Strict Theta*

Shorter Motion Planning Using Taut Paths

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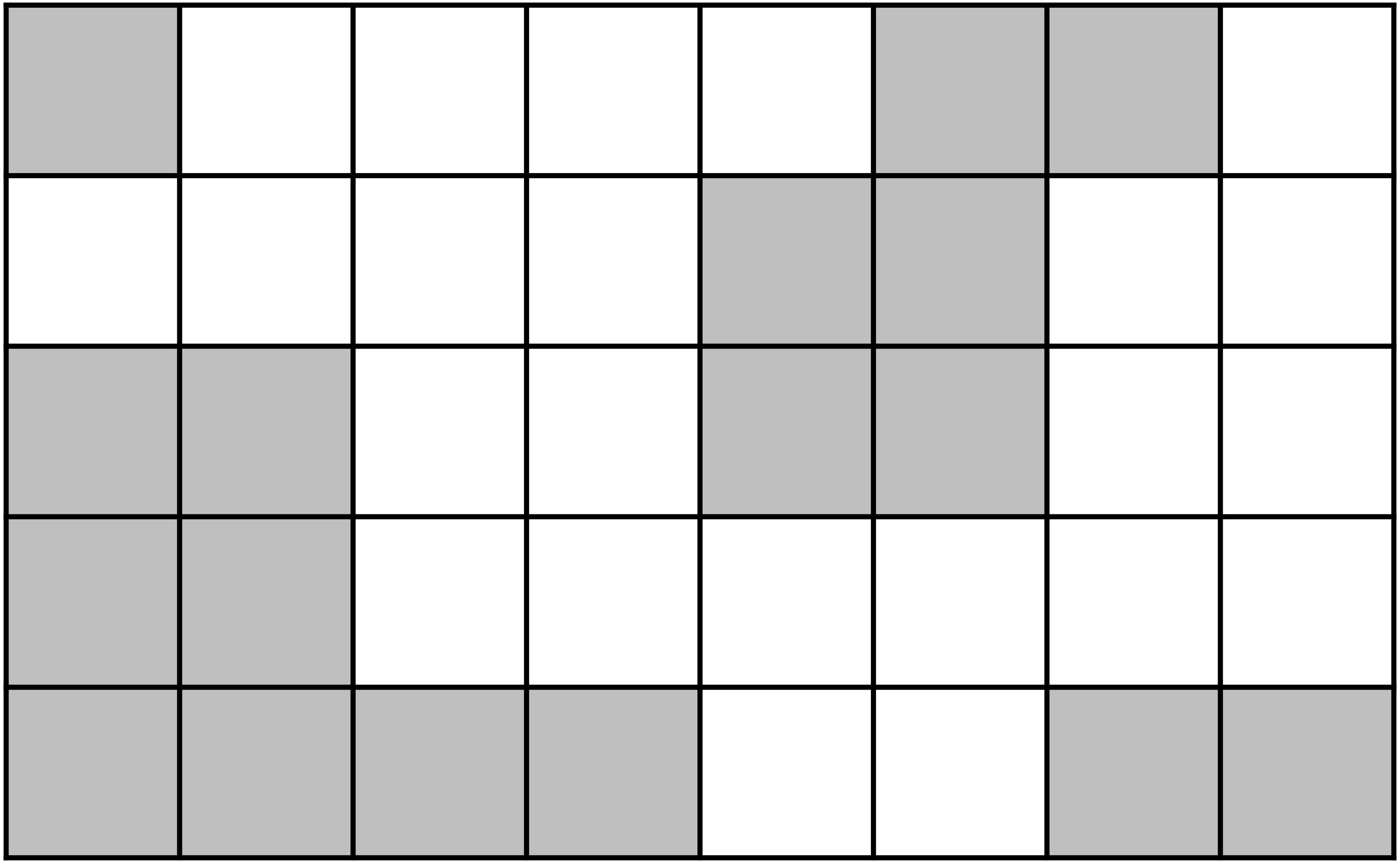
National University of Singapore

