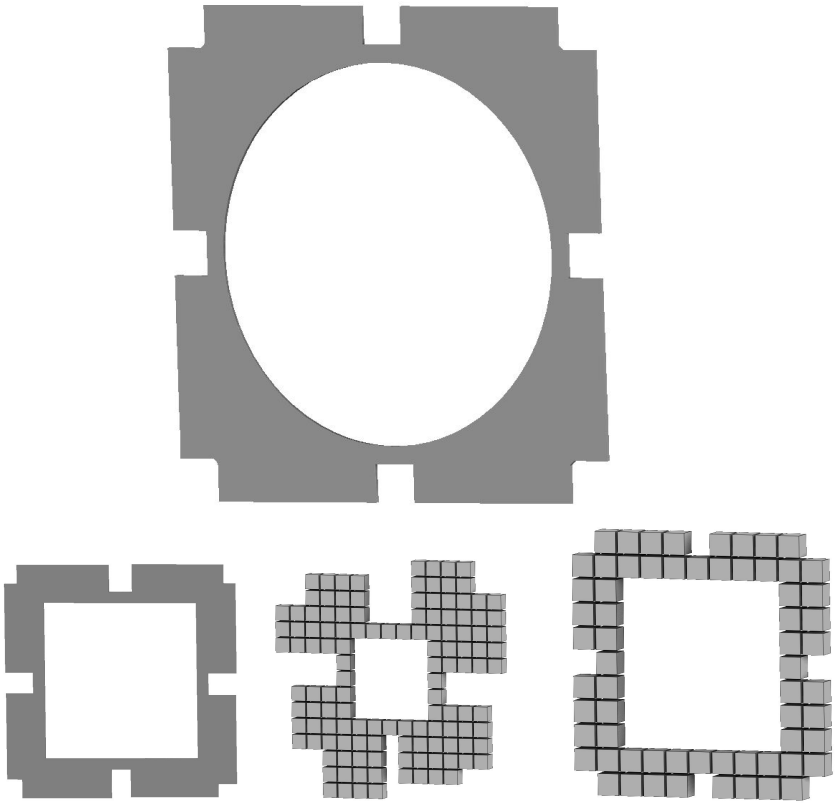
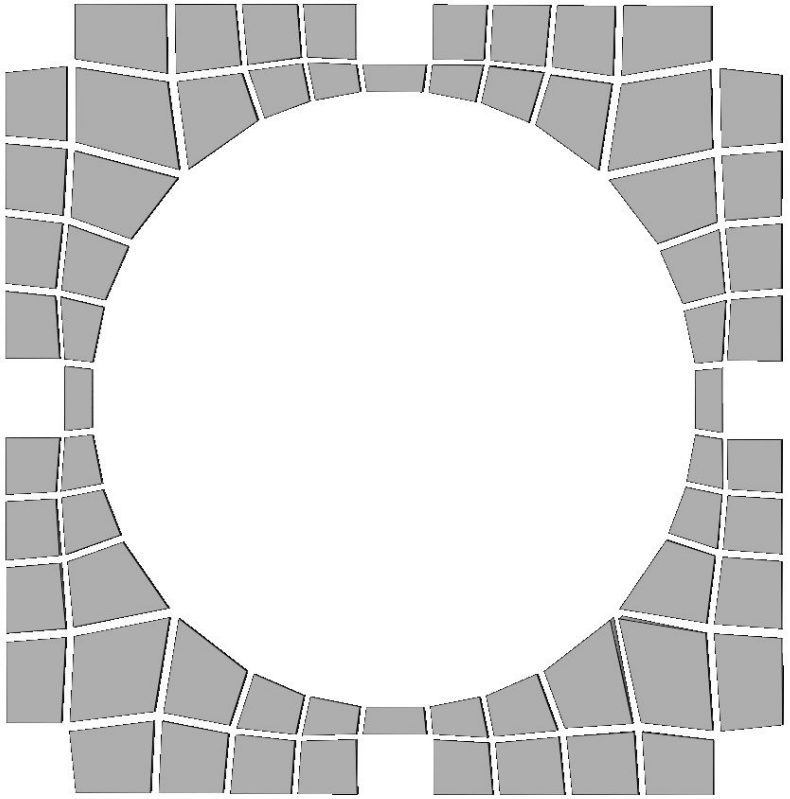
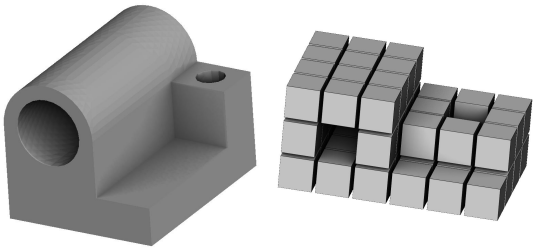
