INFO-F420 Computational Geometry project

# Reflections in an octogonal mirror maze

By **David Eppstein**

Presented by
**Chassagne Aurélien** and **Swirydowicz Szymon**

# Hypotheses and properties

## Environment

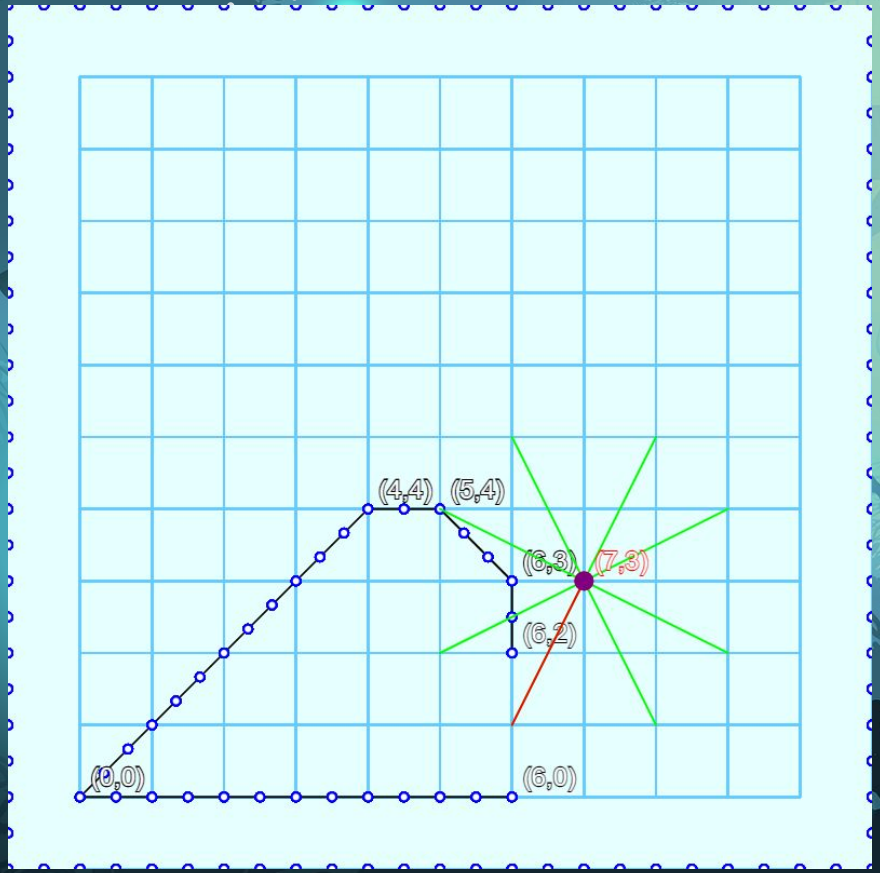
- Integer grid for mirrors and light ray.
- Horizontal, vertical, diagonal mirrors.
- Start and end points of mirrors do not reflect.
- Fixed initial direction for the light ray.