Any-Angle Path Planning

Problem Definition

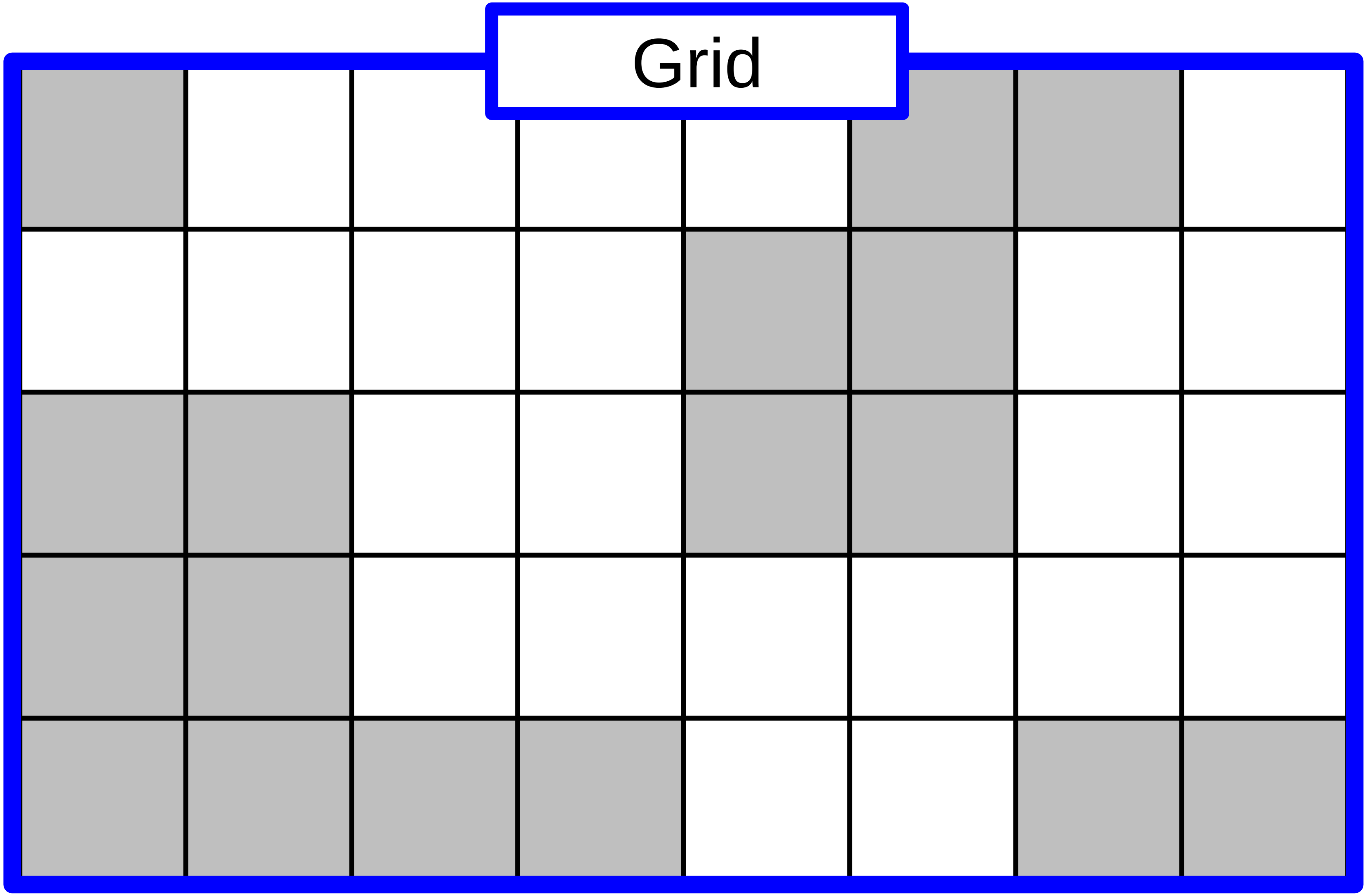
Any-Angle Path Planning

Problem Definition



Any-Angle Path Planning

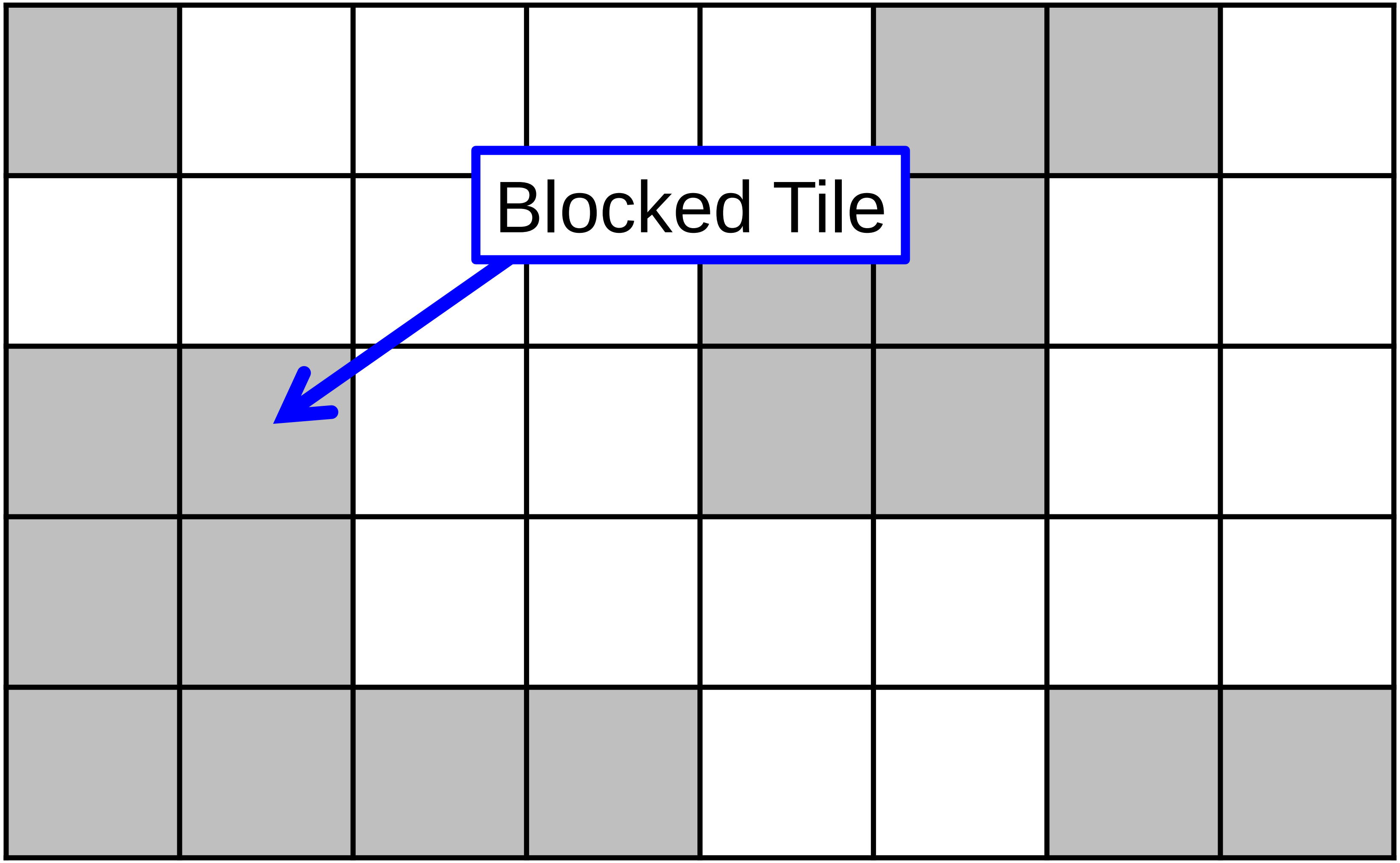
Problem Definition



Grid

Any-Angle Path Planning

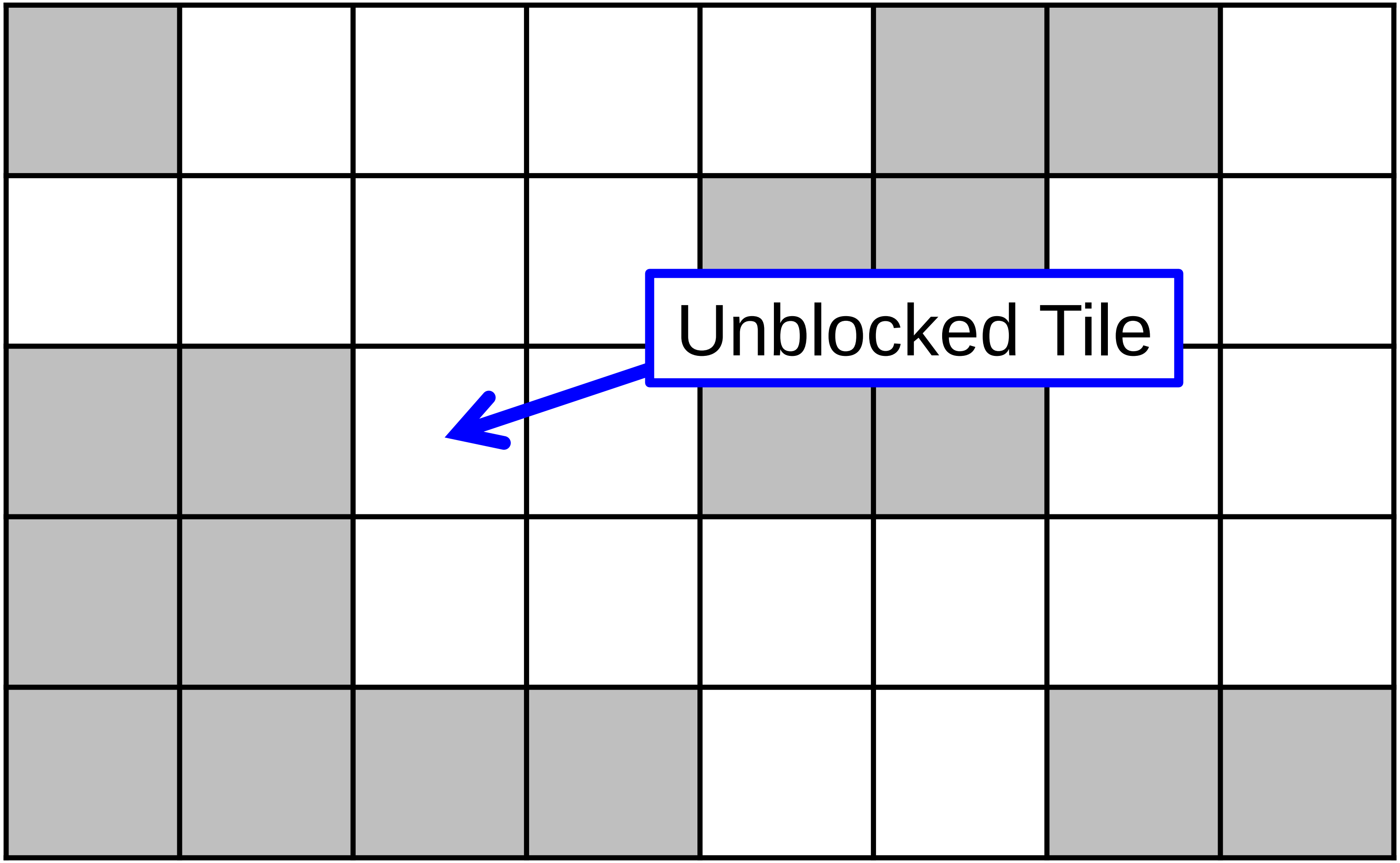
Problem Definition



Blocked Tile

Any-Angle Path Planning

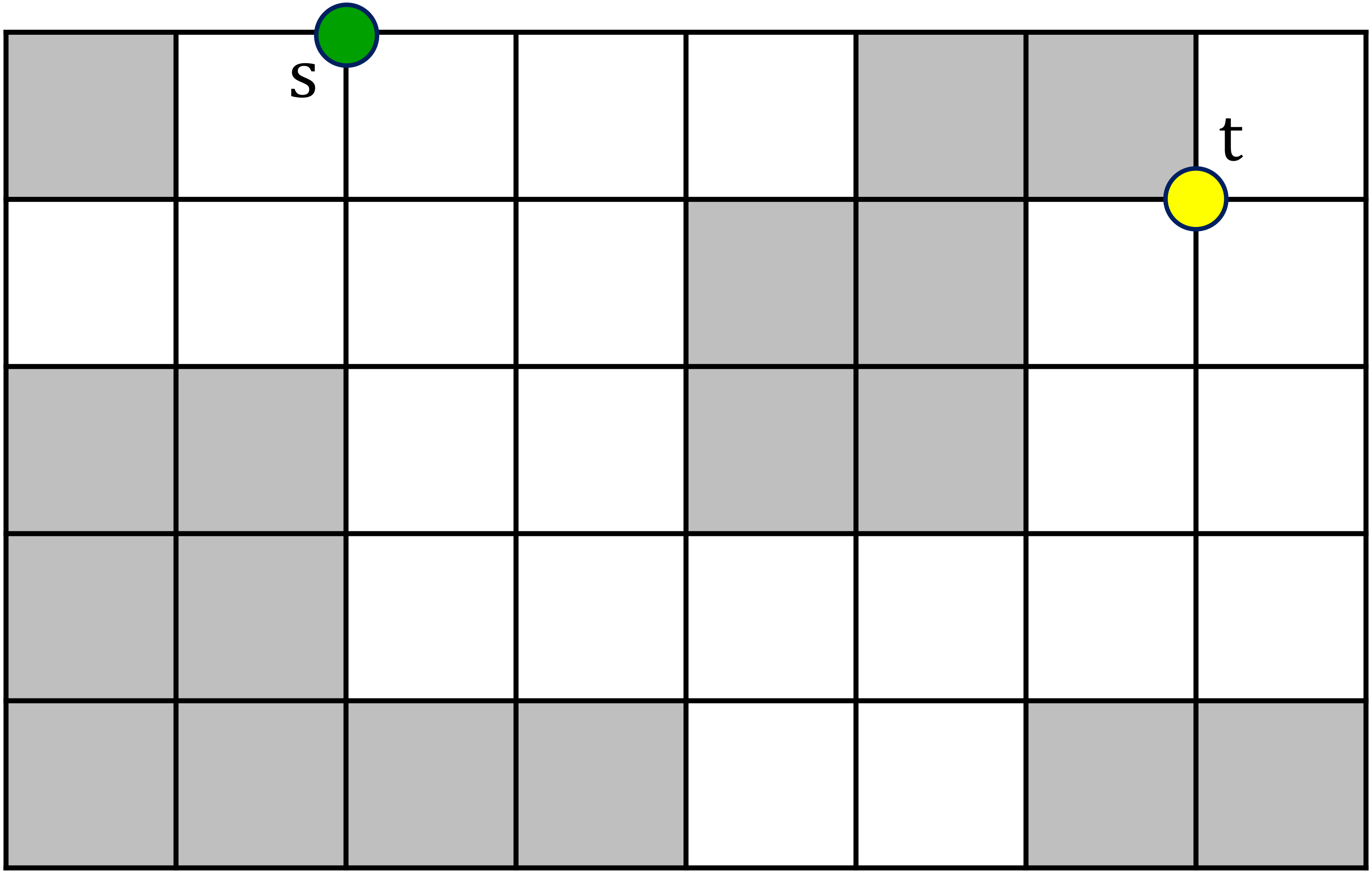
Problem Definition



Unblocked Tile

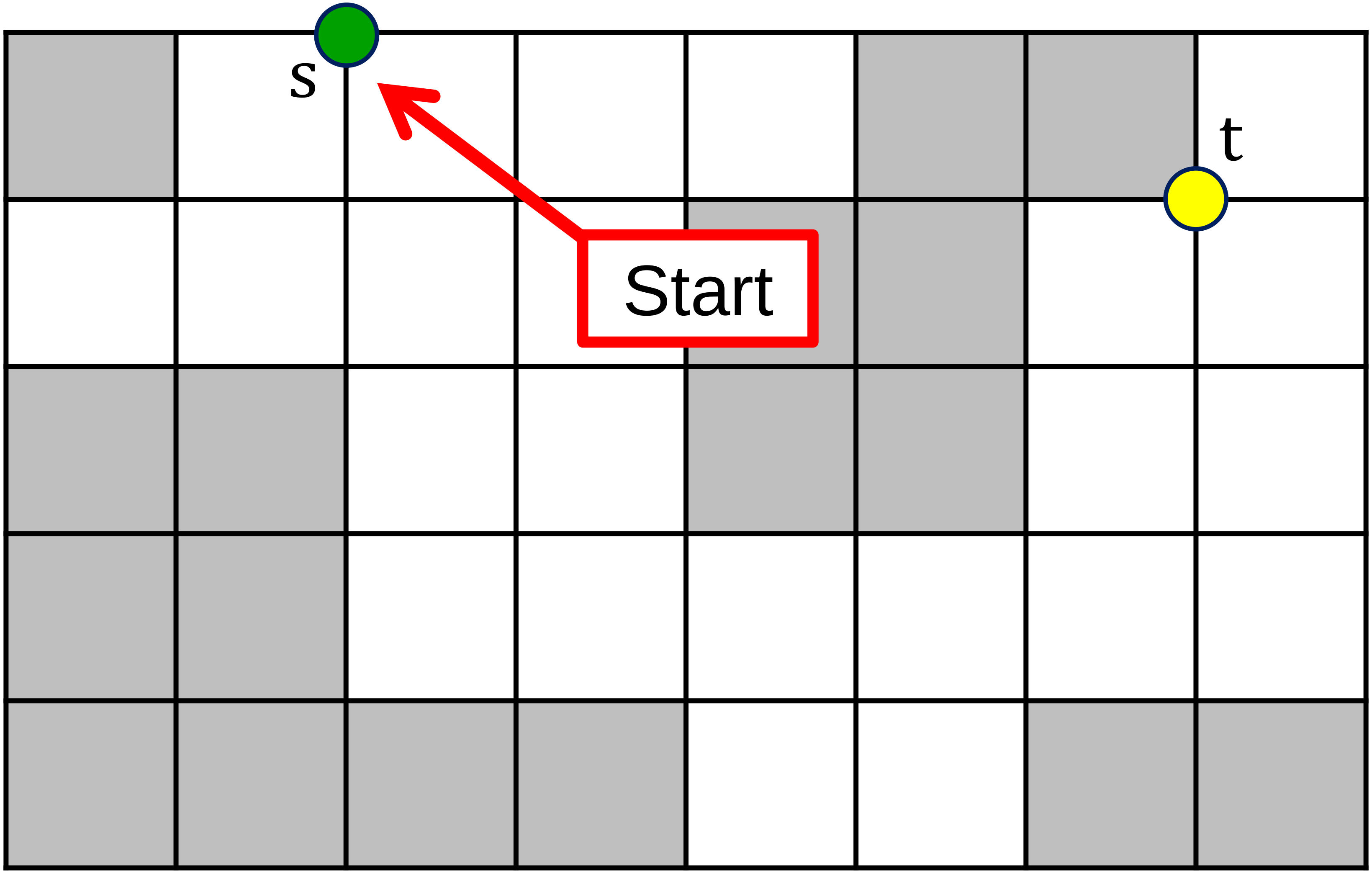
Any-Angle Path Planning

Problem Definition



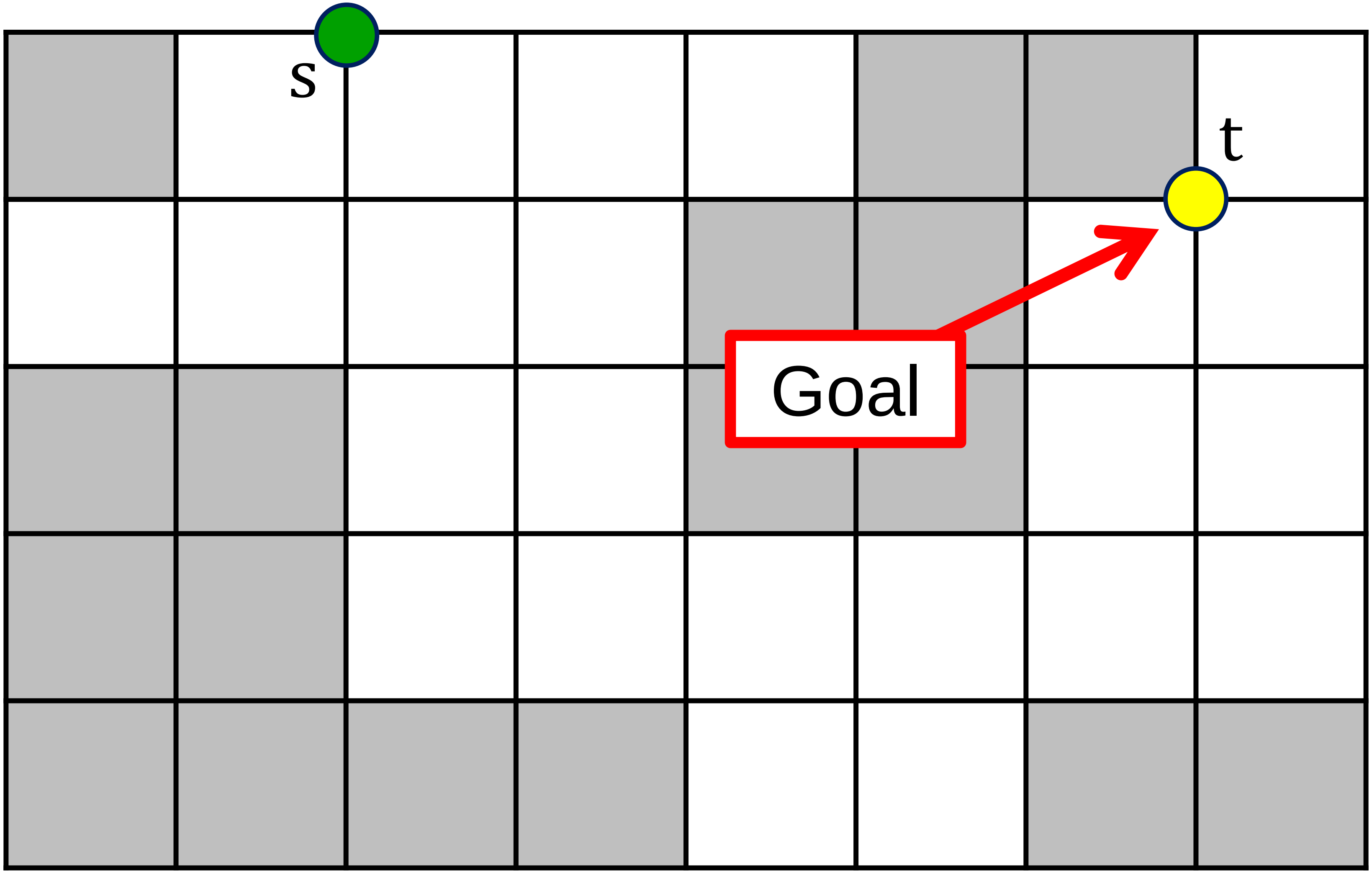
Any-Angle Path Planning

Problem Definition

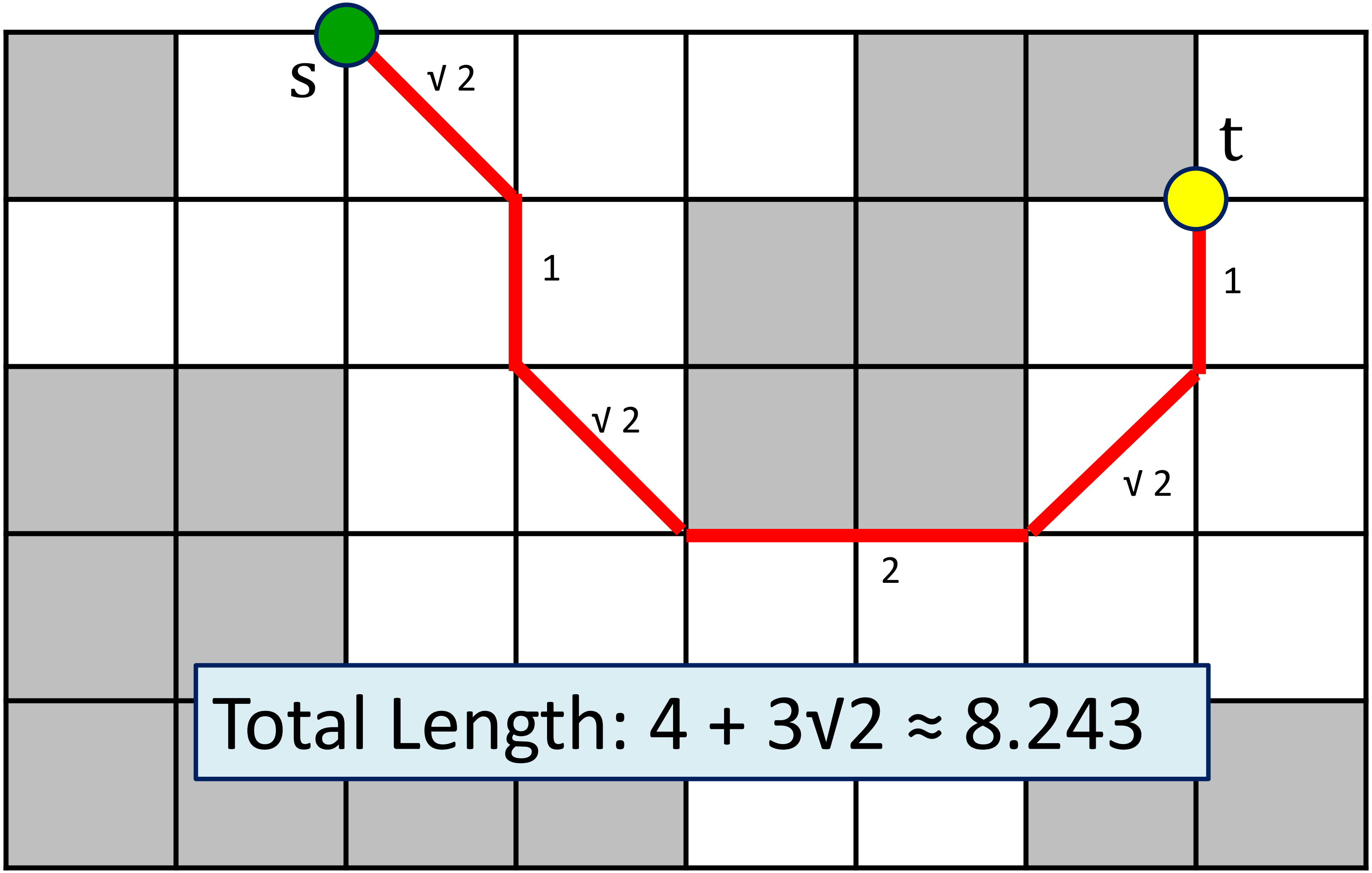


Any-Angle Path Planning

Problem Definition

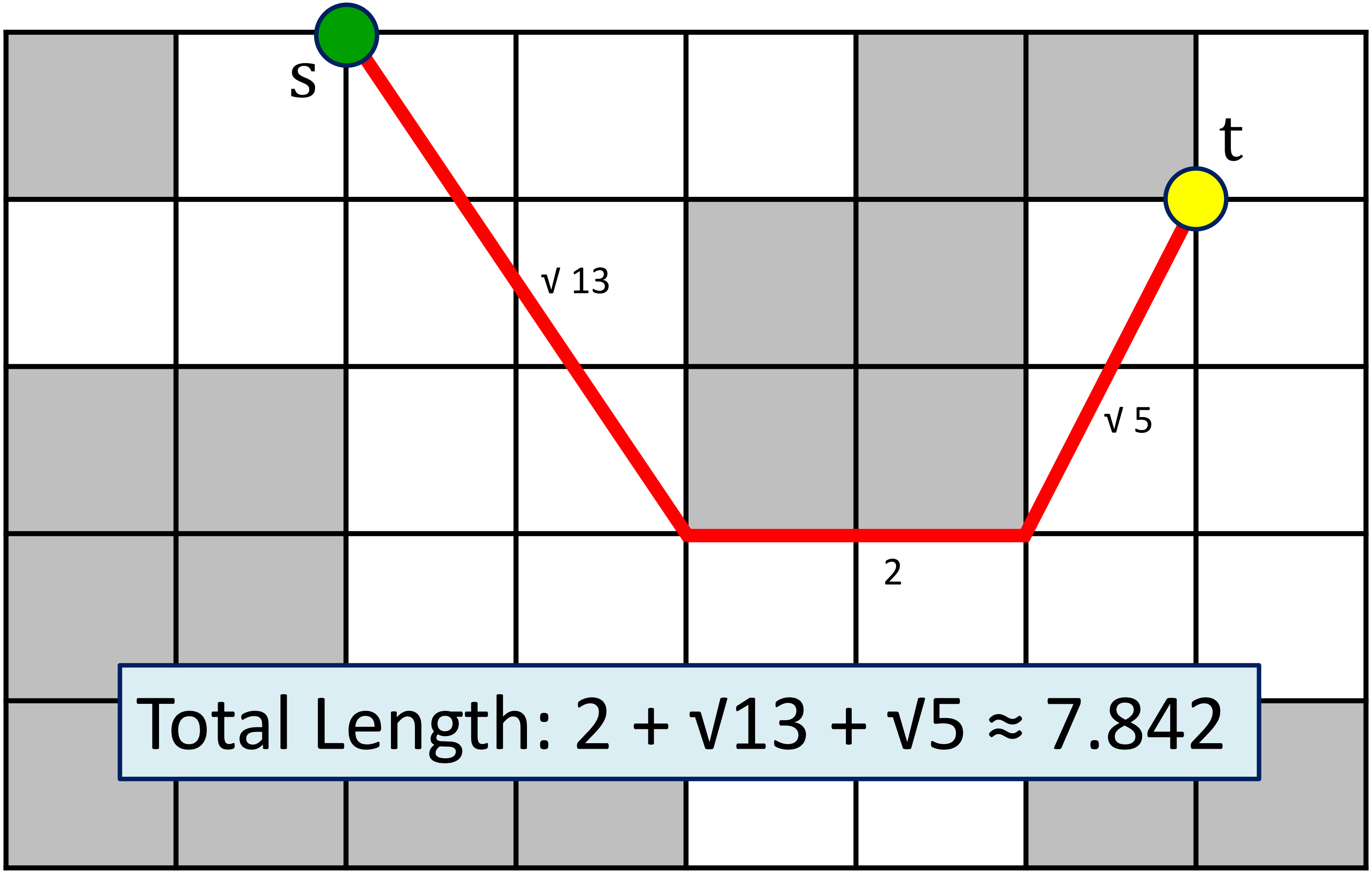


8-Directional Path

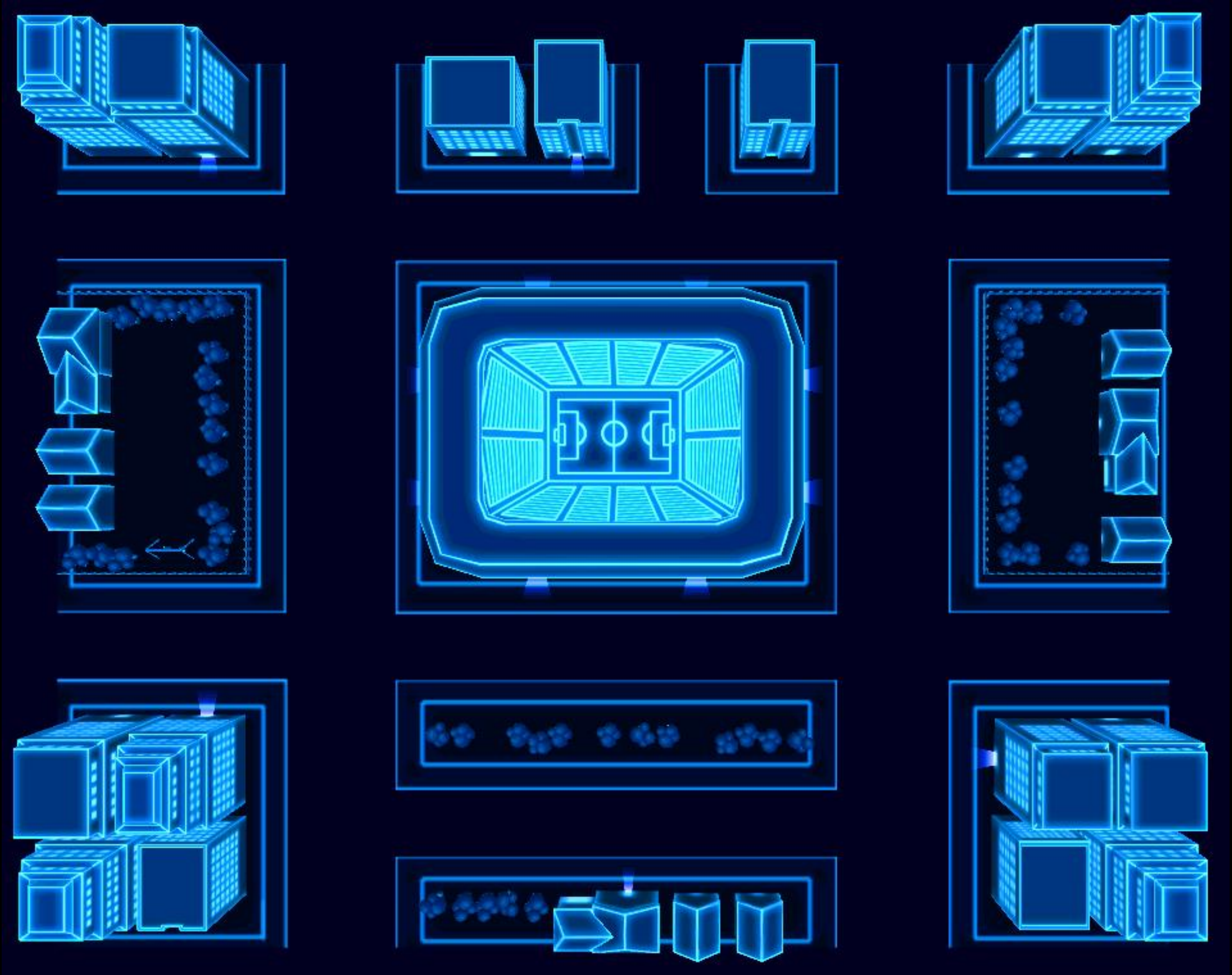


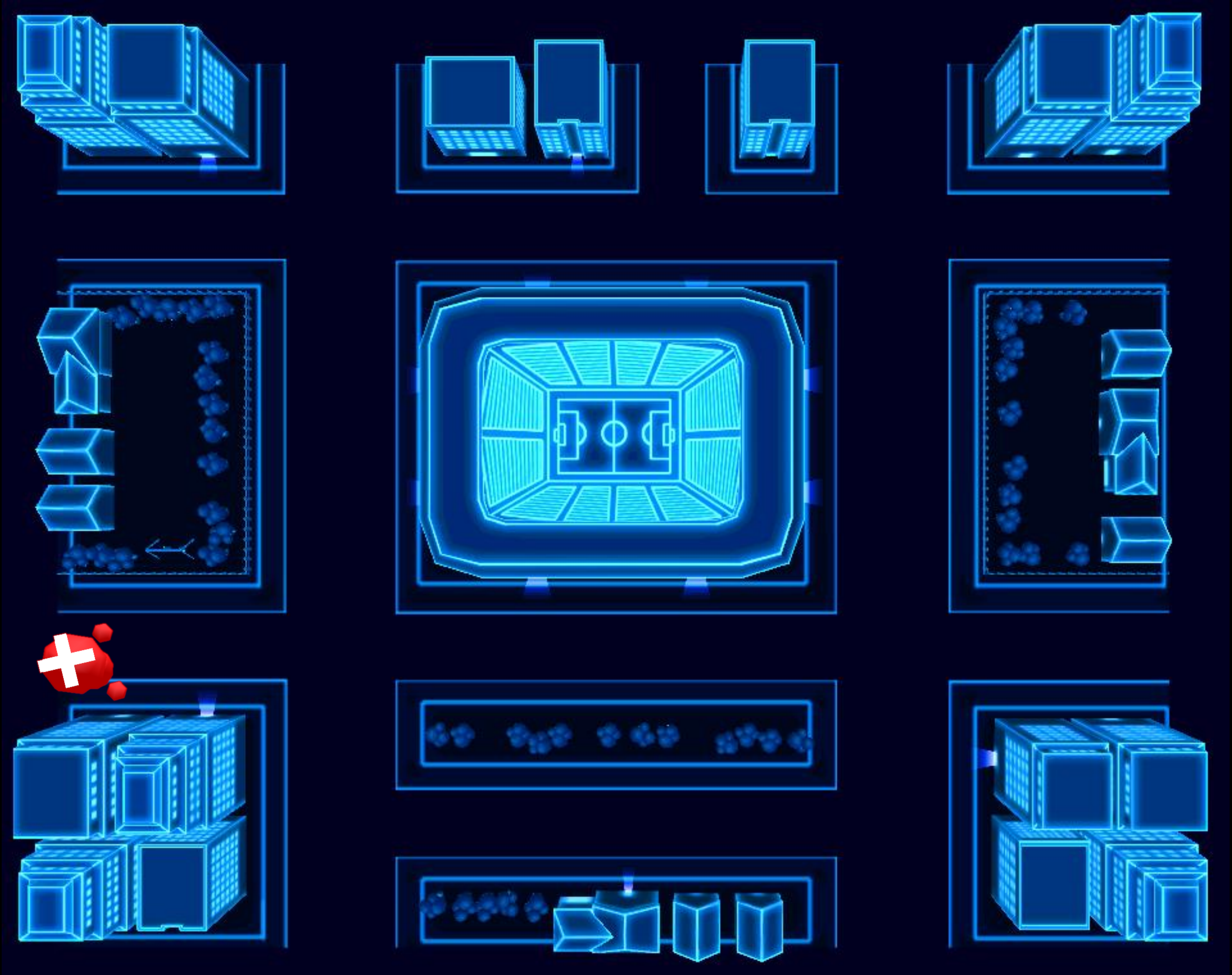
Total Length: 4 + 3√2 ≈ 8.243

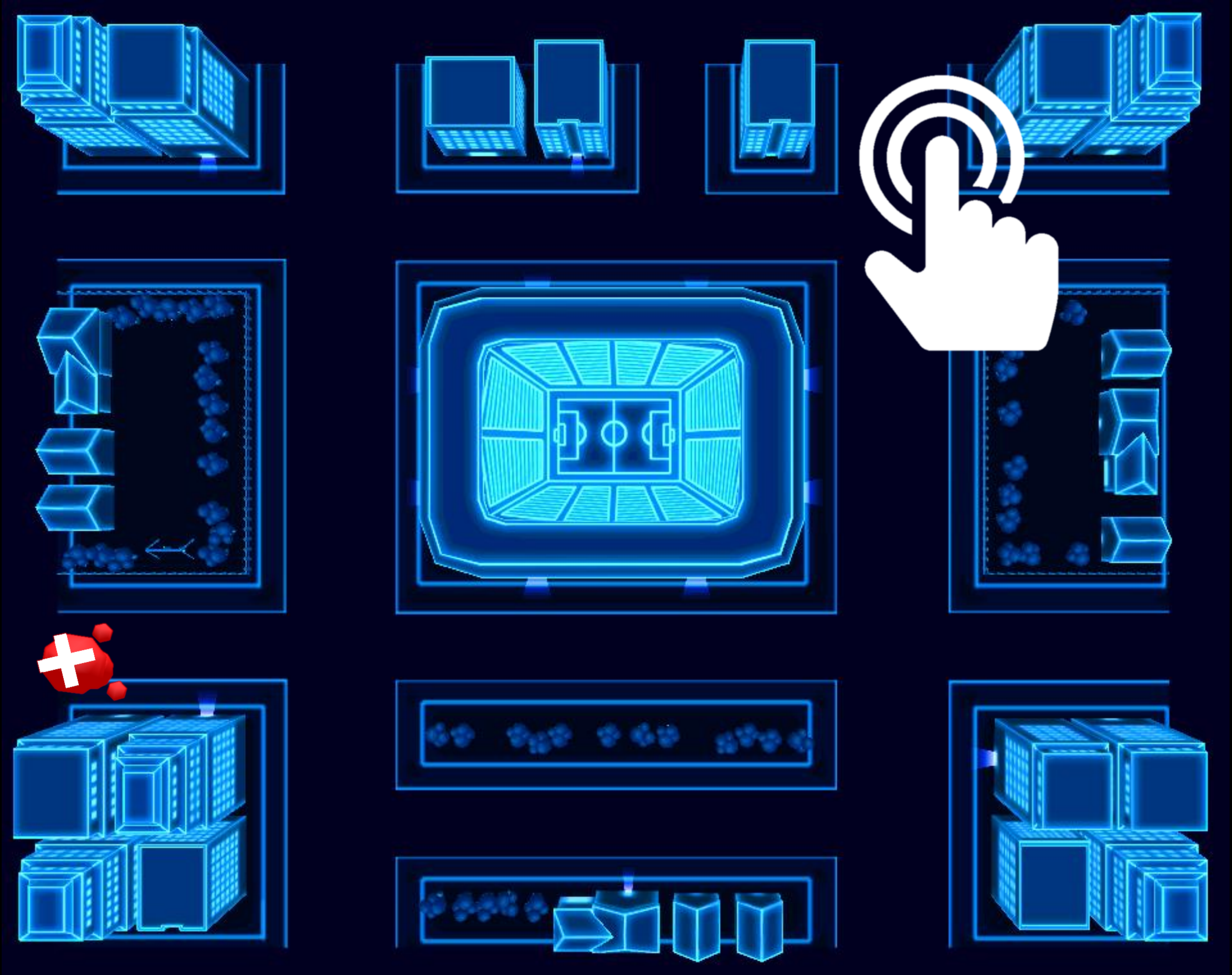
Any-Angle Path

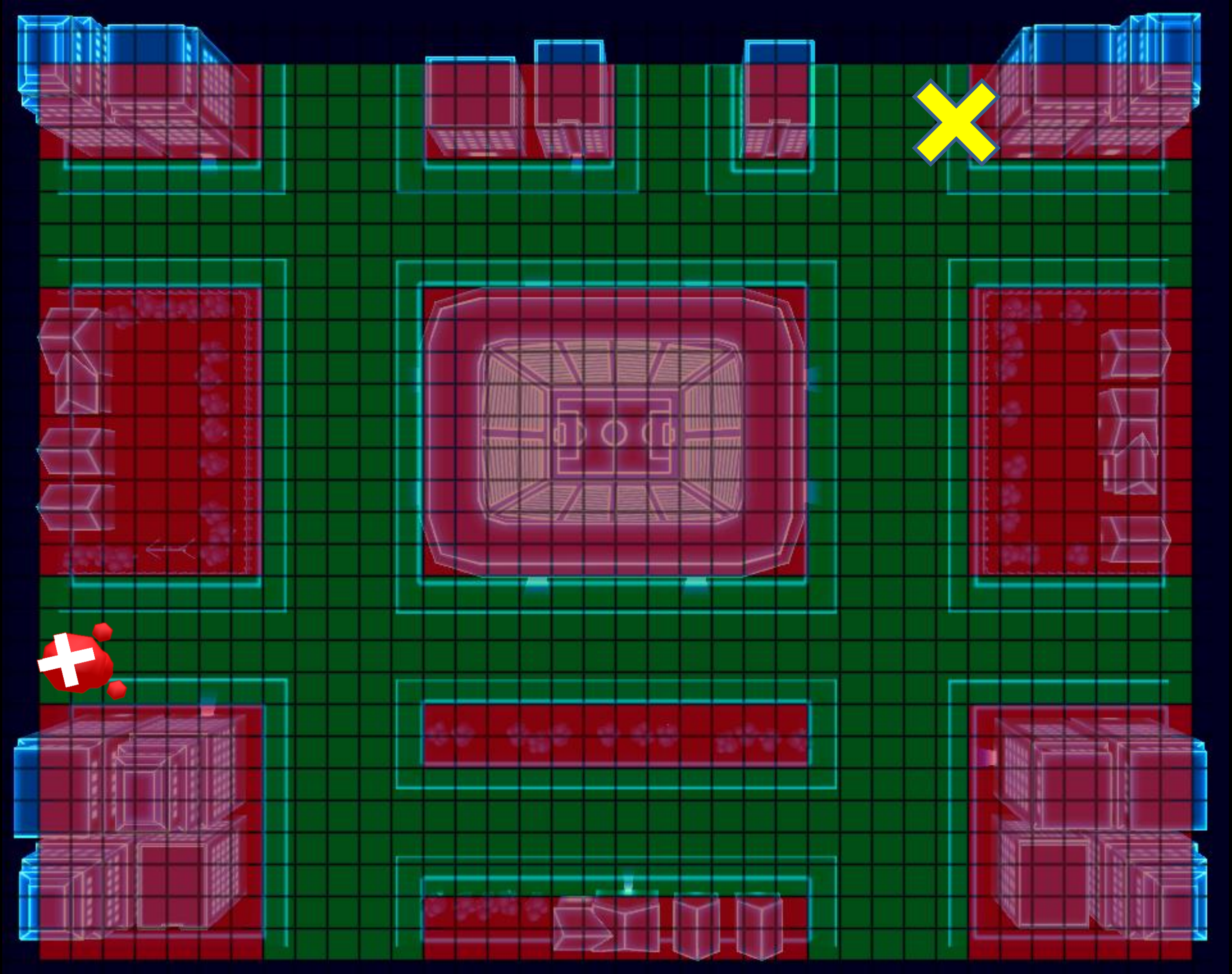


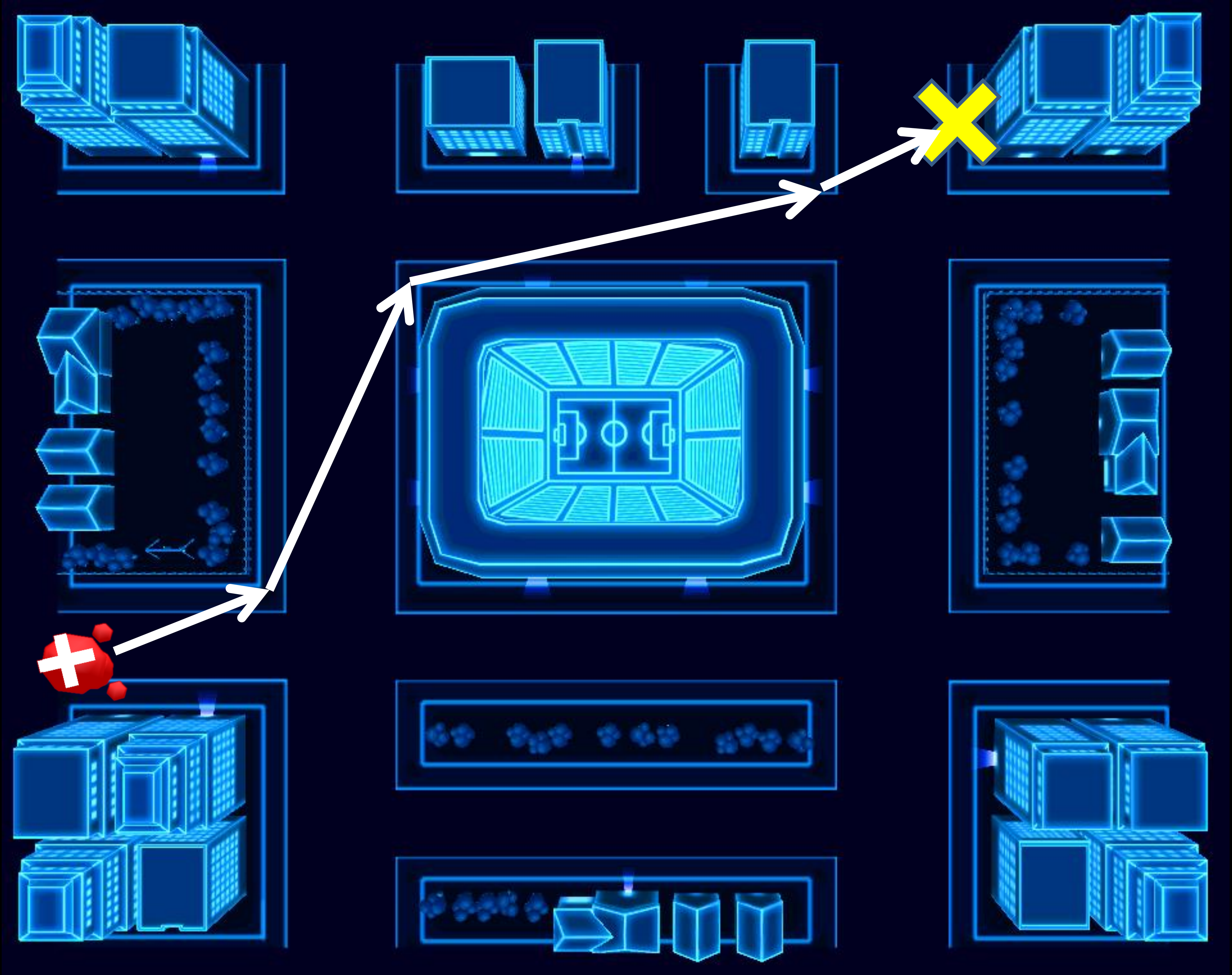
Total Length: 2 + √13 + √5 ≈ 7.842

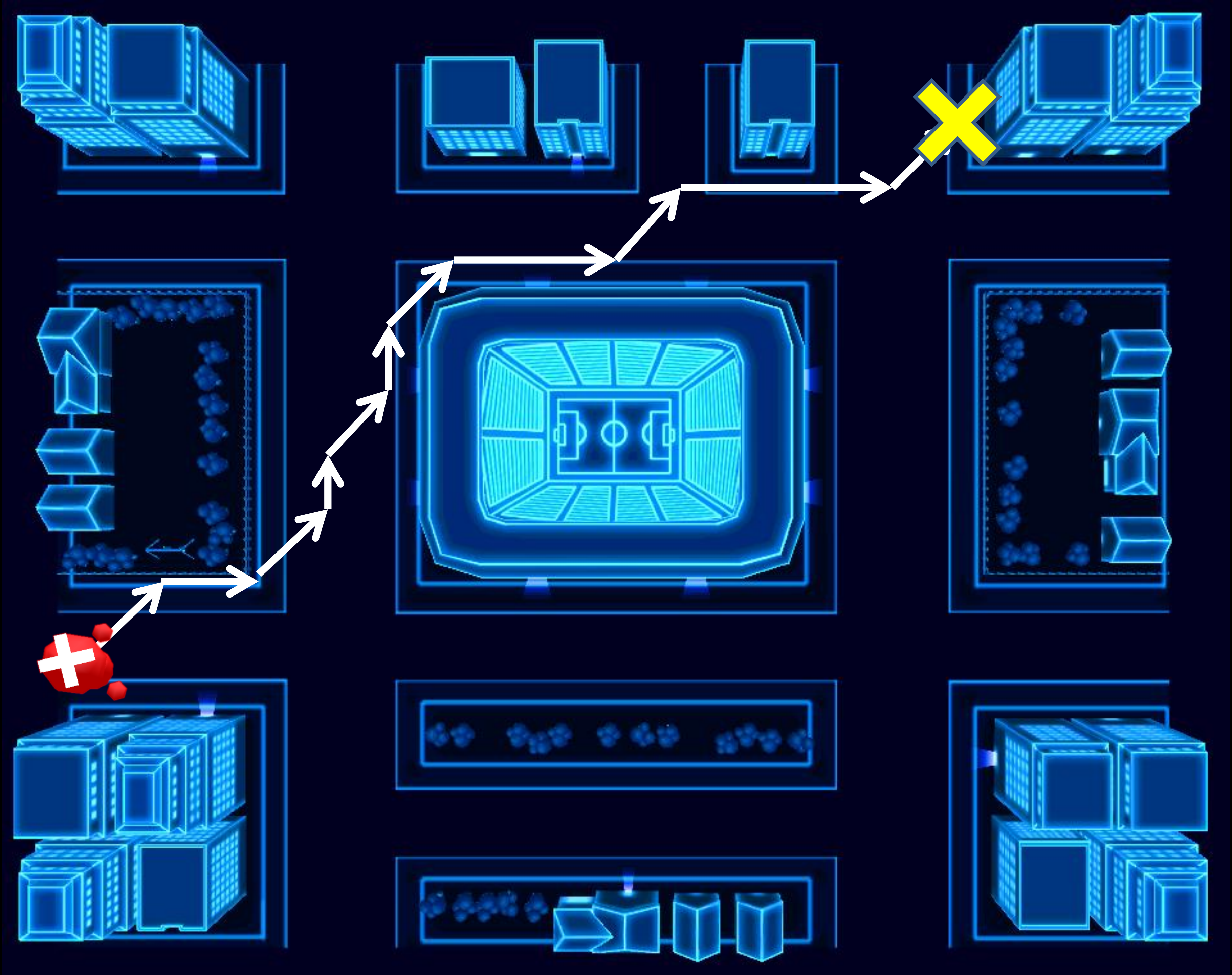




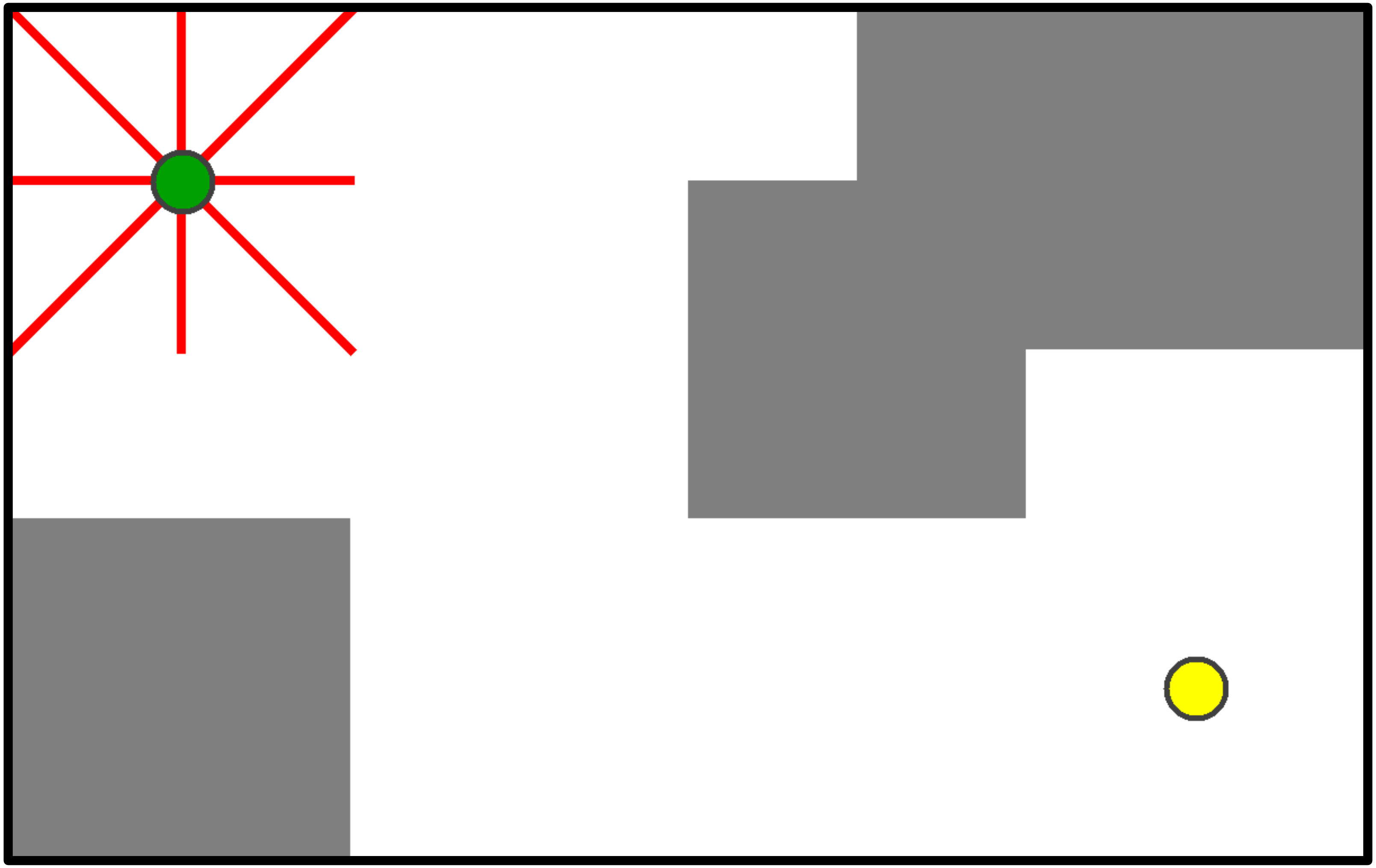








A* on 8-directional Grids



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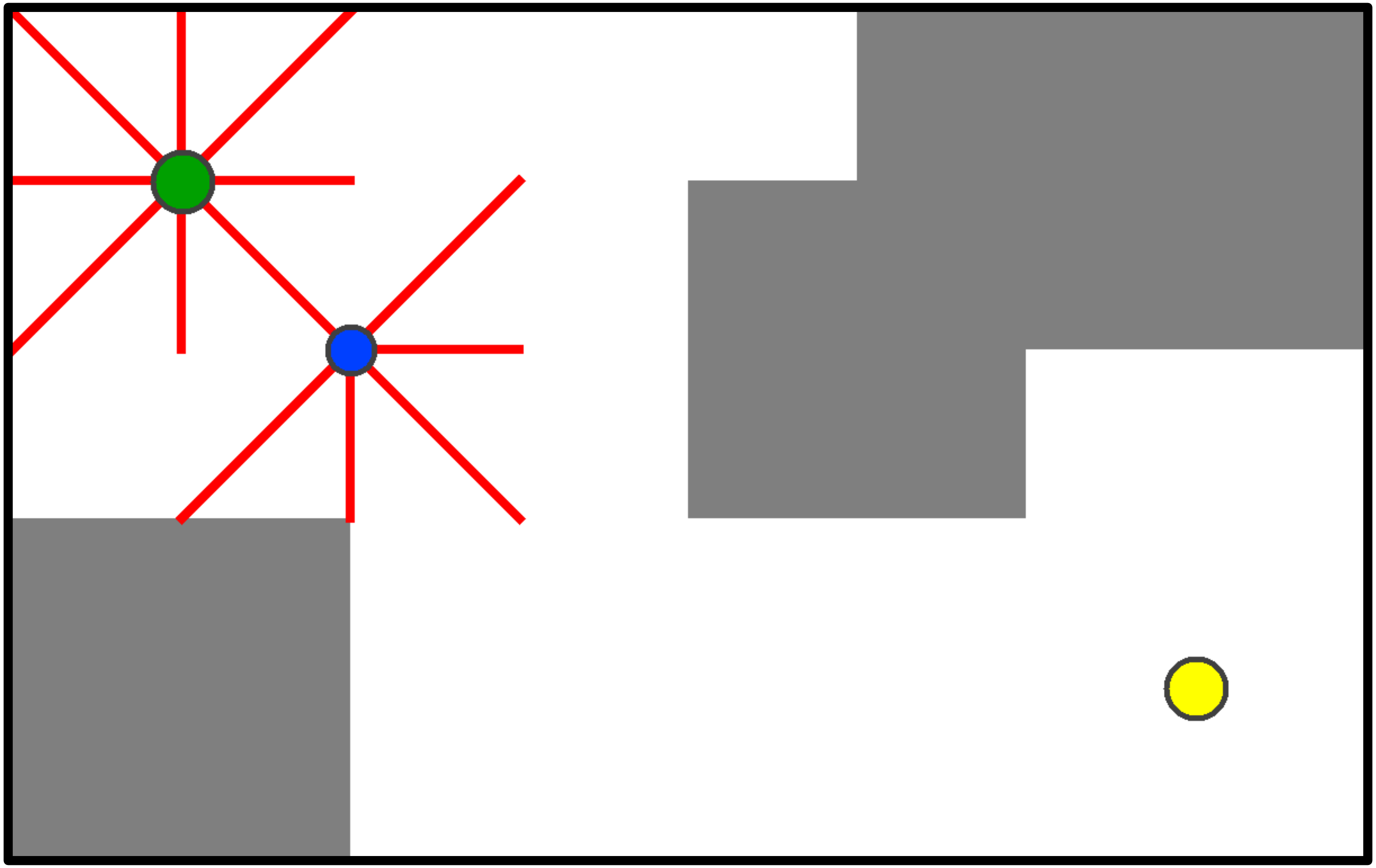

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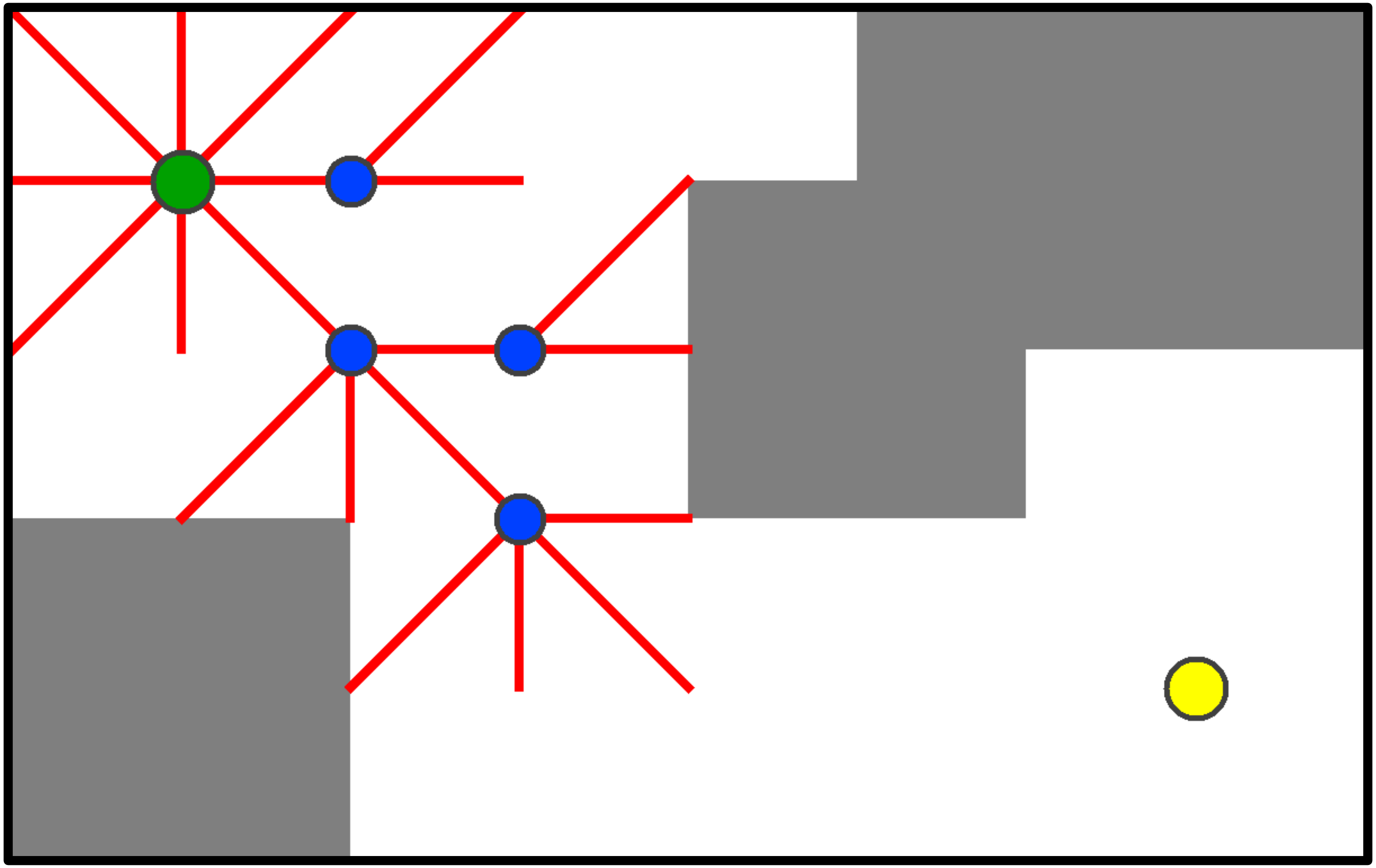

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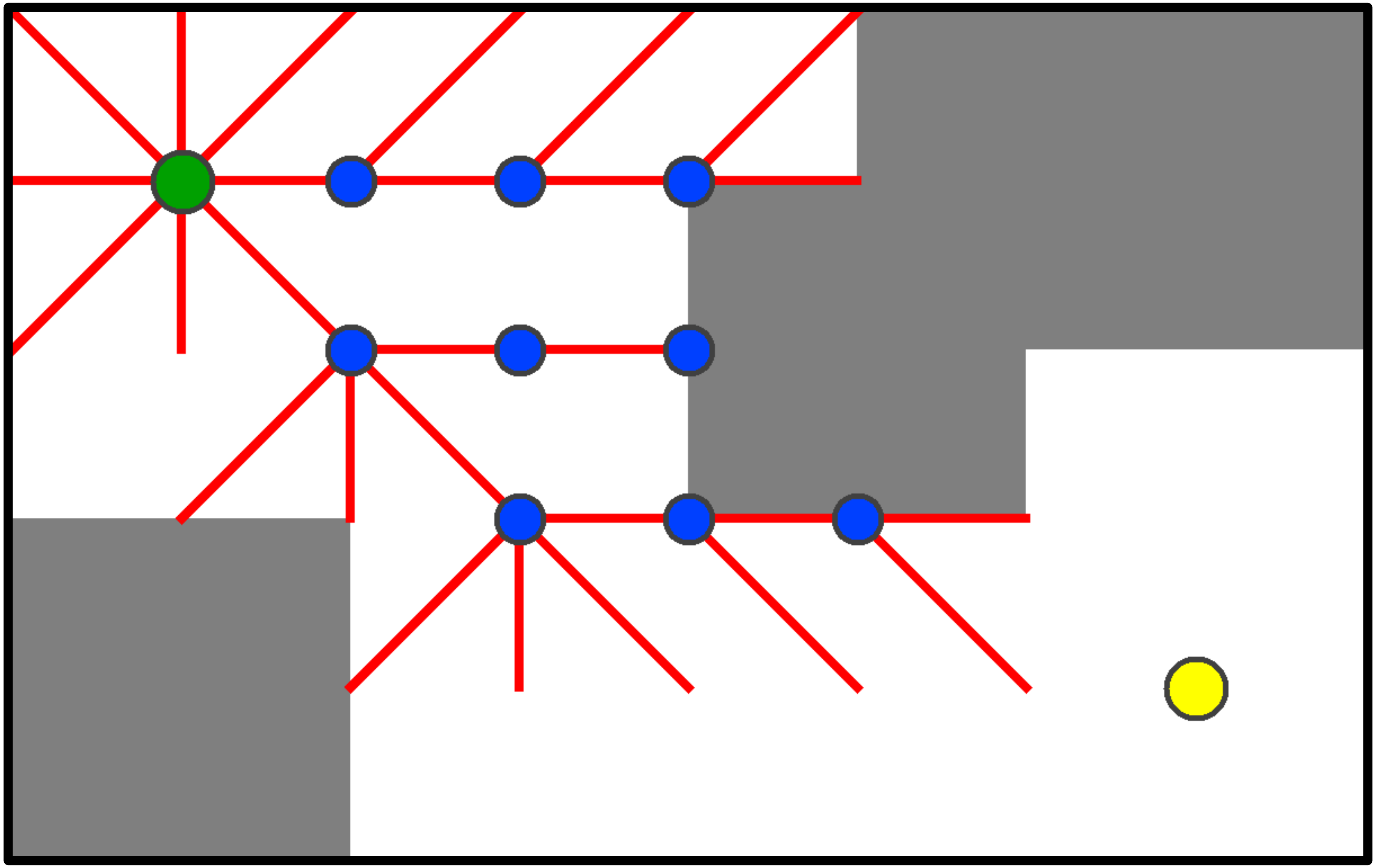

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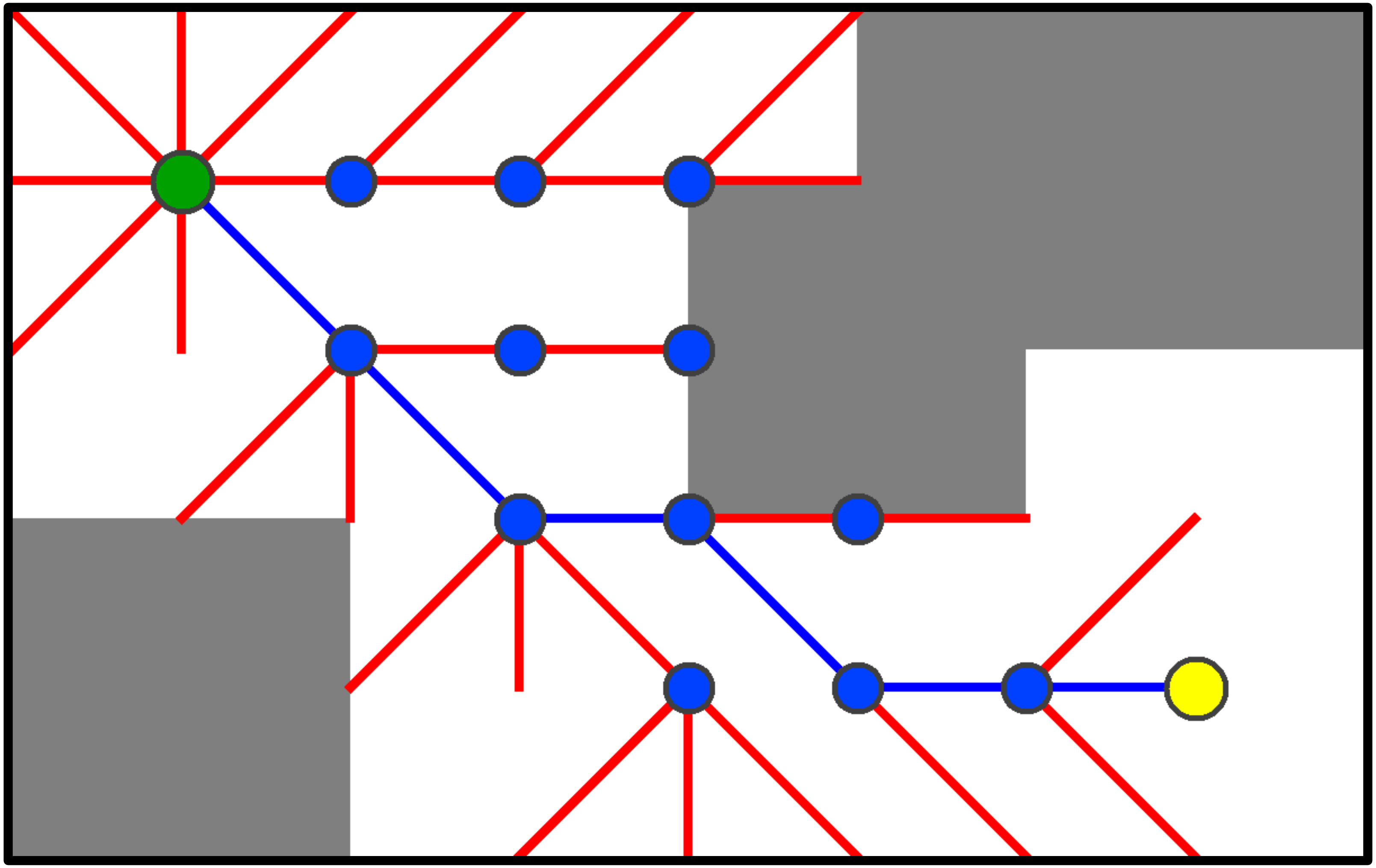

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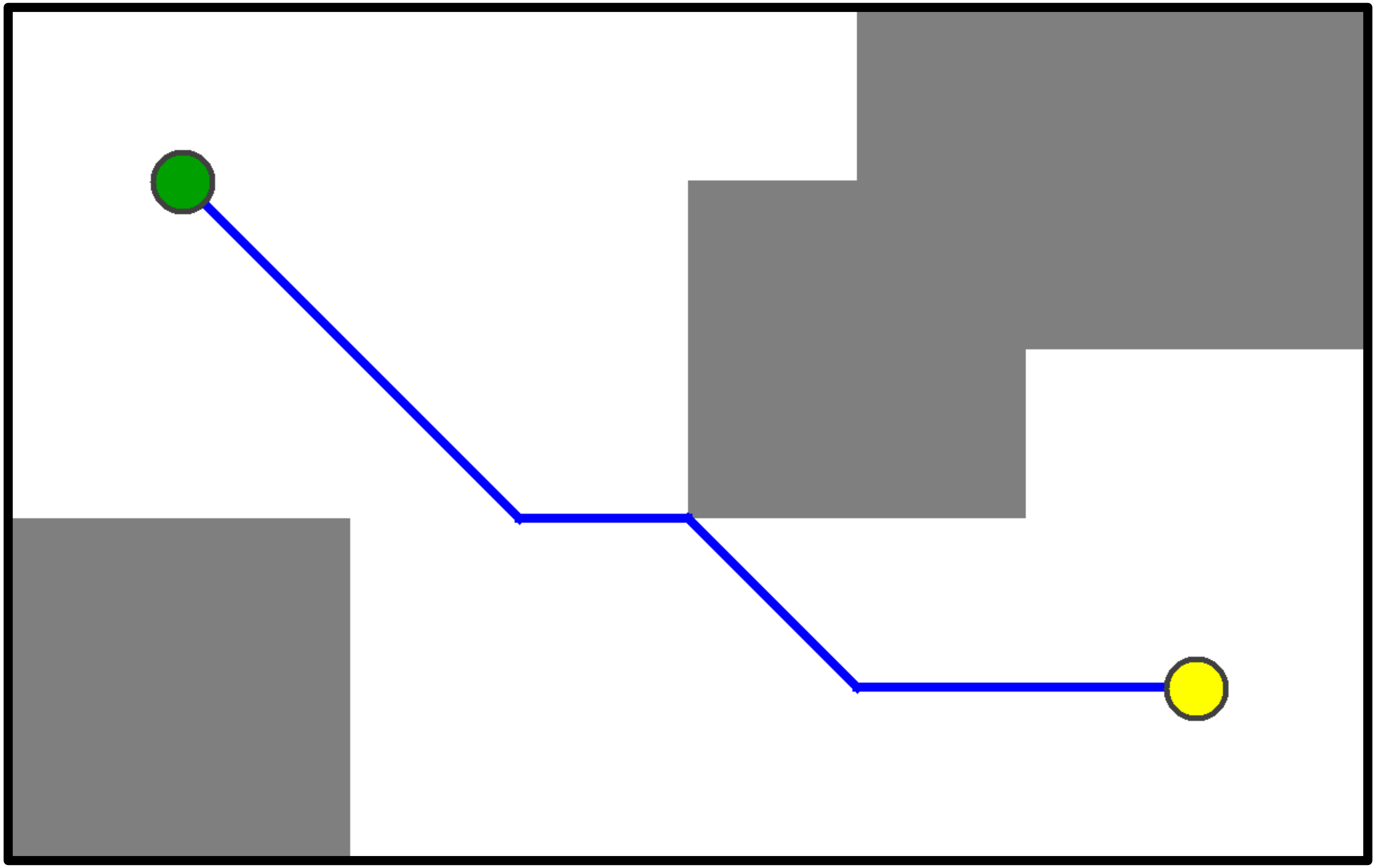

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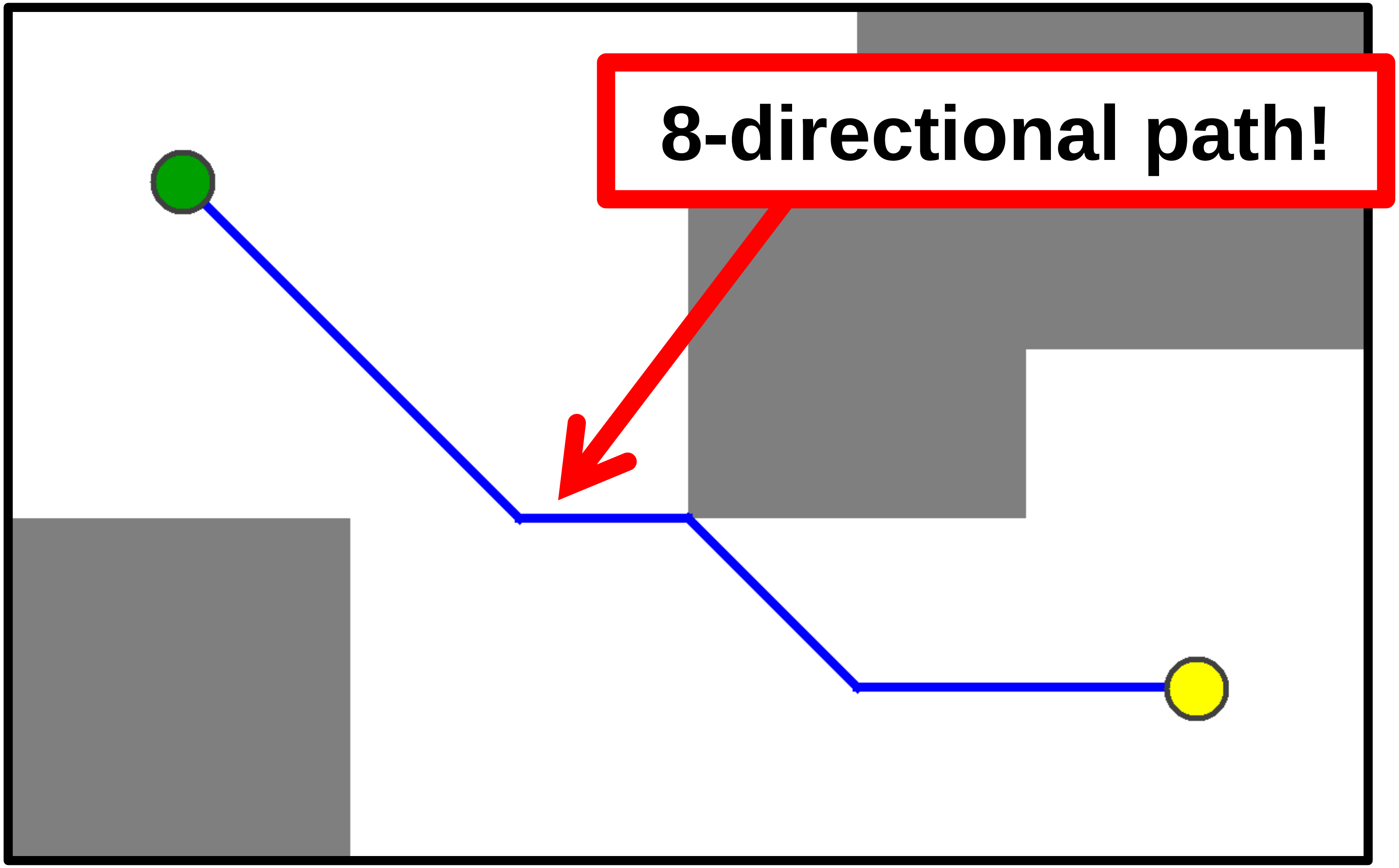
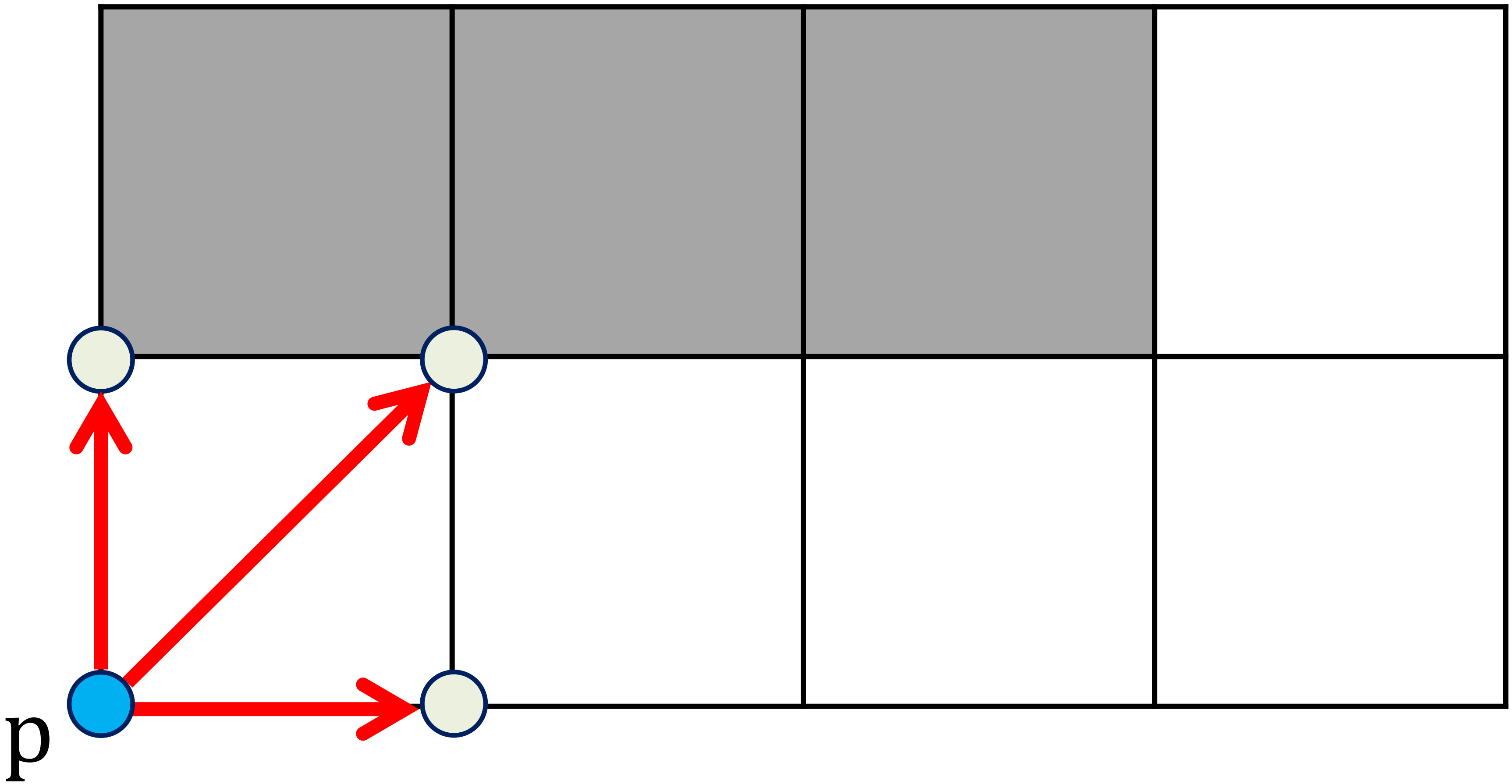


8-directional path!