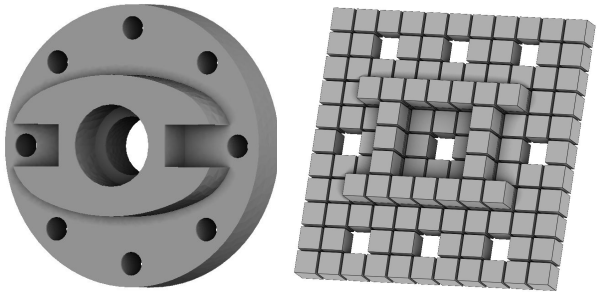
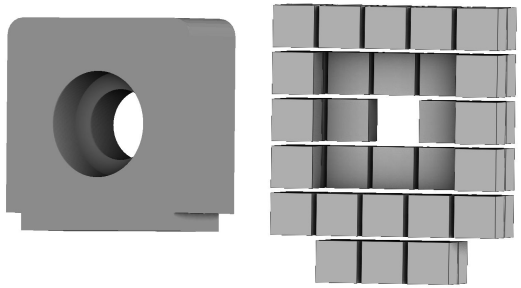


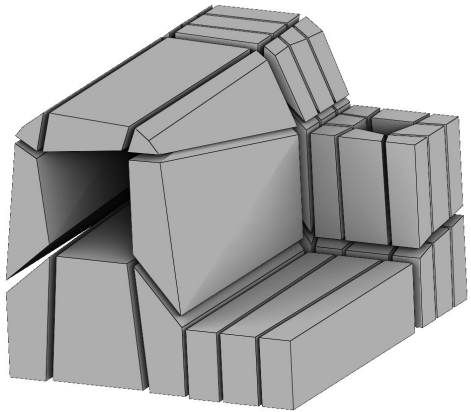