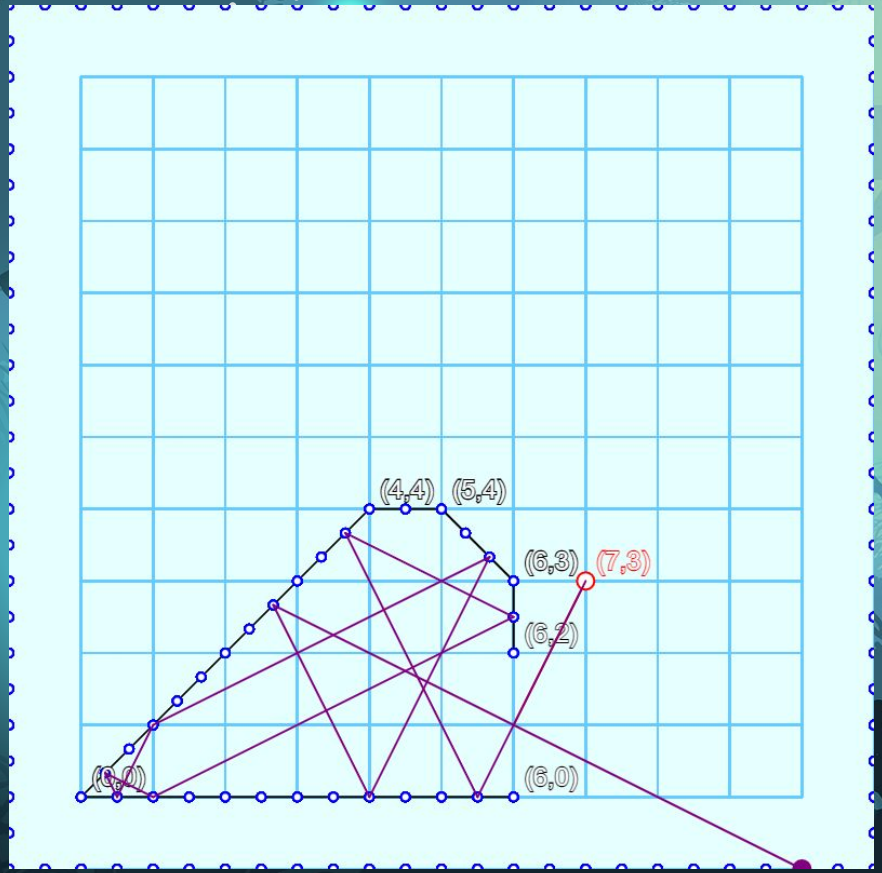
## Mirrors

Finite number of hit points.

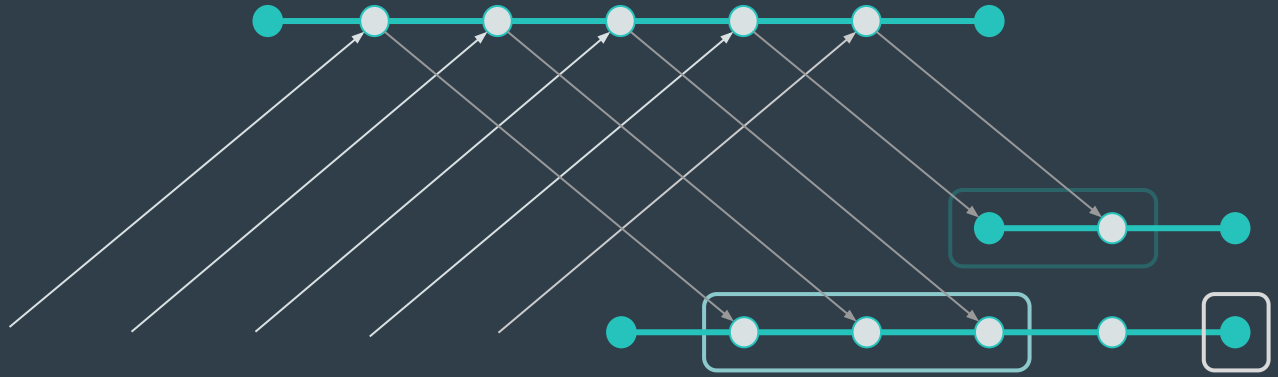
## Light ray

Only 4 or 8 possible directions.

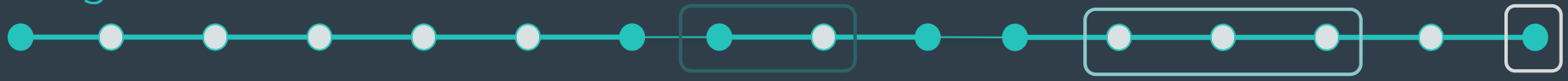

(4,4)
(5,4)
(6,3)
(7,3)
(6,2)
(0,0)
(6,0)


(4,4)
(5,4)
(6,3)
(7,3)
(6,2)
(6,0)
(6,0)