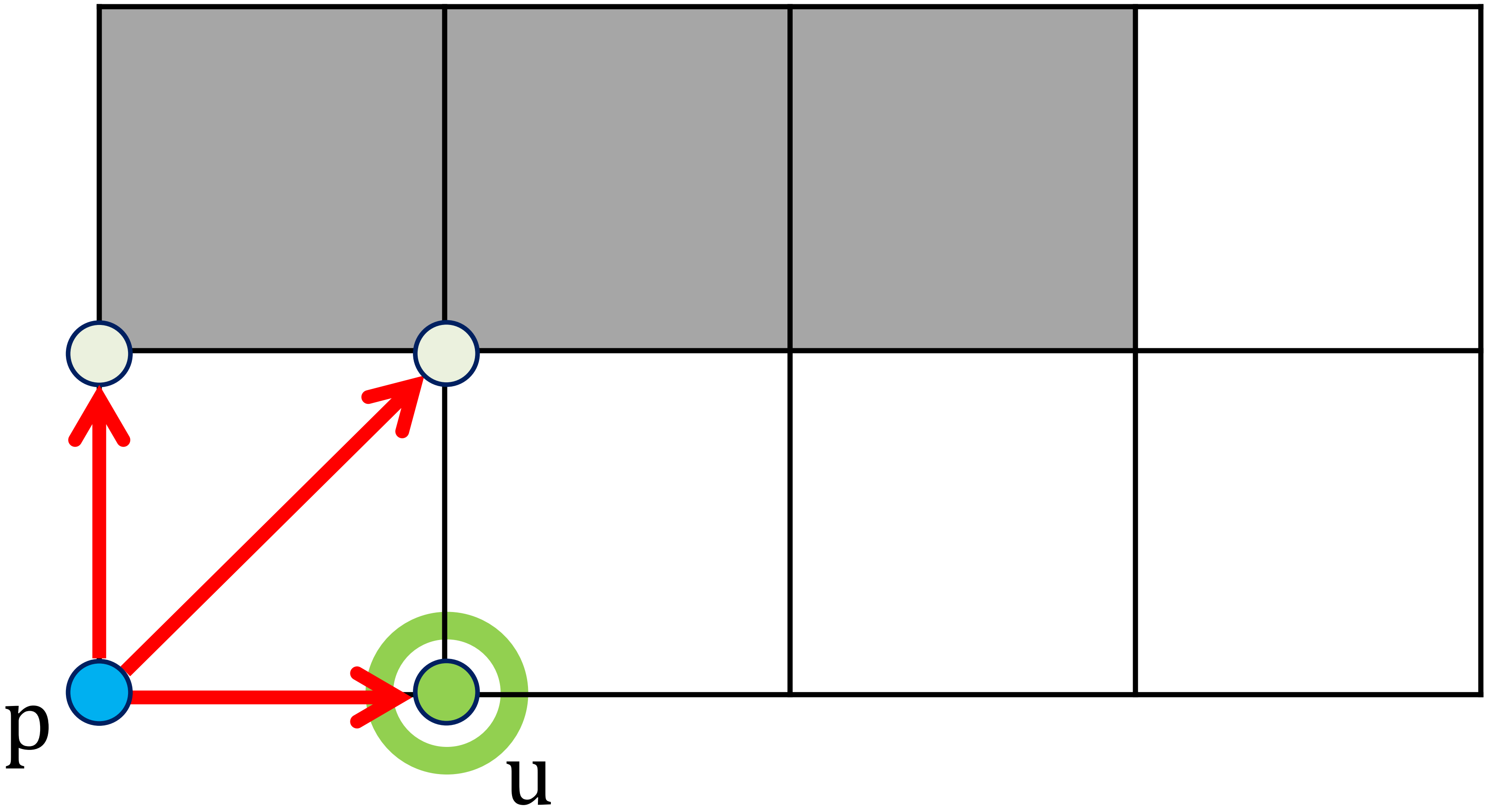
Basic Theta*

(Daniel, Nash, Koenig, Felner, 2007)

Theta* Algorithm



Theta* Algorithm



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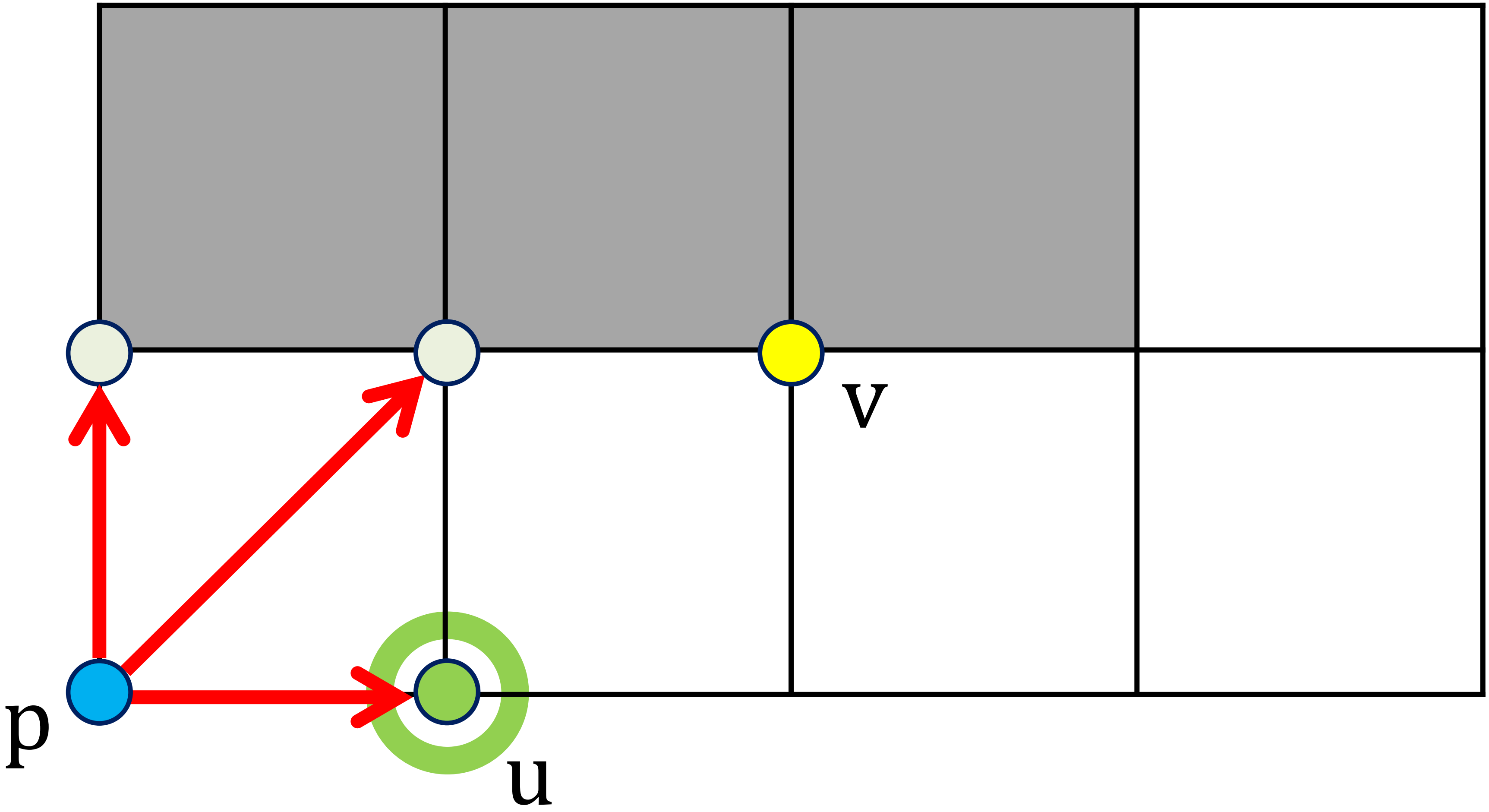

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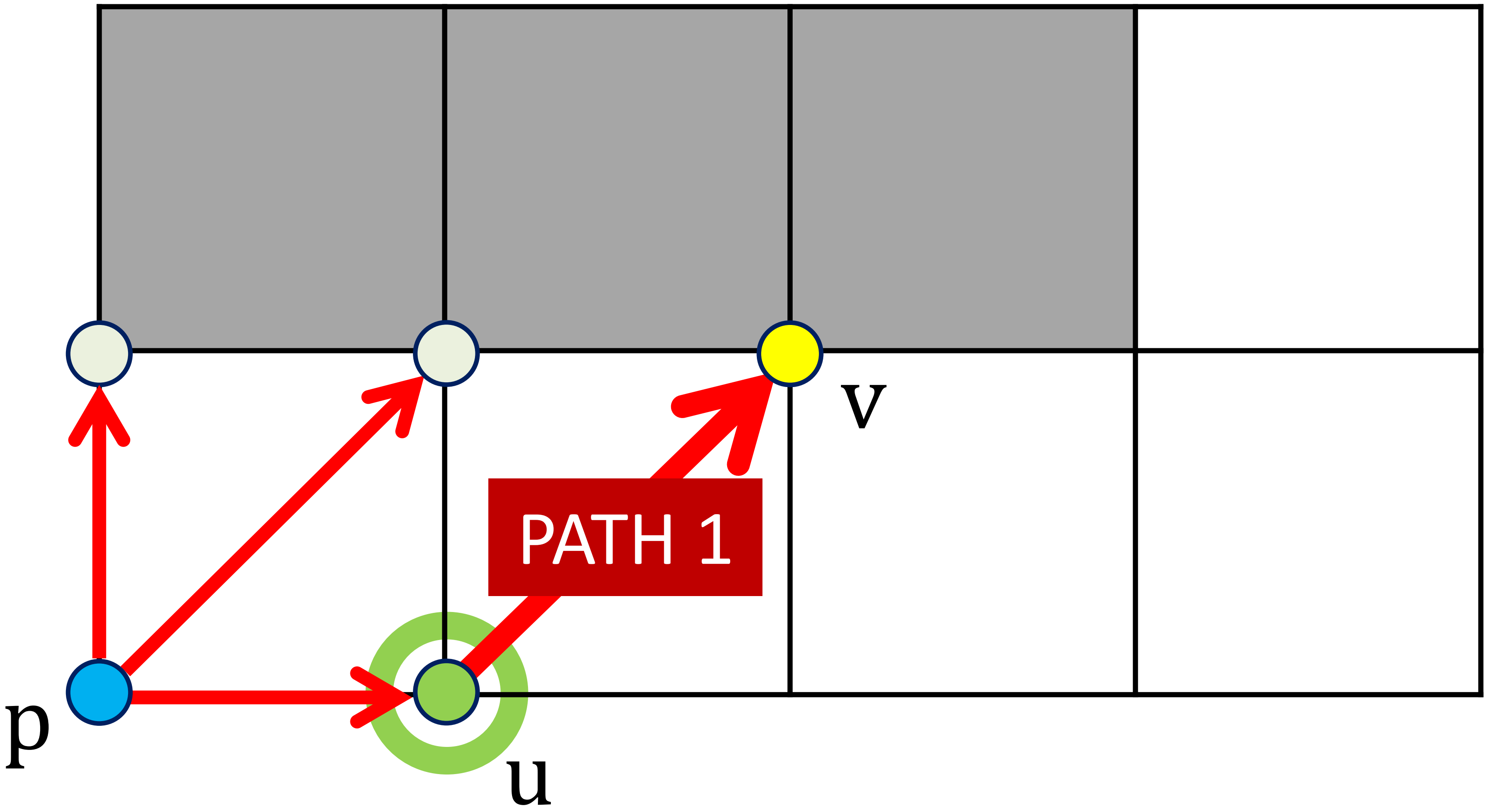

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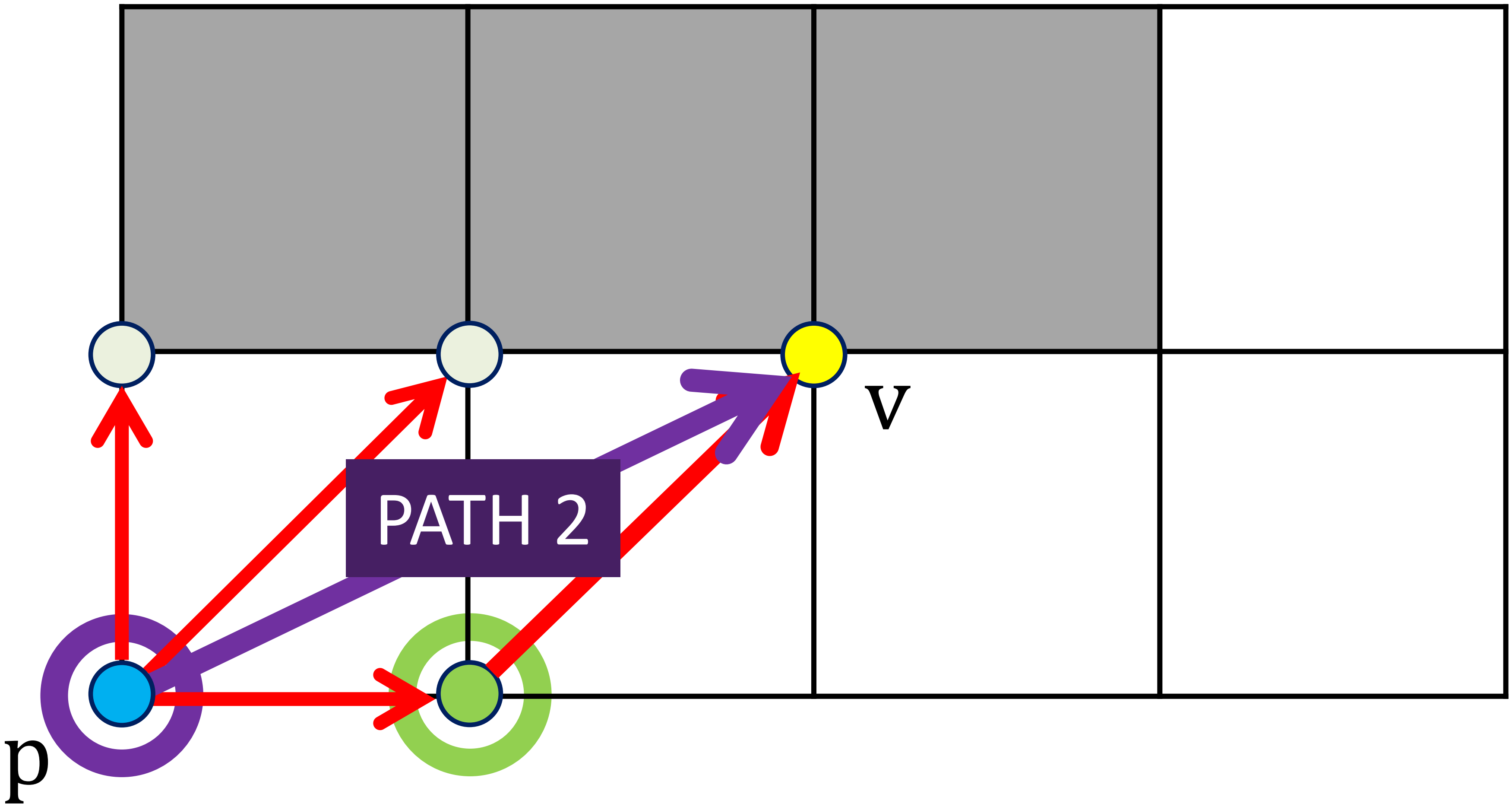

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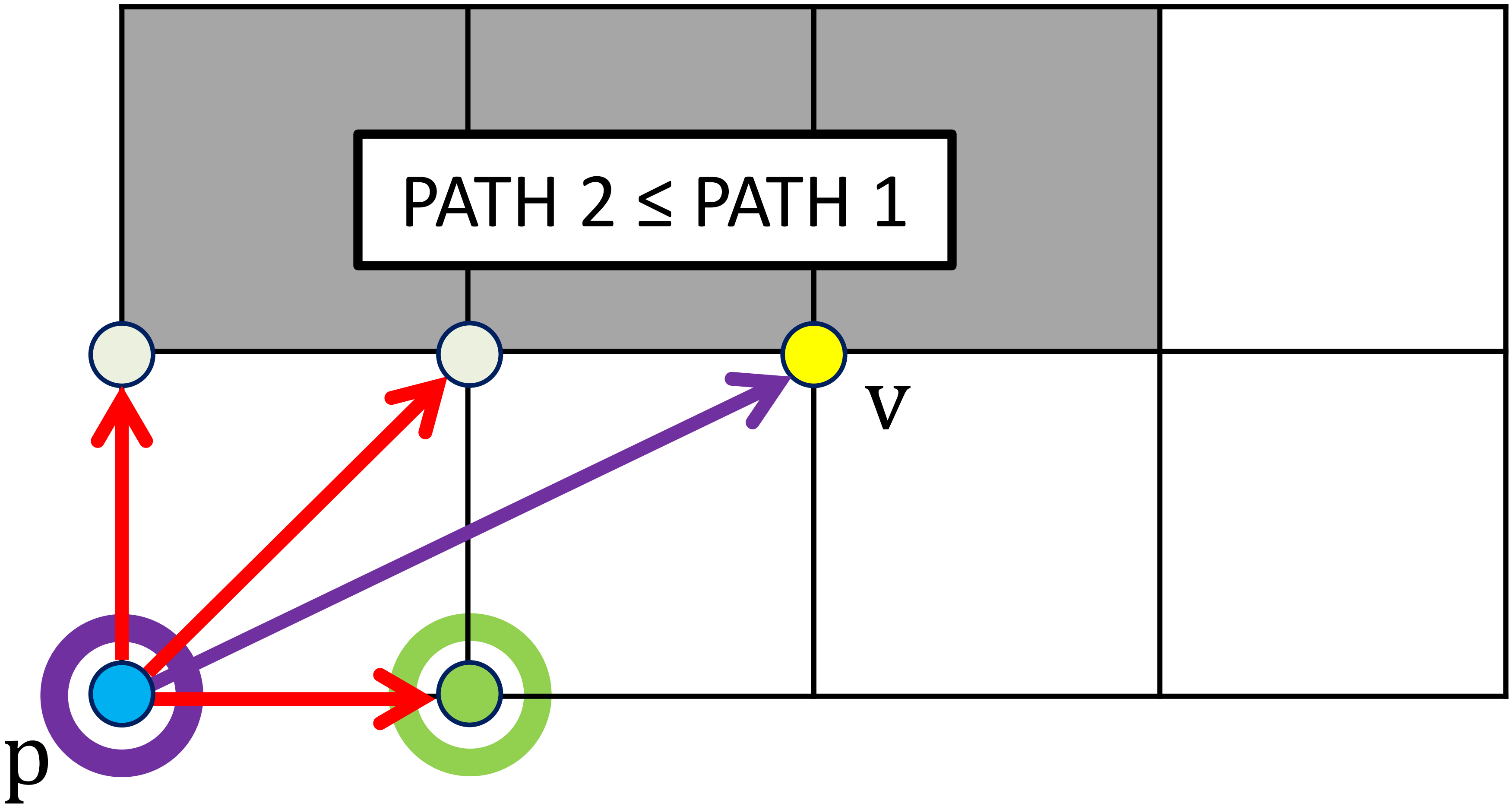

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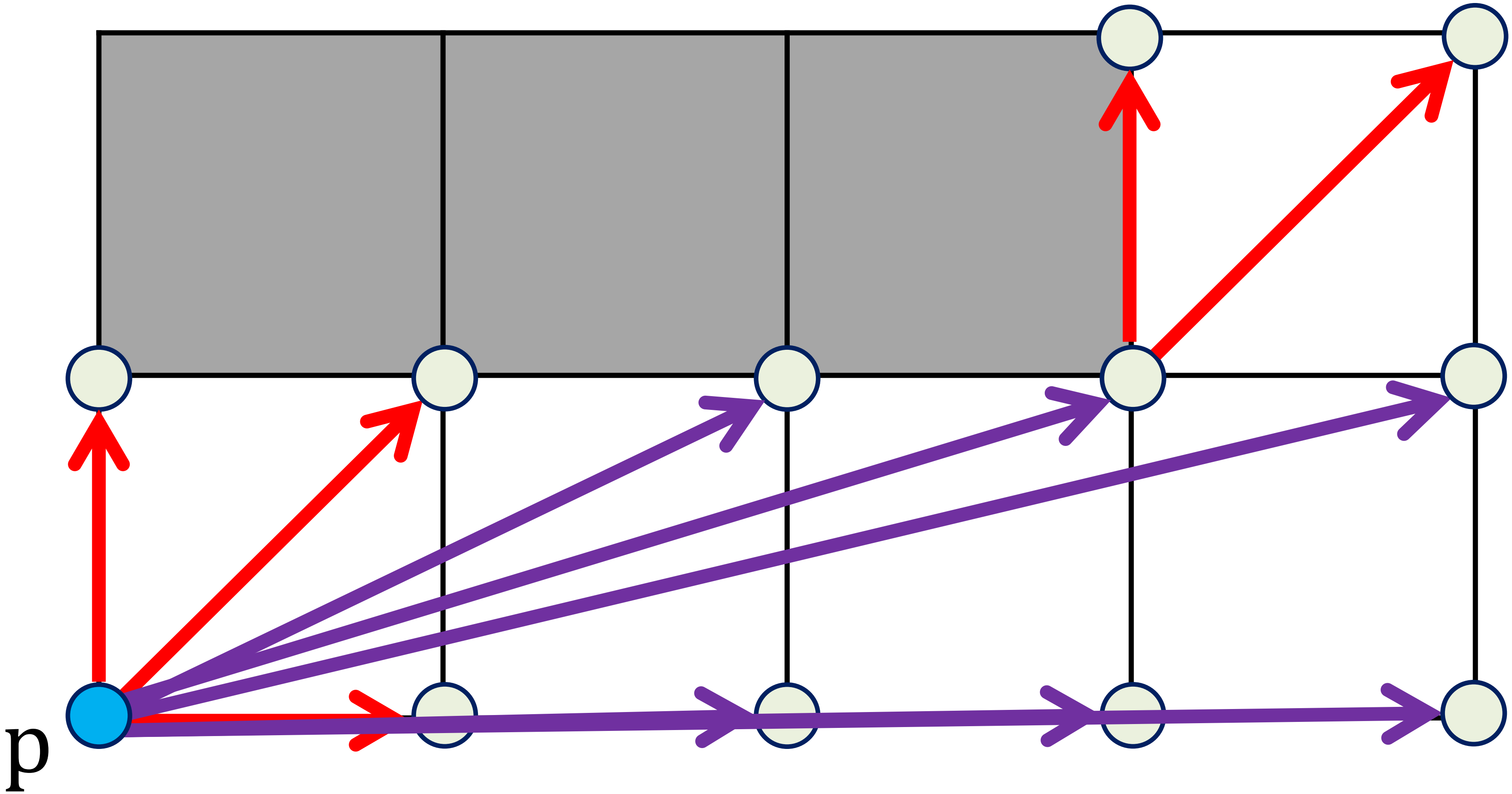
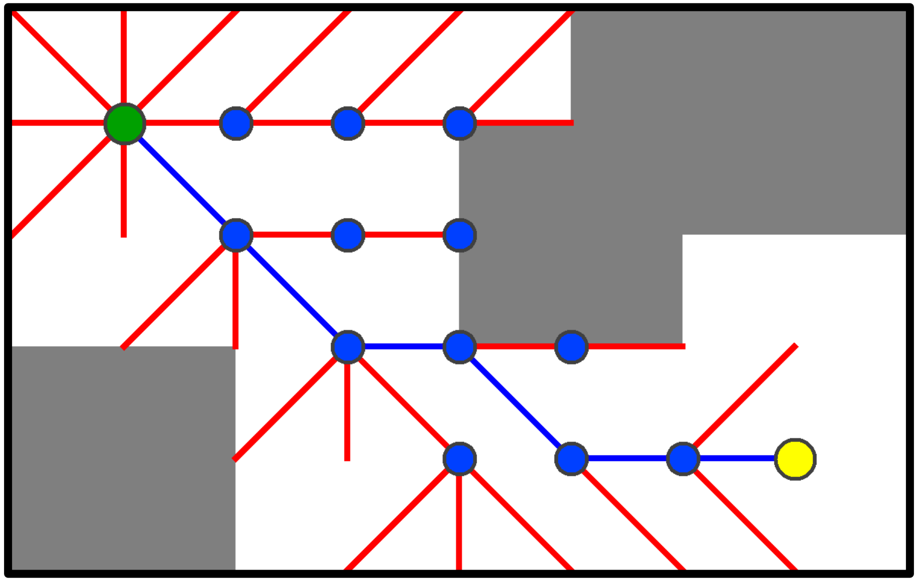
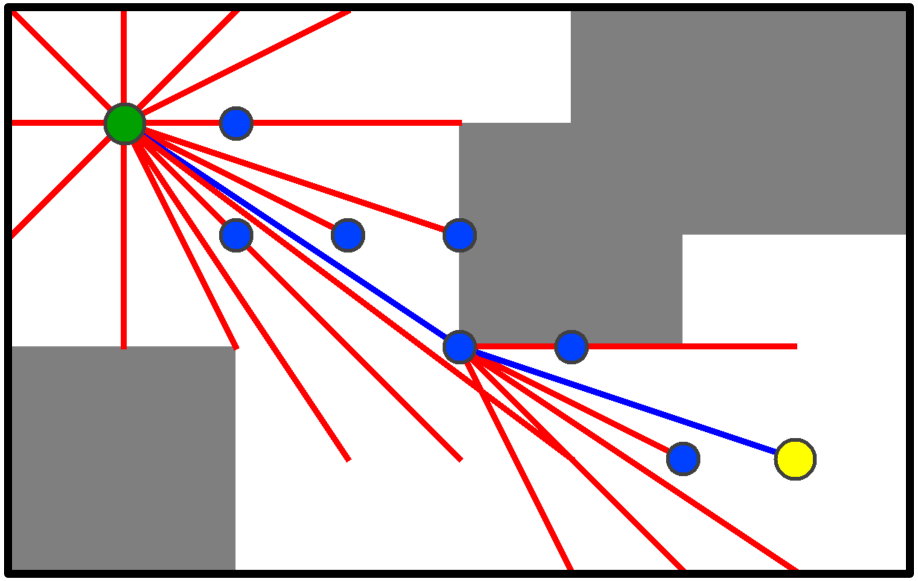


Basic Theta*

8-directional A*

Theta*





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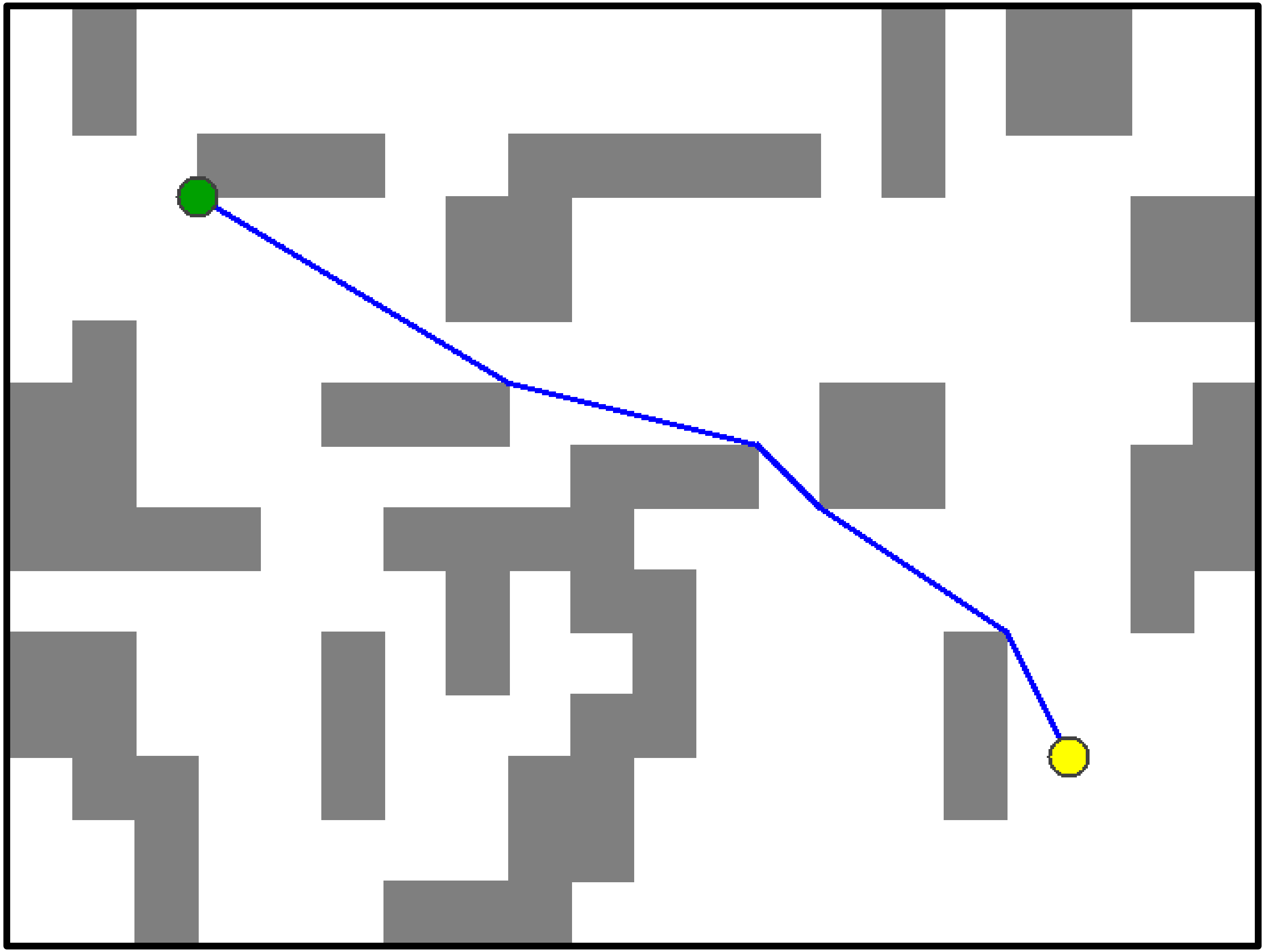

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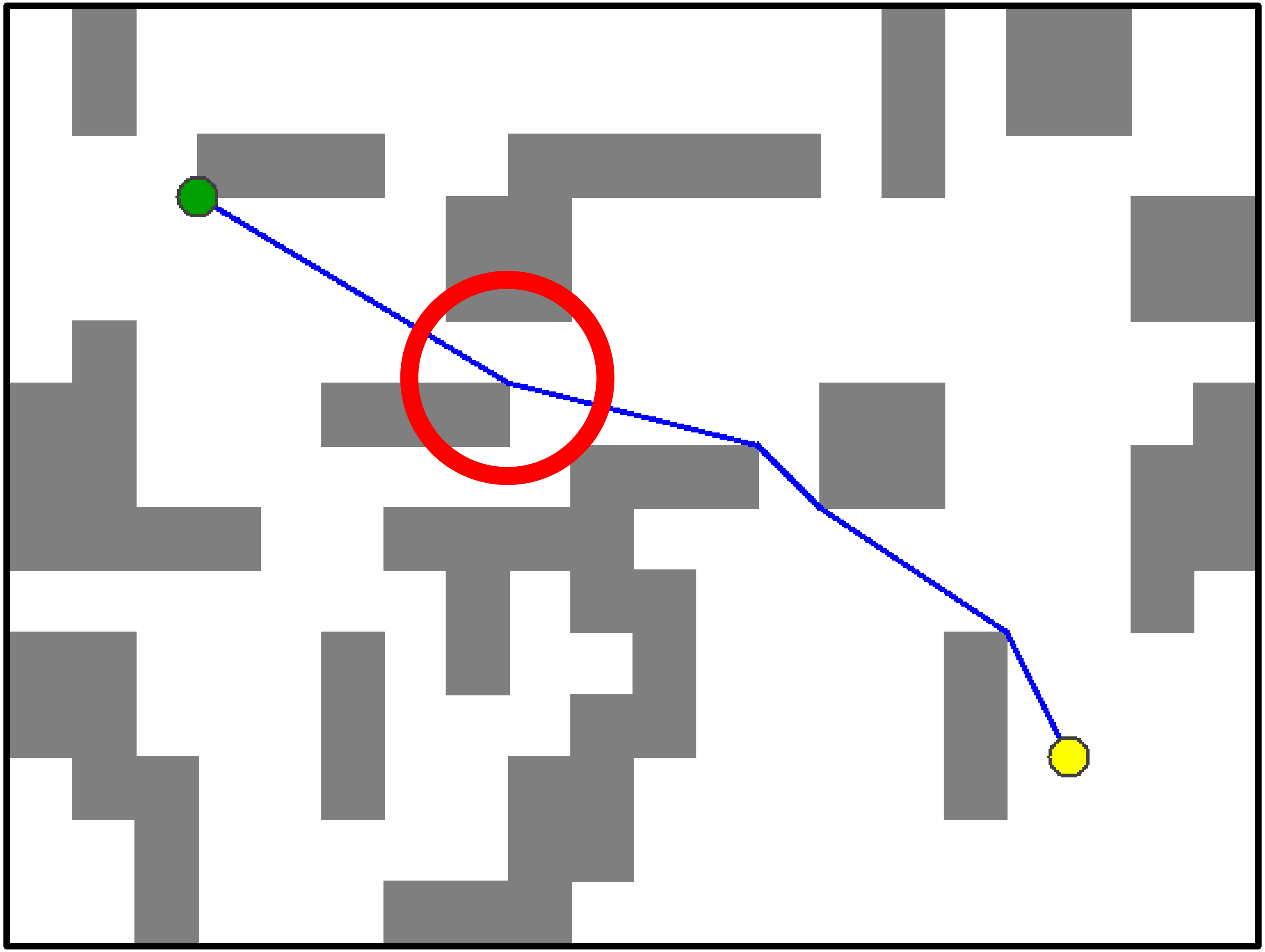

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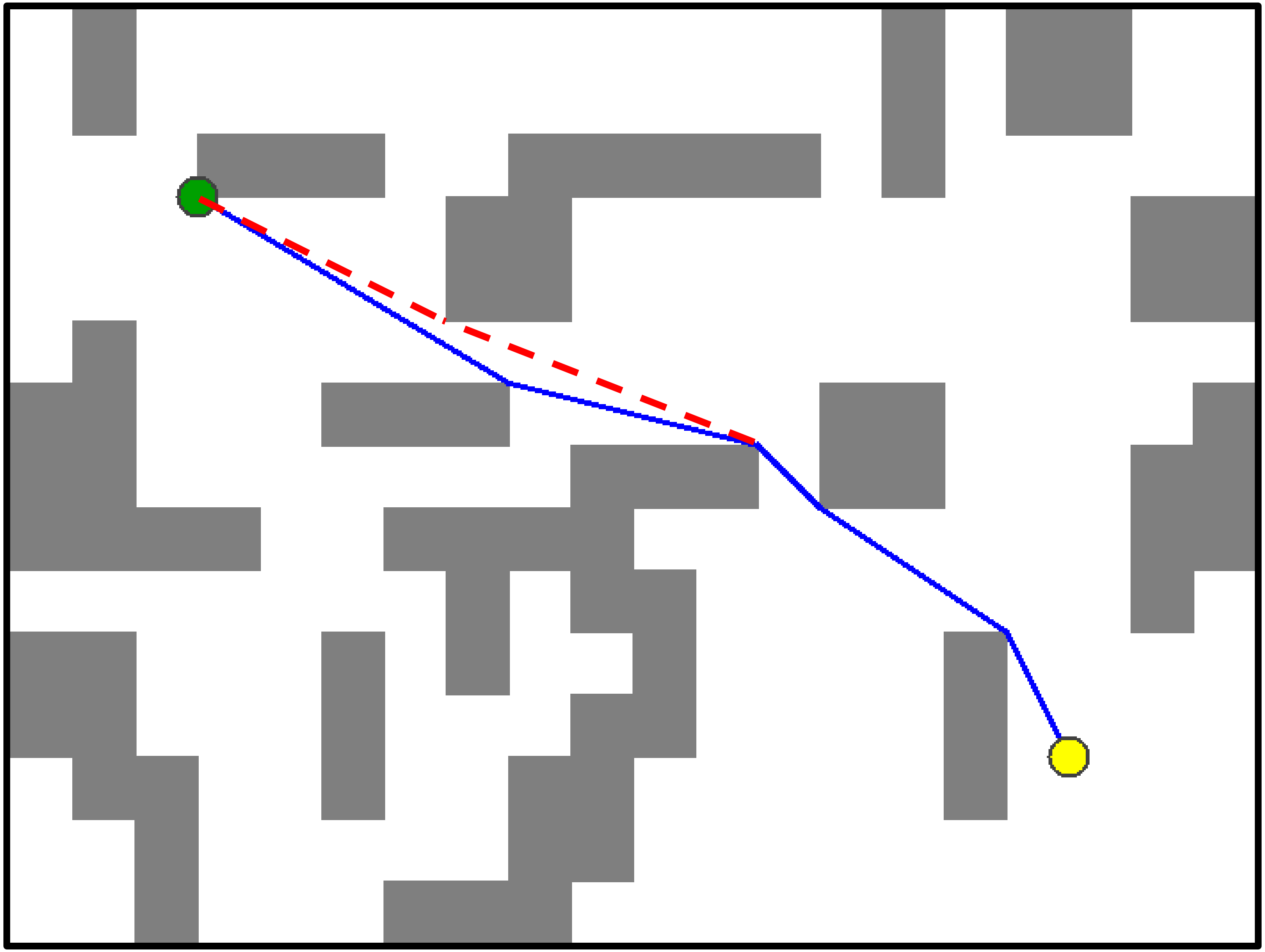

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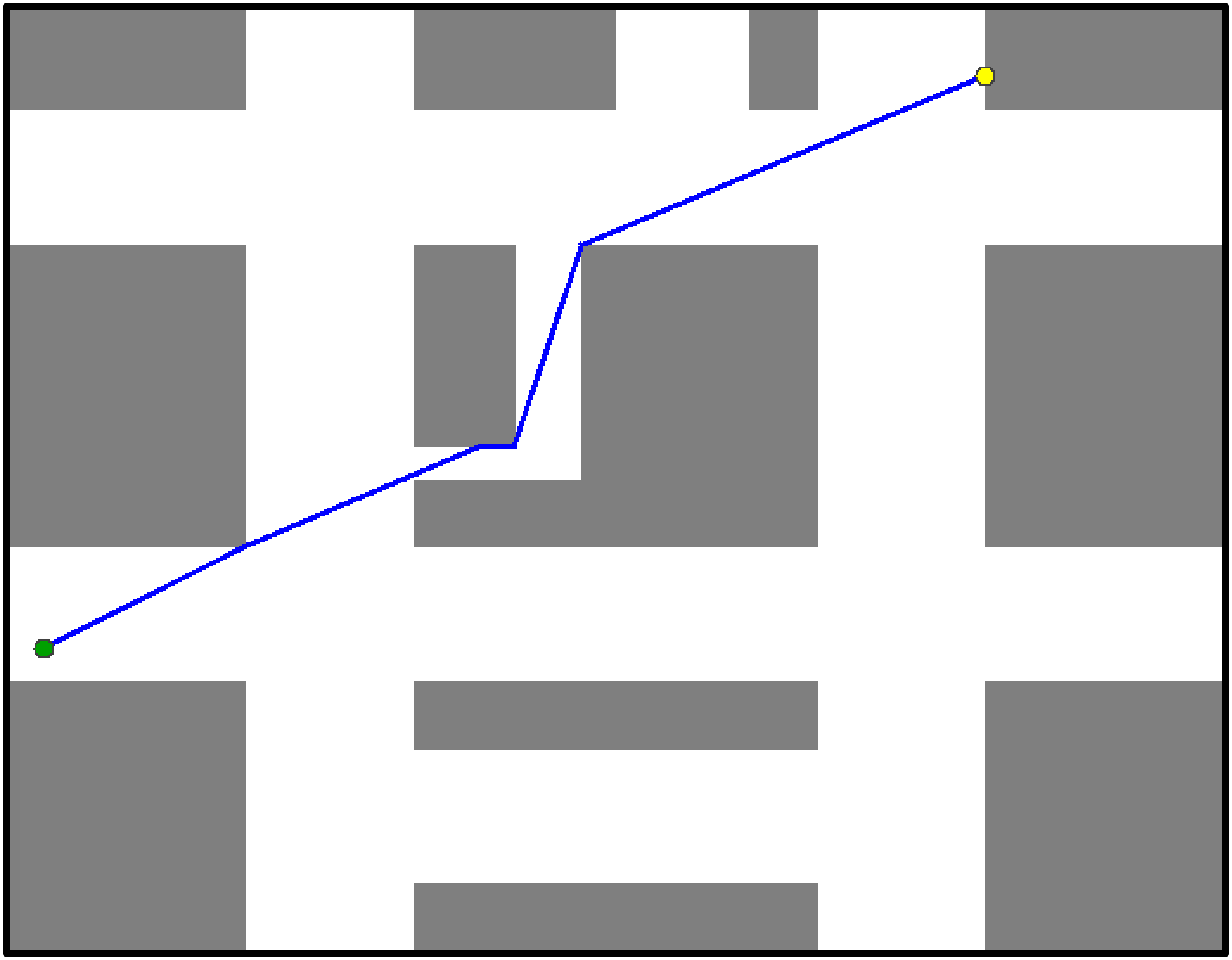

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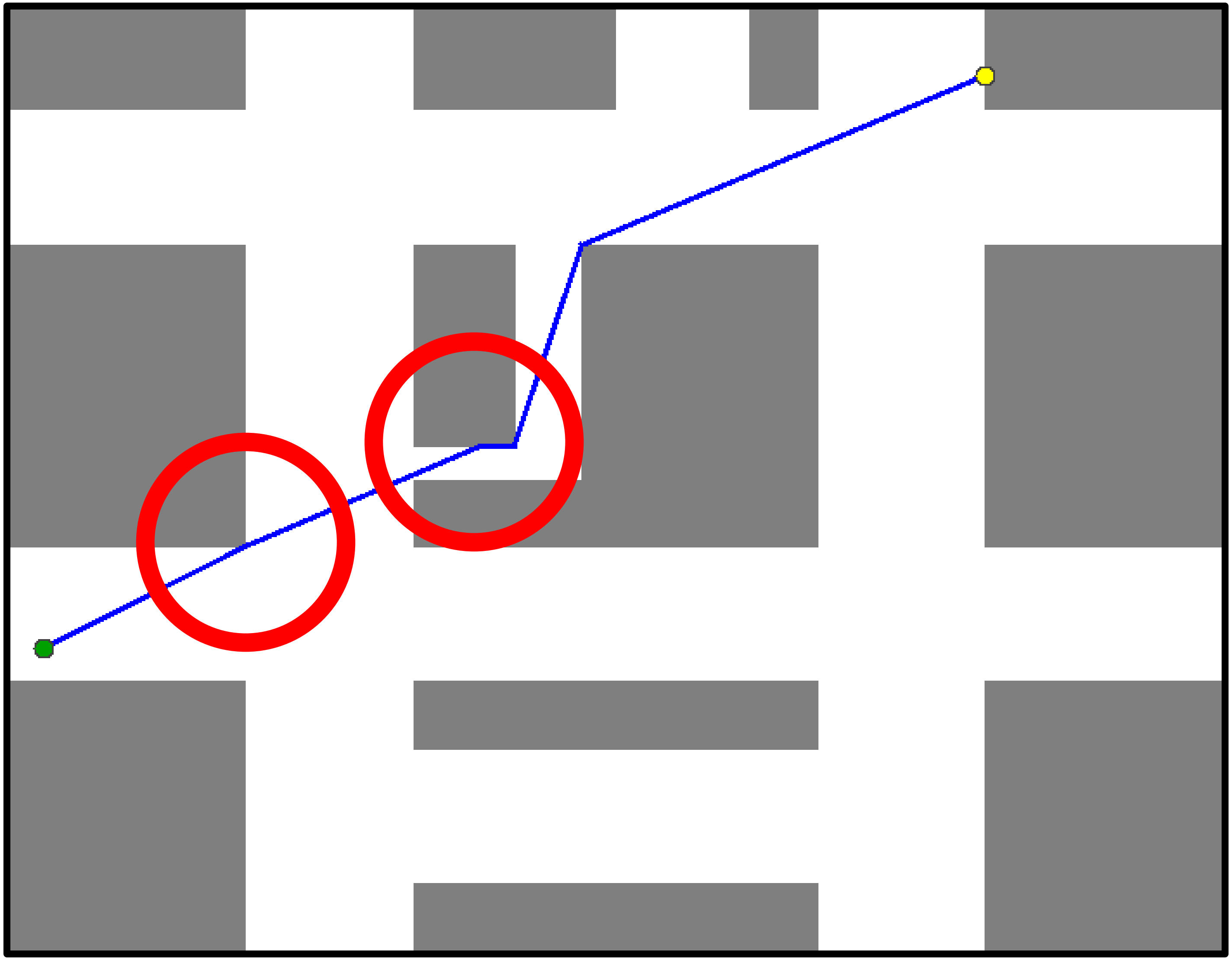