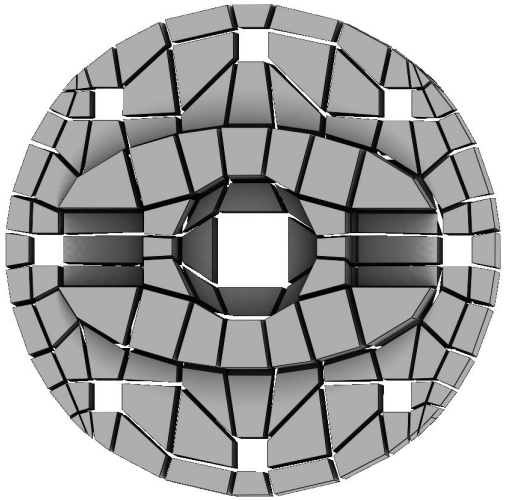
Aiming for big cubes

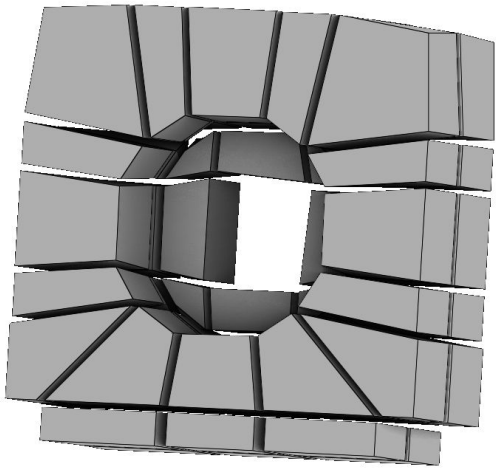




