# Enumeration of Common Developments 

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## Introduction

- Unfold the cube, we can get its "developments".

- Big Open Problem:

Any convex polyhedron can be developed without overlapping by just cutting along its edges (?)

## Open problem

- Theorem [Biedl et al. 1999]

Two polygons that can fold two boxes
"Geometric Folding Algorithms: Linkages, Origami, Polyhedra"p424, 25.8.3, figure 25.53


Any more?


Theorem [Abel, Demaine, Demaine, Matsui, Rote, Uehara 2011] For area 22, there are 2263 polygons that can fold to two boxes of size $1 \times 1 \times 5$ and $1 \times 2 \times 3$ (by exhaustive search). Among them, only one admits to fold a "box" of size $0 \times 1 \times 11$ of volume 0.


## The enumerate approach

- We enumerate all developments by super computer. It takes around 2 months to complete search.


Theorem [Dawei, Horiyama, Uehara 2015]
By searching all developments of area 30, 1080 polygons fold boxes of size $1 \times 1 \times 7$ and $1 \times 3 \times 3$.
Among 1080, there is 9 polygons that fold to a cube of size $\sqrt{5} \times \sqrt{5} \times \sqrt{5}$, and Only one of 9 , it has two ways of folding into the cube!



## Future Algorithms with BDD

## Development should be ...



- Cut-edges form a spanning tree No cycles
- All vertices are connected by cut-edges
- A pseudo spanning tree No cycles


8 corners are connected
by cut-edges

- Degrees of vertices:
- Corners: 1 or more cut-edges
- Other vertices: 0, 2, 3, 4