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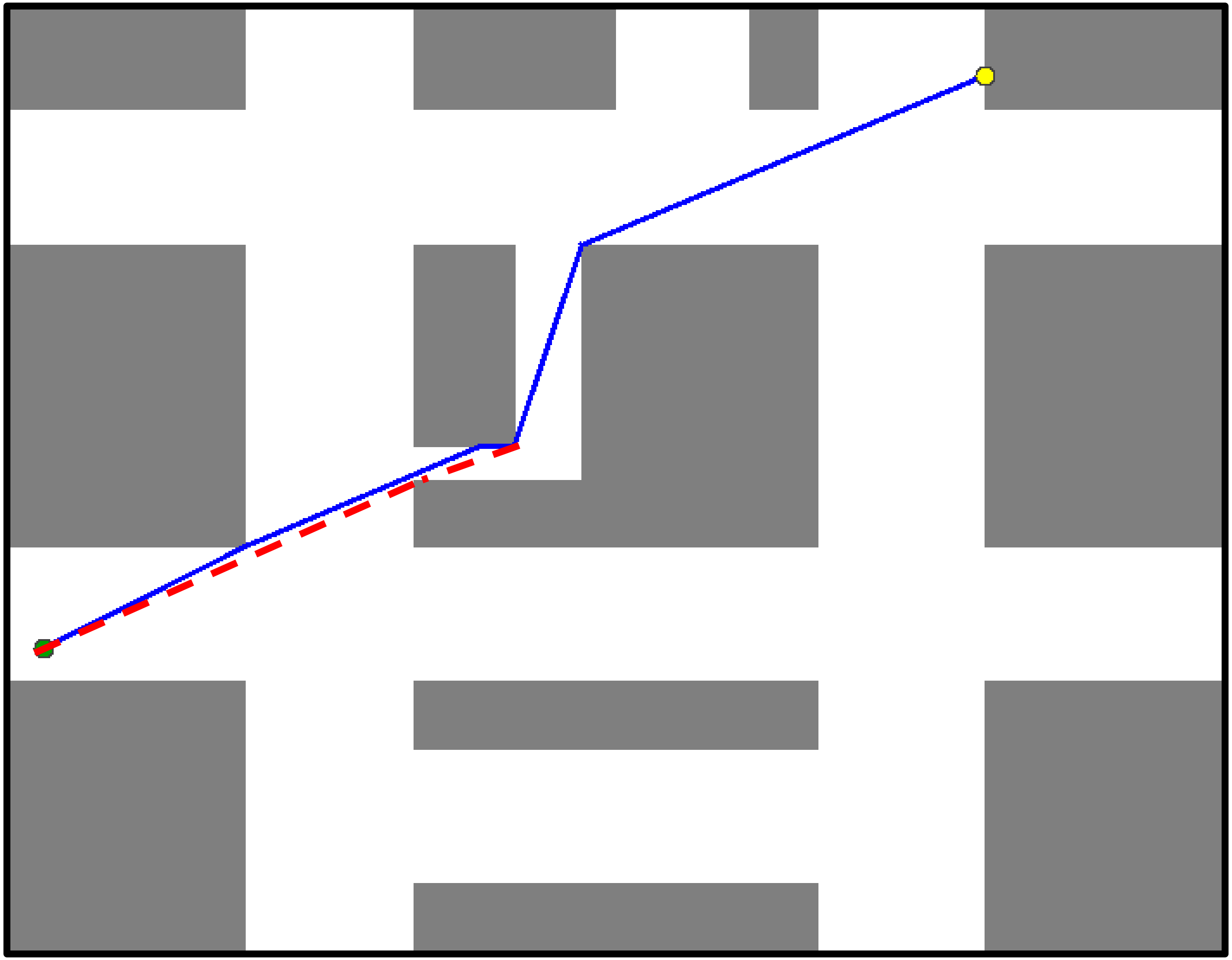

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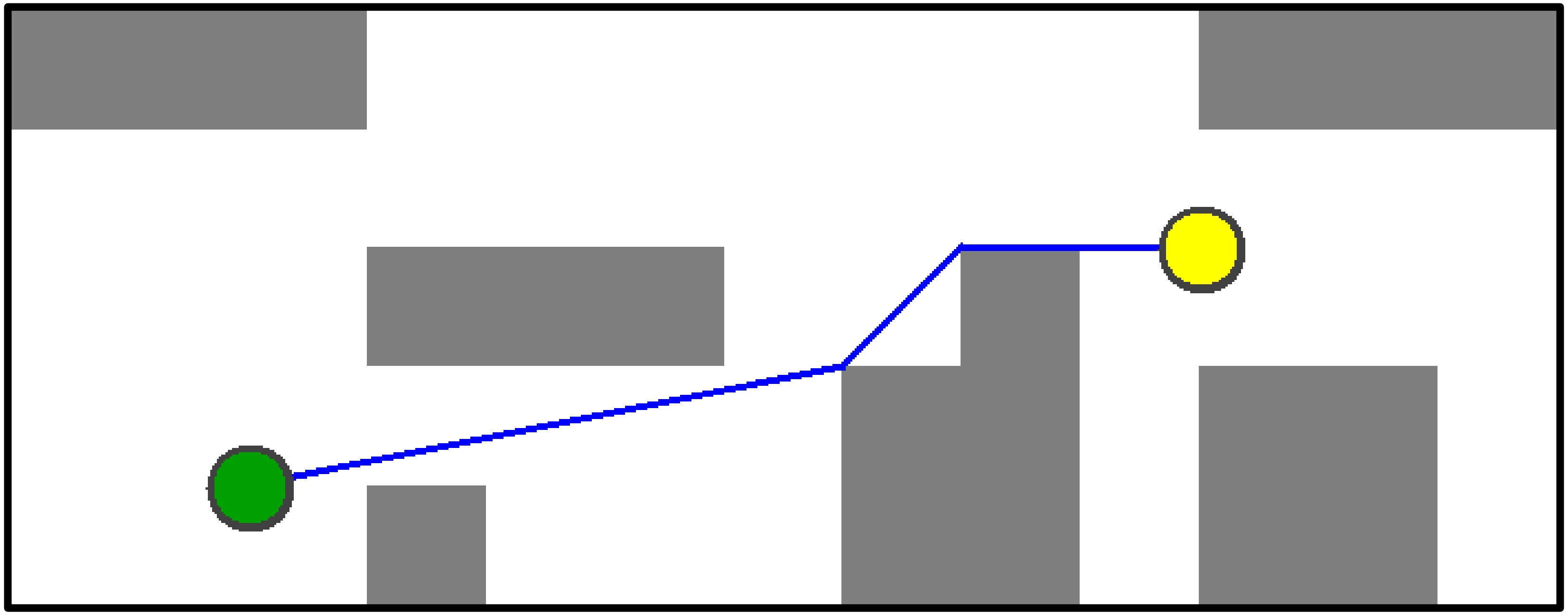

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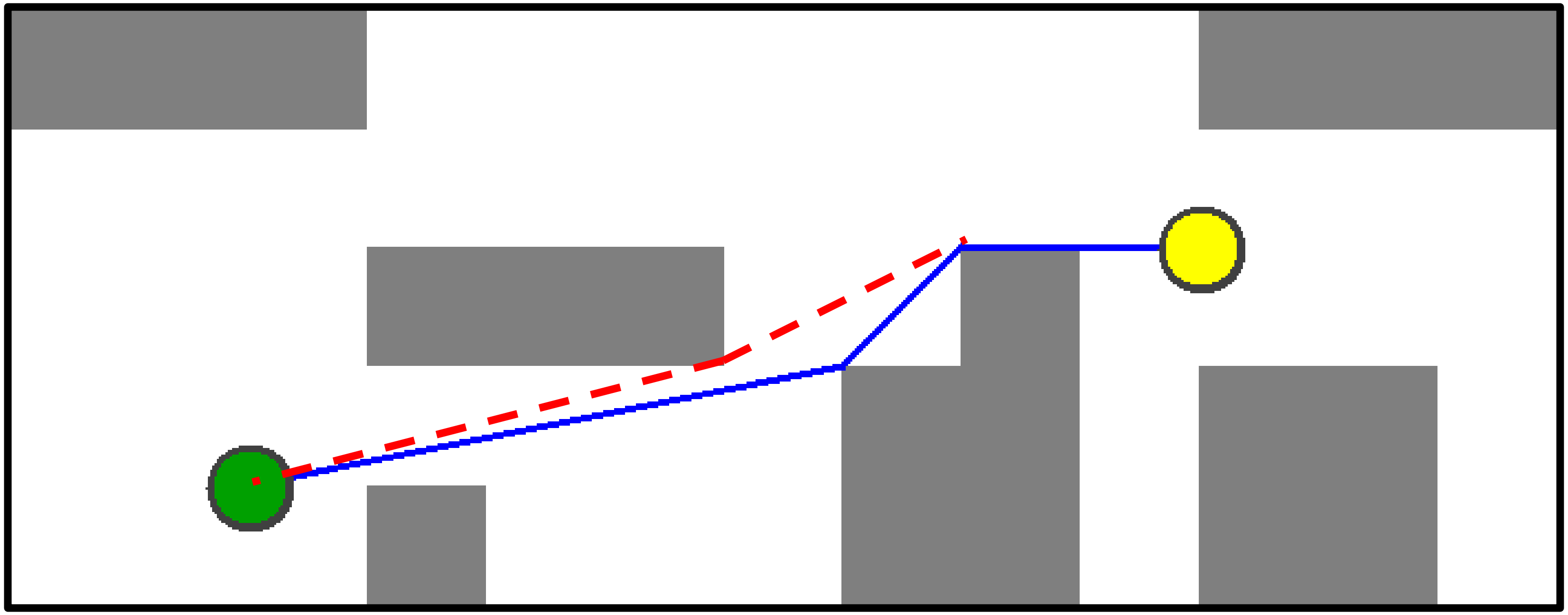
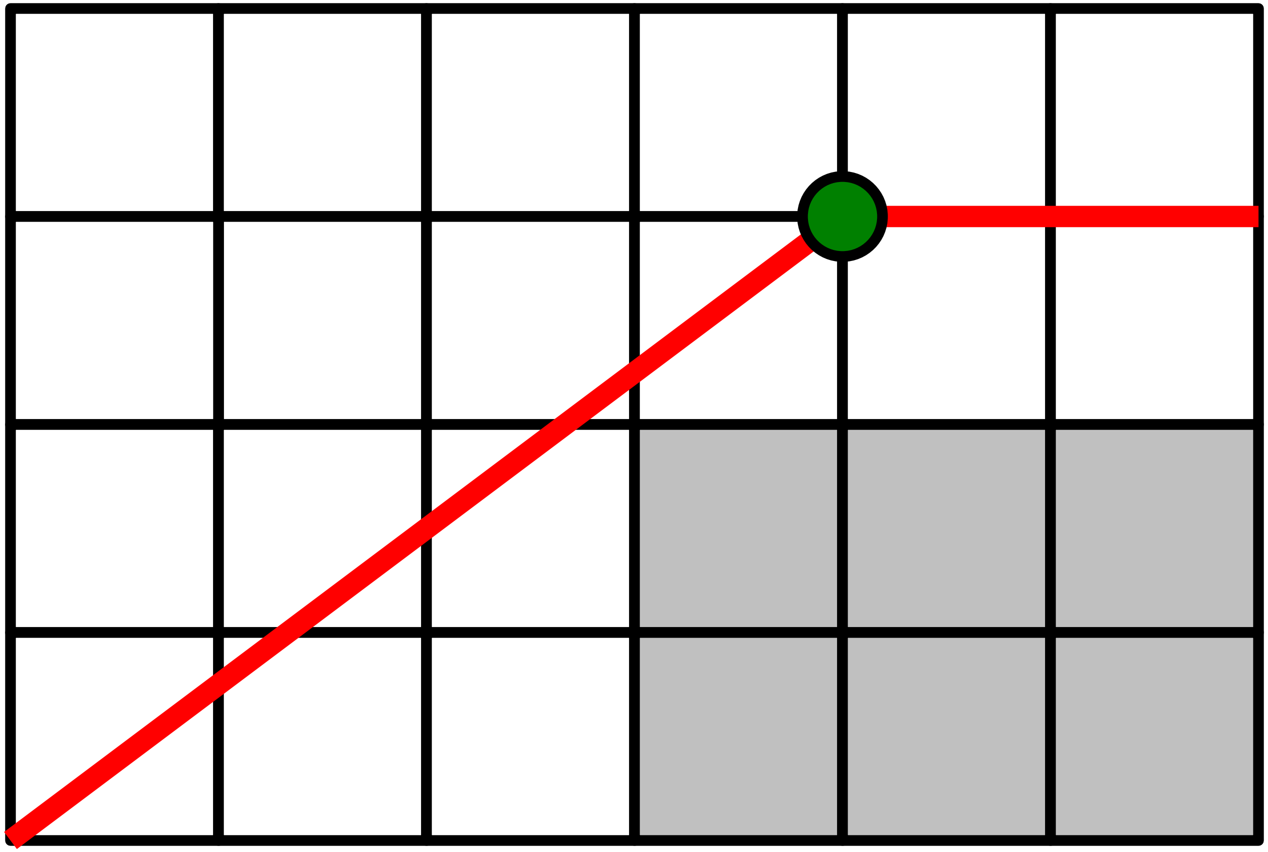
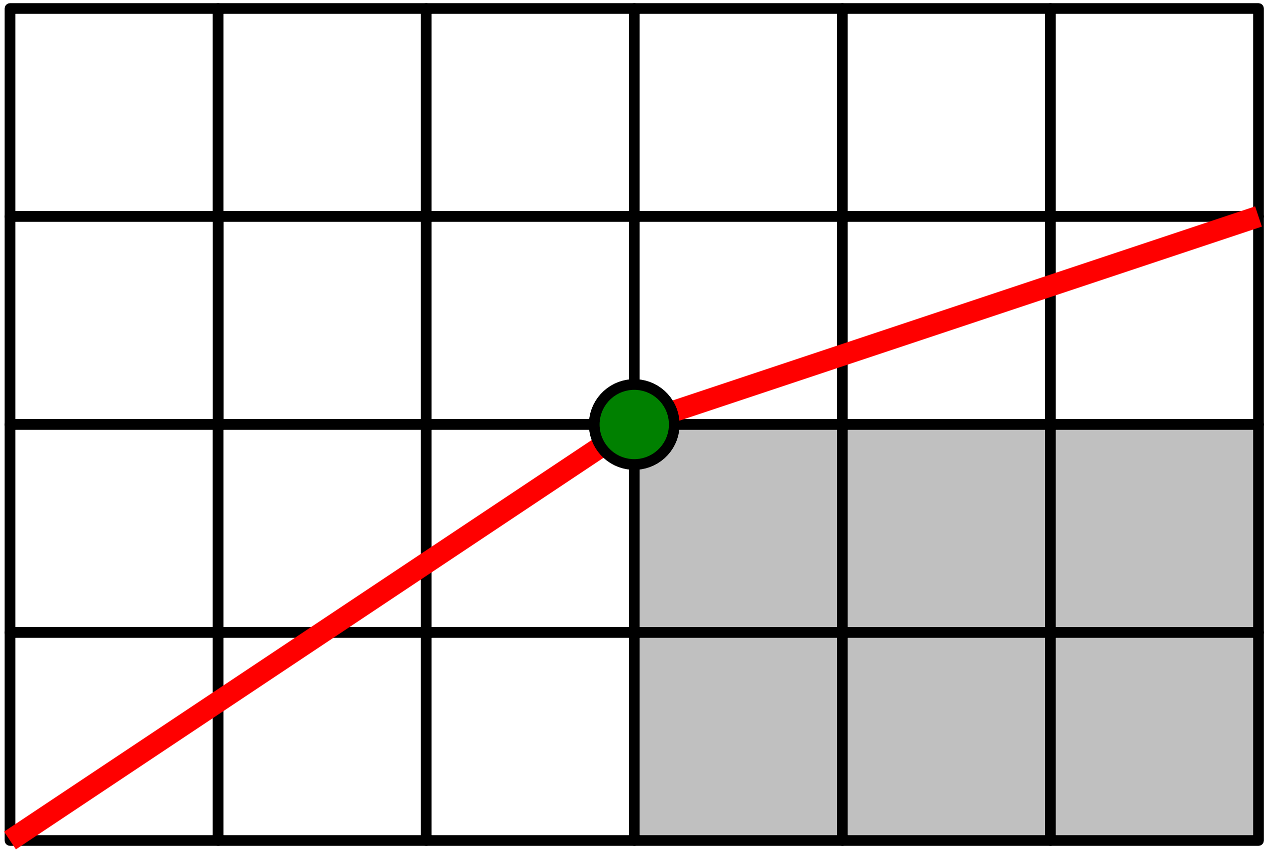


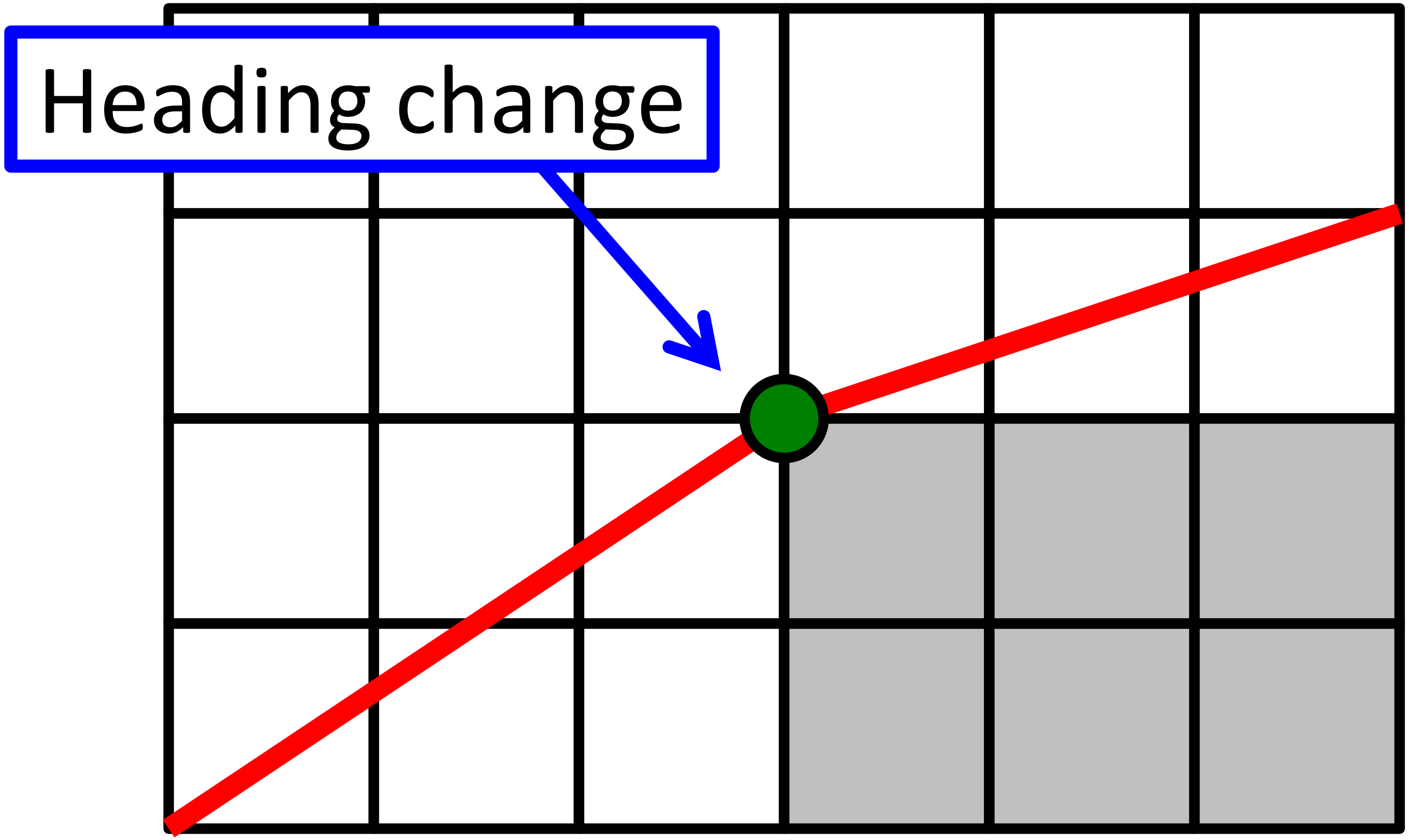
Non-Taut Path



Taut Path

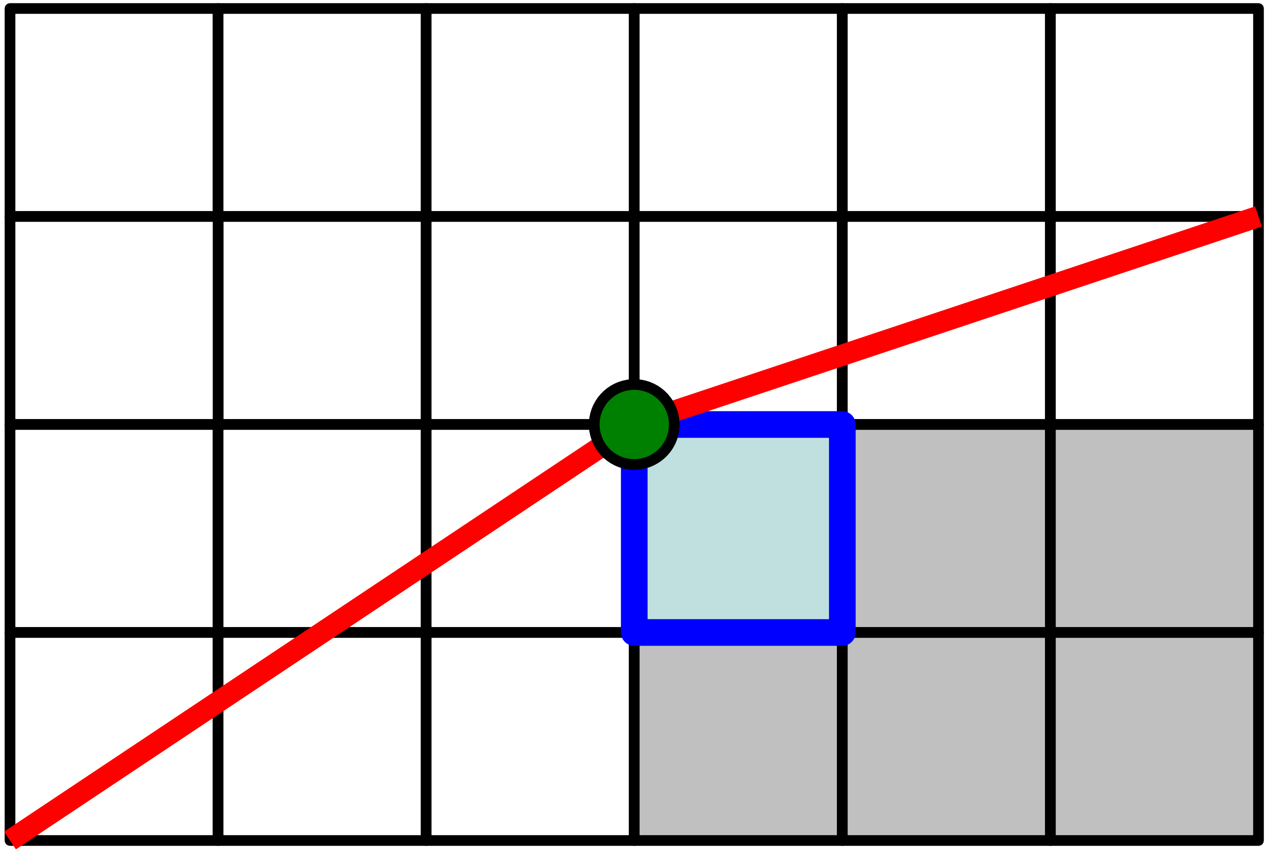


Taut Path



Heading change

Taut Path



Strict Theta*

Shorter Motion Planning Using Taut Paths

Strict Theta*

Strict Theta*

Easy to implement

Much shorter paths

Low runtime overhead

Idea:

Restrict the search to Taut Paths

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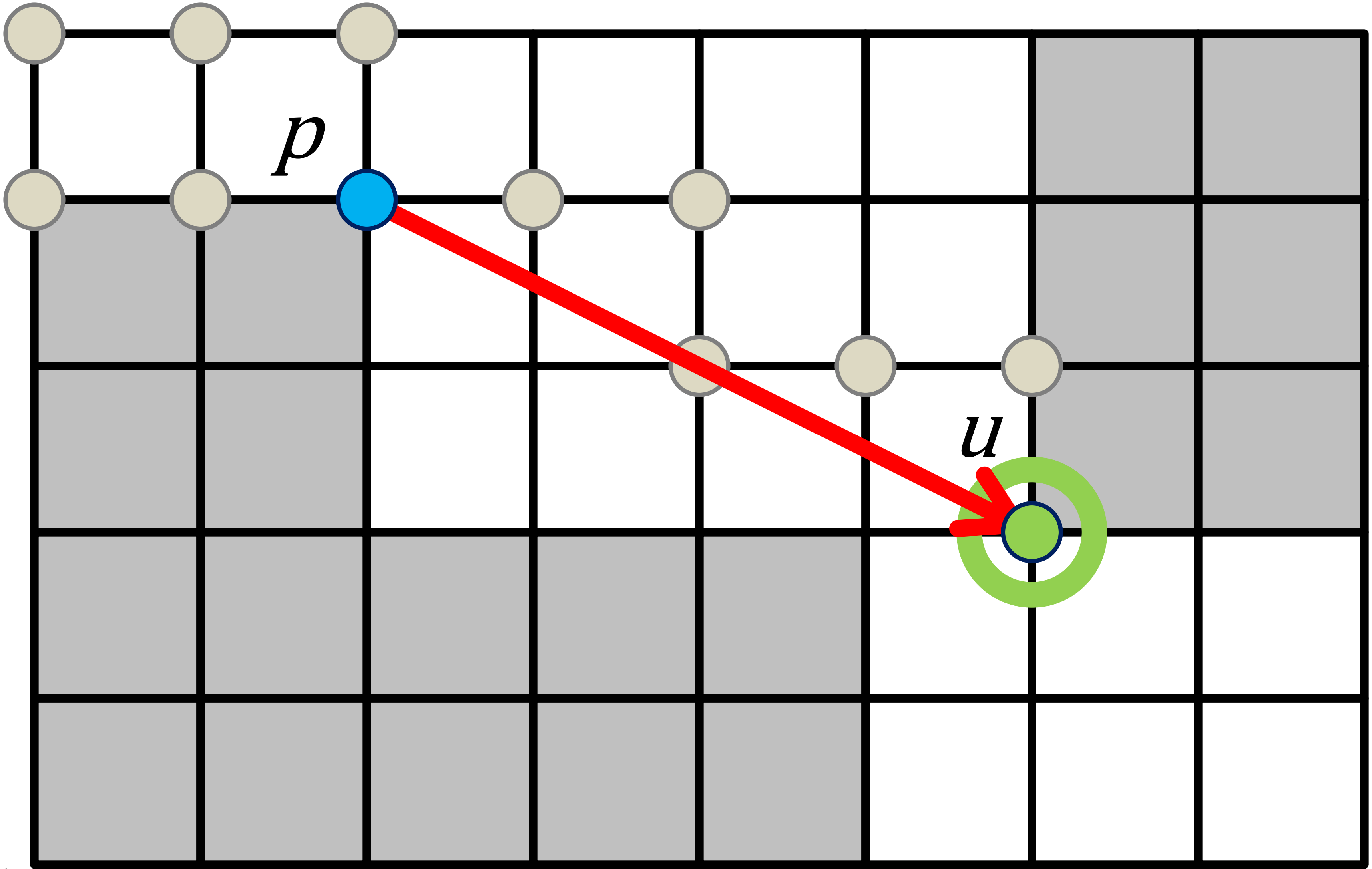
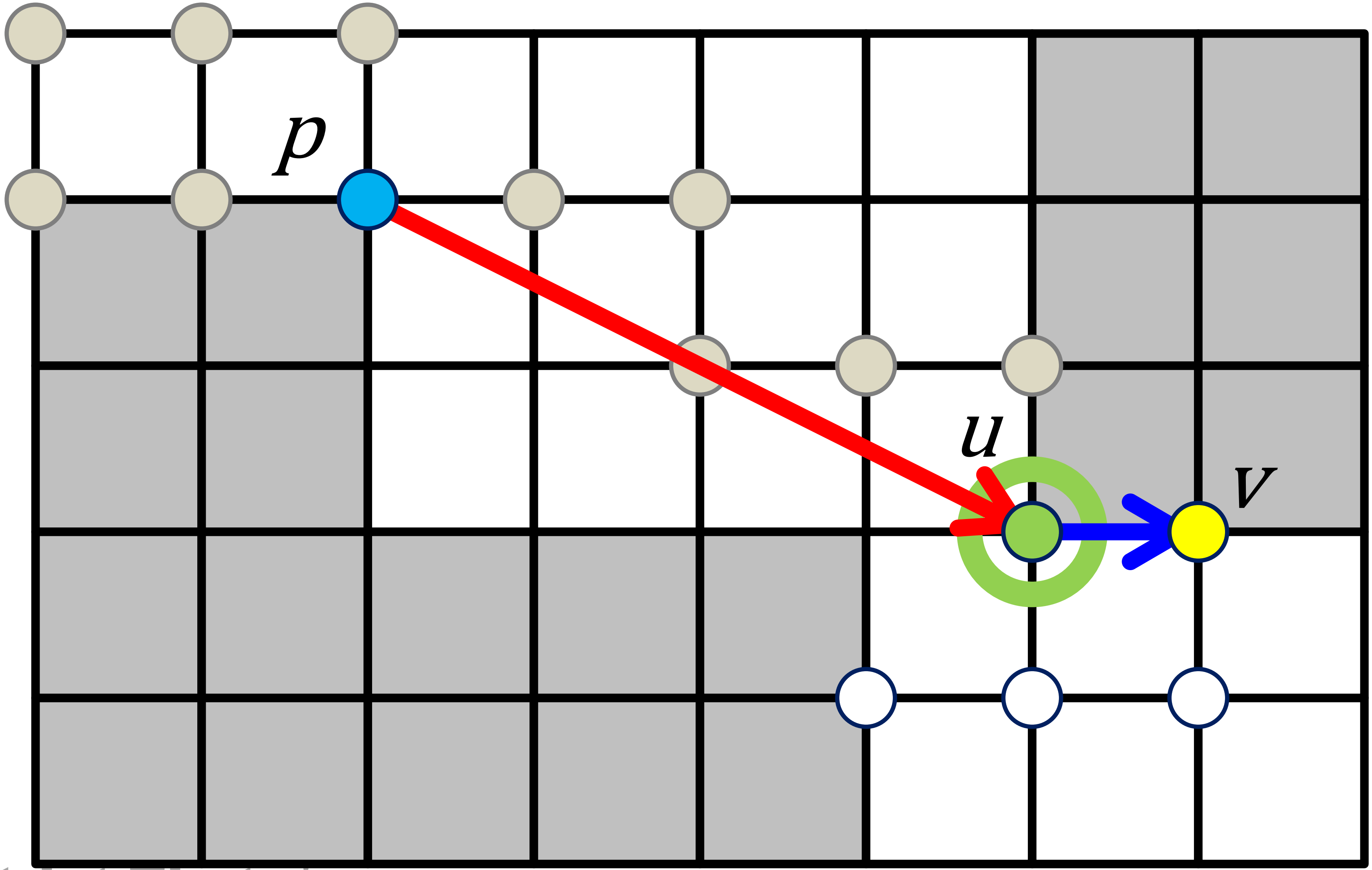
“Restrict” the search to Taut Paths

Penalise non-taut paths

Strict Theta*



Is Taut



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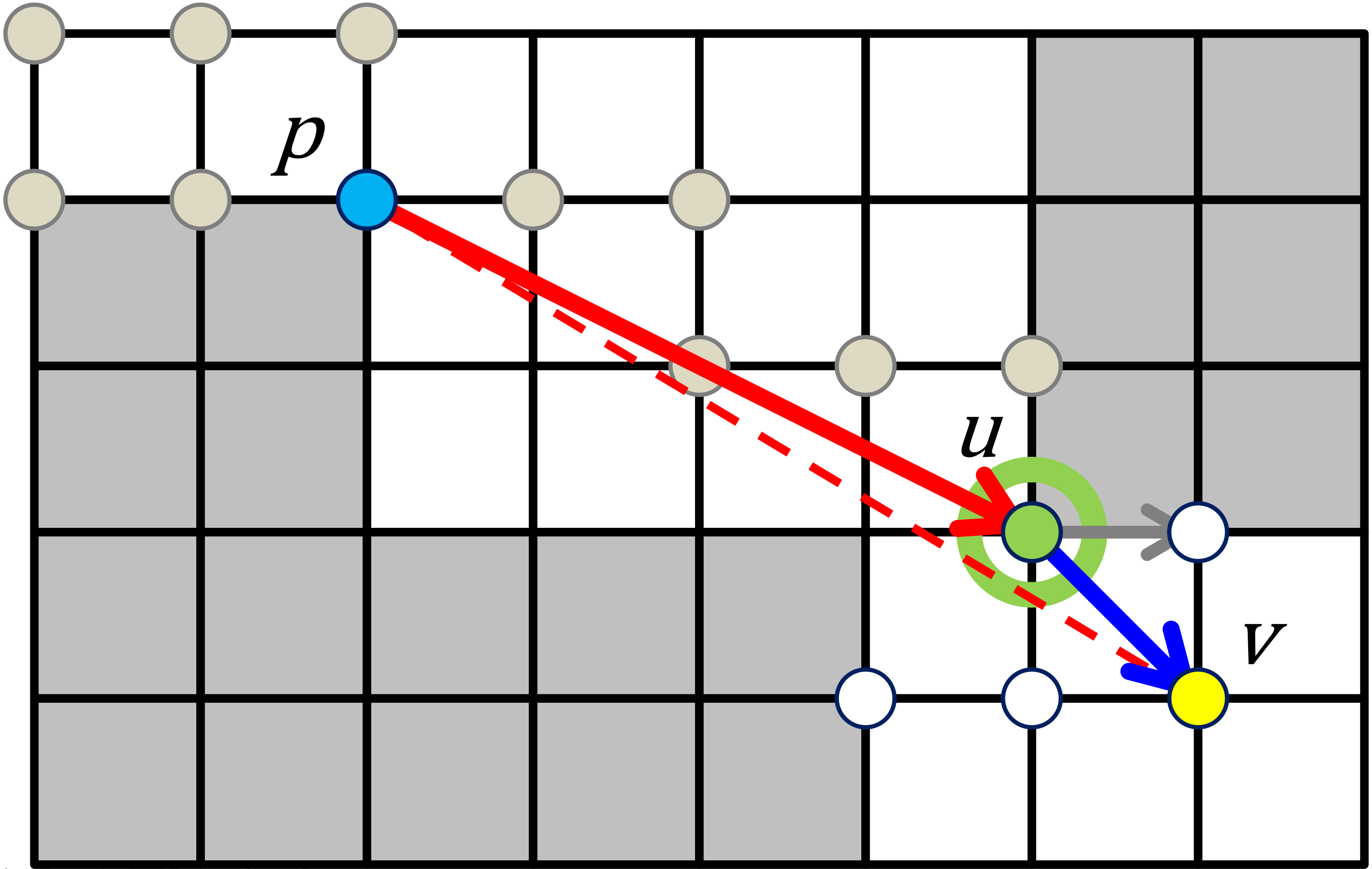
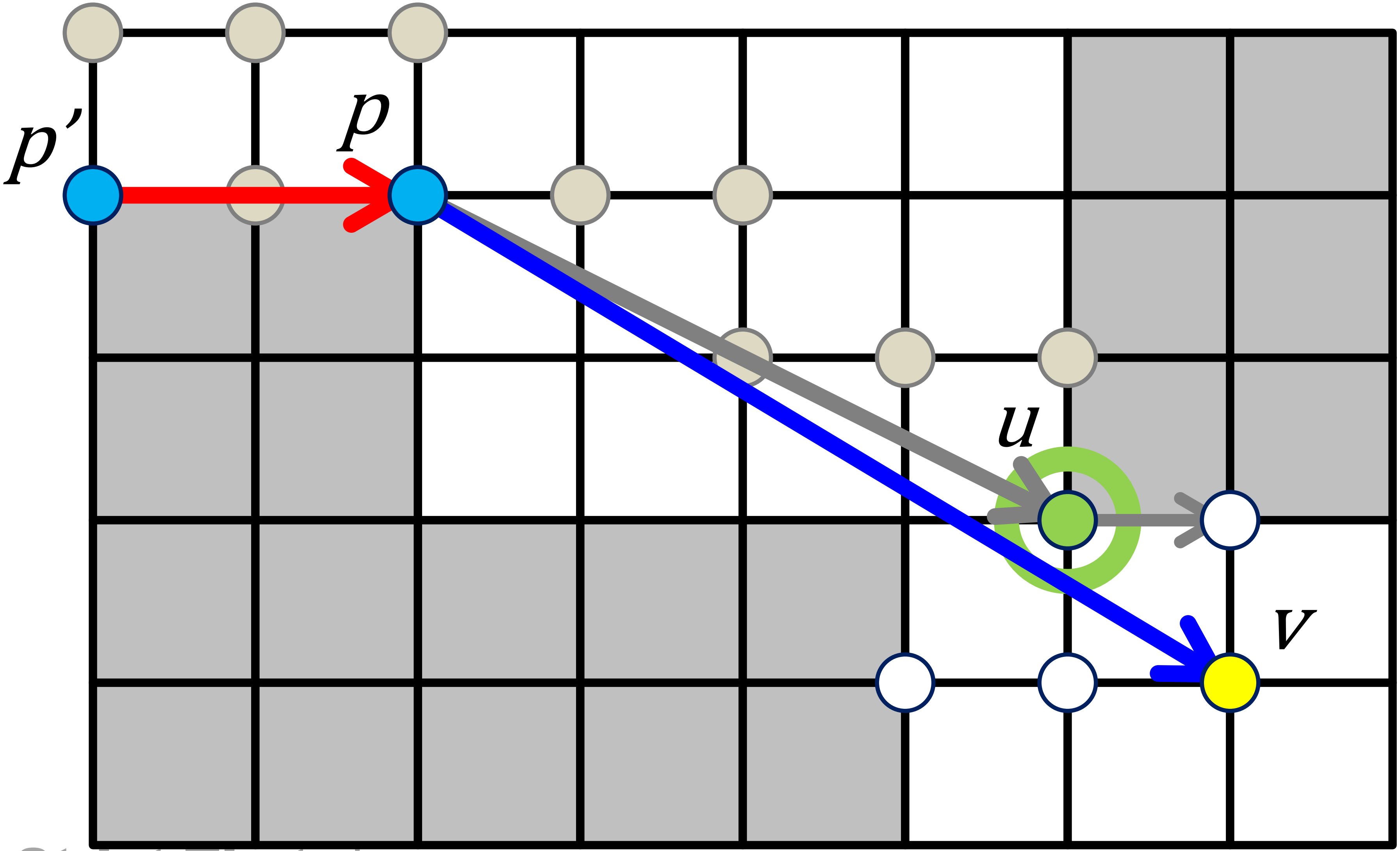