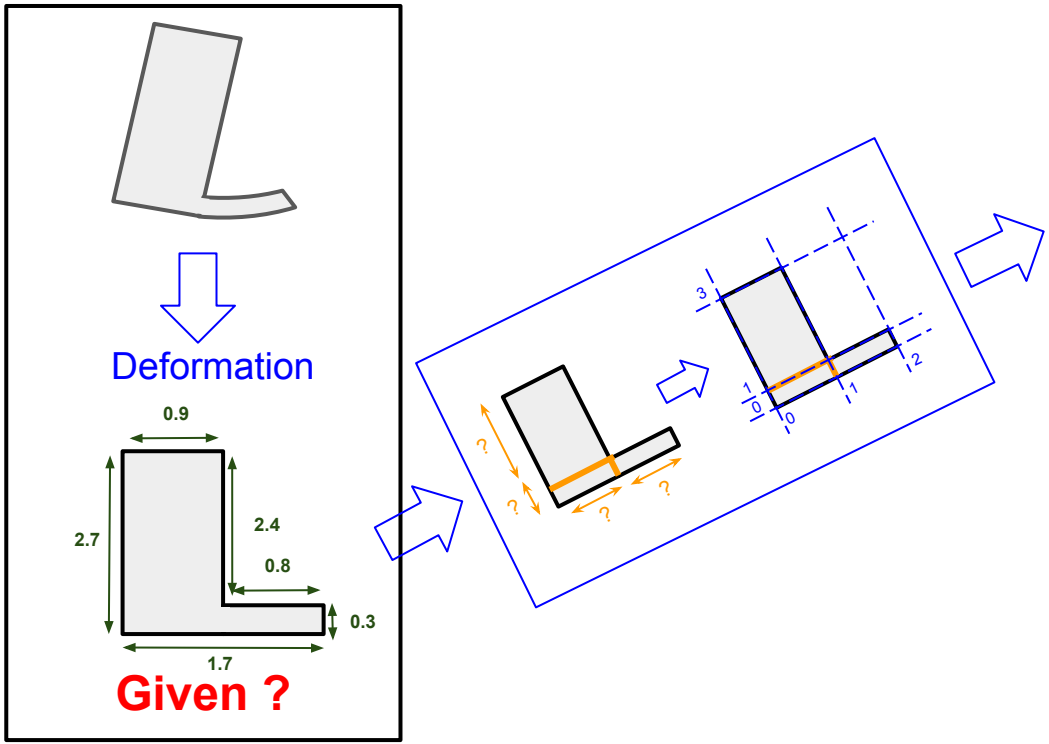


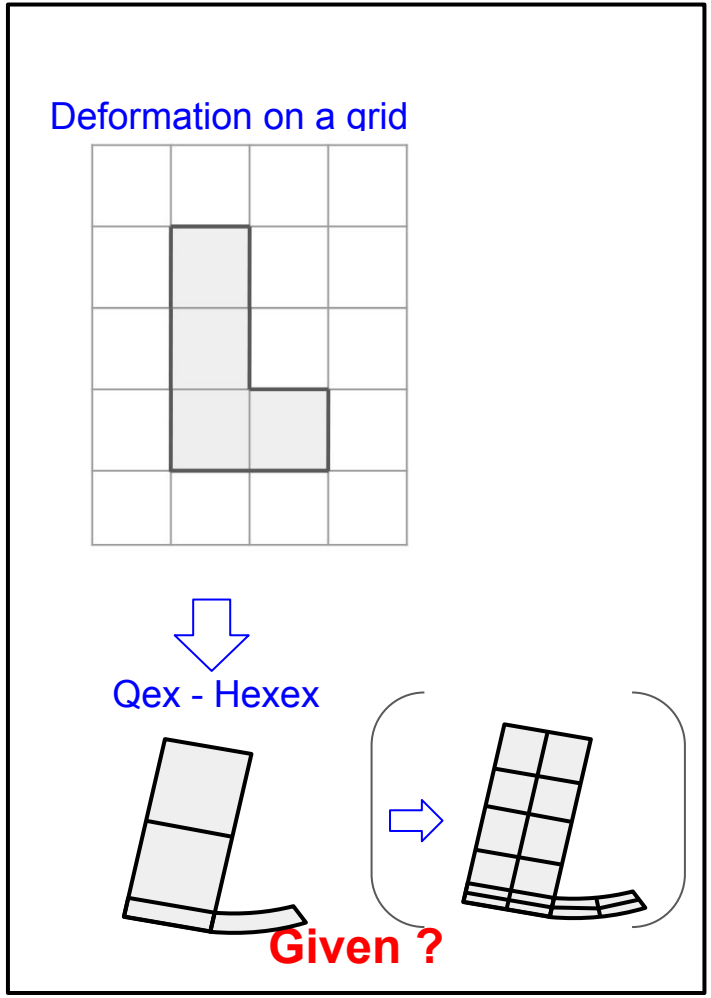






Talk on robustness