# Integer interval exchange transformation



Big interval

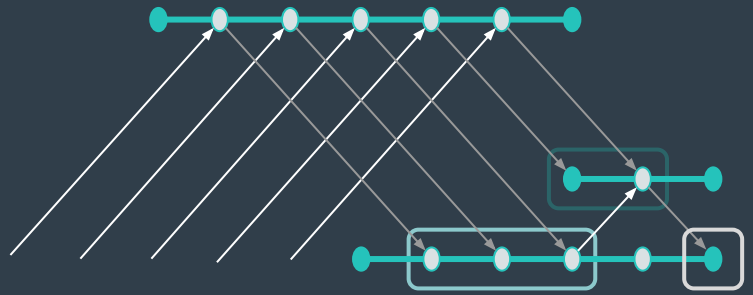


Mapping

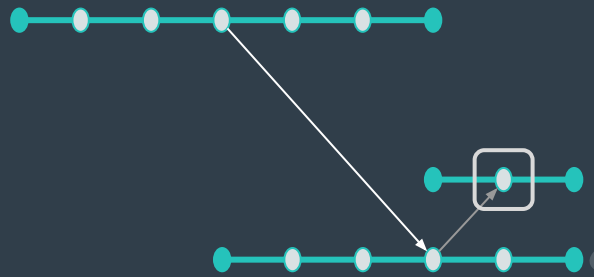
# Integer interval exchange transformation

Big interval : *Concatenation of the **8 ray's directions***

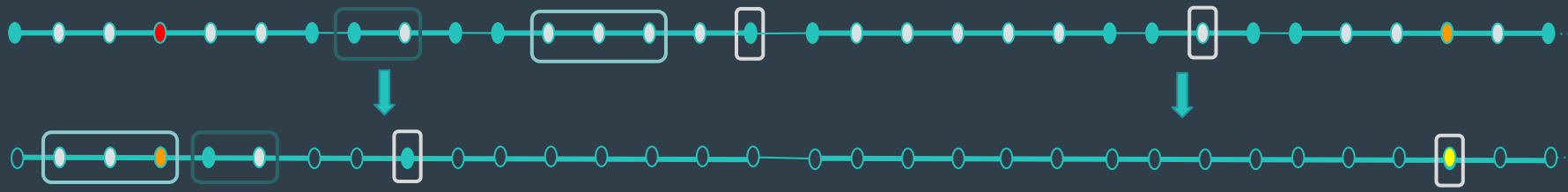
**Ray's direction :**



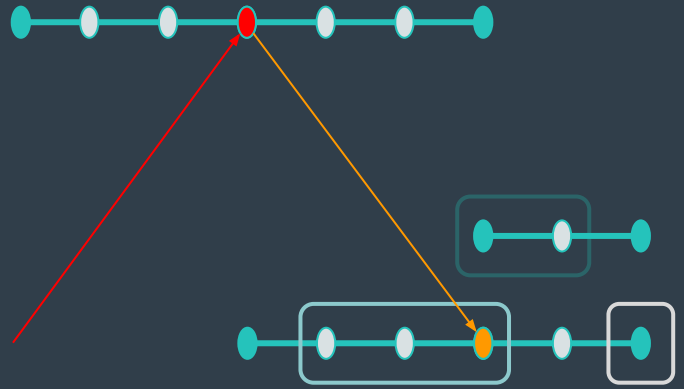
**Ray's direction :**



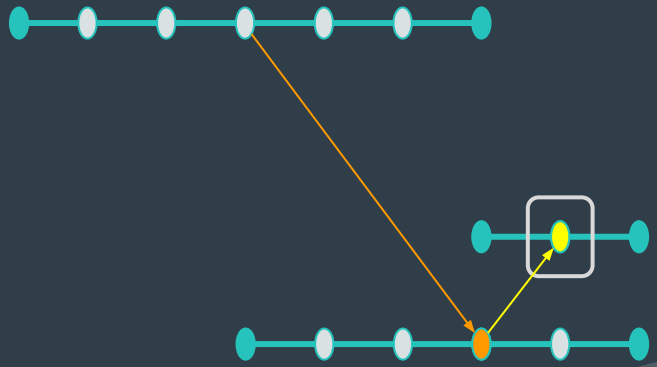
# Integer interval exchange transformation



1)



2)



# Mapping must be bijective

Problem:

Finite problem,
Max *n* bounces

→

Apply max *n* times
the transformation

Optimization:

Possible to compute the ***n*$^{th}$ transformation directly**

↔

Mapping is **bijective**

⚠ The mapping is **partial**, not bijective yet

# Partial to complete exchange

The mapping is not bijective because of **outgoing rays**, **non-reflective surfaces** and **mirror's endpoints** that are not mapped.