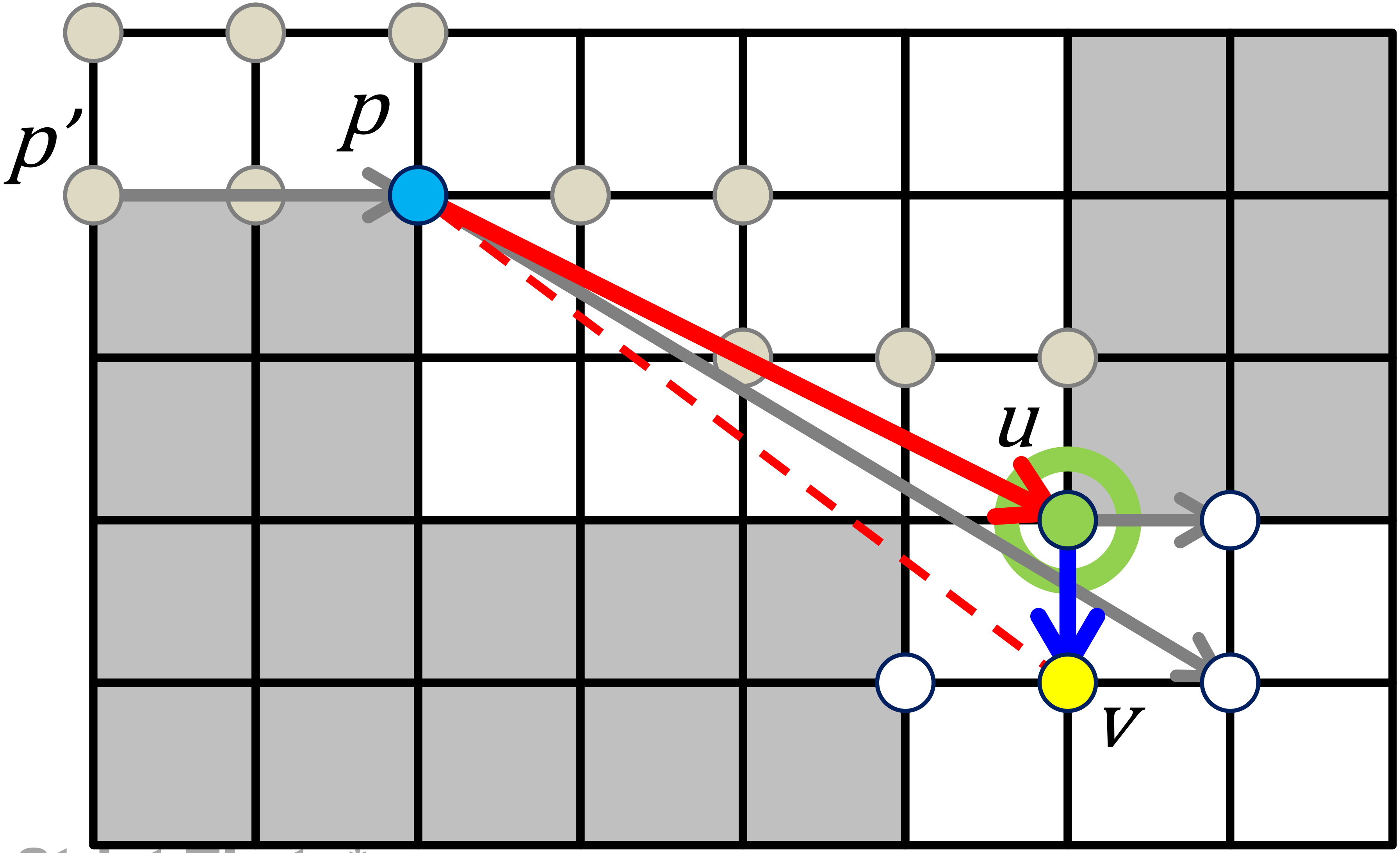
Strict Theta*

Is Taut



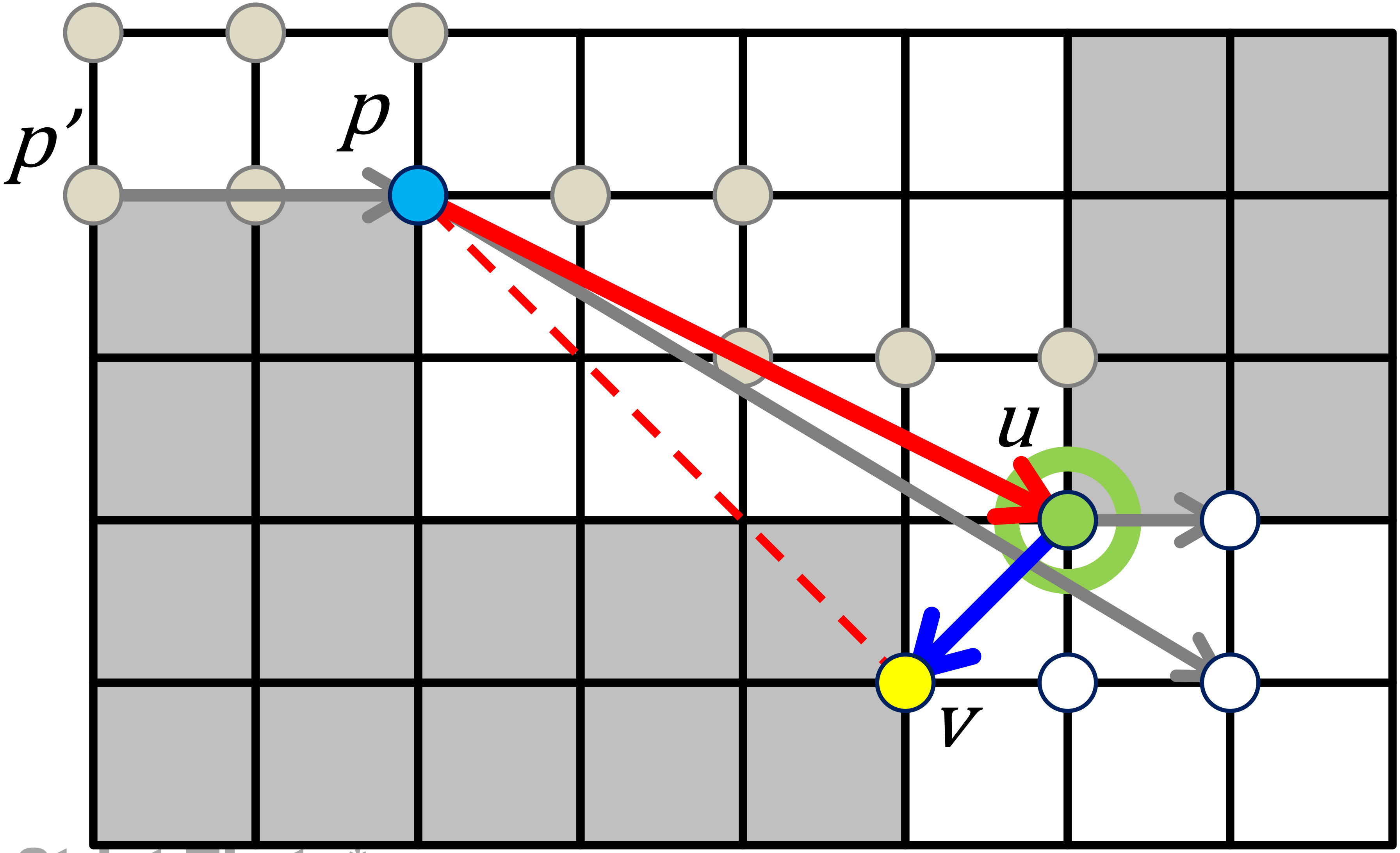
Strict Theta*

Not Taut



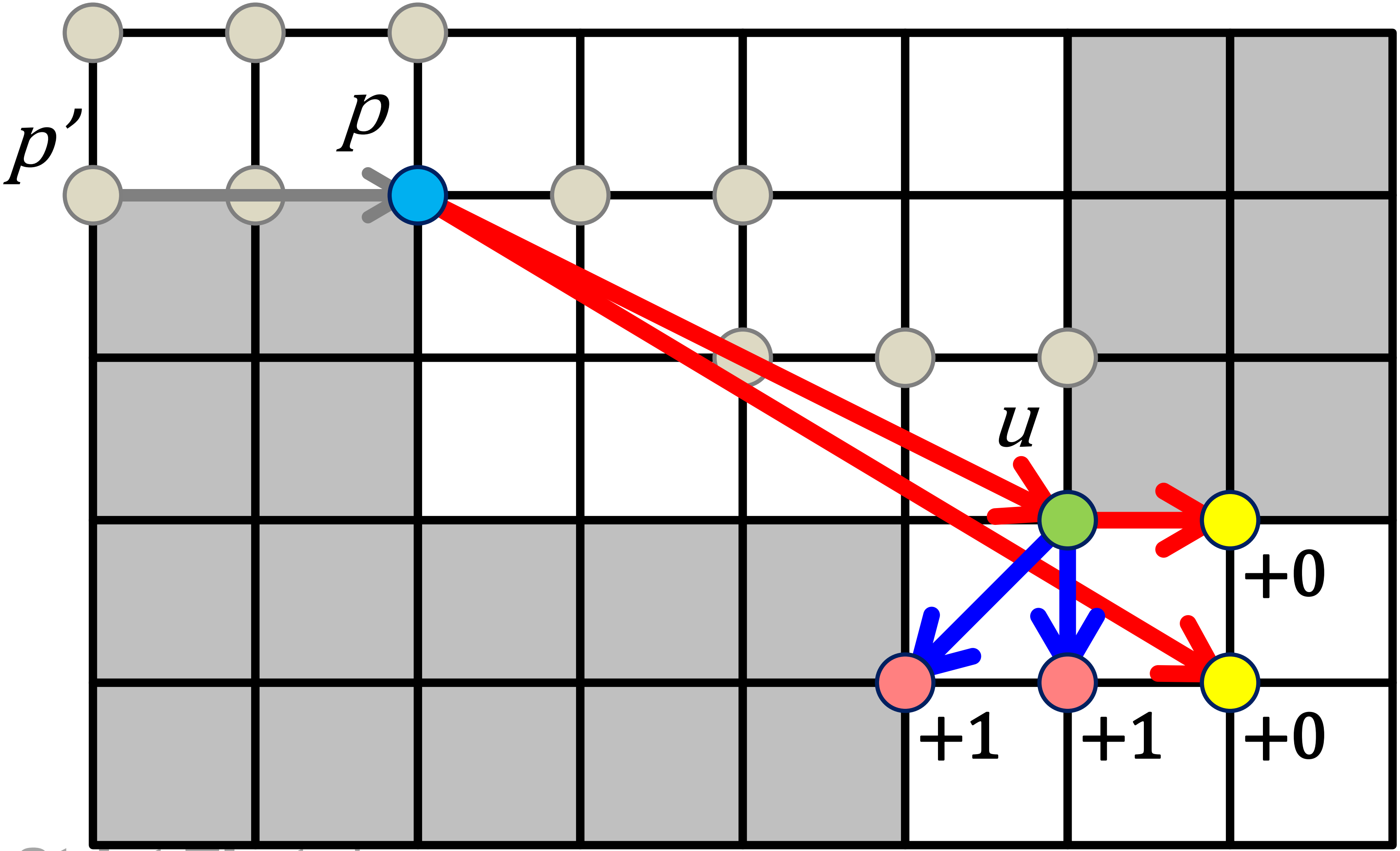
Strict Theta*

Not Taut



Strict Theta*

Add Penalties



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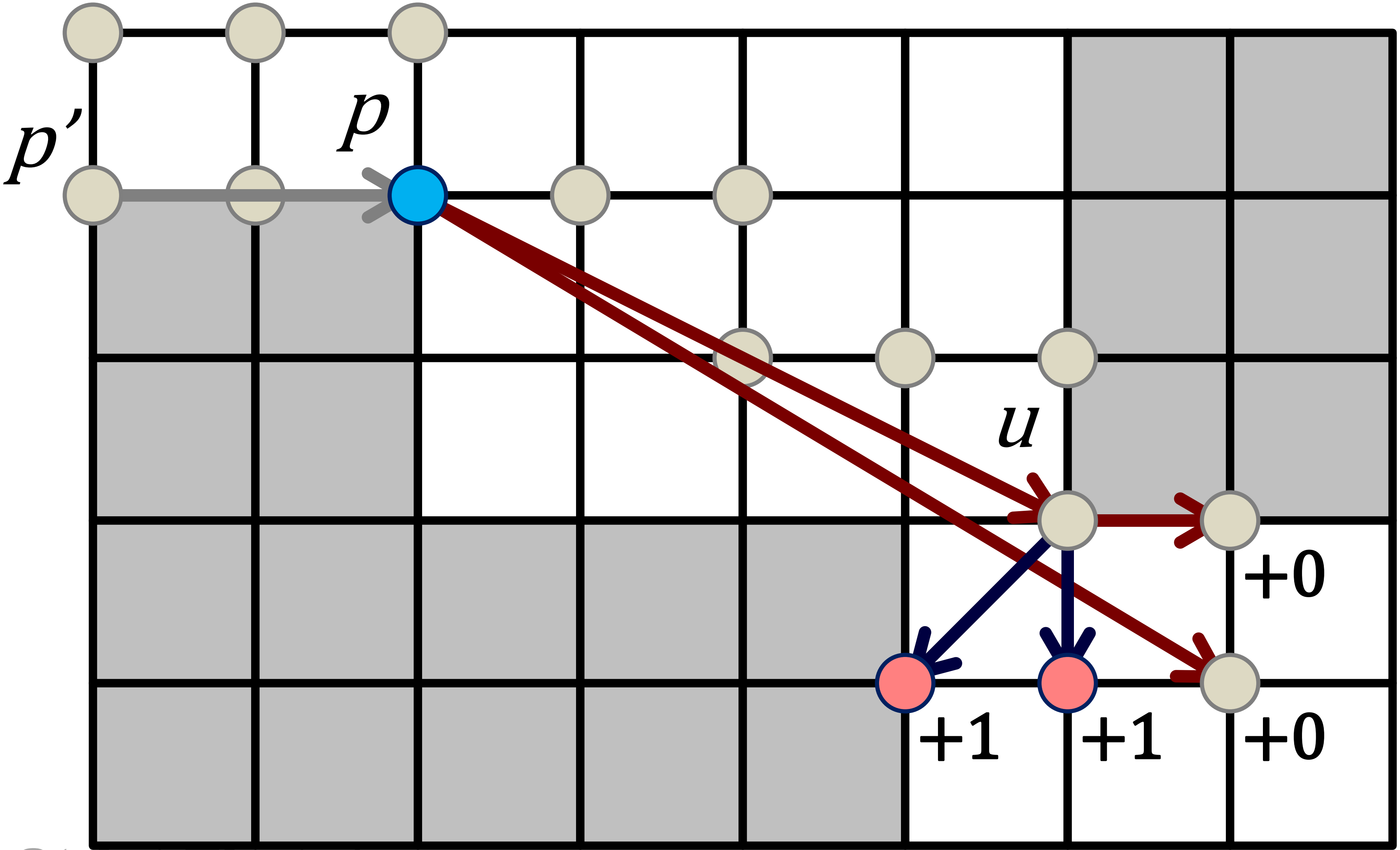

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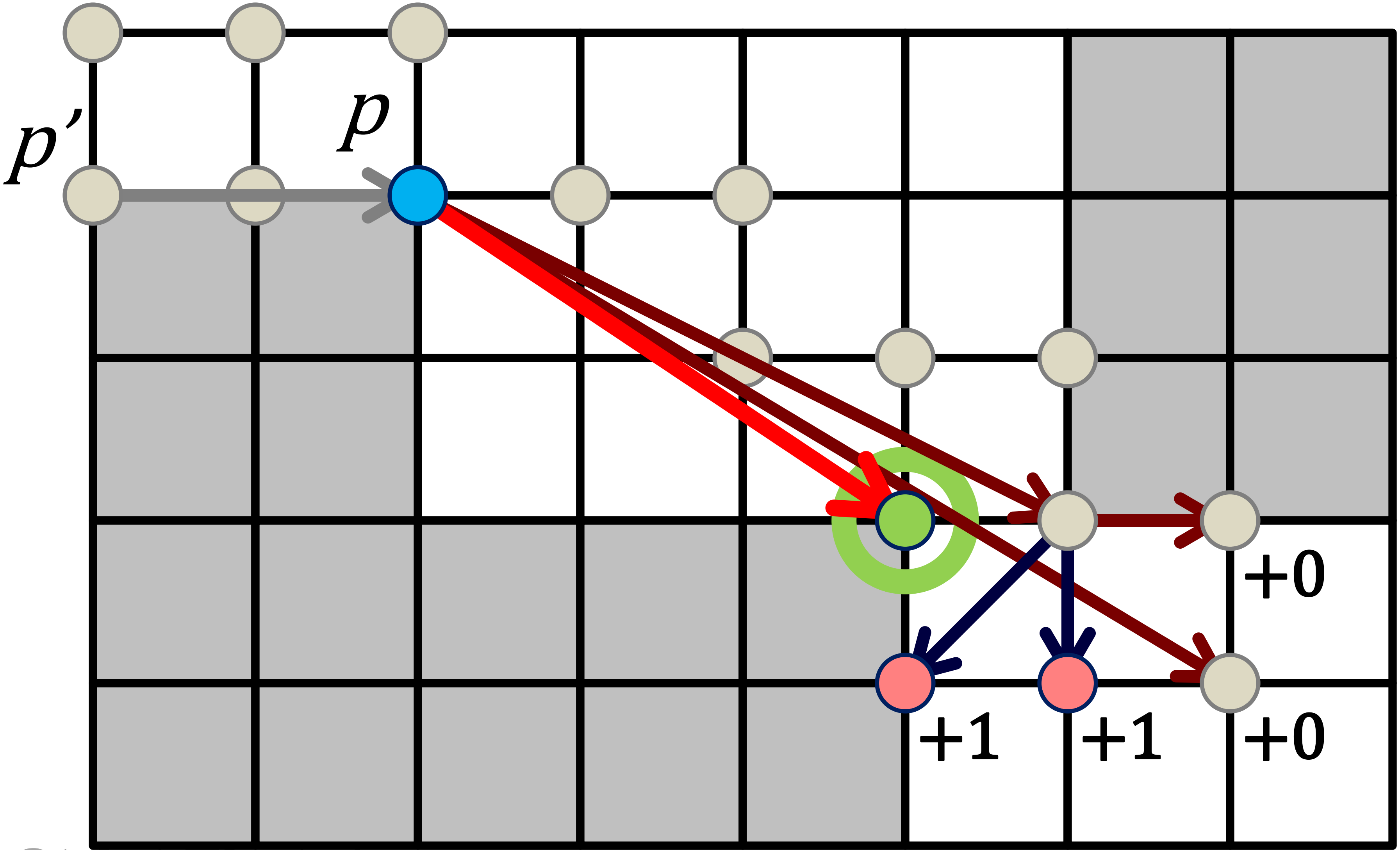

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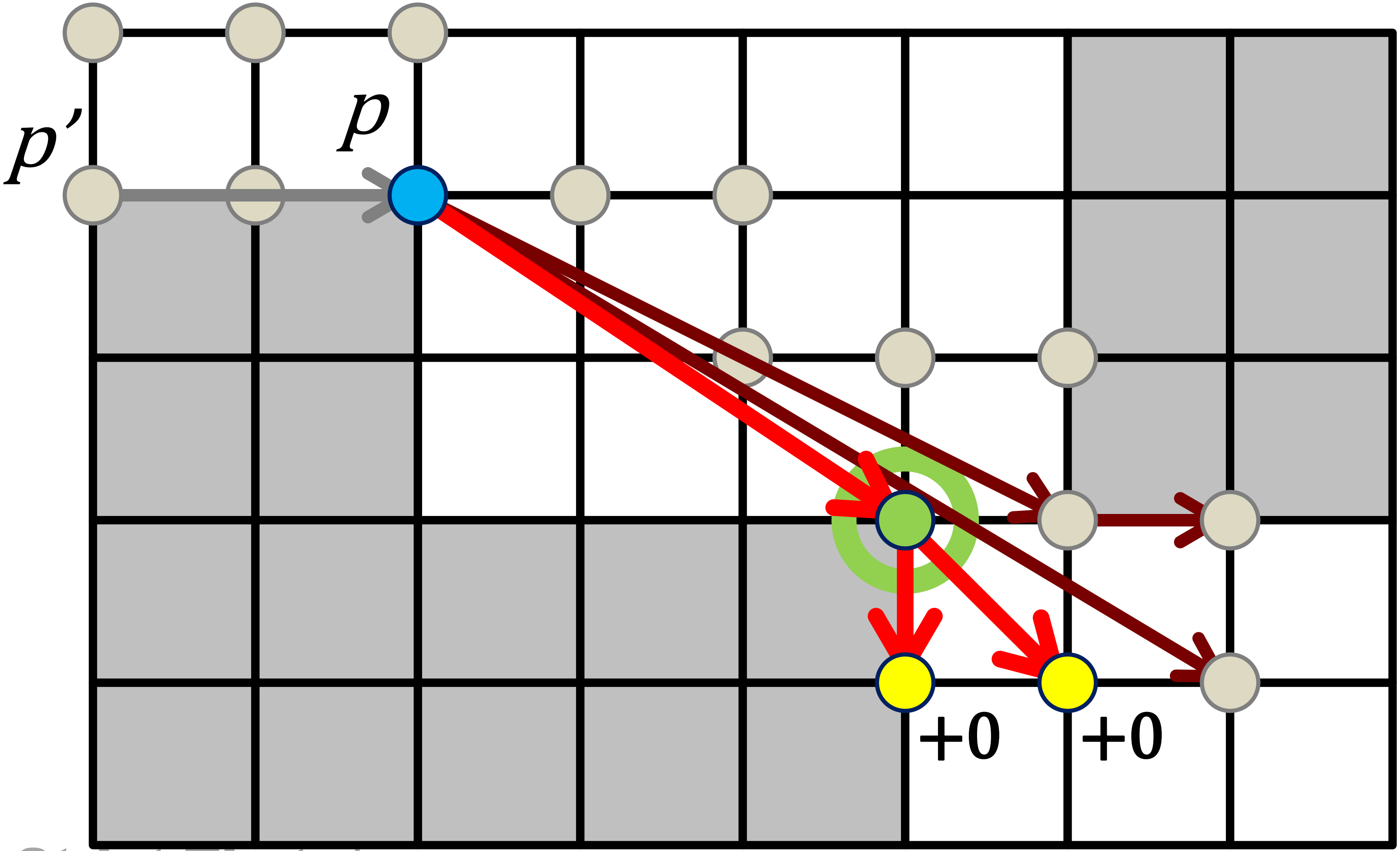
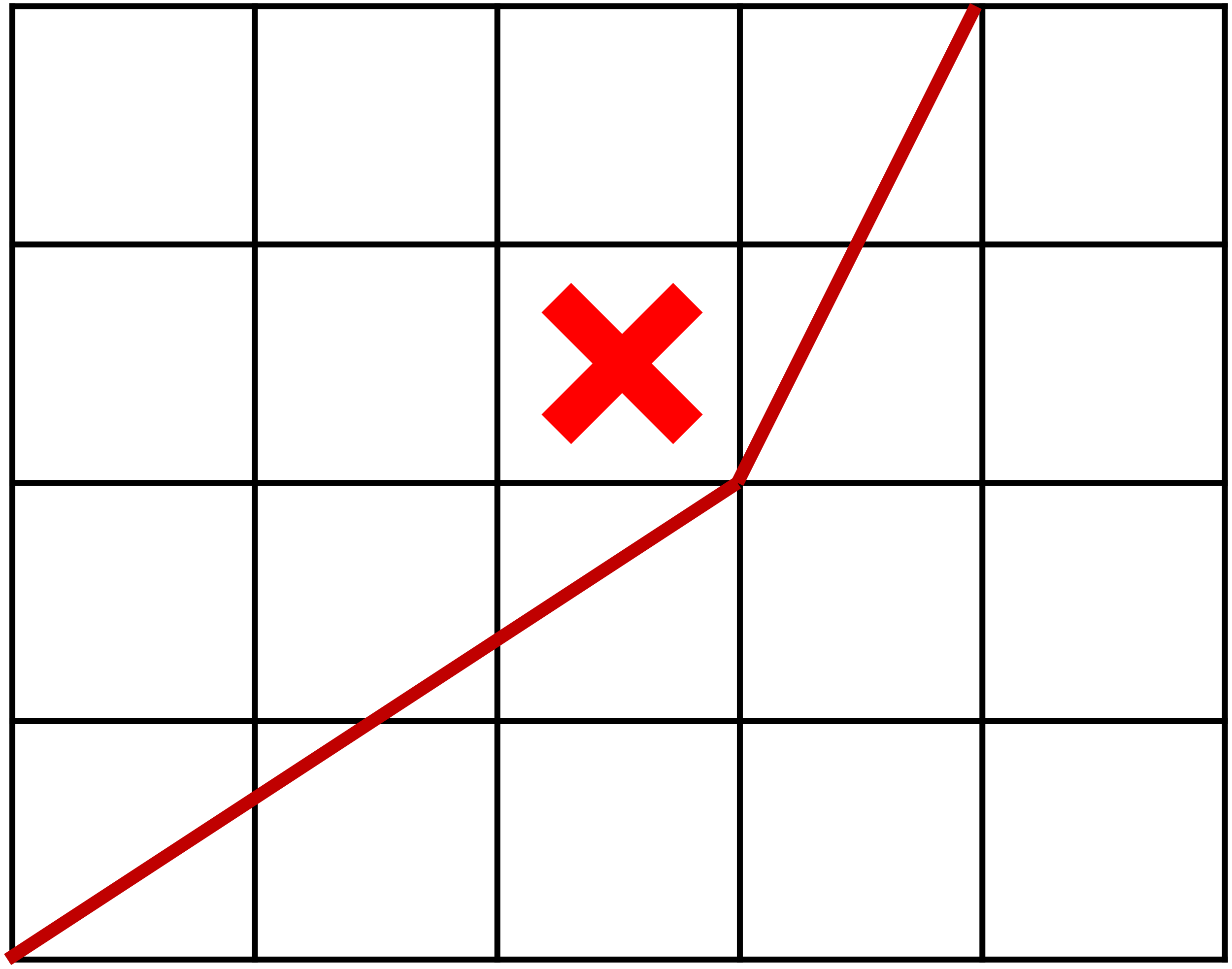


Strict Theta*

Tautness checks

Tautness Checks

We need only check one tile.



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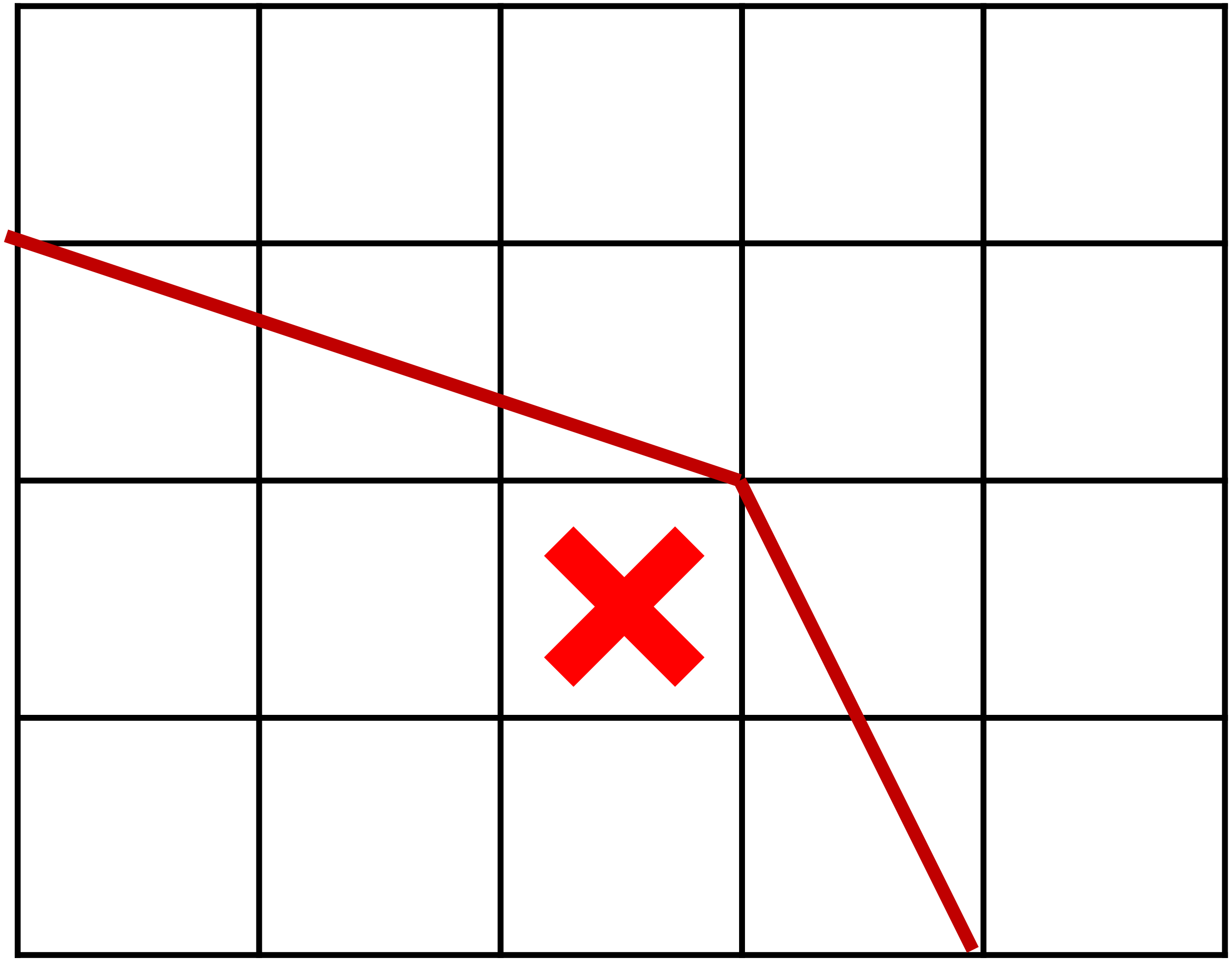

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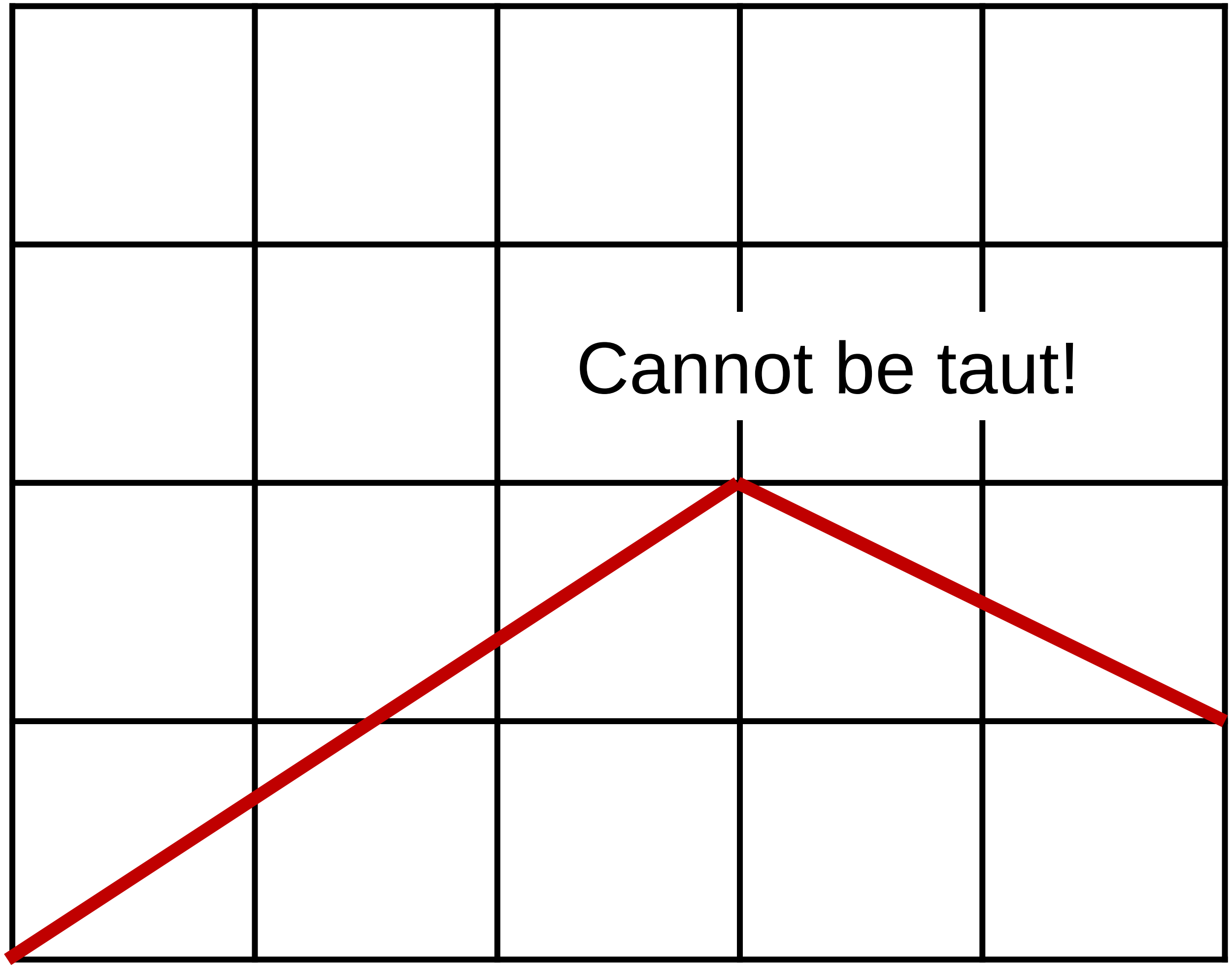
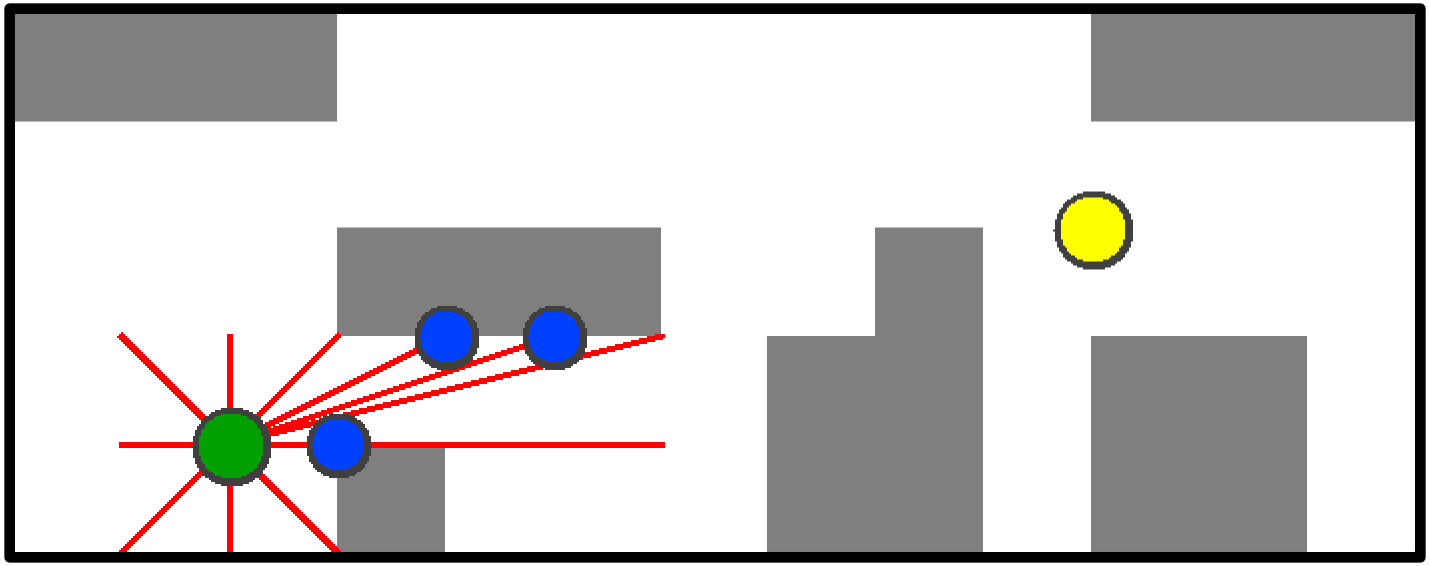


The Advantage of Taut Path Restriction

Basic Theta*



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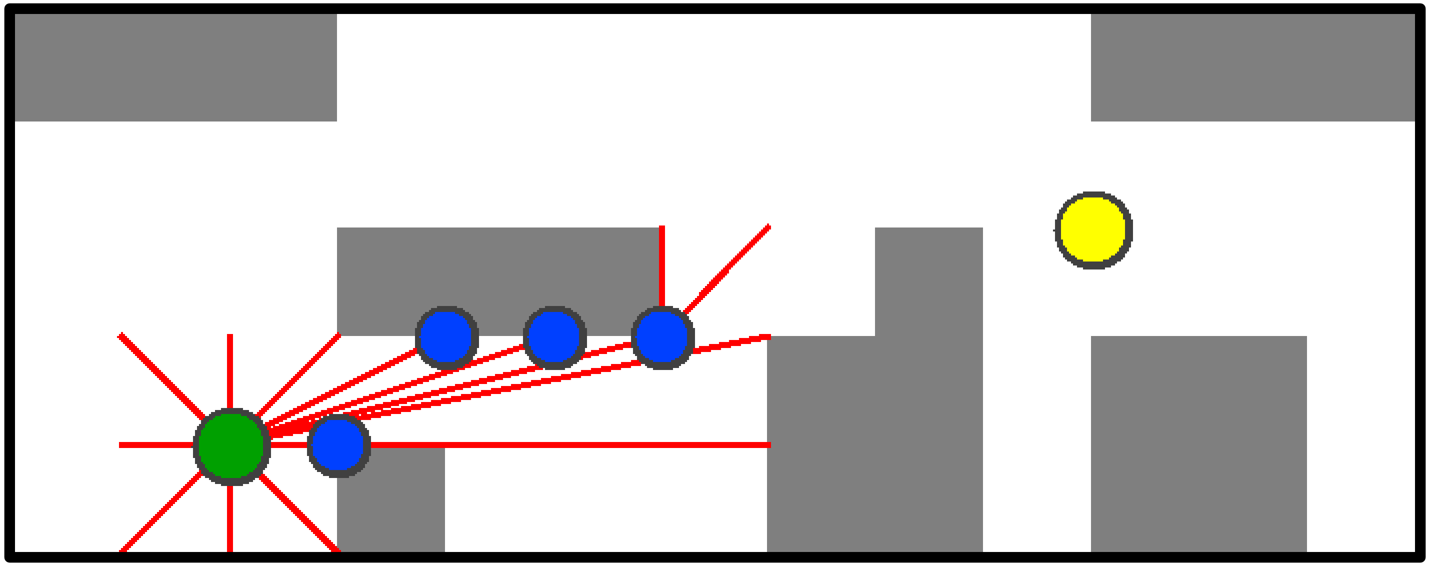

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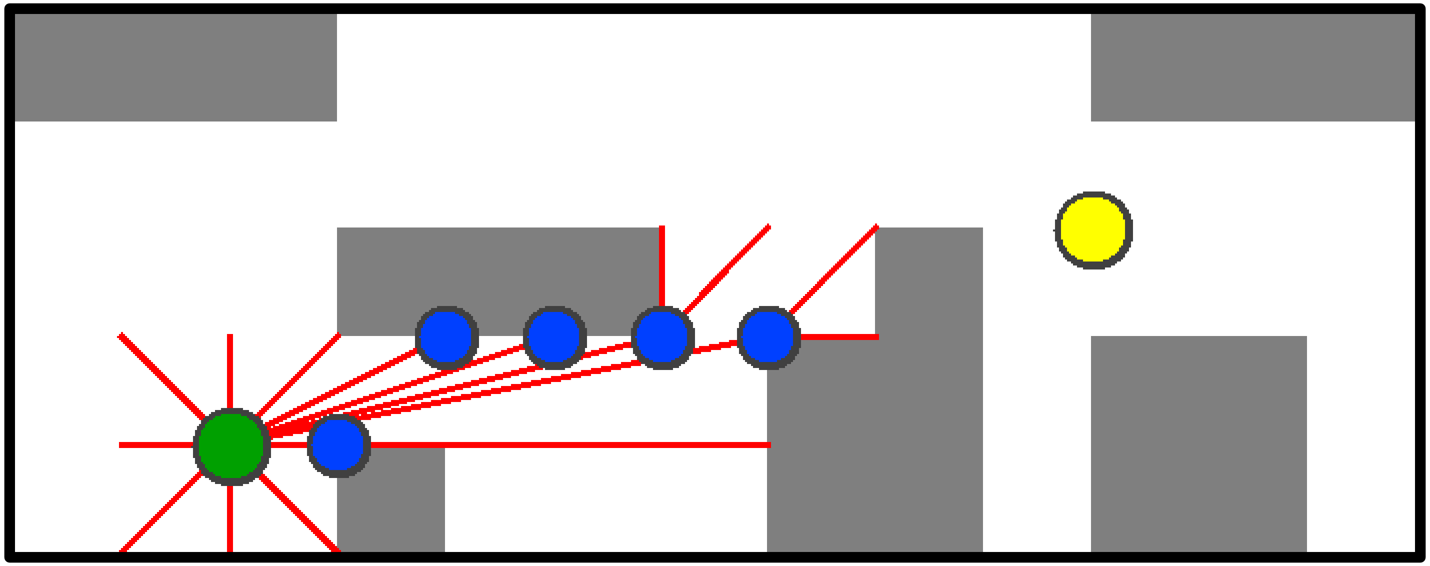

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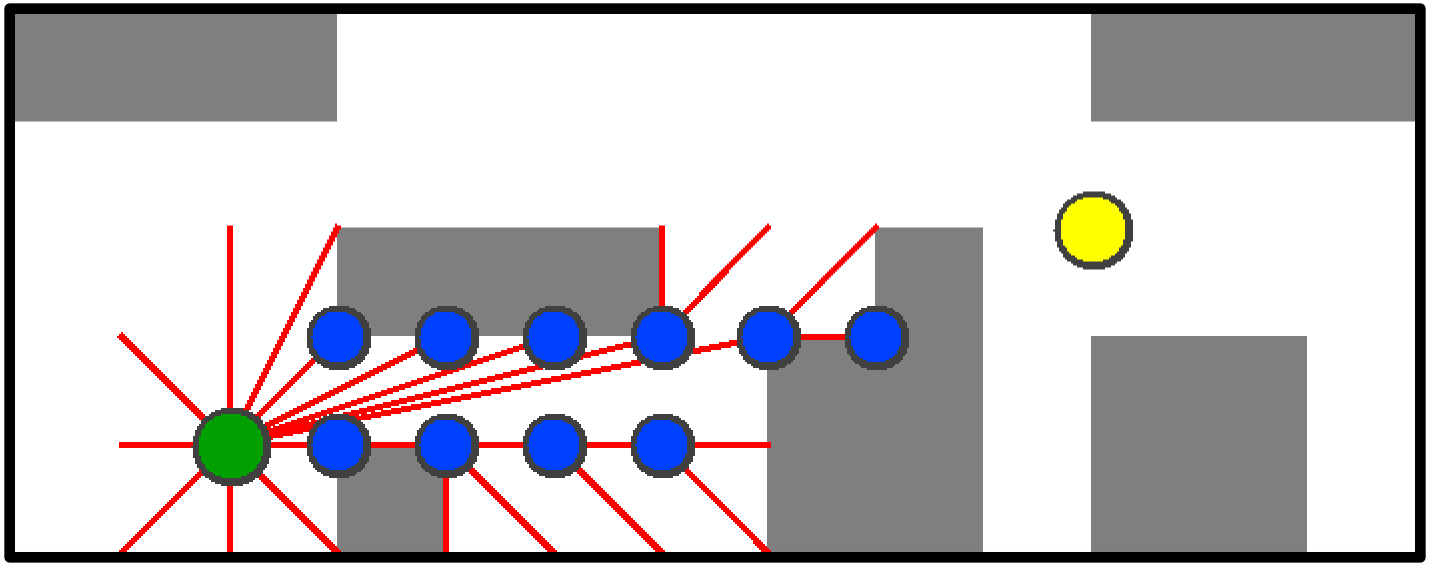

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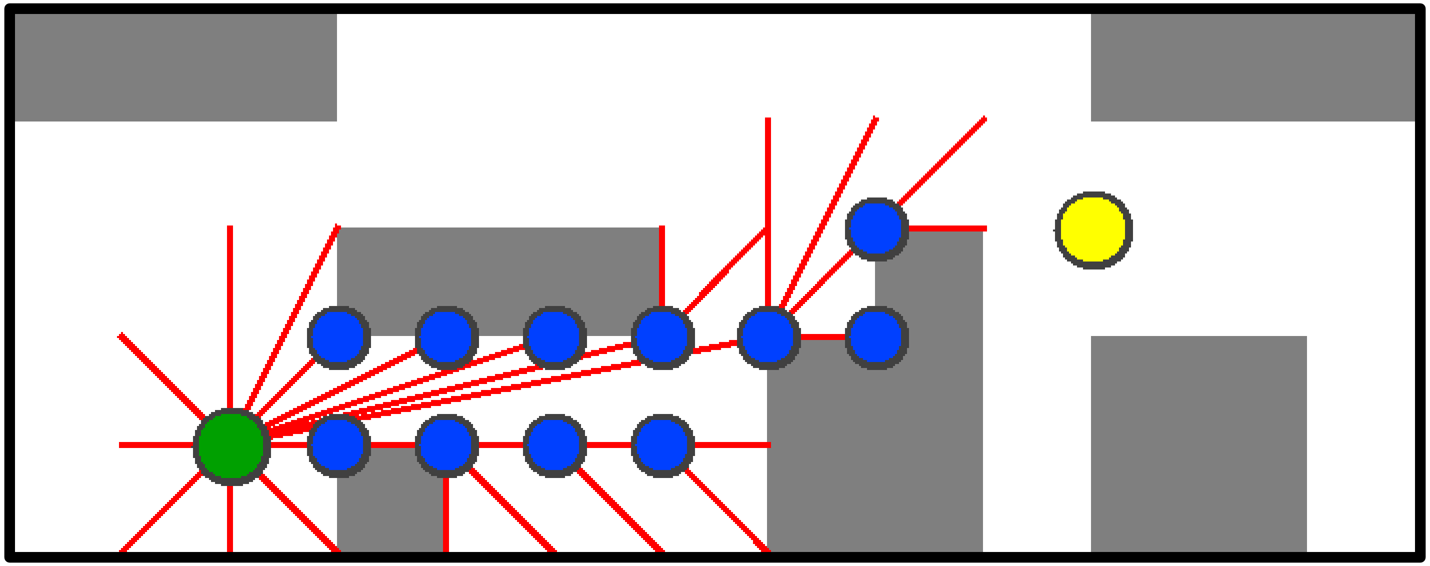

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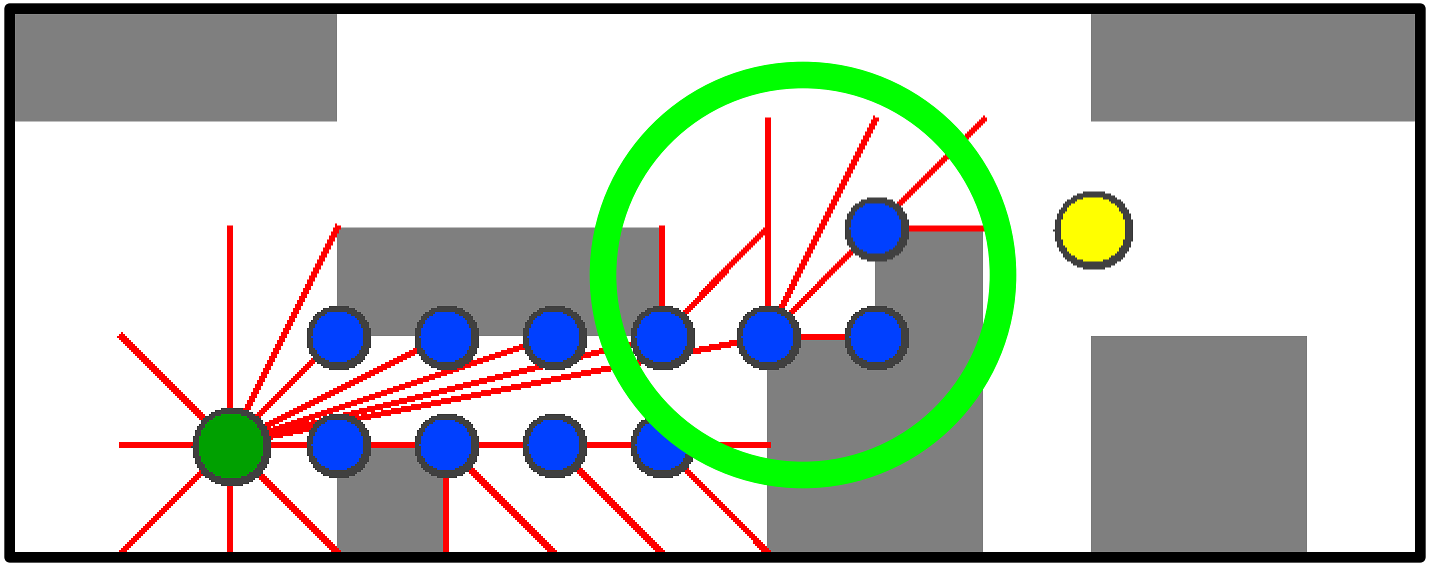