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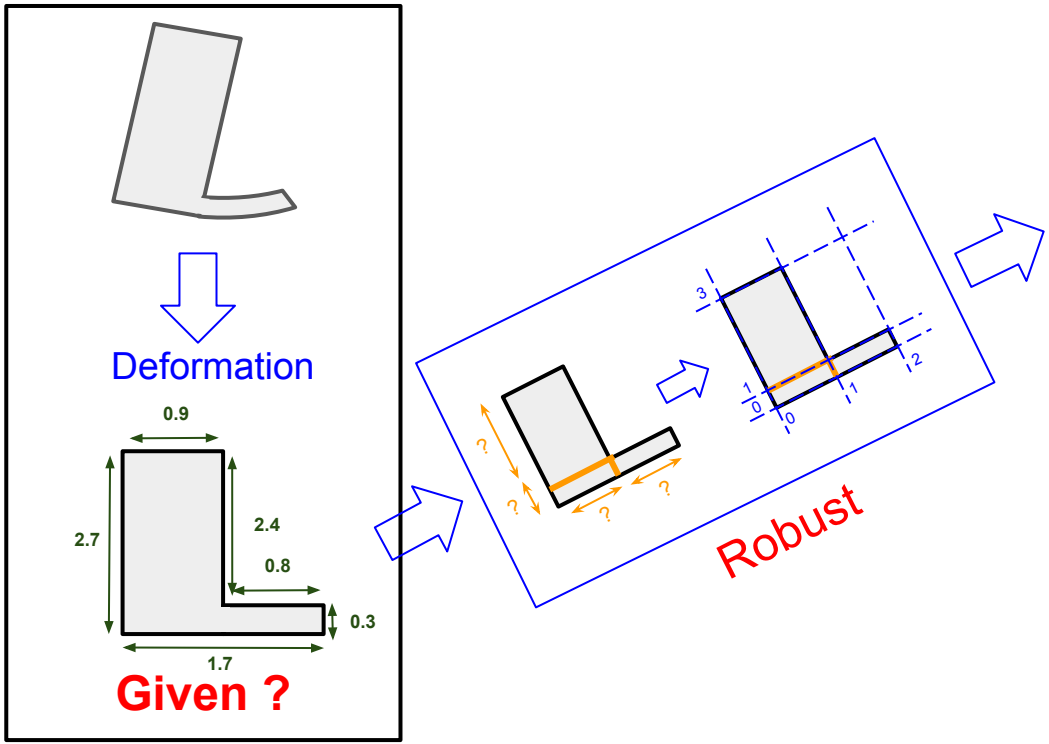