**Goal**: Make the mapping bijective

| | | |
|---|---|---|
| Outgoing rays | → | Surrounding environment in a box |
| Non-reflective surfaces | → | Considered as virtually reflective |
| Mirror's endpoints | → | Considered as flipping back the ray |

The mapping is **complete** (bijective) but **false**

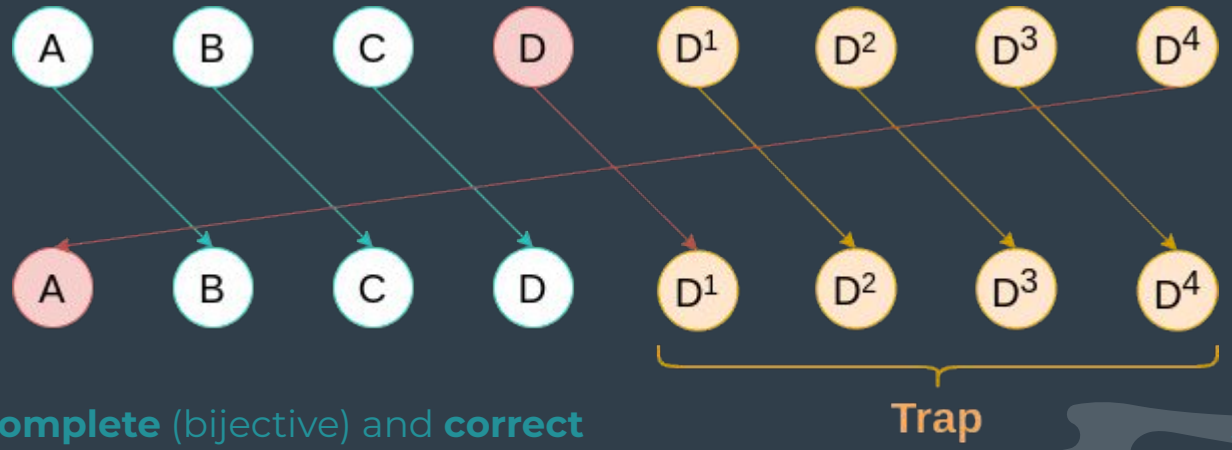
# Repair the mapping

The mapping is bijective but **false** since we mapped non-reflective points

**Goal**: Use *"traps"* when reaching non-reflective points

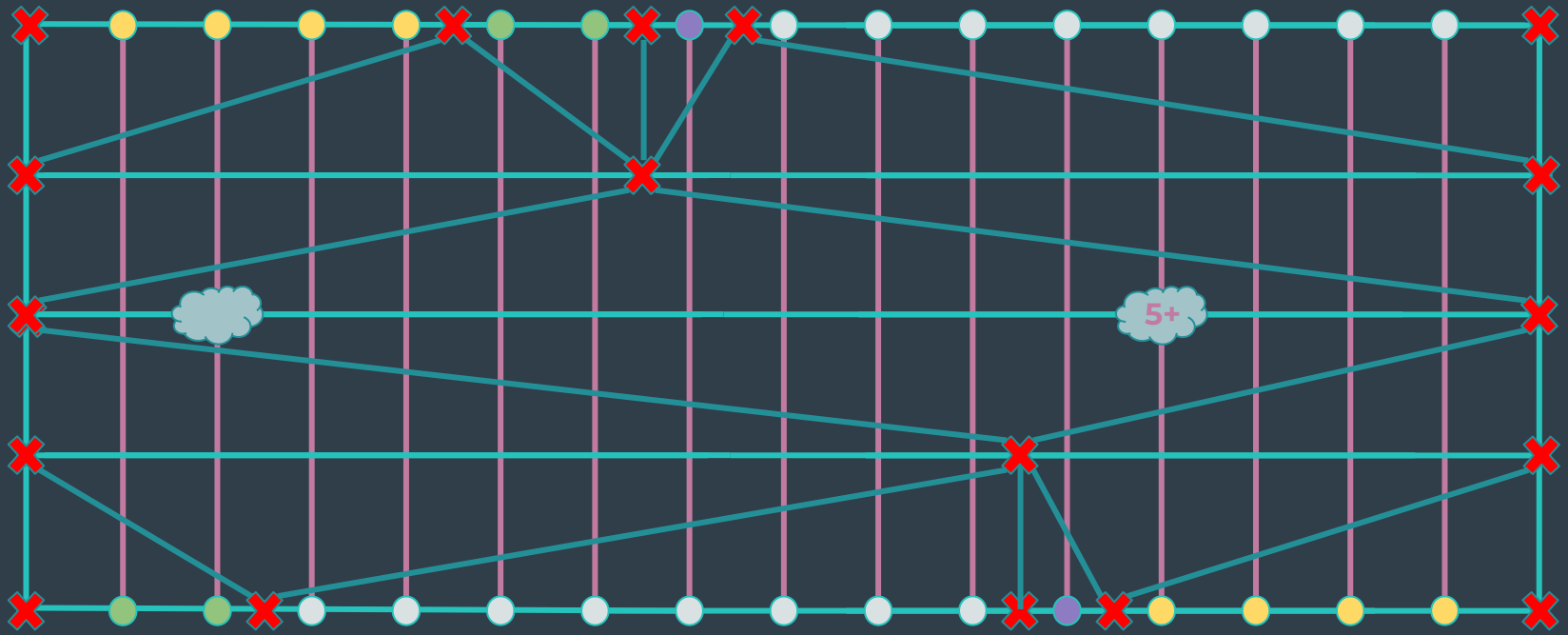
Inserting *n* virtual intermediate points between the non-reflective point and its target