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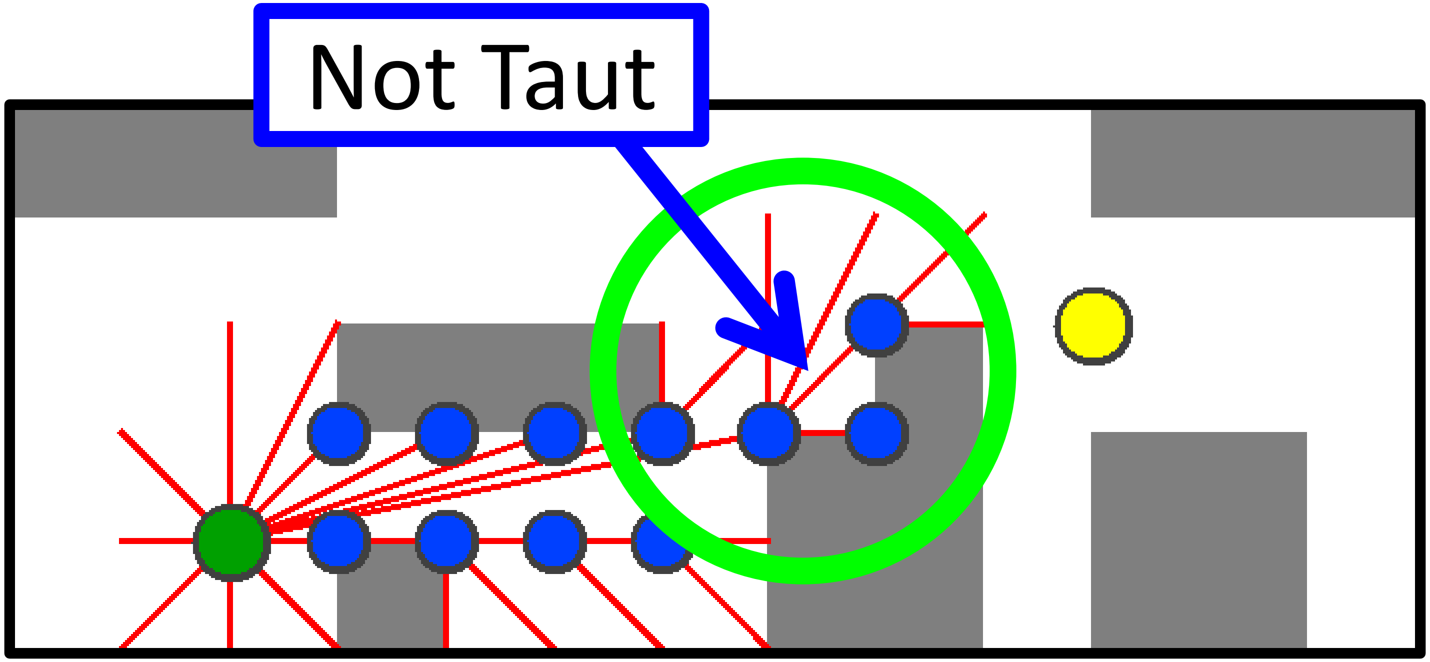

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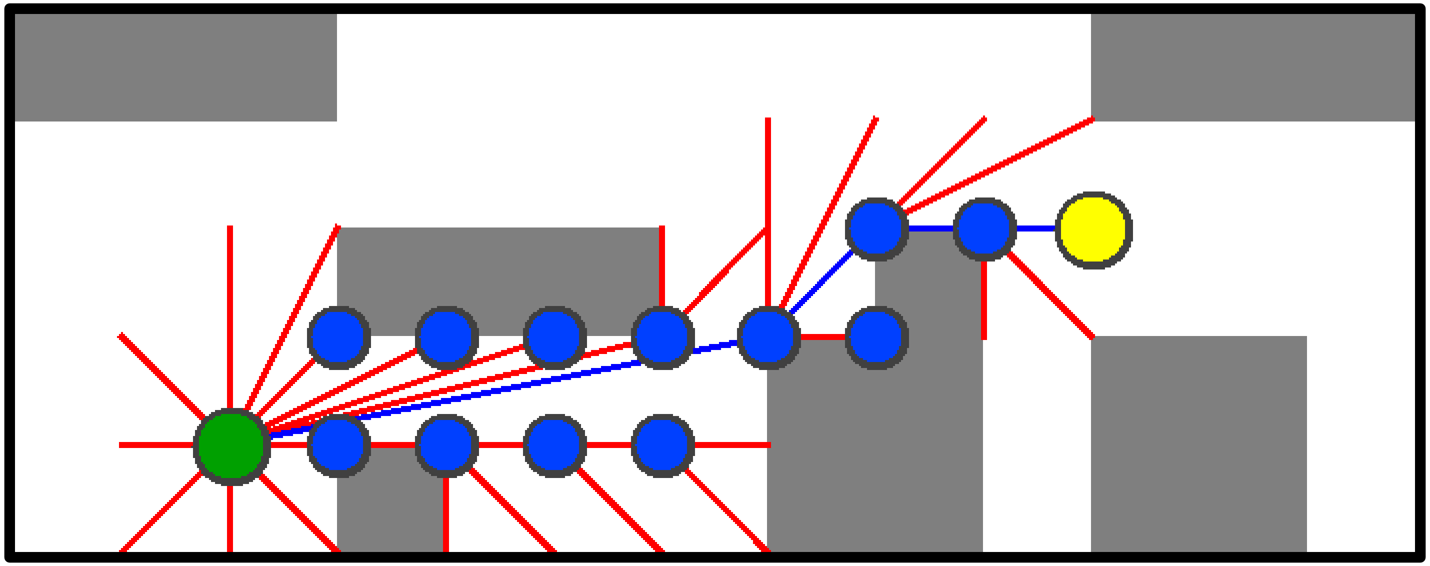

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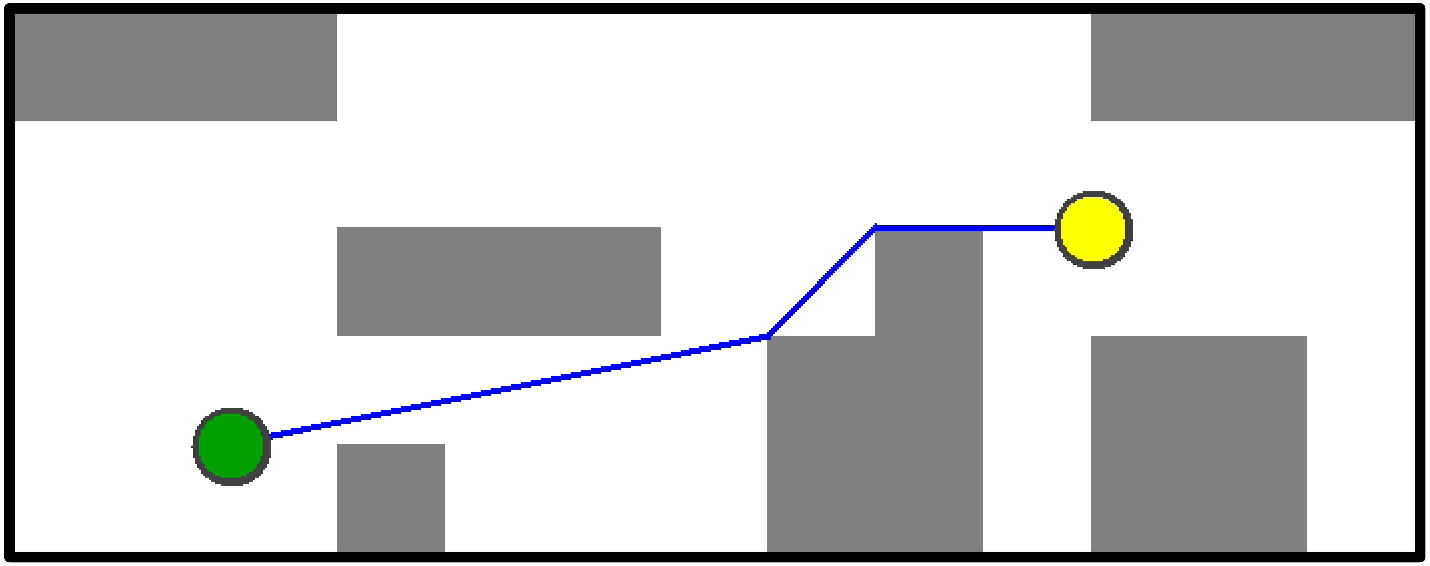

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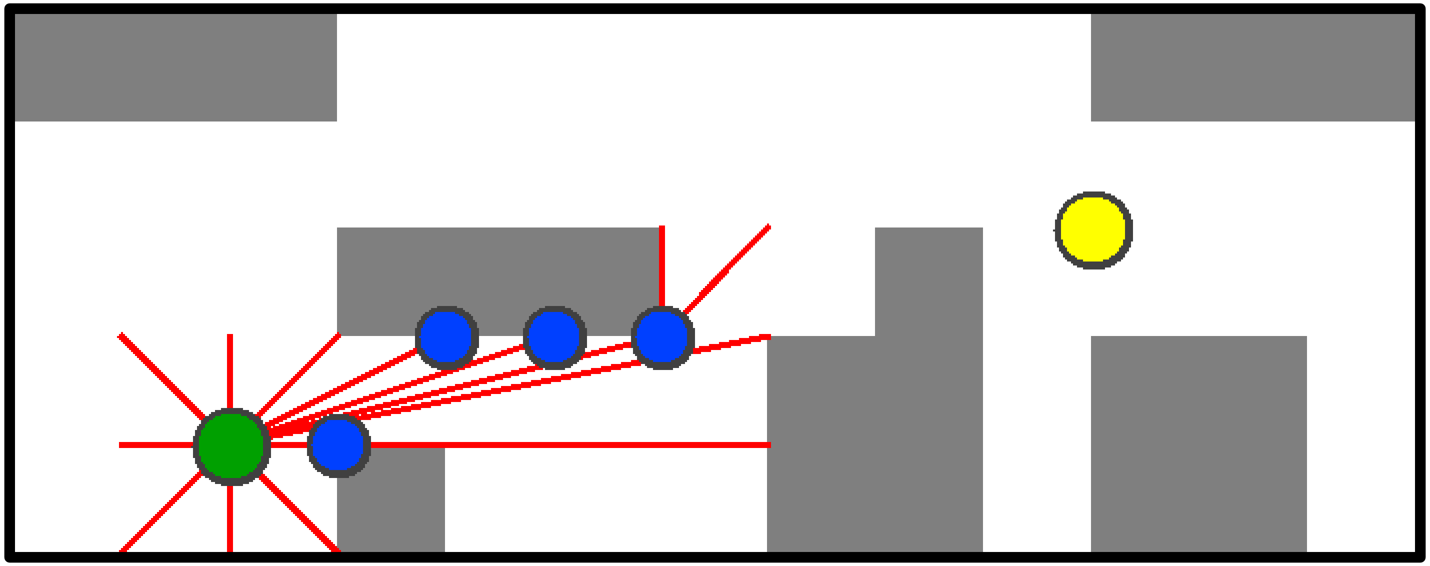

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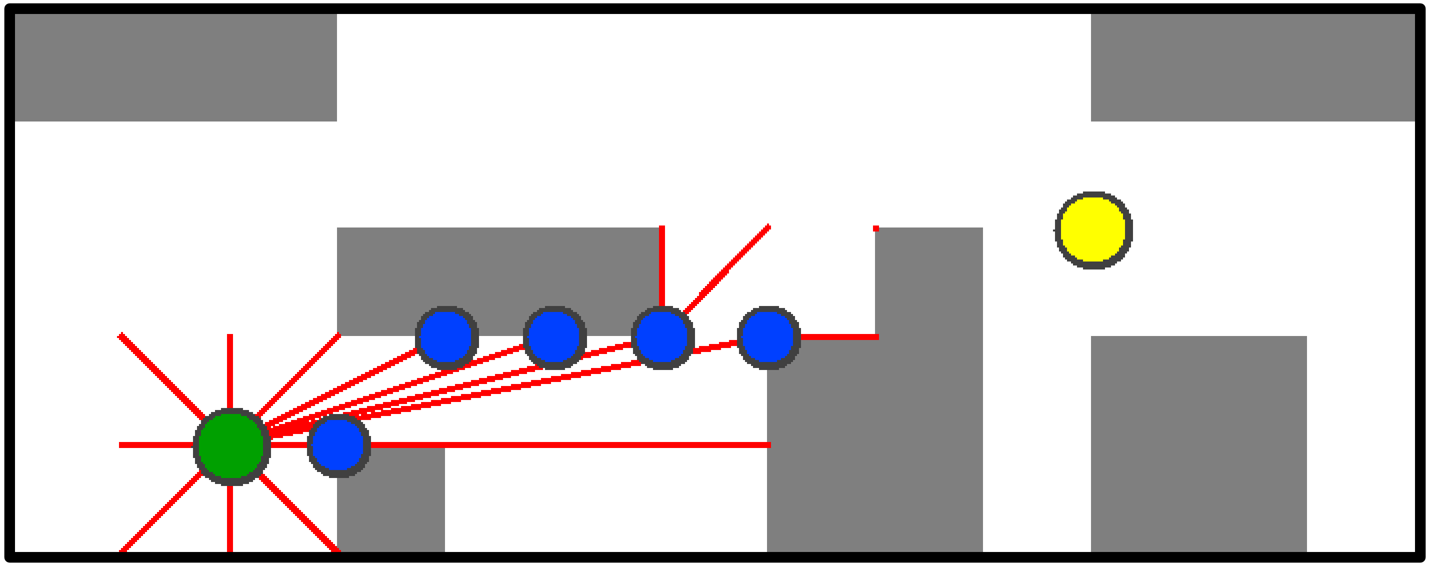

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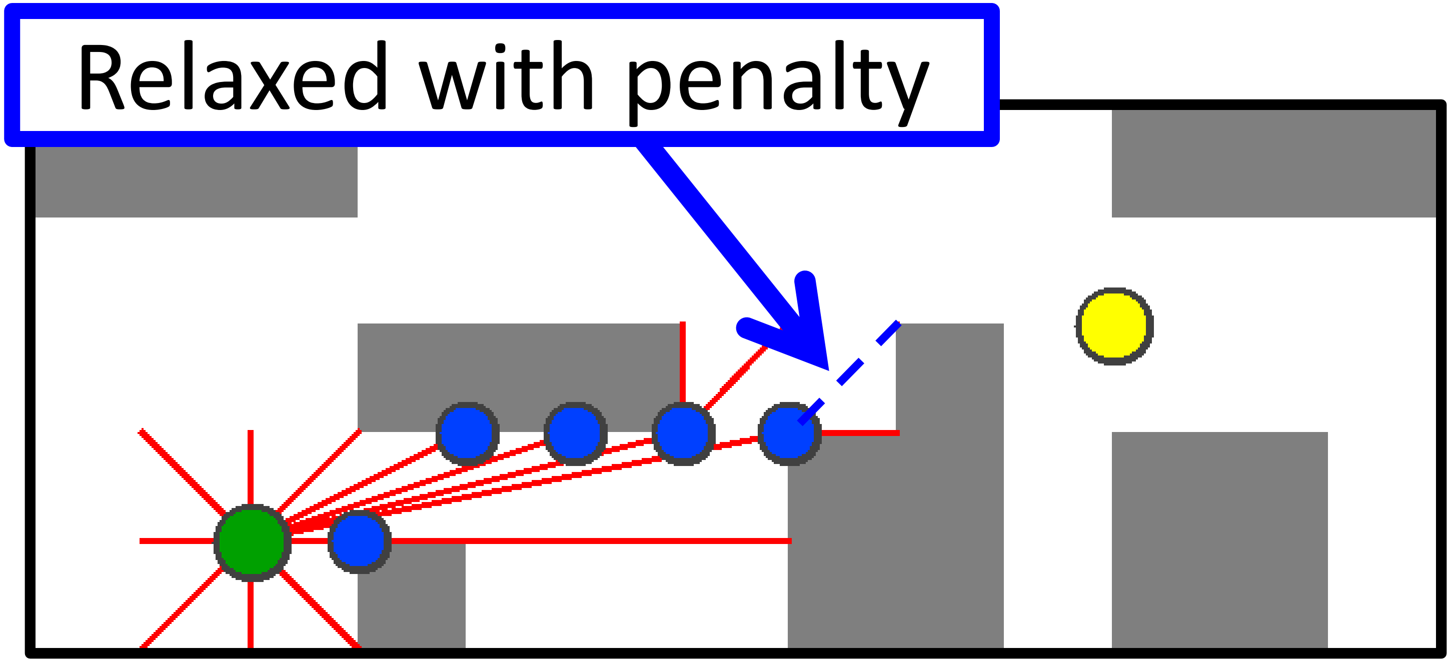
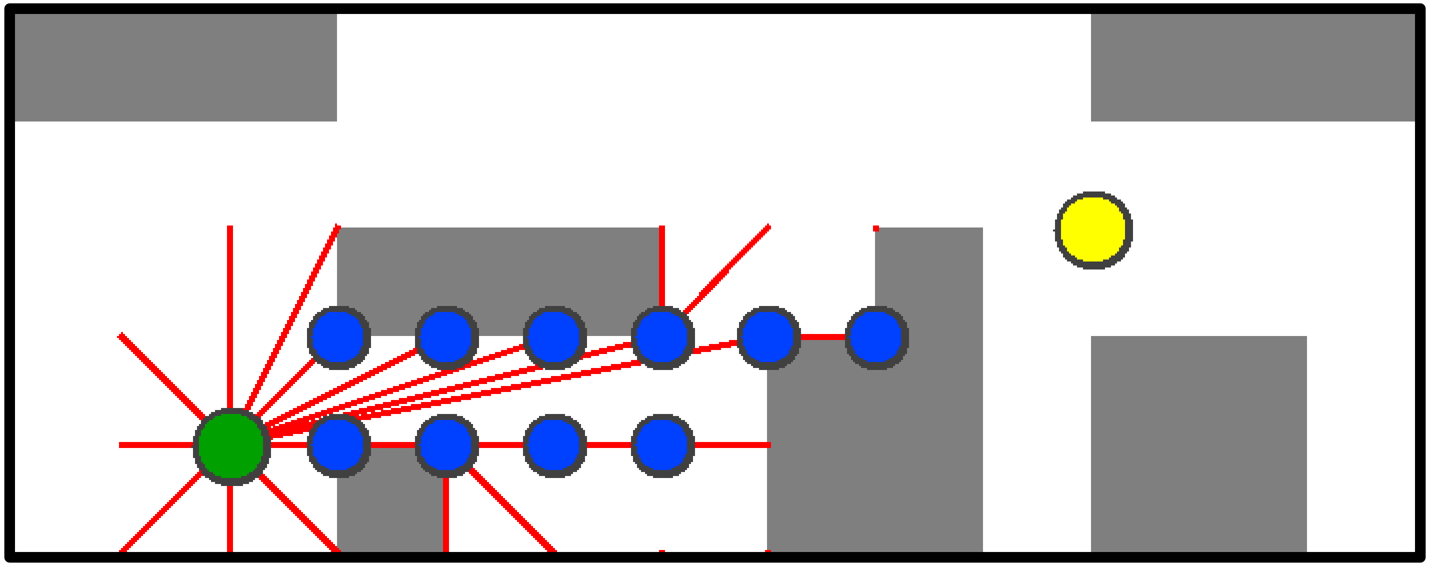


Relaxed with penalty

Strict Theta*



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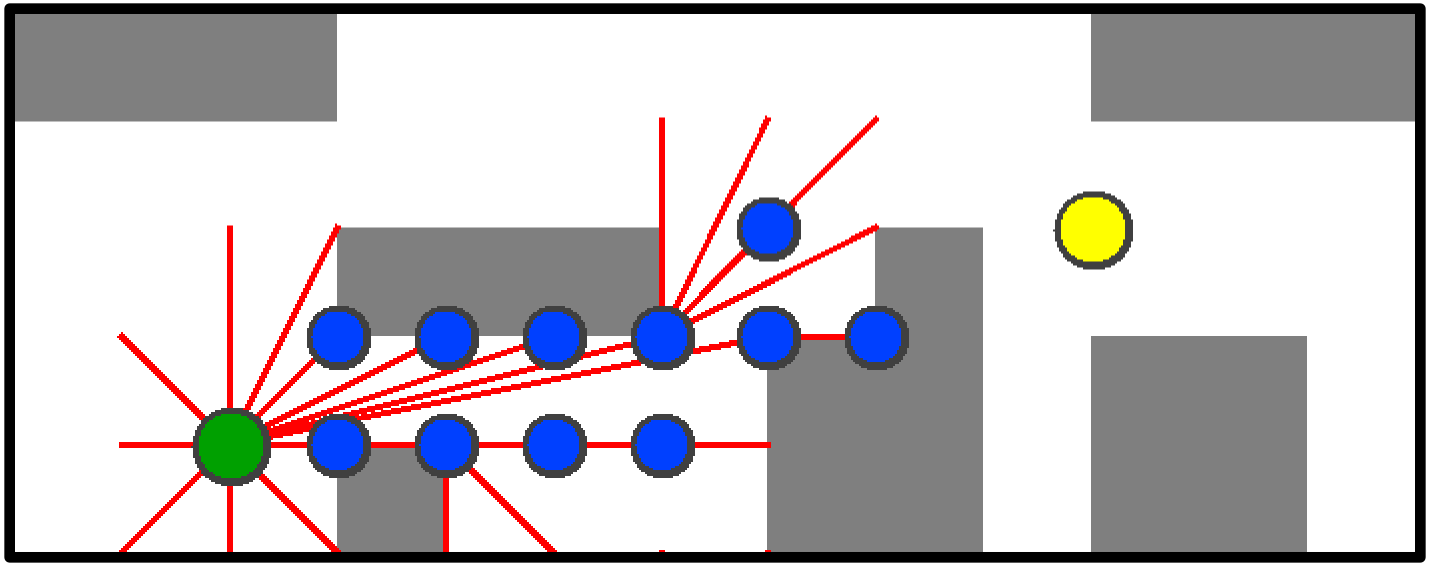
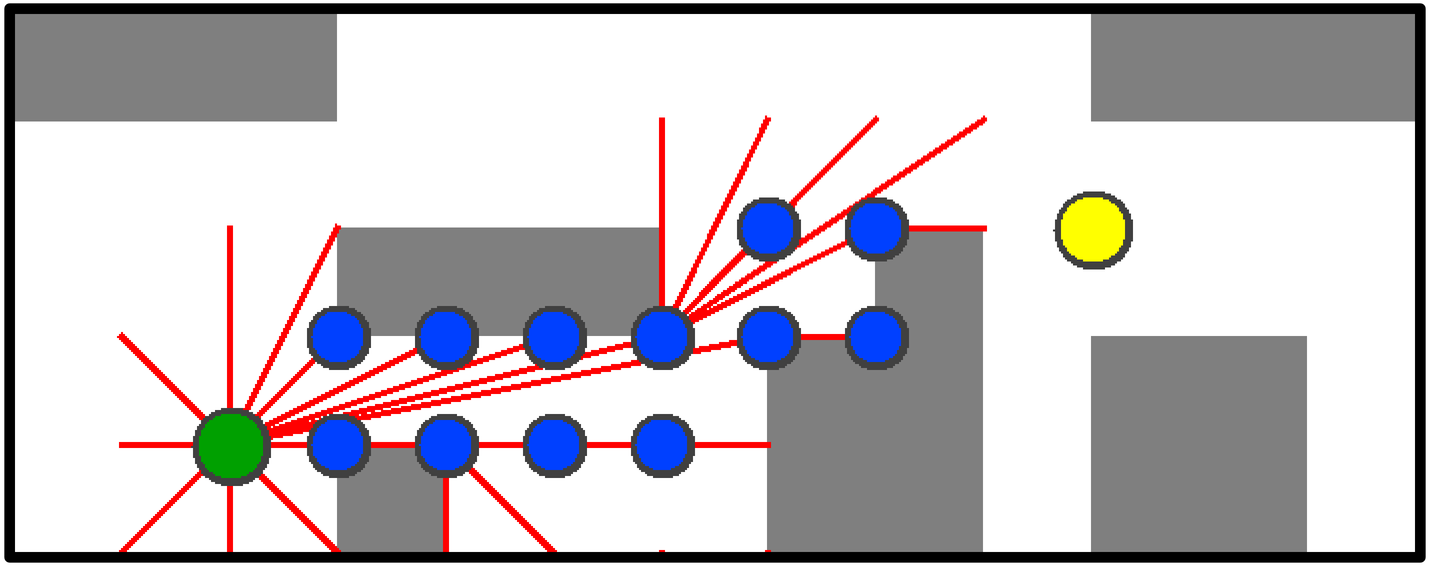
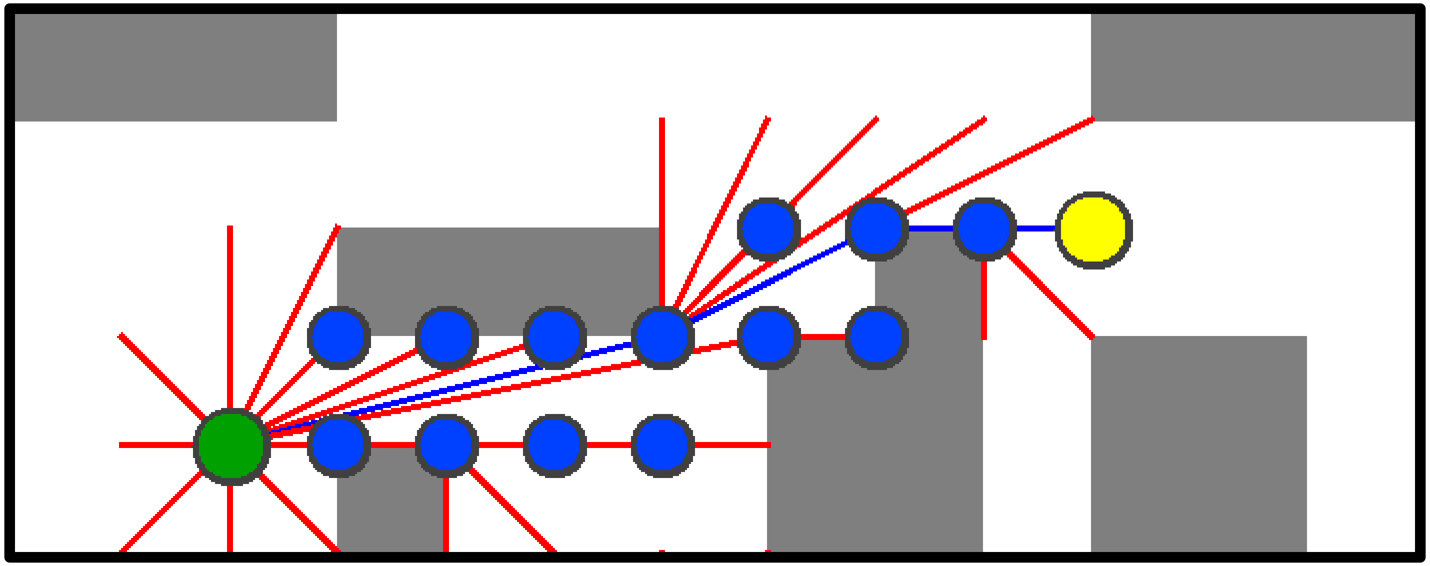