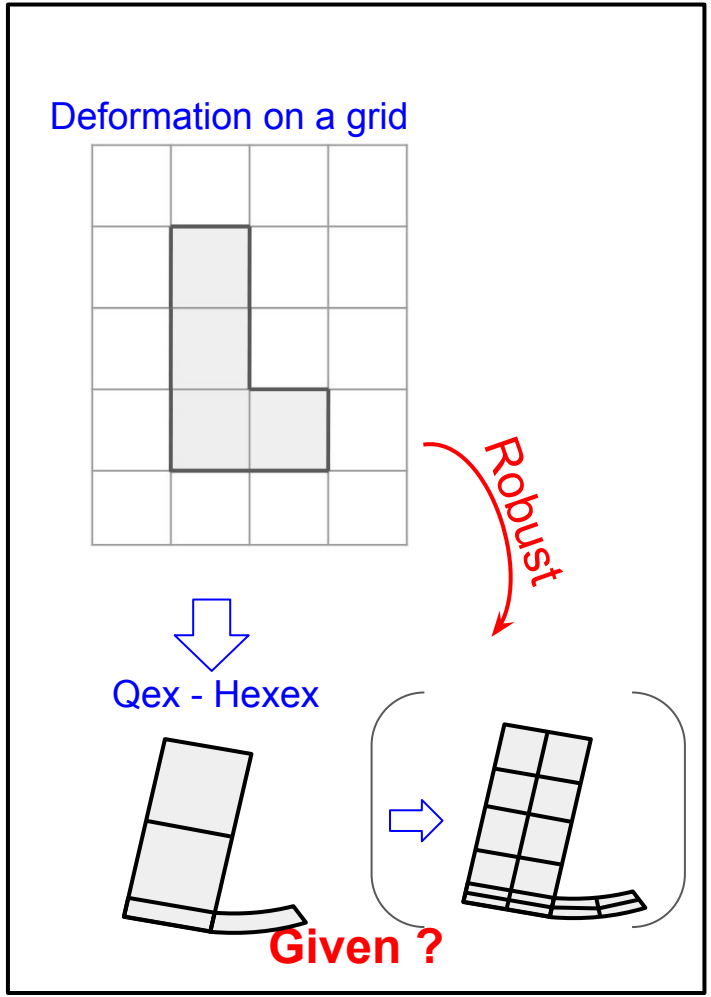
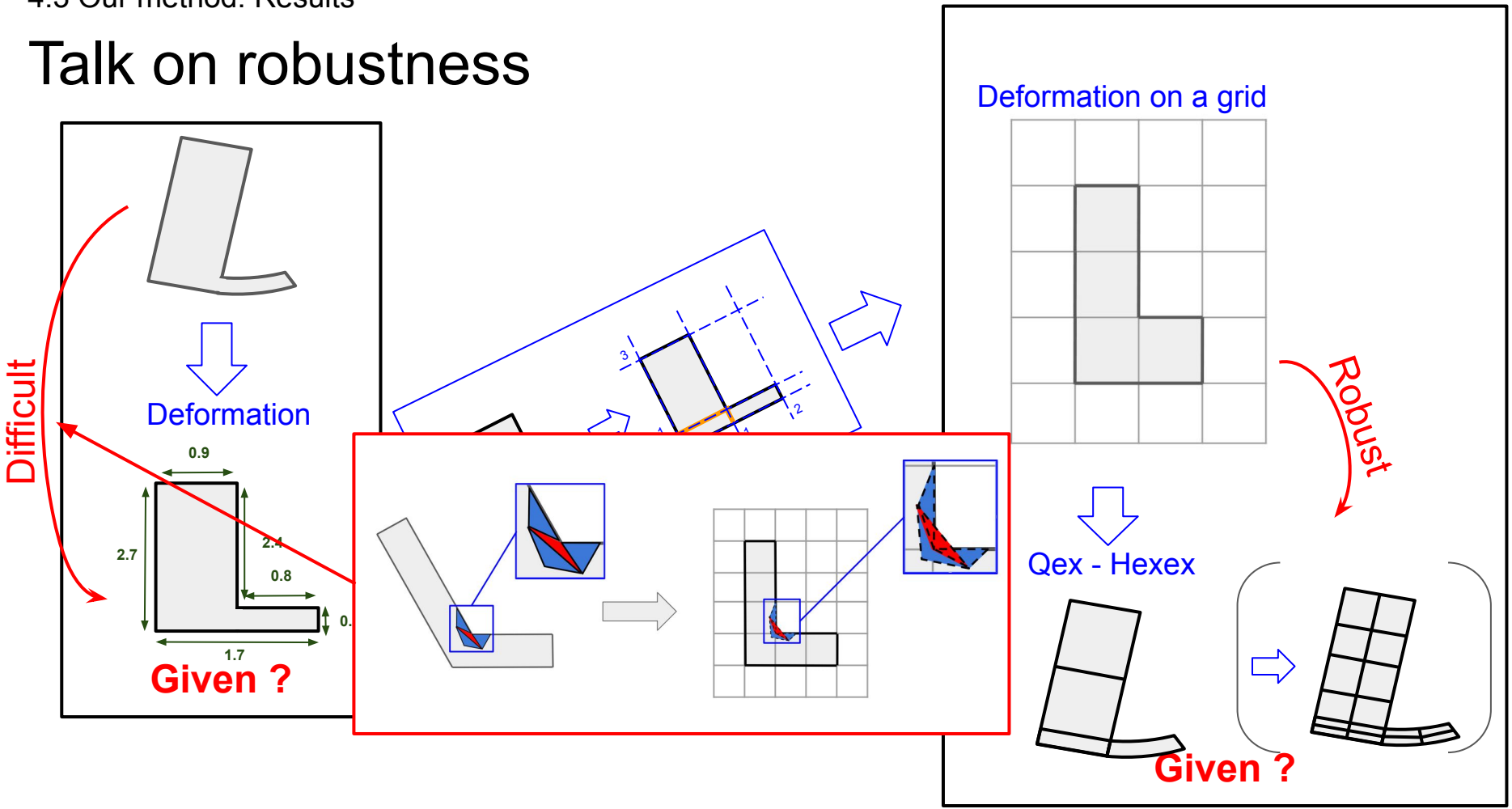
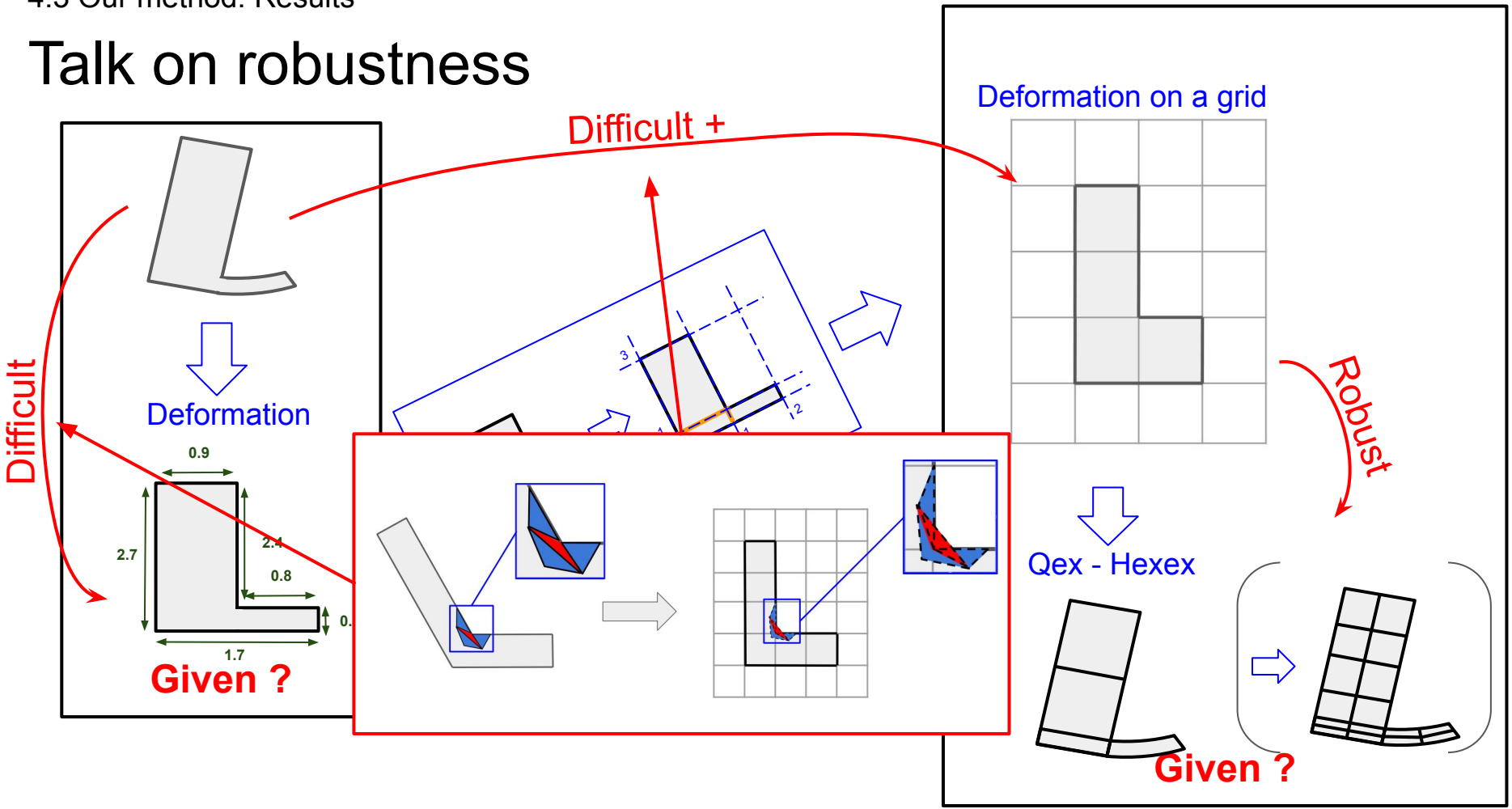