E.g. The non-reflective point "D" reflects to point "A"




➡ The mapping is **complete** (bijective) and **correct**

# Triangulation




https://sswirydo.github.io/Ray-shooting/index.html


Q&A

# Thank you!

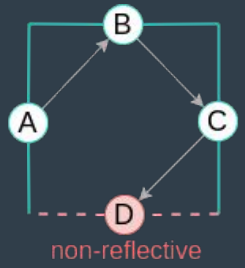
# References


"*Reflections in an octagonal mirror maze*"
by **David Eppstein**

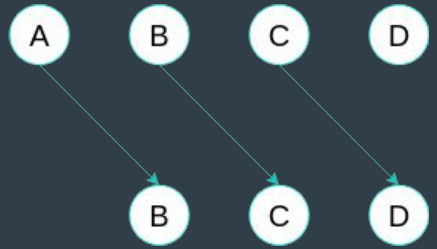
"*The Complexity of Iterated Reversible Computation*"
by **David Eppstein**

"*Tracing Compressed Curves in Triangulated Surfaces*"
by **Erickson Jeff** and **Amir Nayyeri**

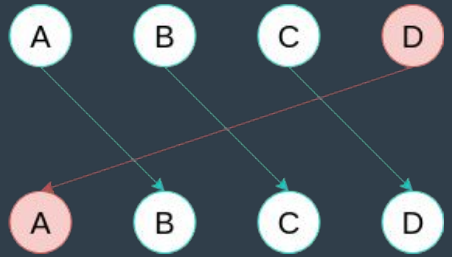
1. Environment




2. Partial Exchange

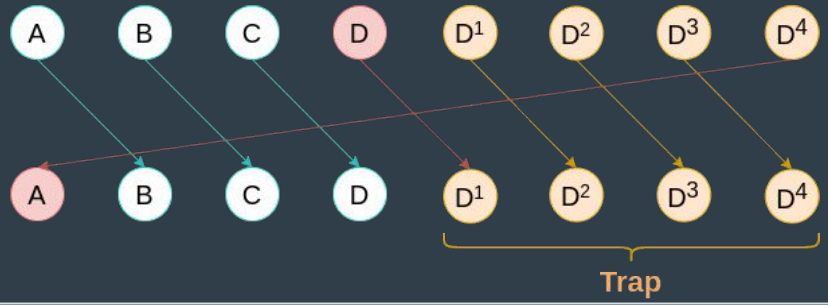



3. *Non-reflective as reflective*




# Algorithm Overview

4. Complete Interval Exchange




5. Fast iterated exchange