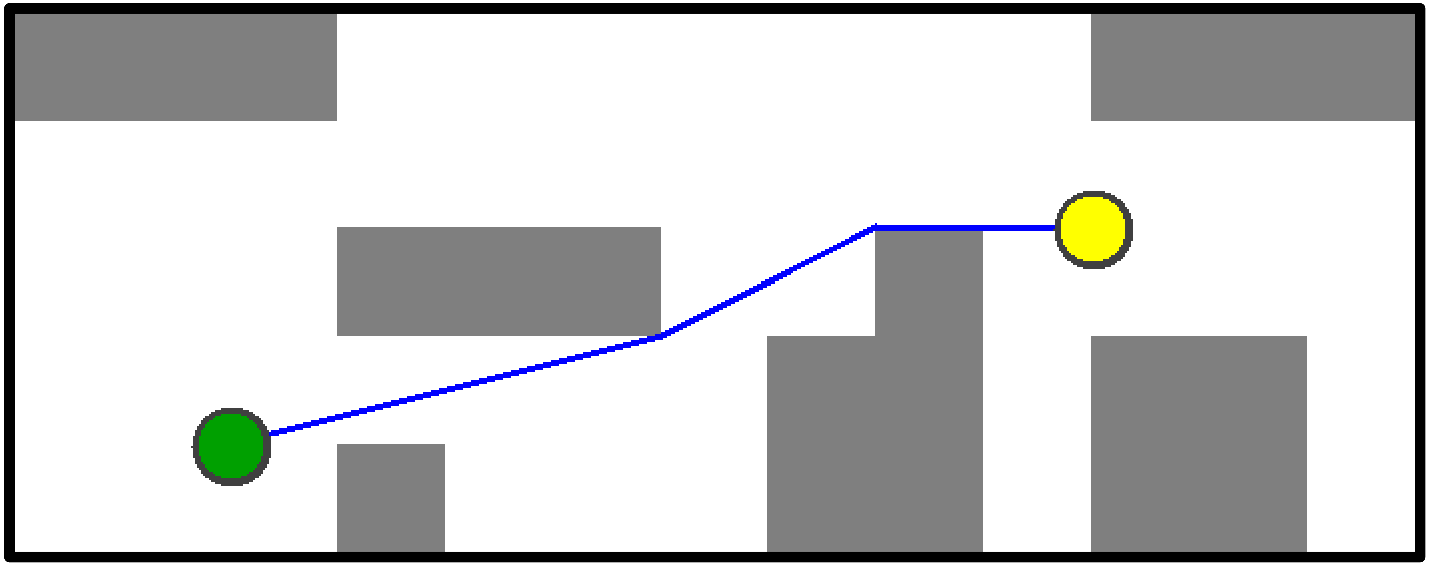
Strict Theta*



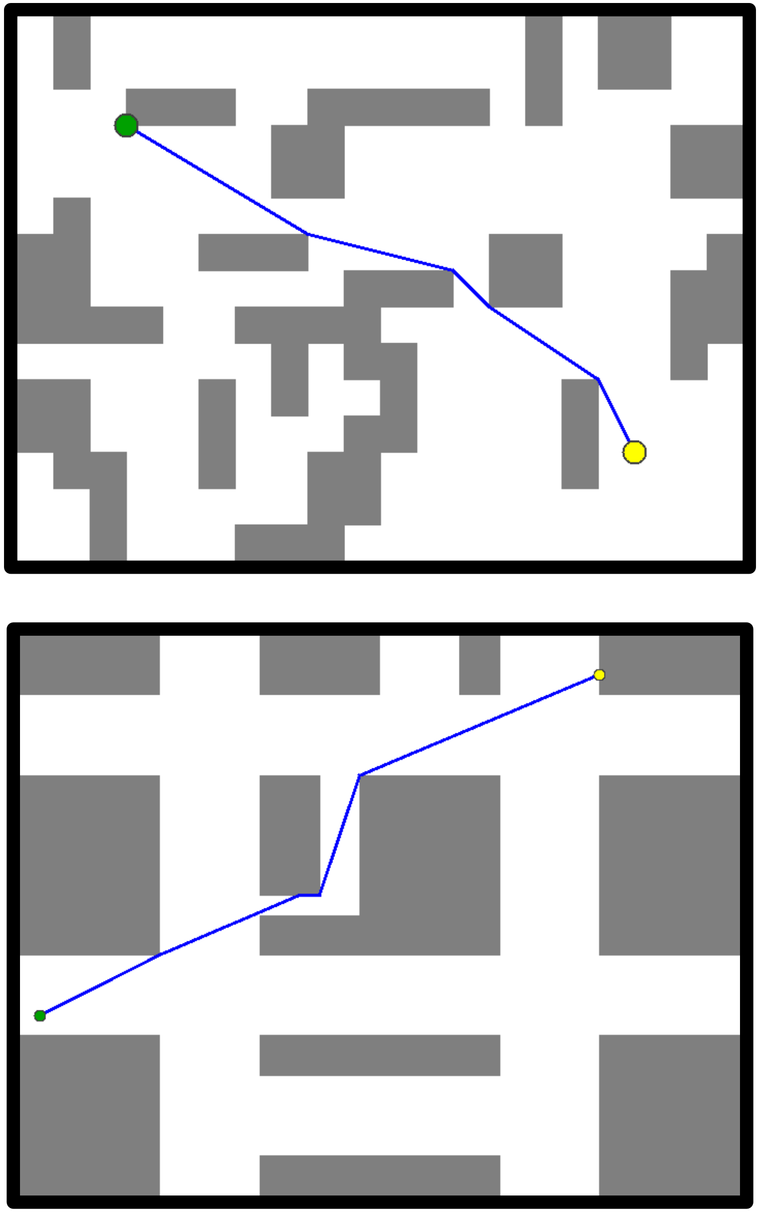
Strict Theta*



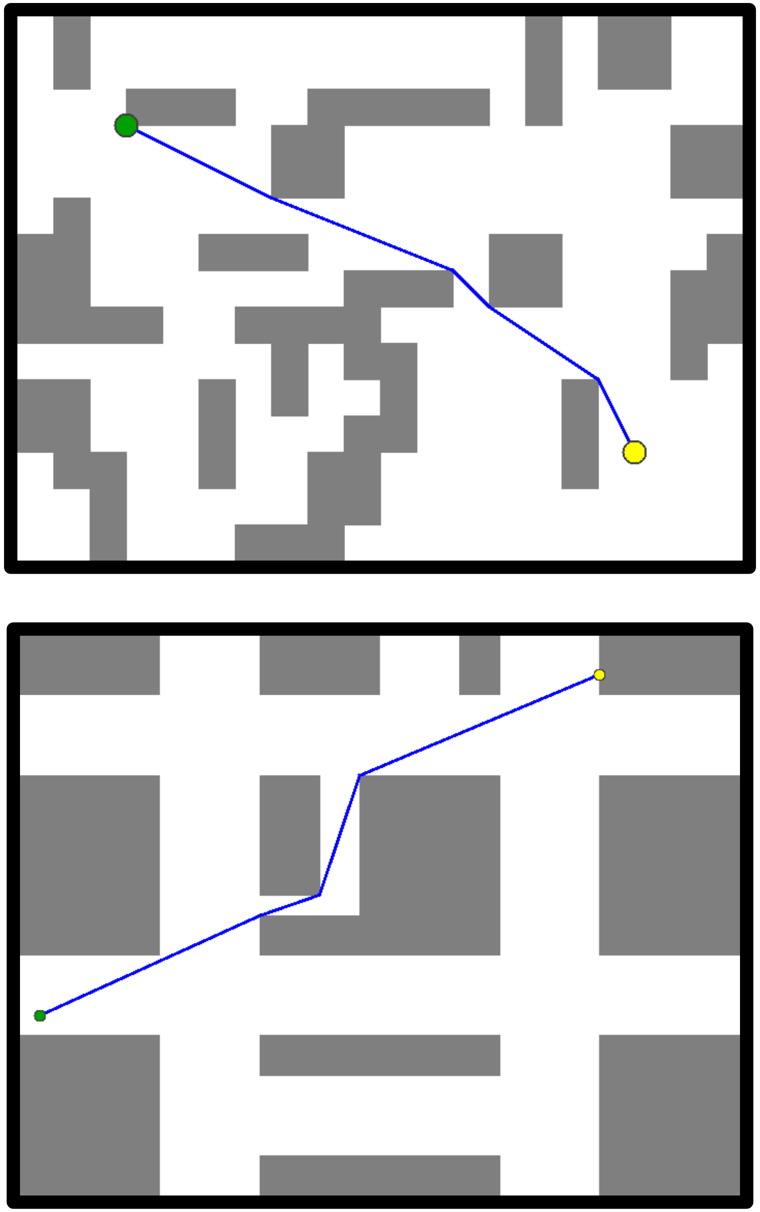
Strict Theta*

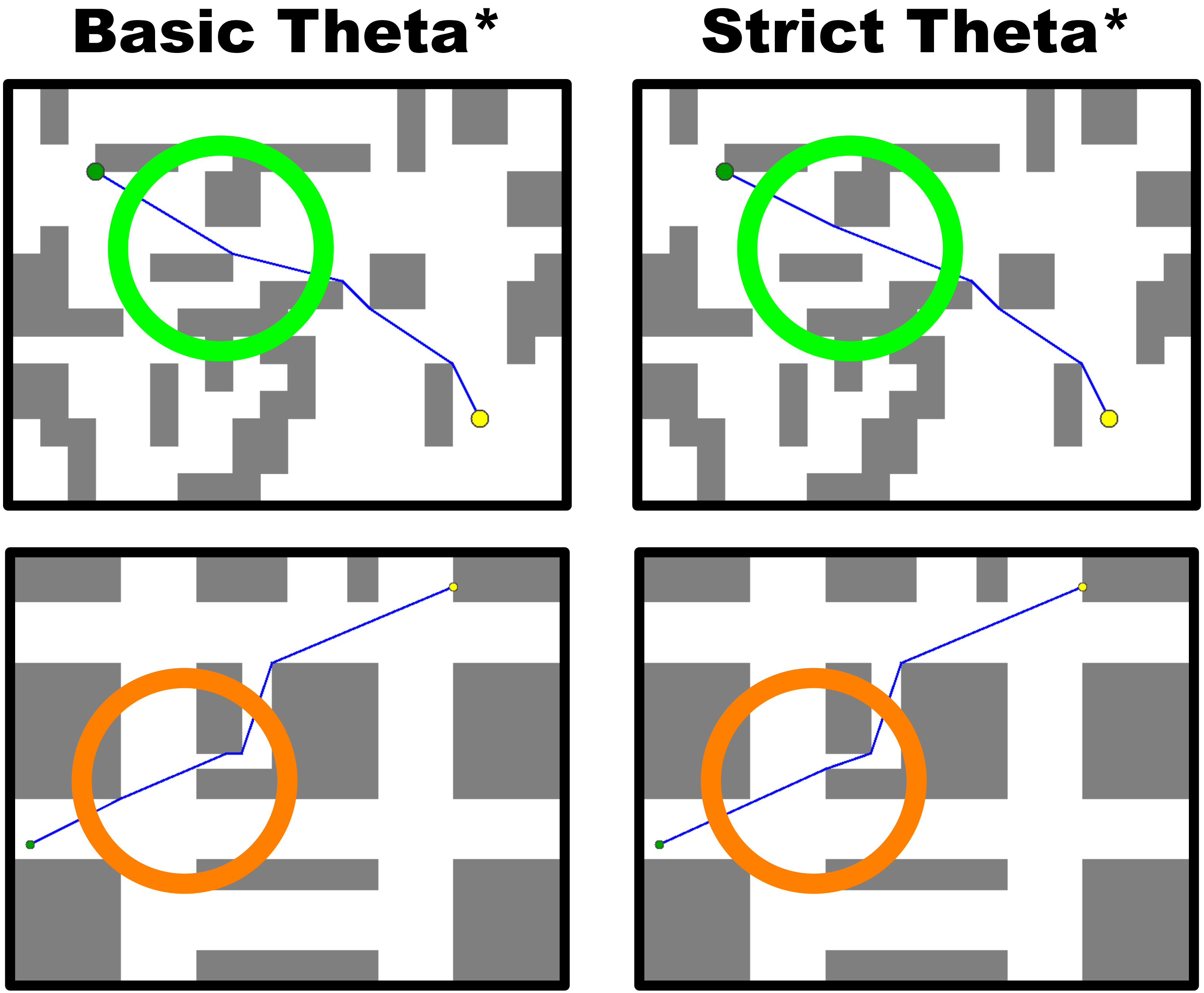


Basic Theta*



Strict Theta*





Basic Theta*

Strict Theta*

Basic Theta*

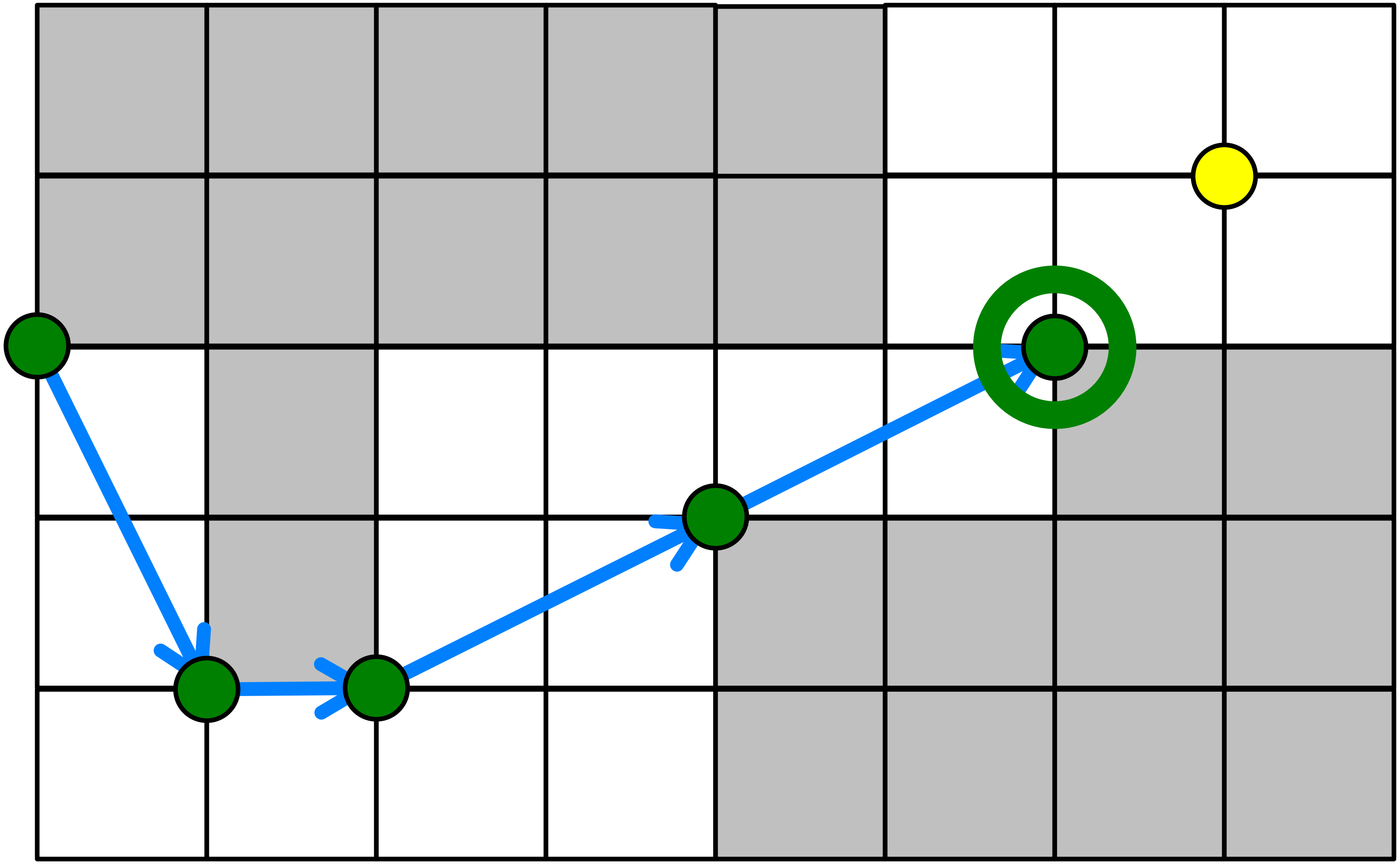
Strict Theta*

Basic Theta*

Strict Theta*

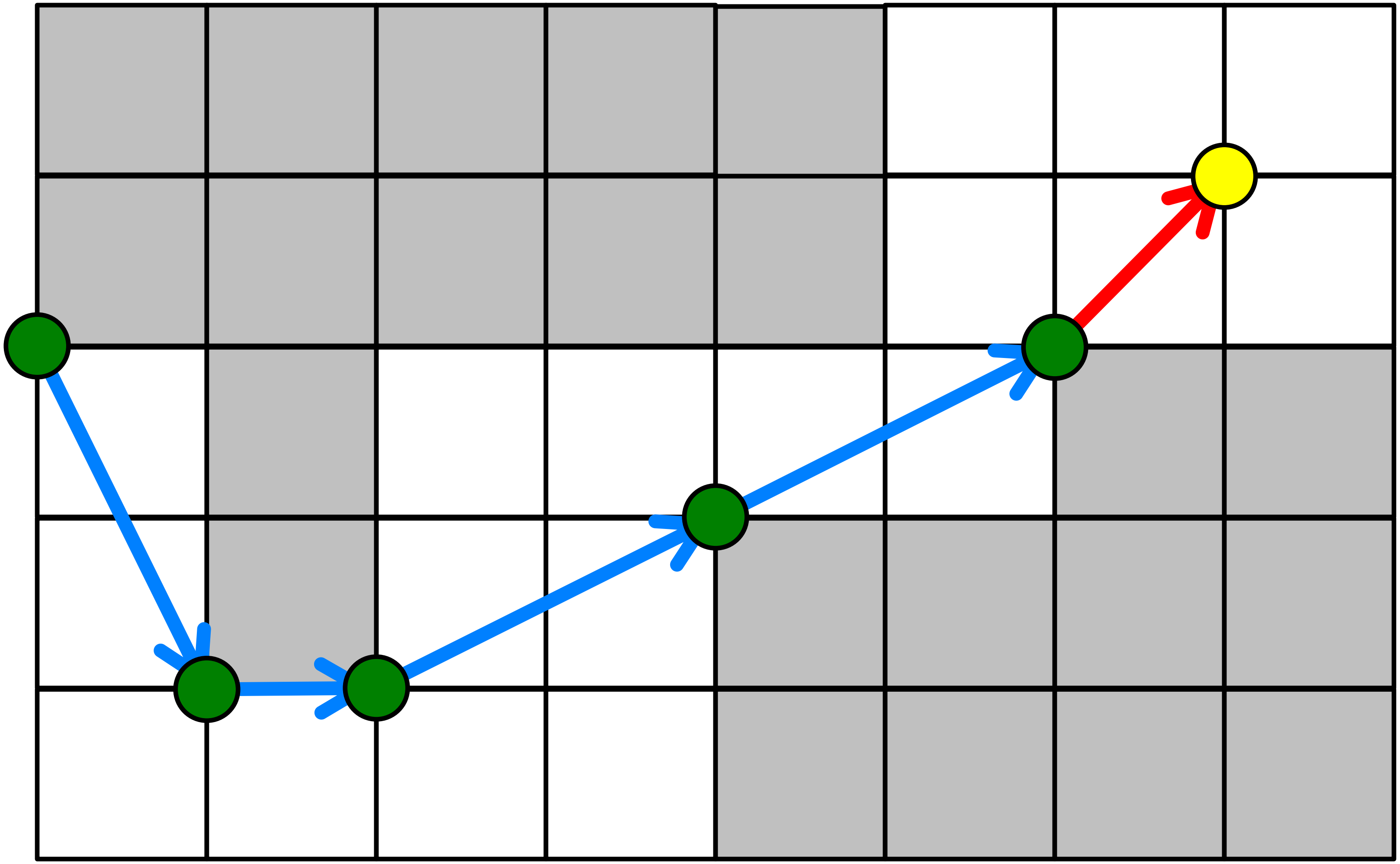
Recursive Strict Theta*

Recursive Strict Theta*

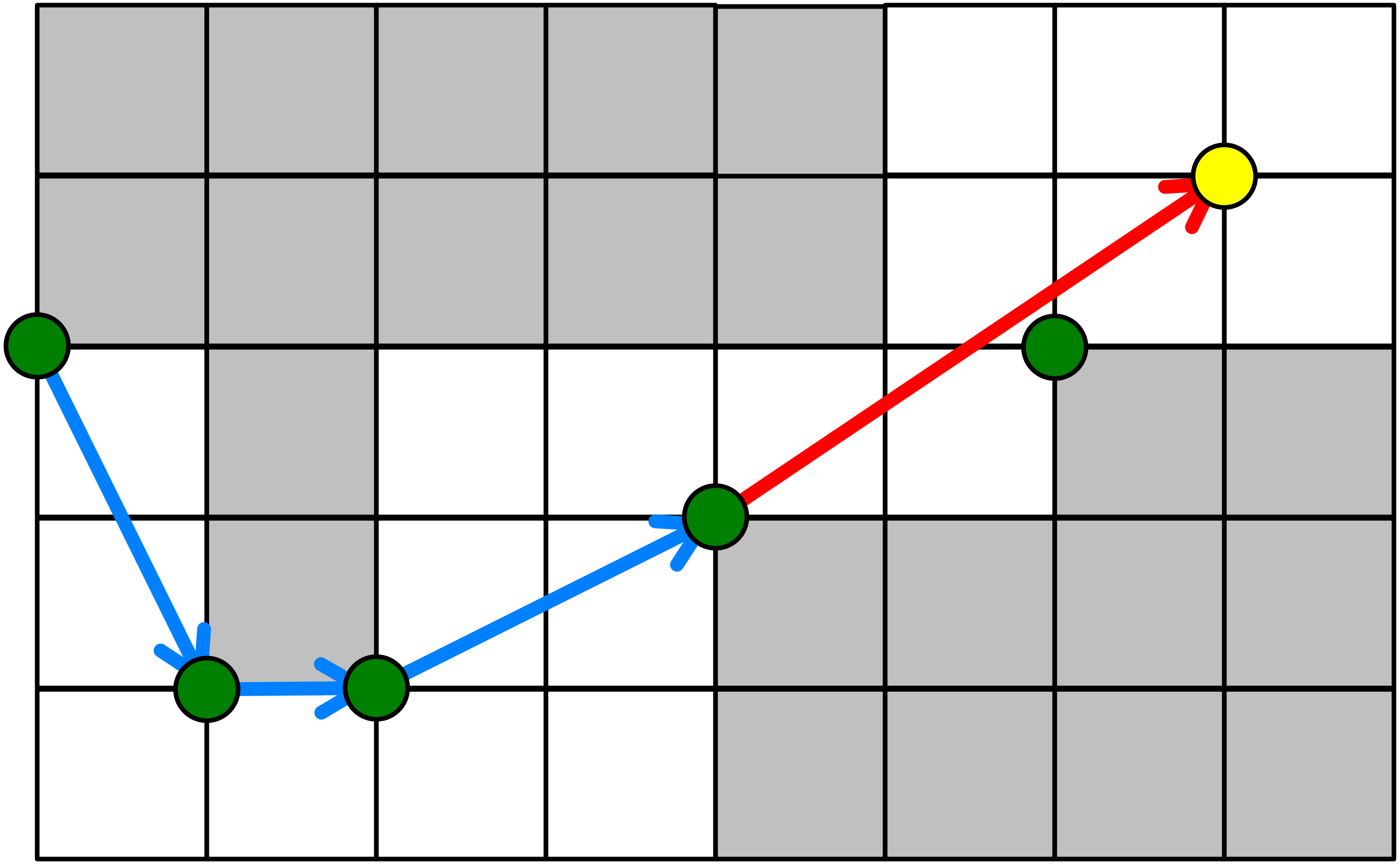


Recursive Strict Theta*

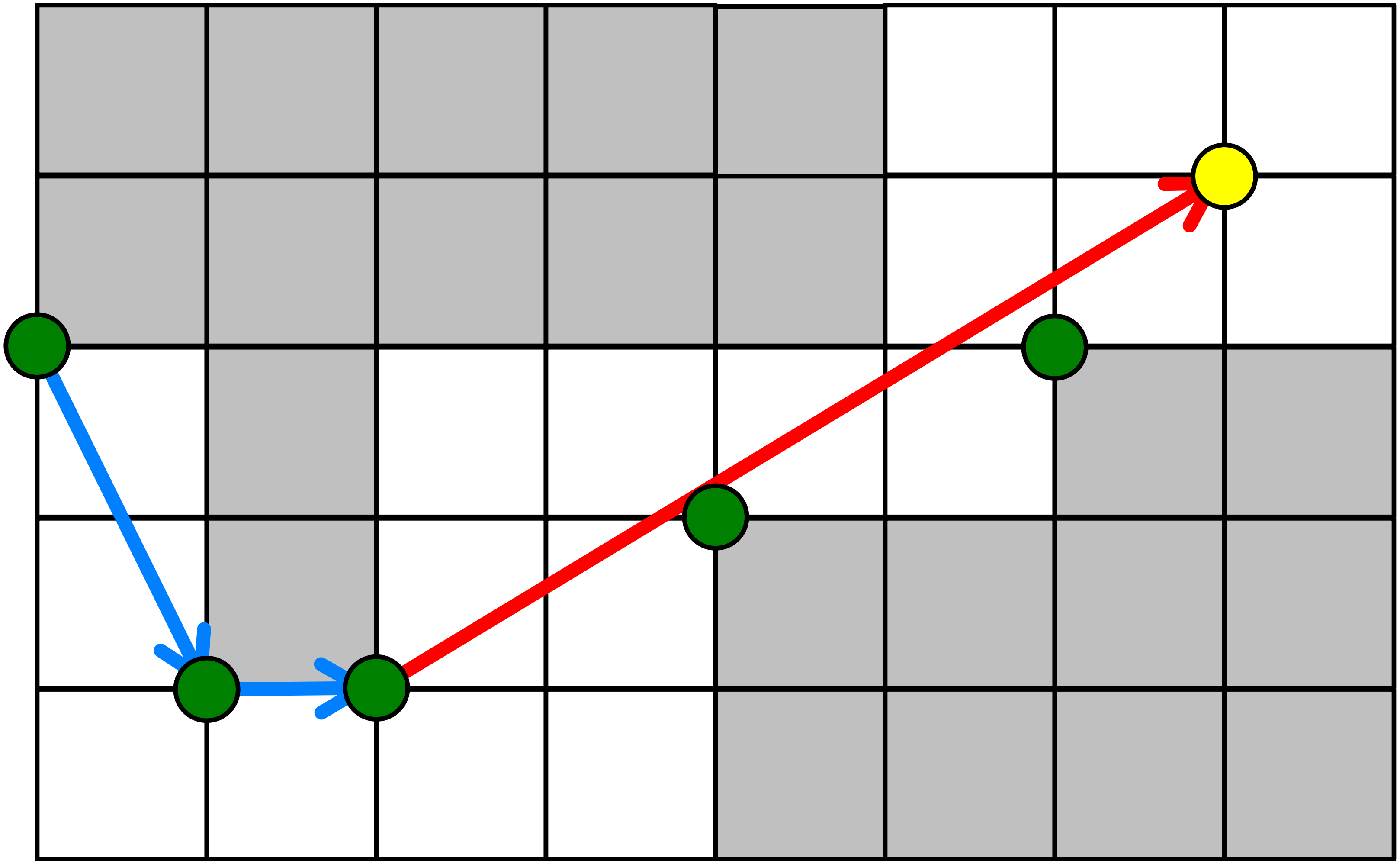
Recursive Strict Theta*



Recursive Strict Theta*

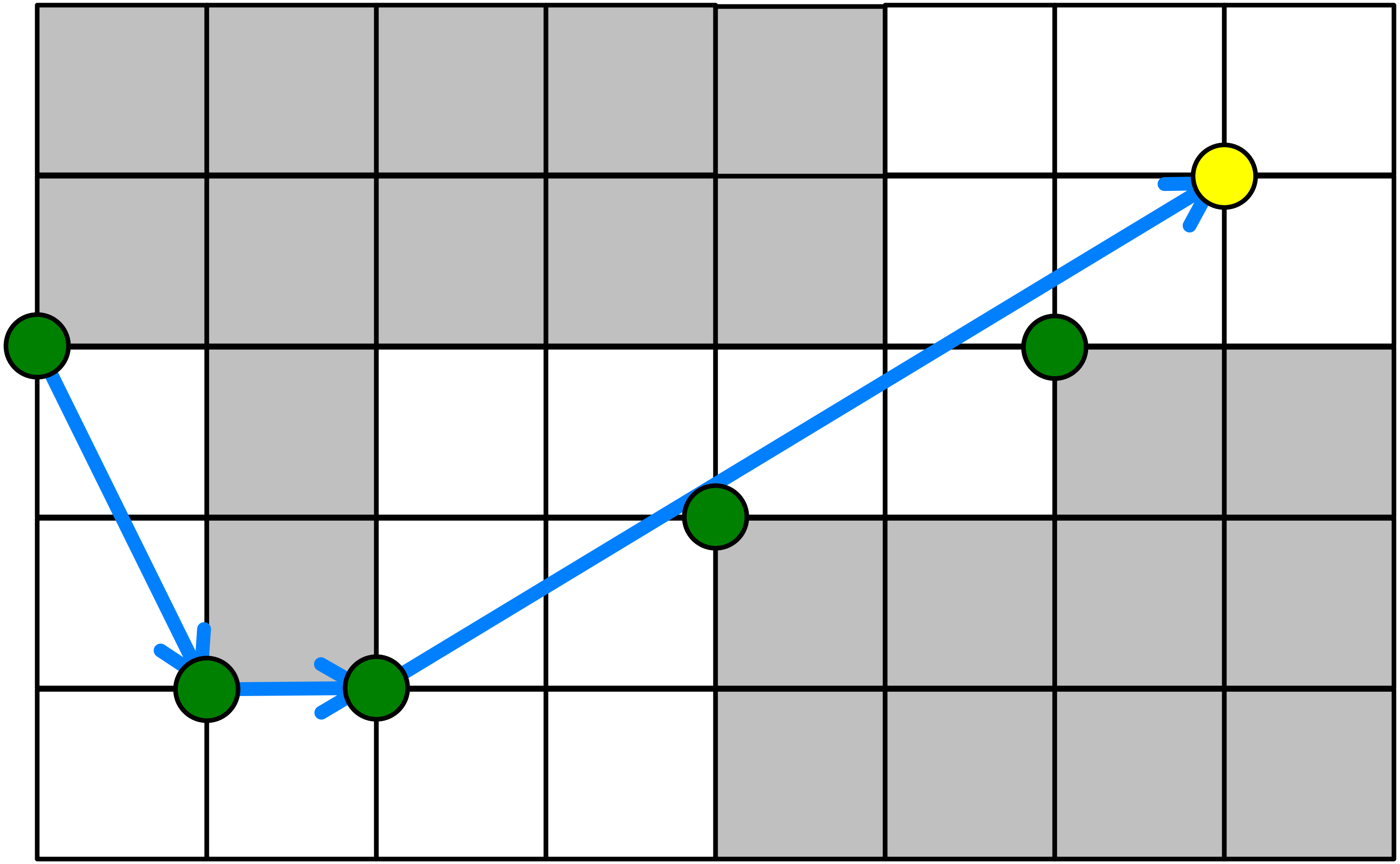


Recursive Strict Theta*



Recursive Strict Theta*

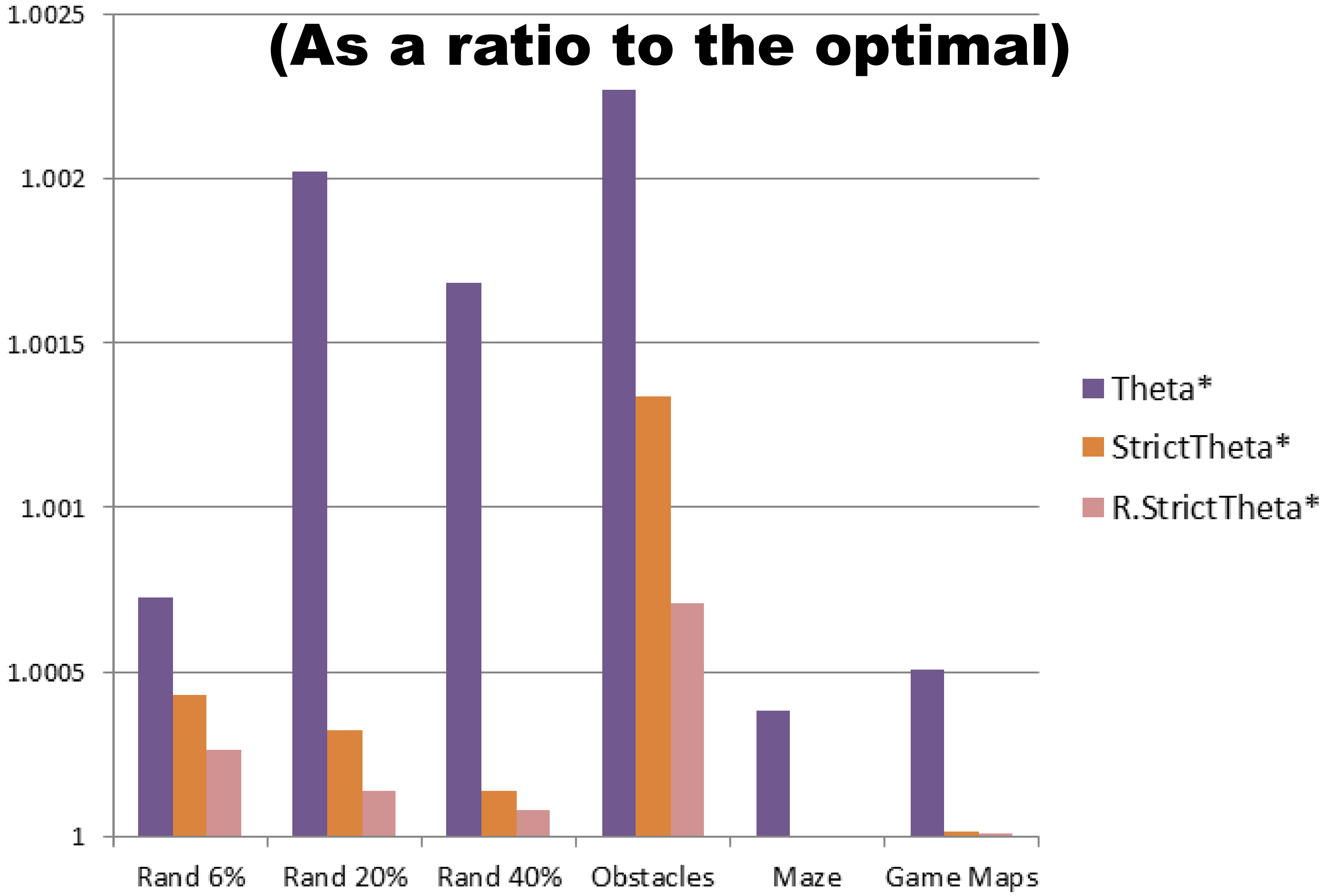
Recursive Strict Theta*



Path Length
(As a ratio to the optimal)

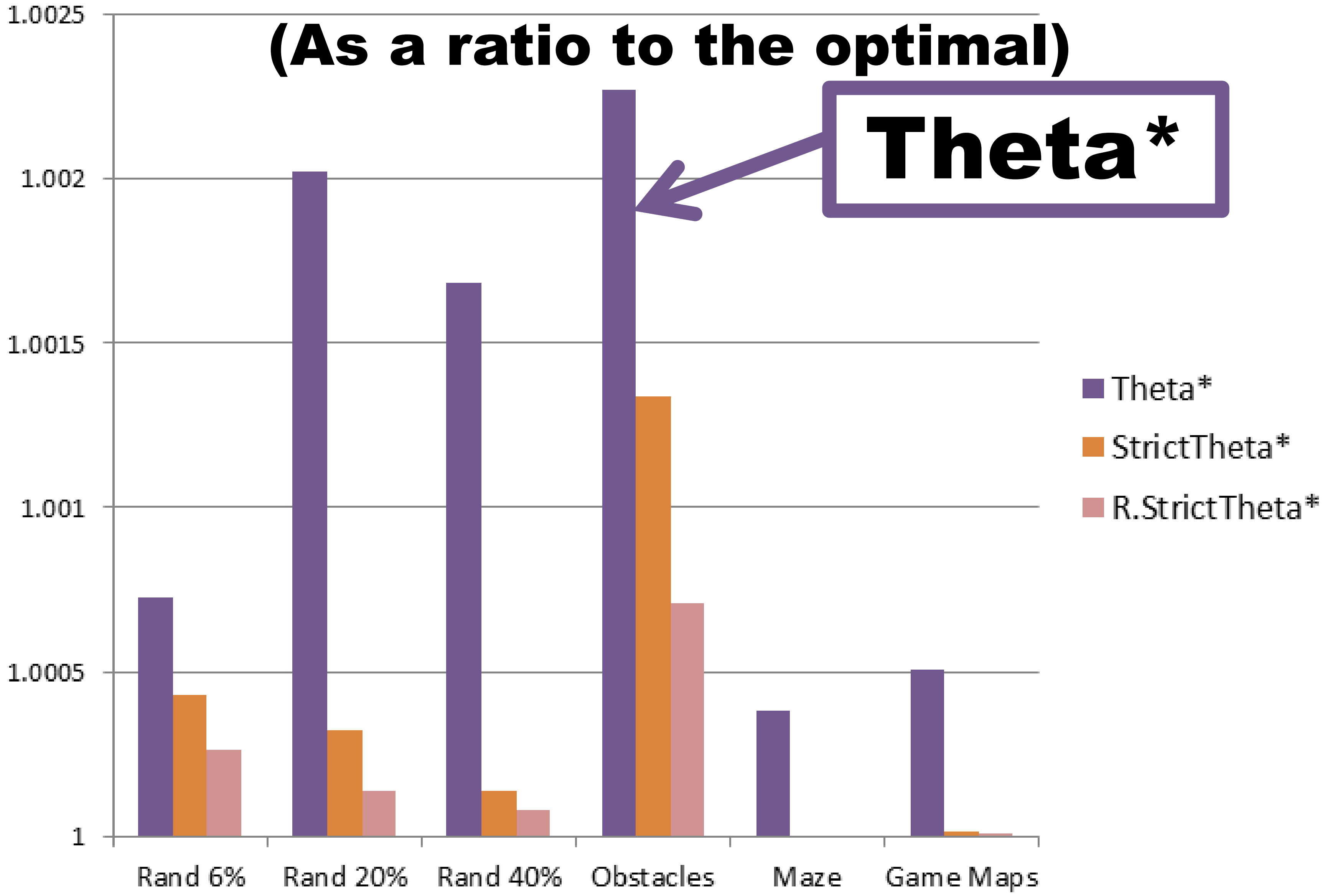
Path Length

(As a ratio to the optimal)



Path Length

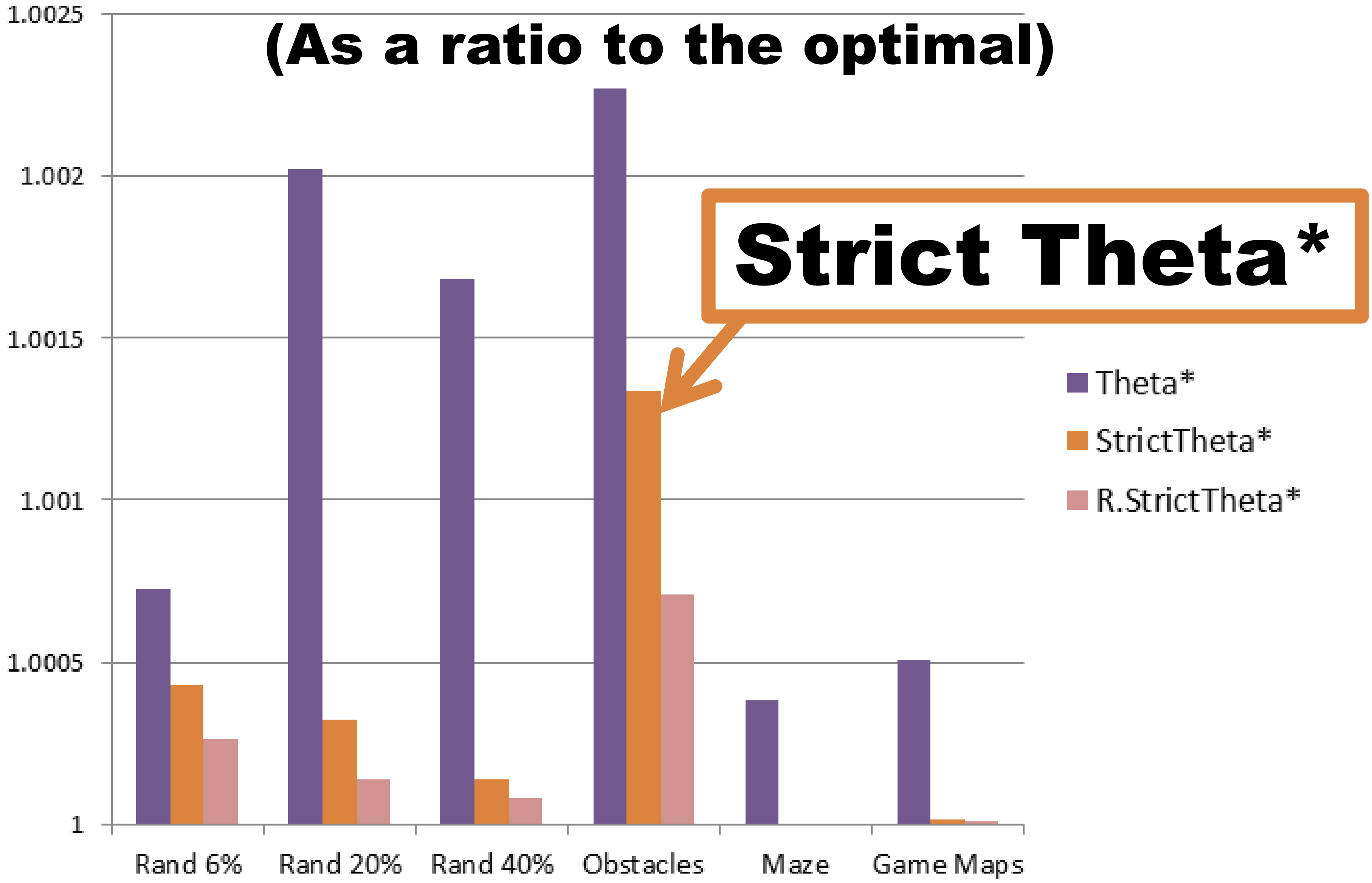
(As a ratio to the optimal)



Theta*

Path Length

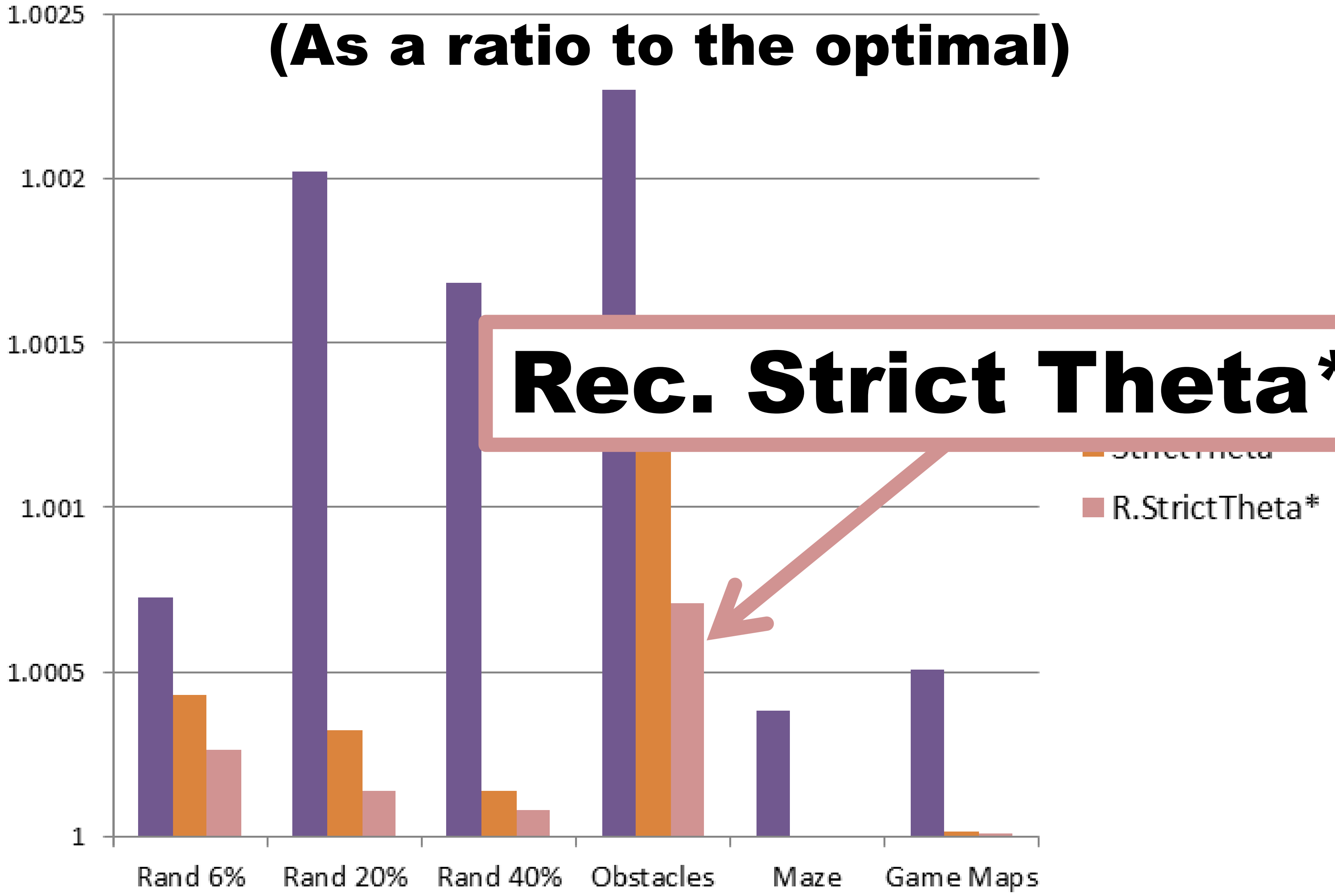
(As a ratio to the optimal)



Strict Theta*

Path Length

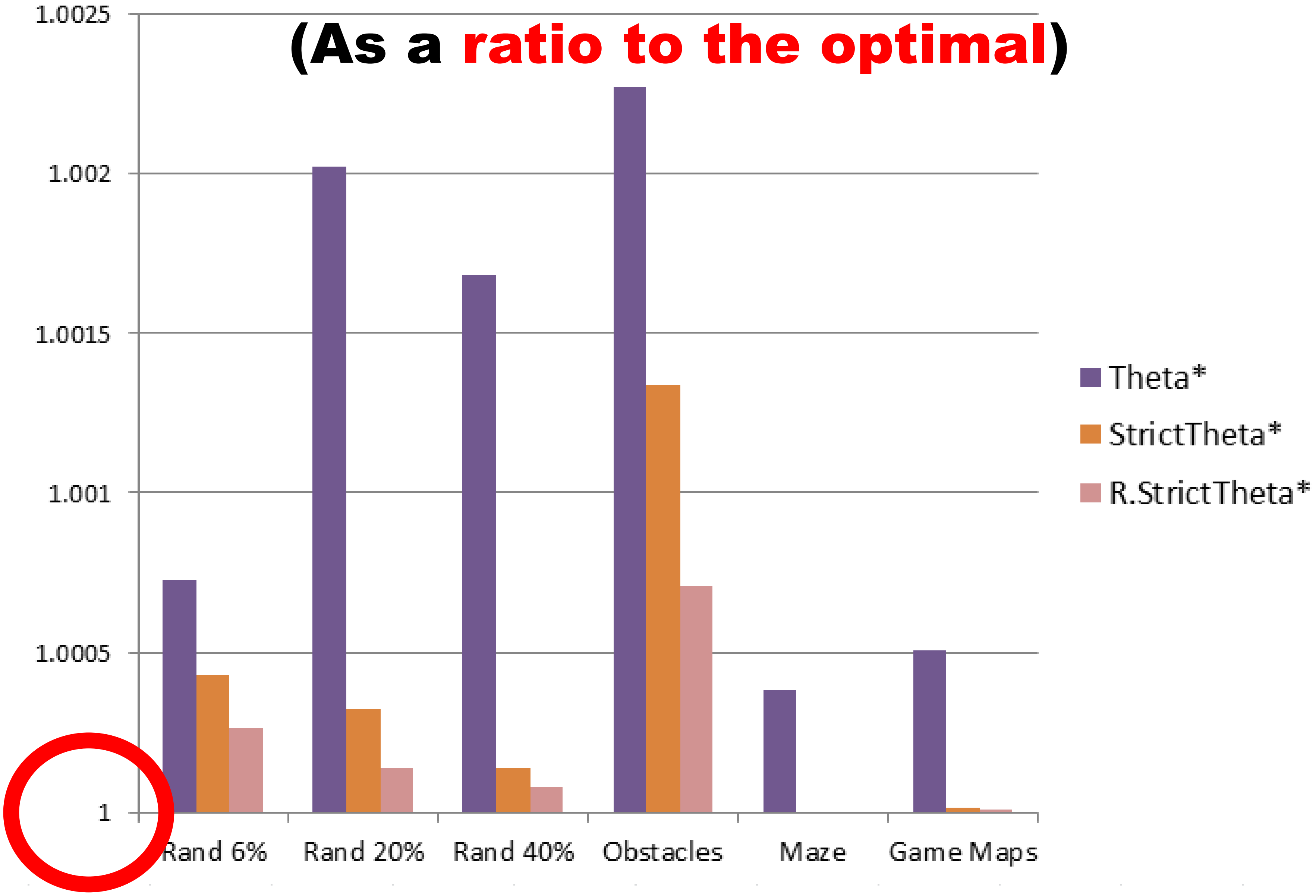
(As a ratio to the optimal)



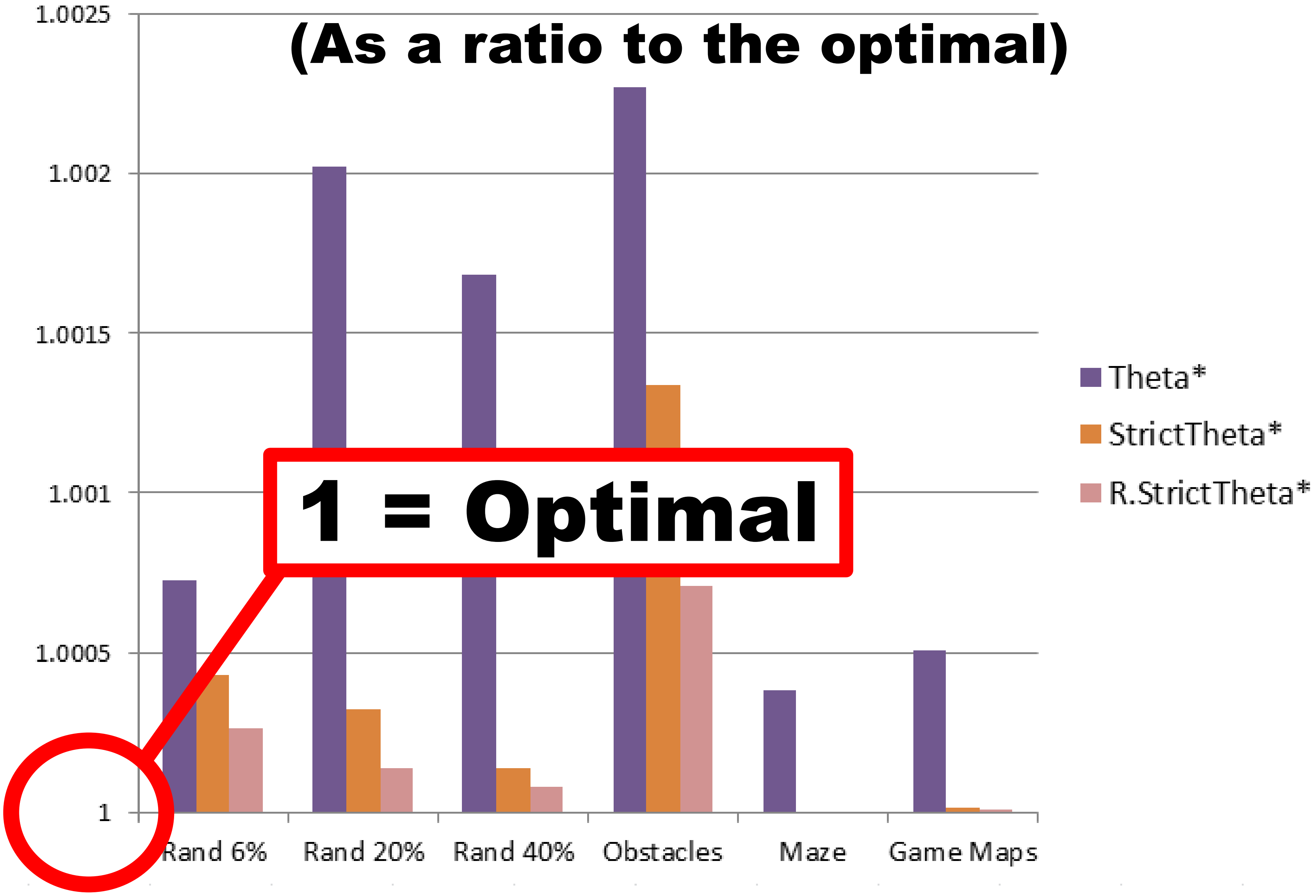
Rec. Strict Theta*

Path Length

(As a **ratio to the optimal**)



Path Length

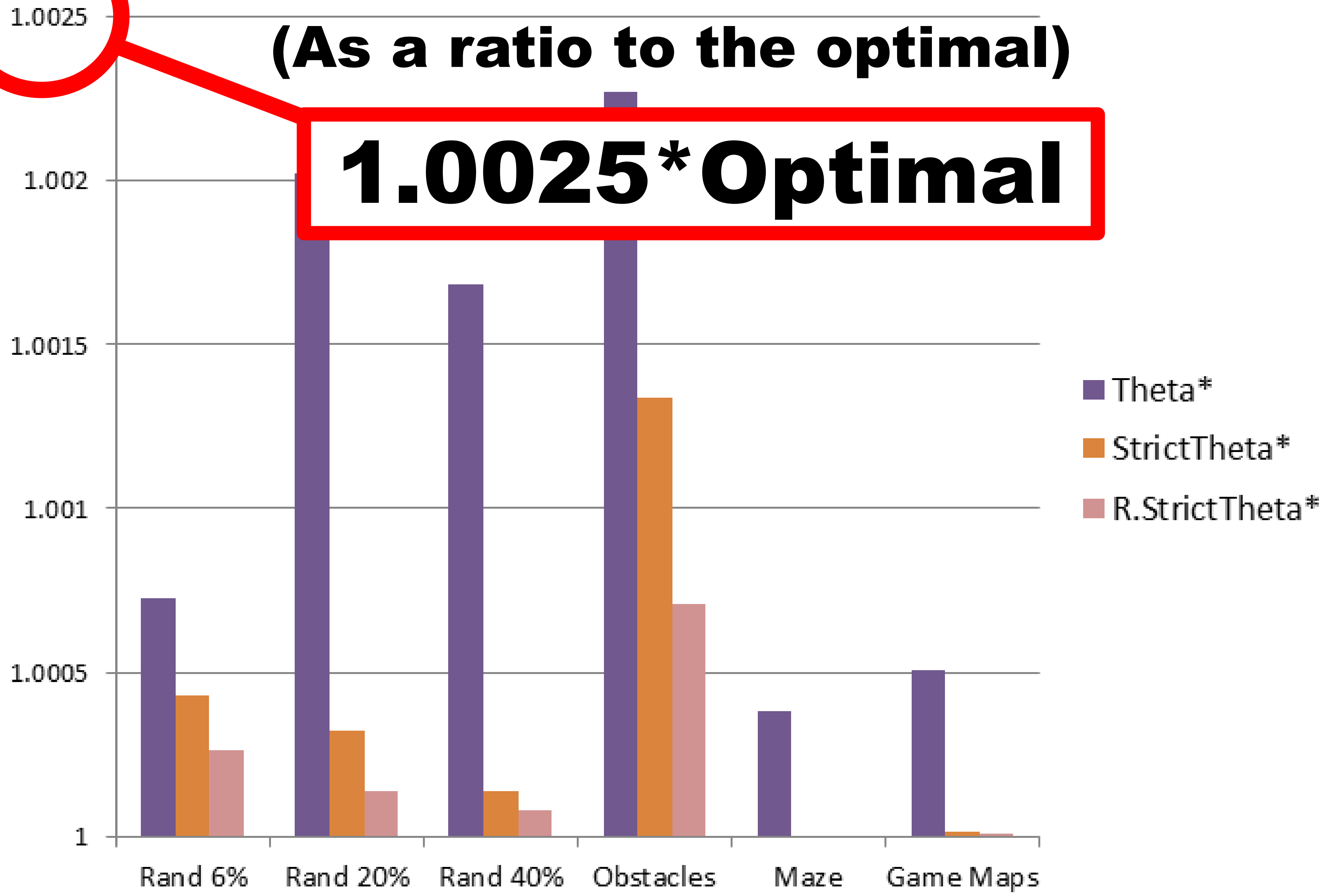


(As a ratio to the optimal)