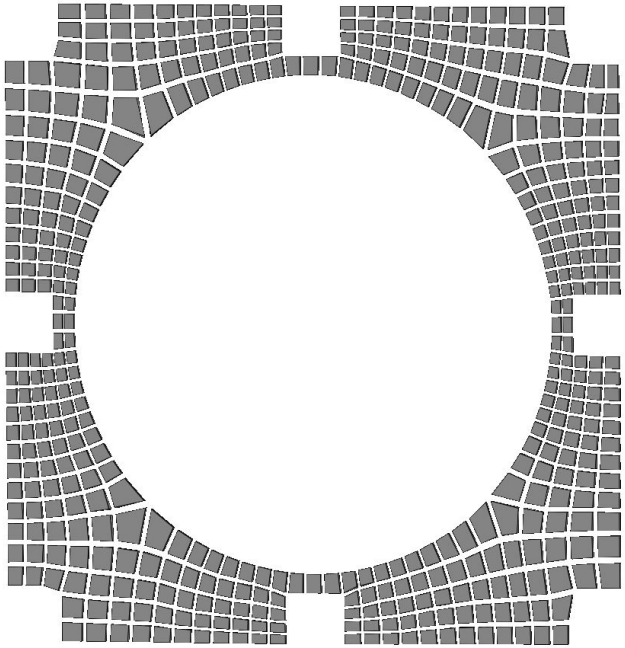
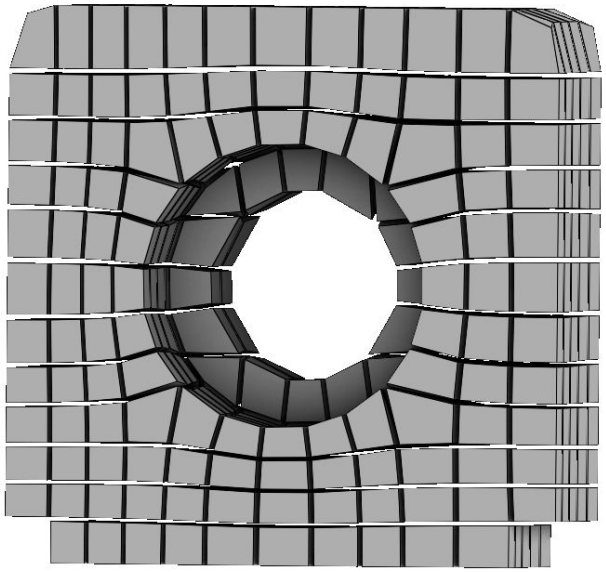
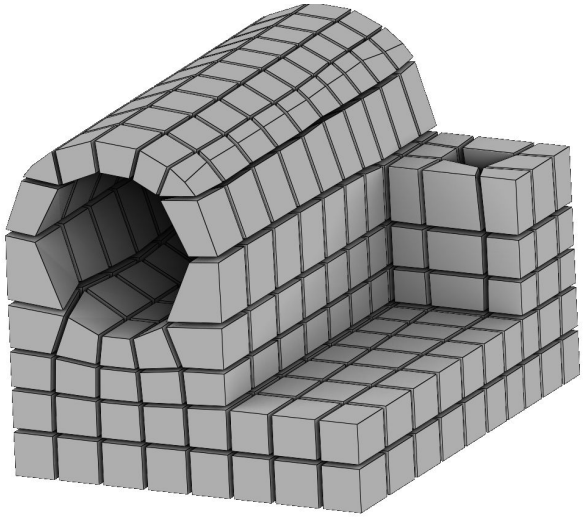
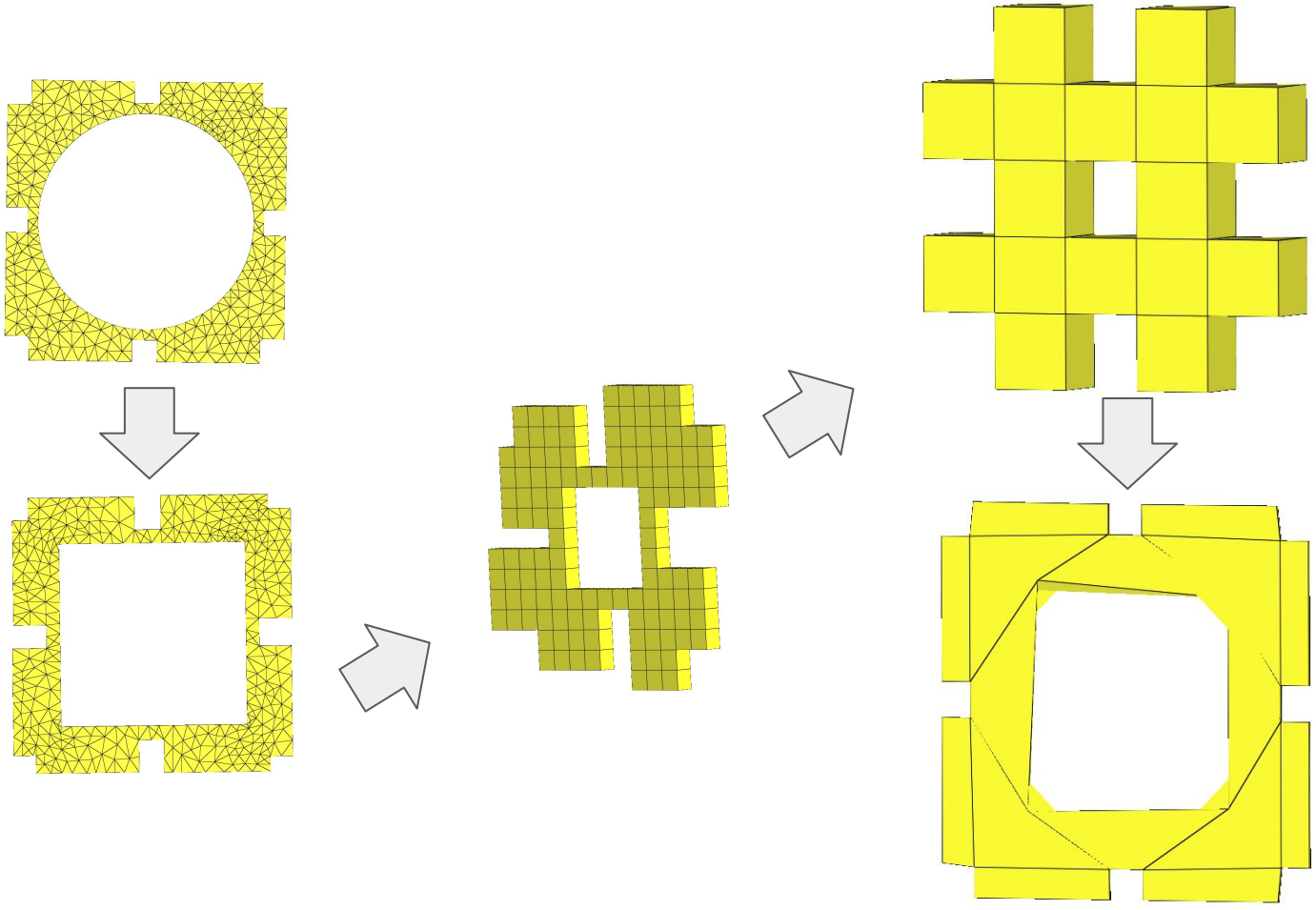




Talk on robustness



Talk on robustness



Thanks for your attention