1 = Optimal

Path Length

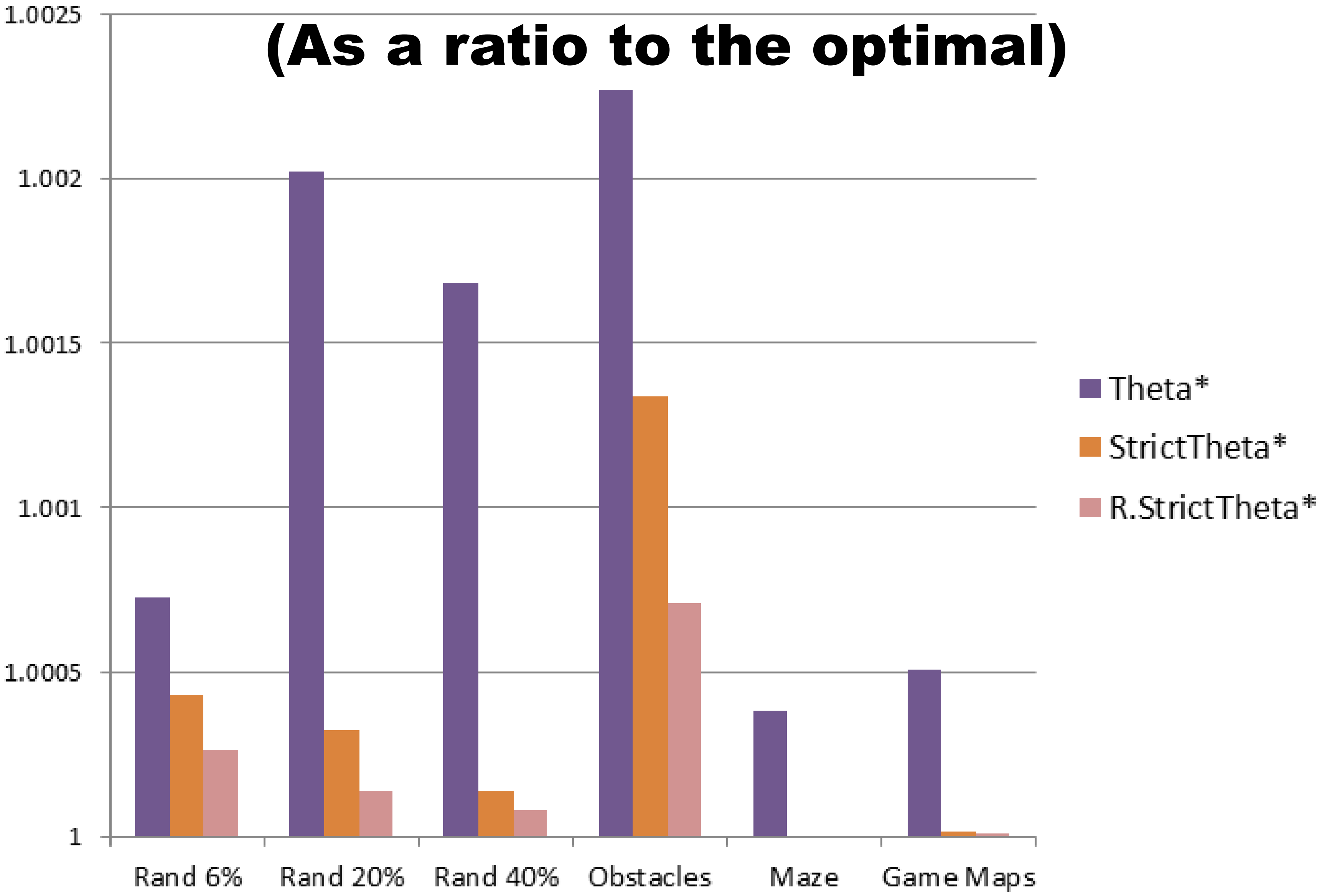
(As a ratio to the optimal)



1.0025*Optimal

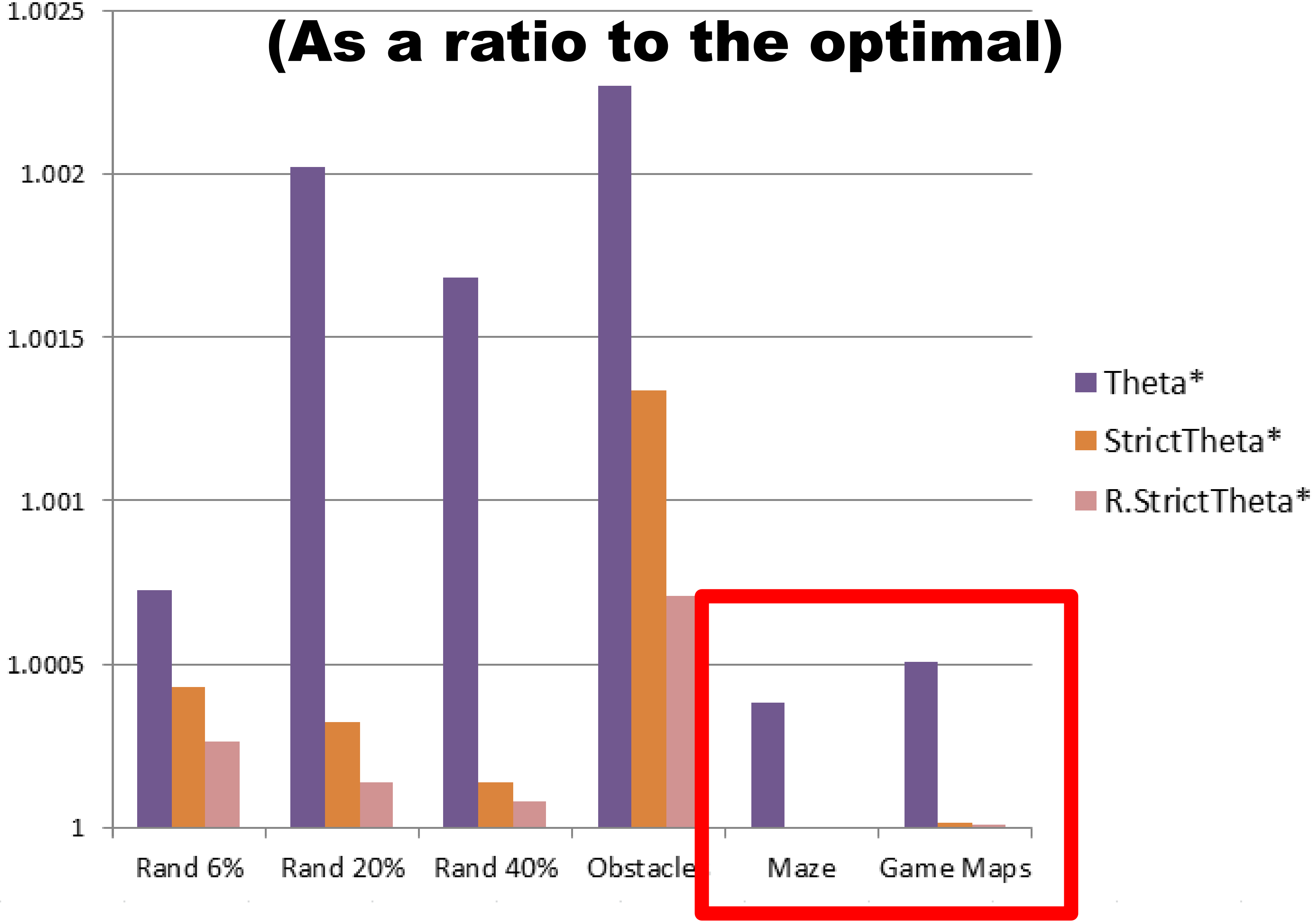
Path Length

(As a ratio to the optimal)



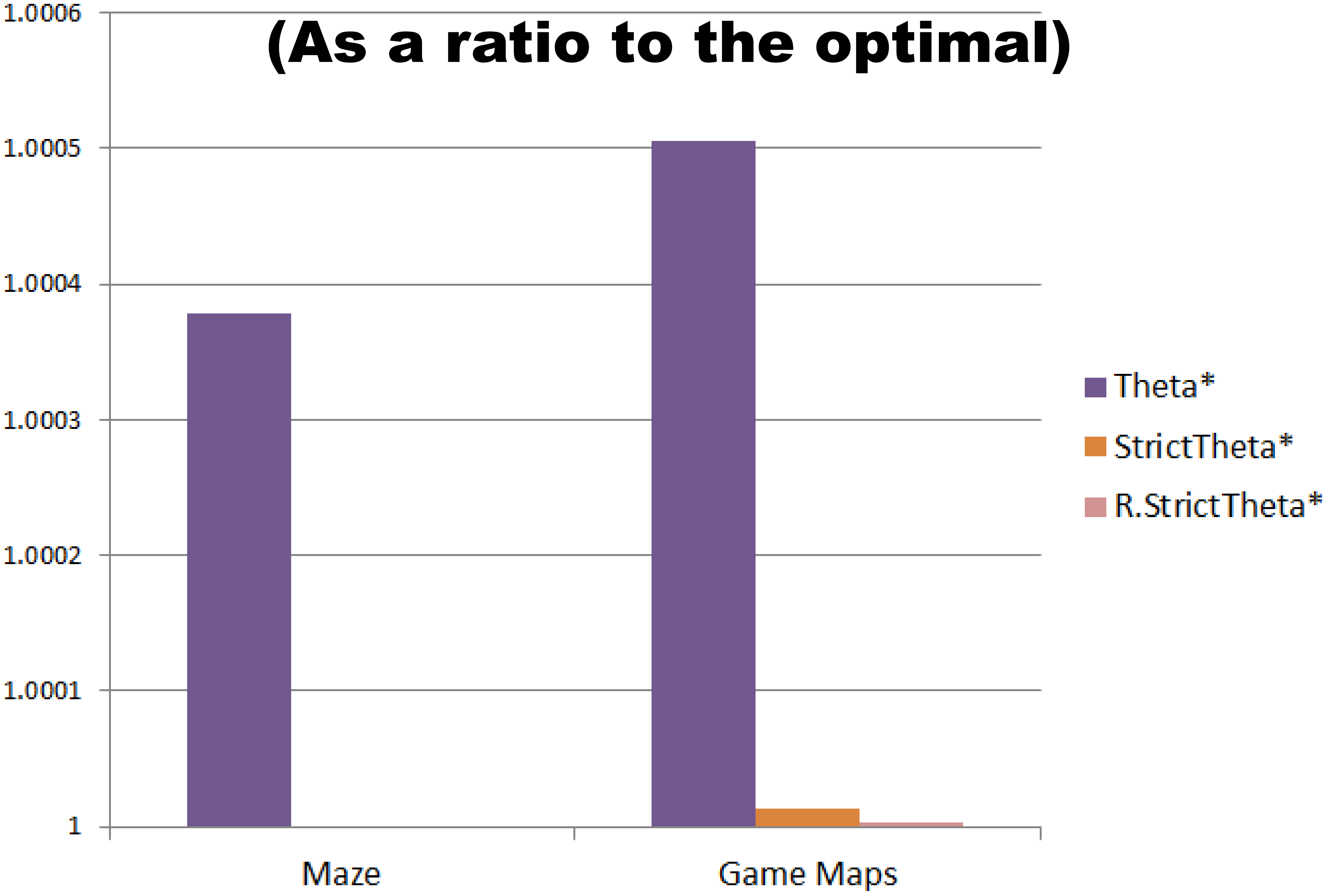
Path Length

(As a ratio to the optimal)



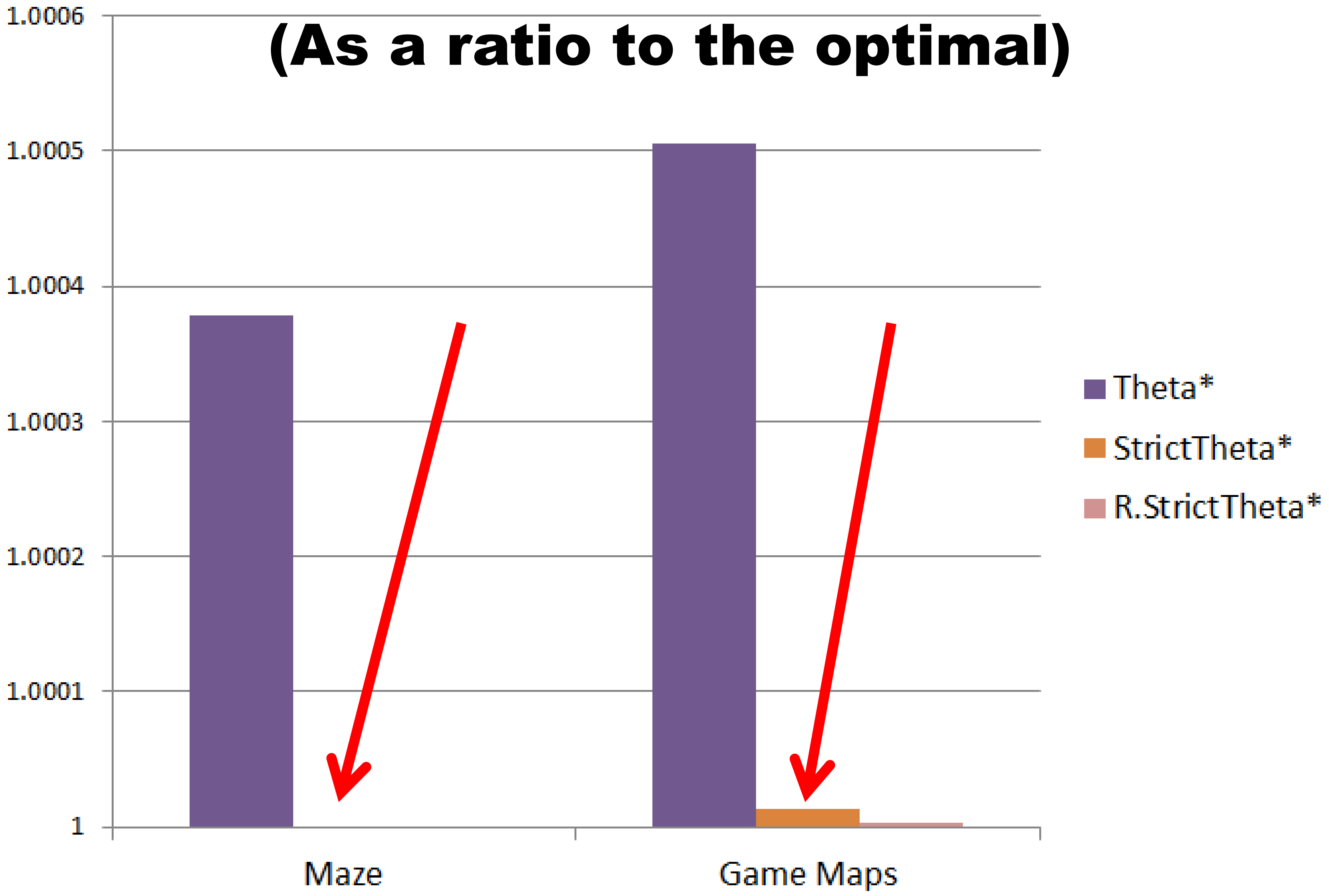
Path Length

(As a ratio to the optimal)



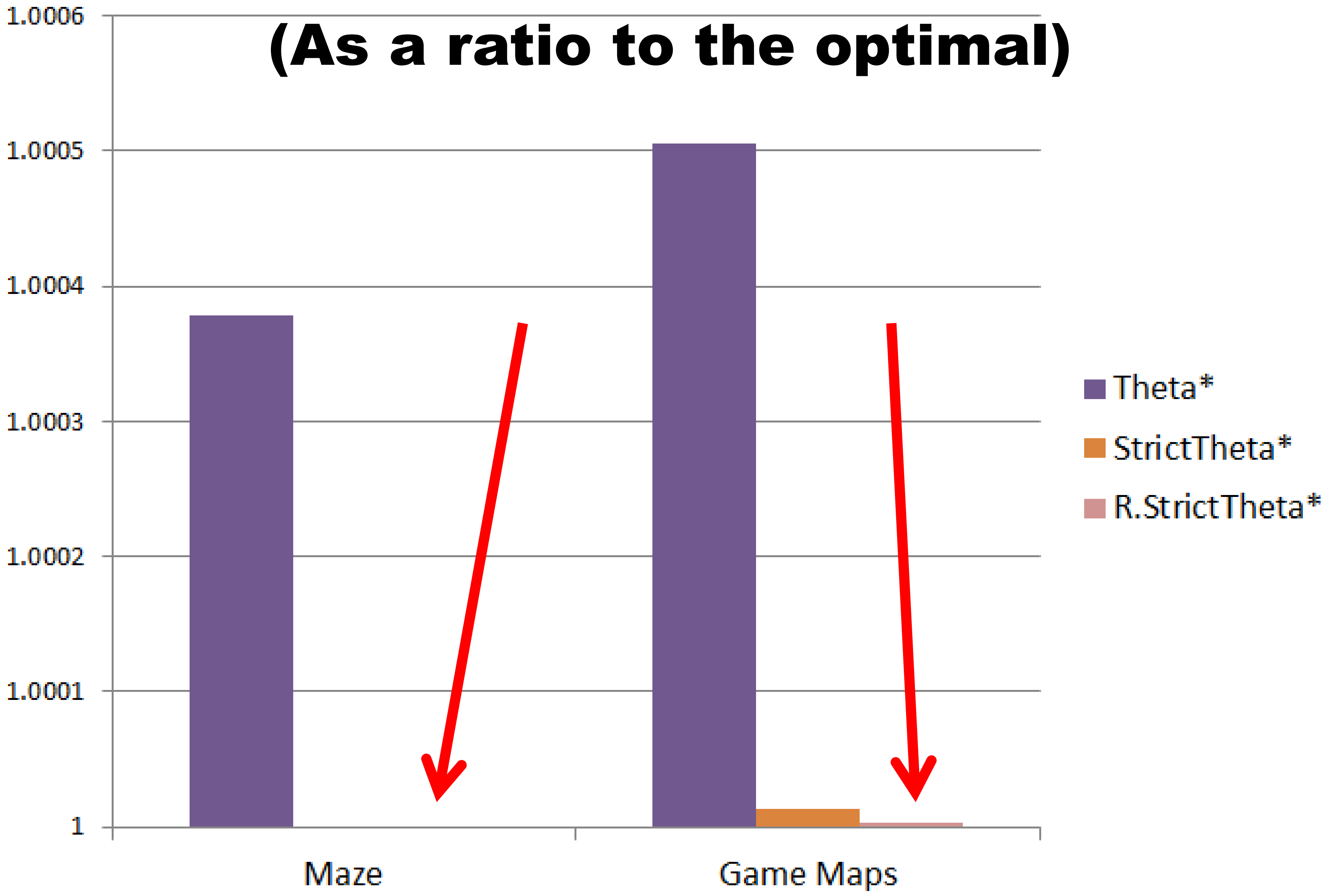
Path Length

(As a ratio to the optimal)



Path Length

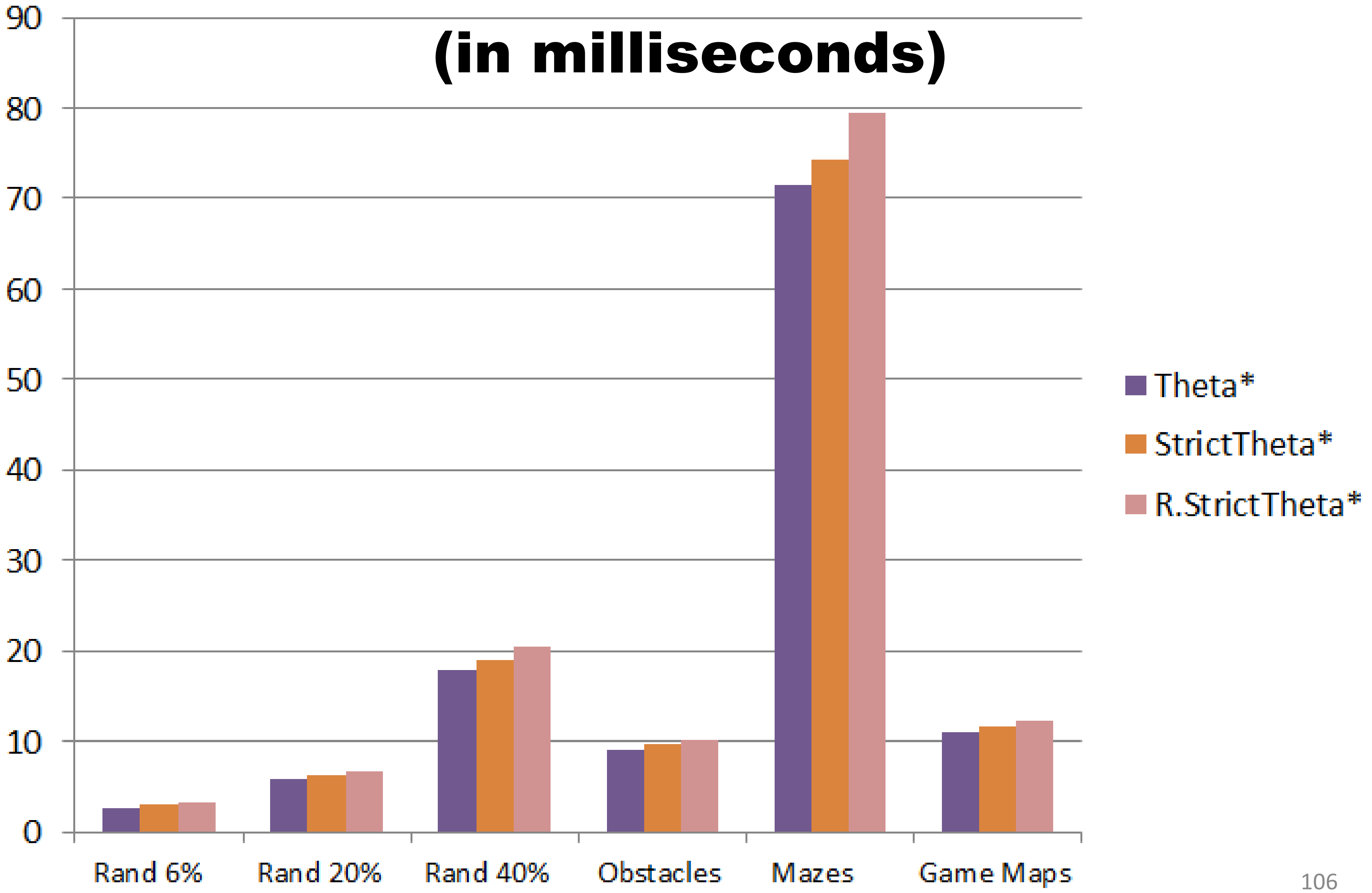
(As a ratio to the optimal)



Running Time

(Averaged, in milliseconds)

Running Time



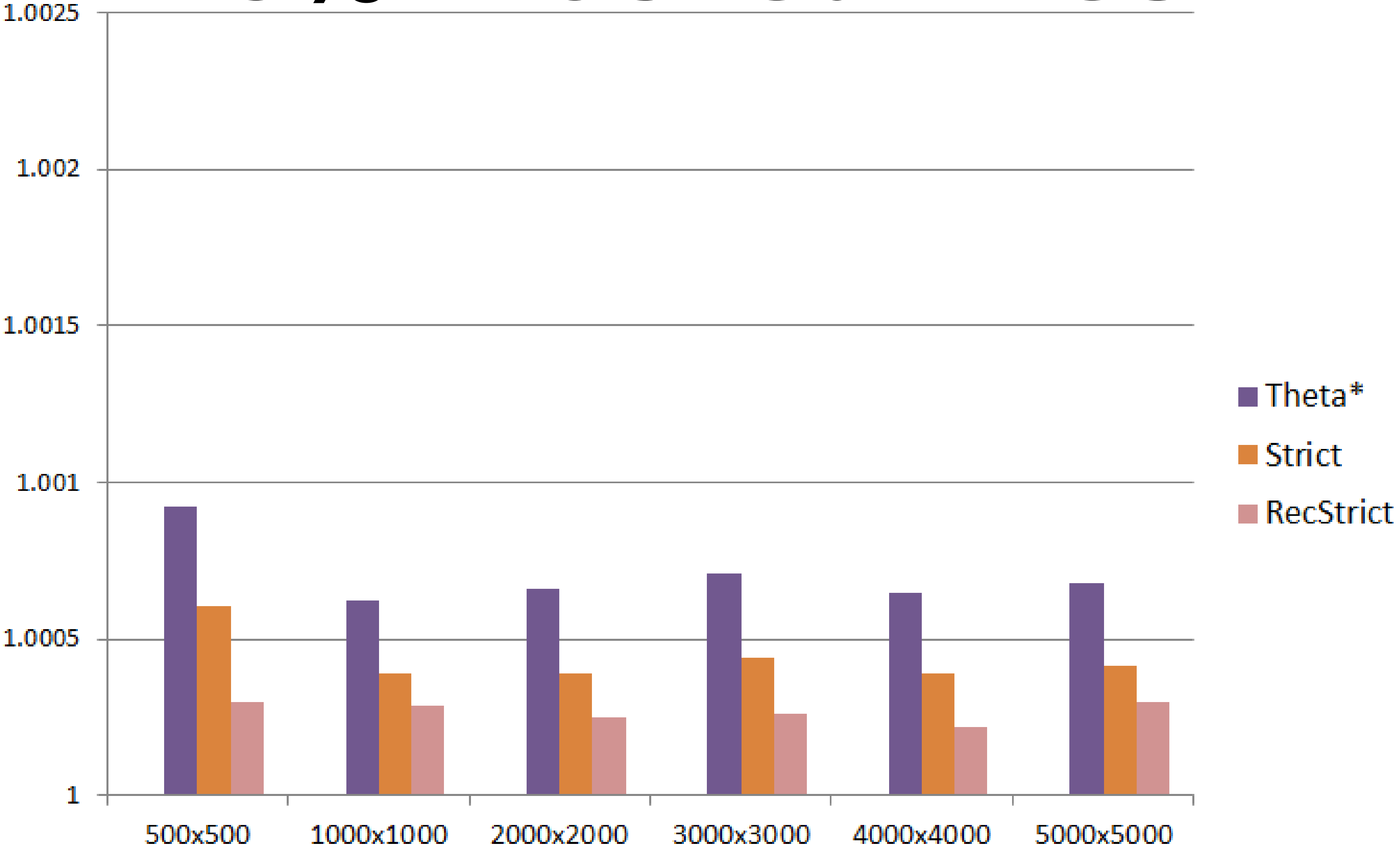
Results

Using large randomly generated maps of sizes:

500x500
1000x1000
2000x2000
3000x3000
4000x4000
5000x5000

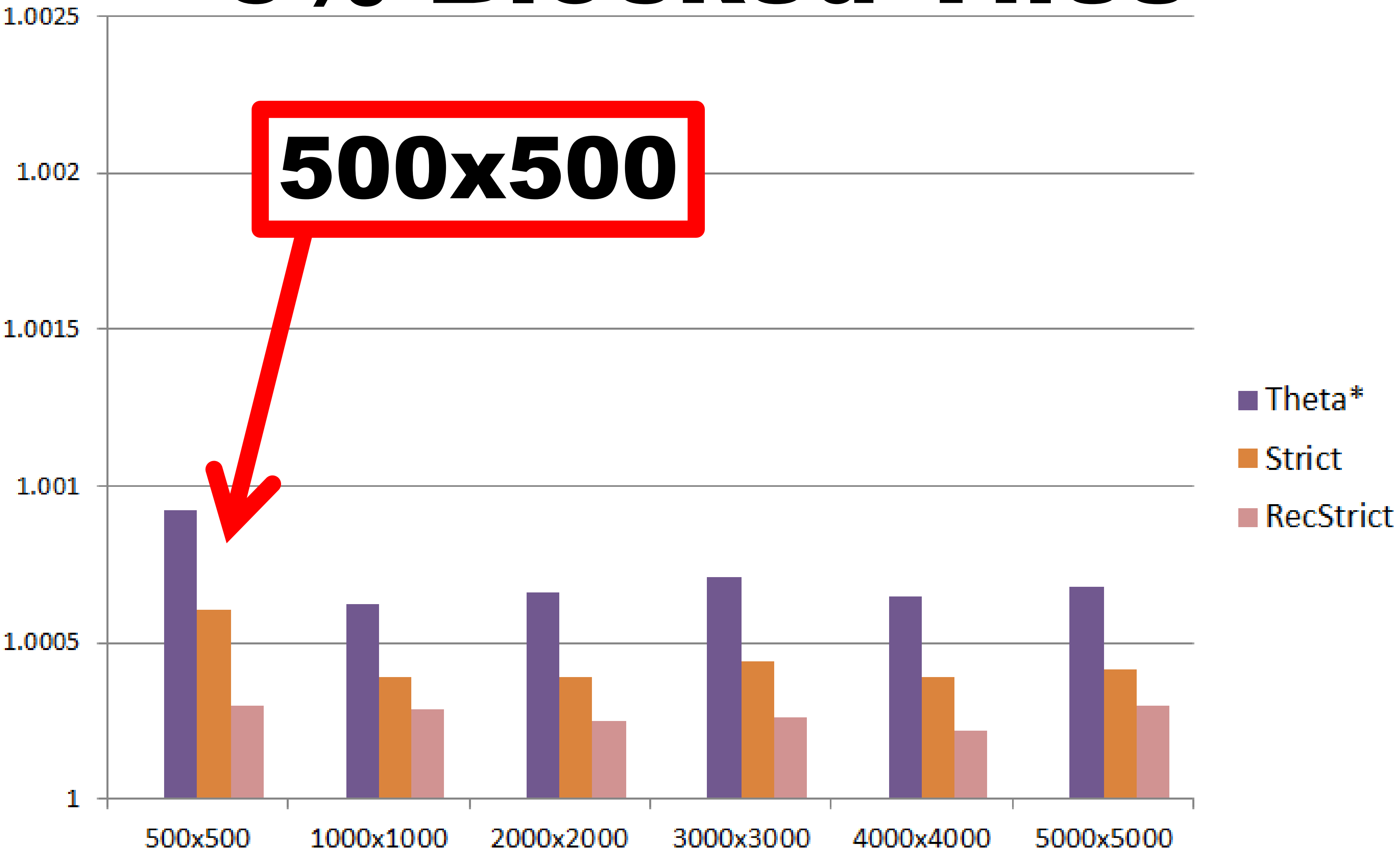
Path Length

6% Blocked Tiles



Path Length

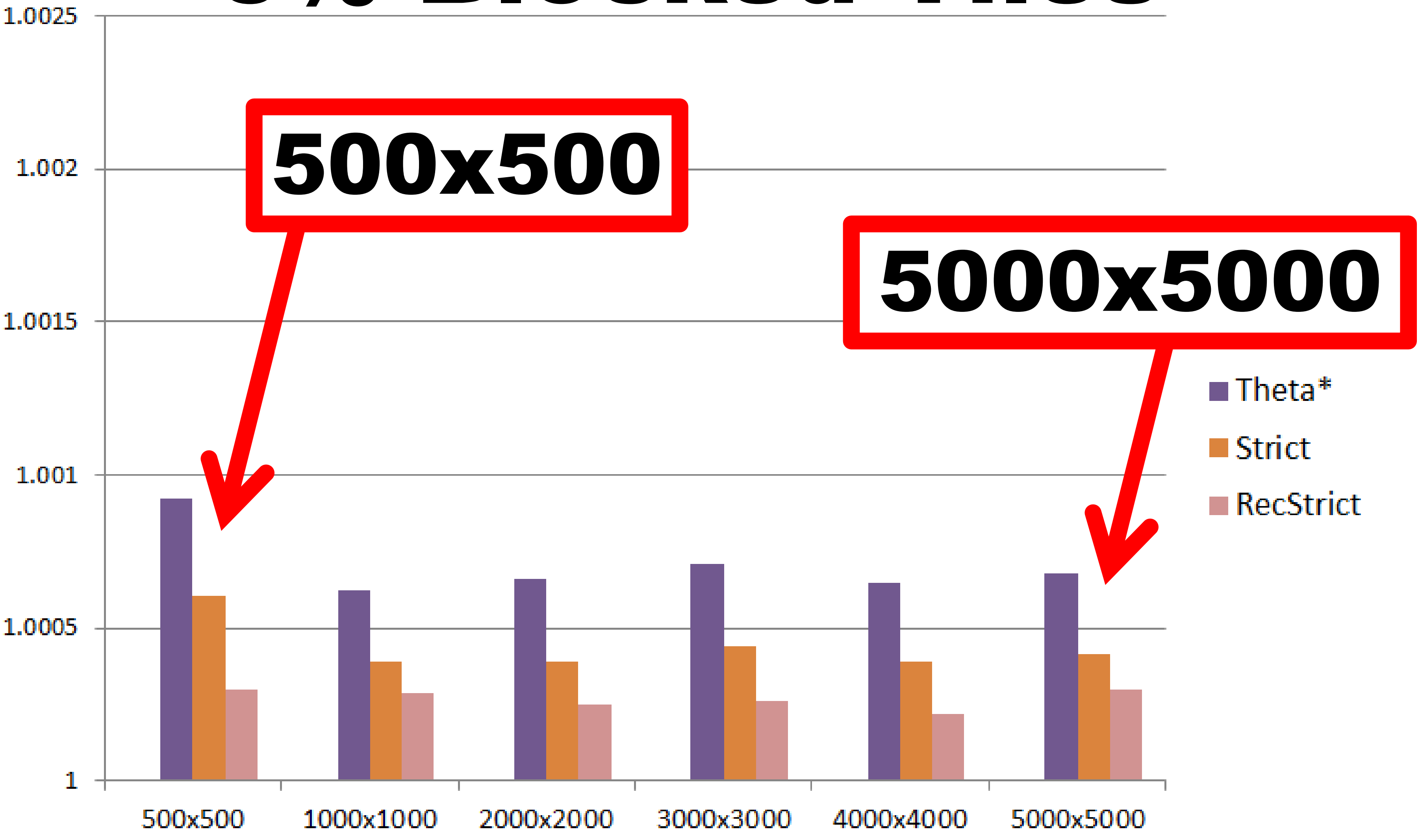
6% Blocked Tiles



500x500

Path Length

6% Blocked Tiles

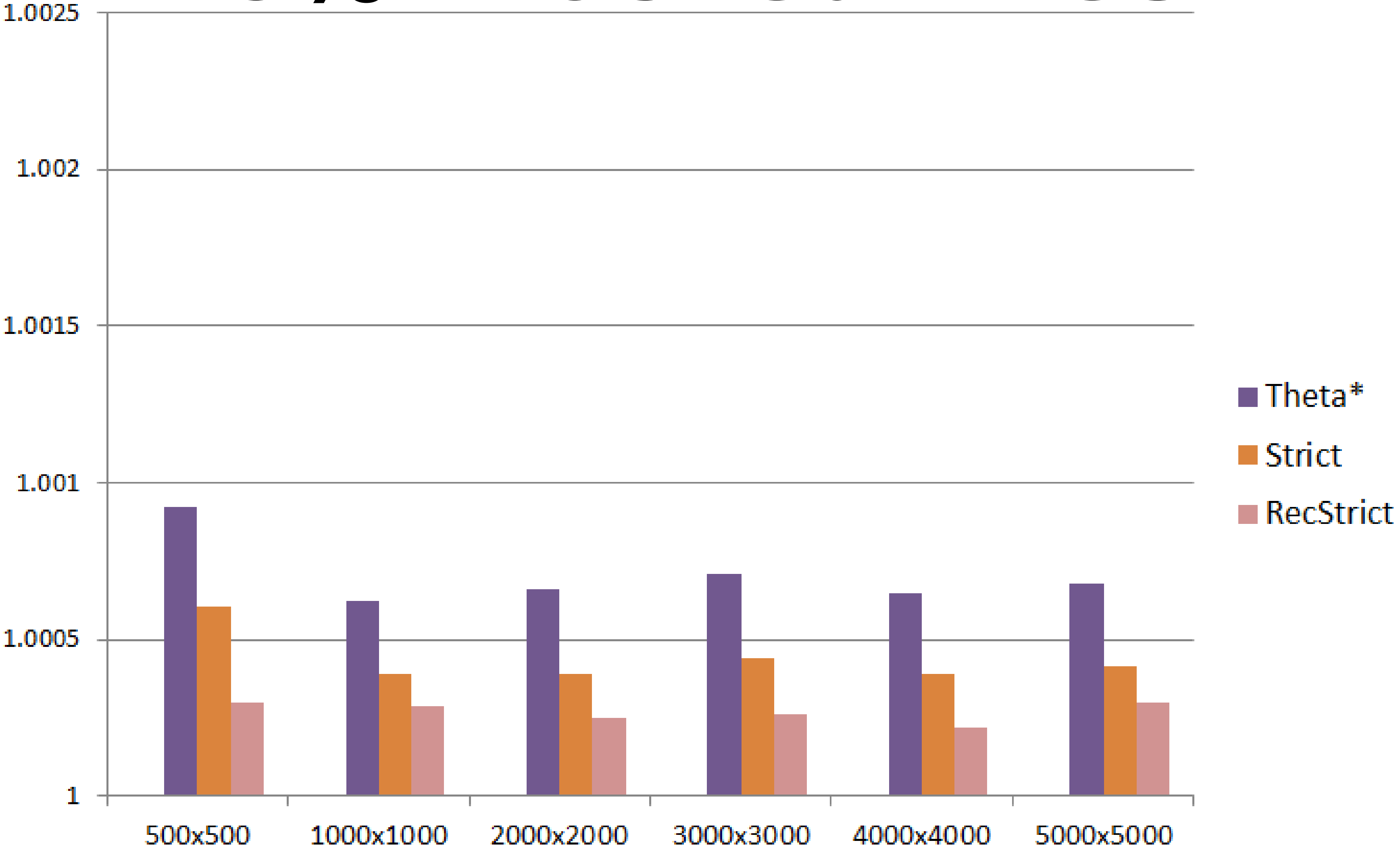


500x500

5000x5000

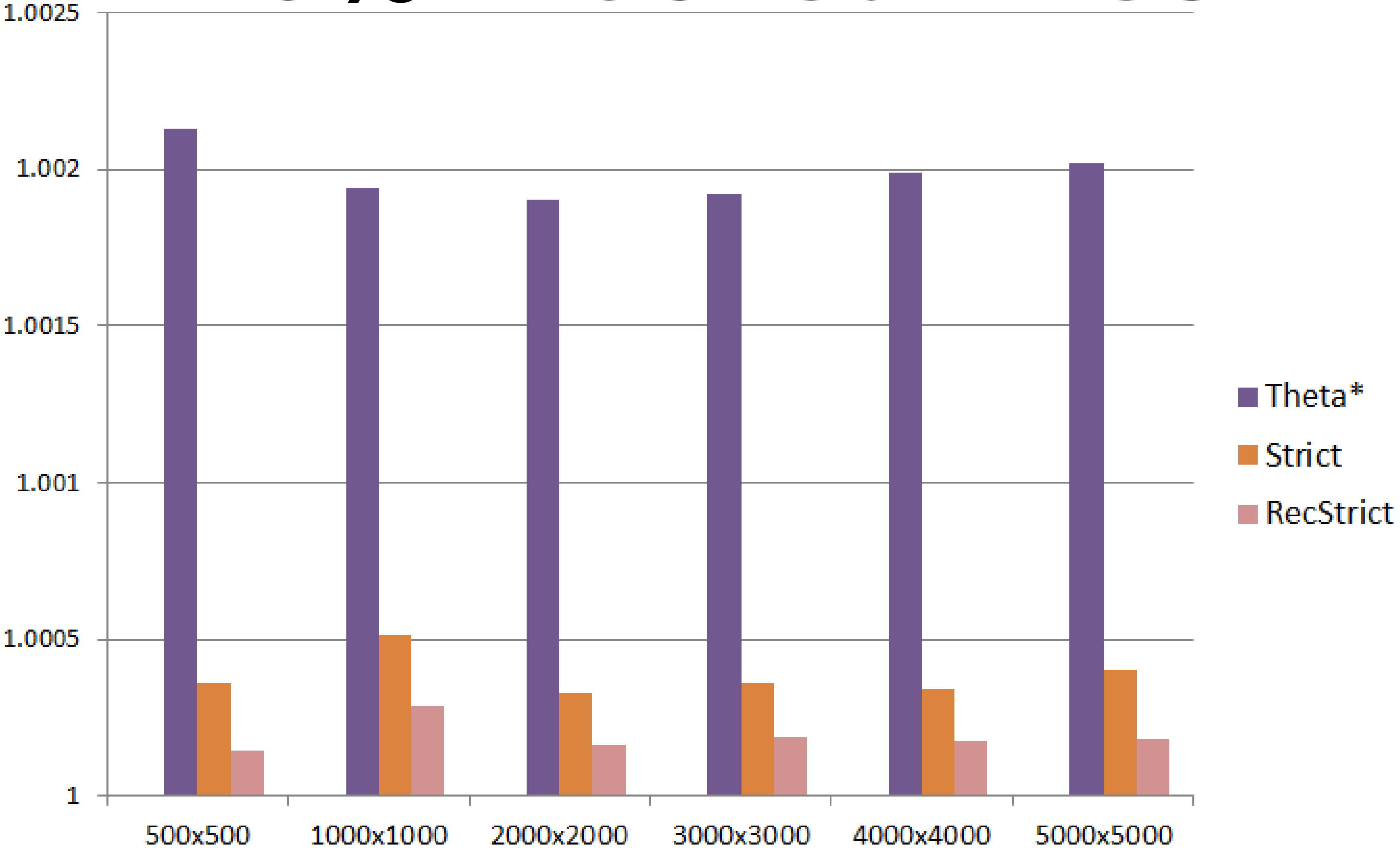
Path Length

6% Blocked Tiles



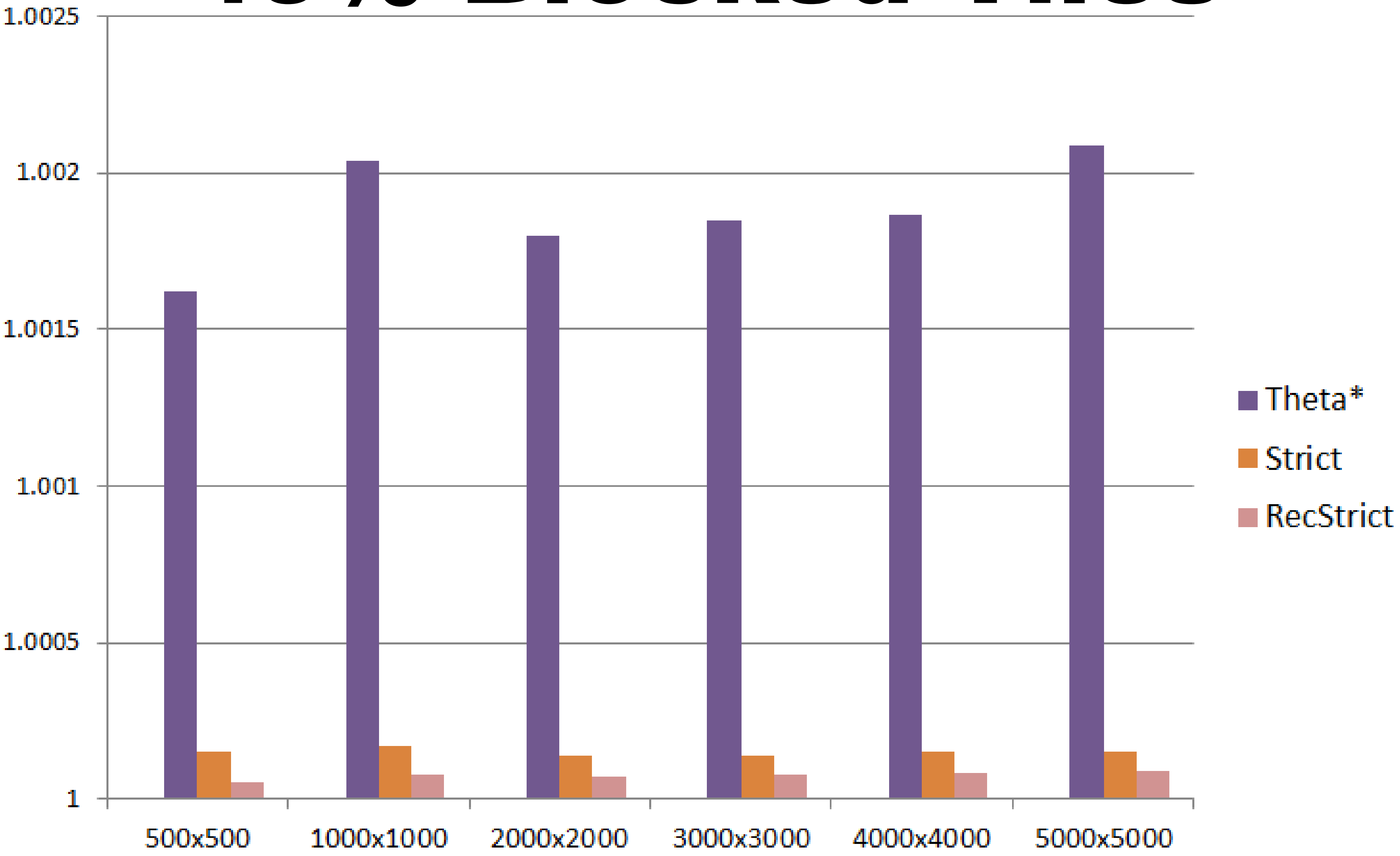
Path Length

20% Blocked Tiles



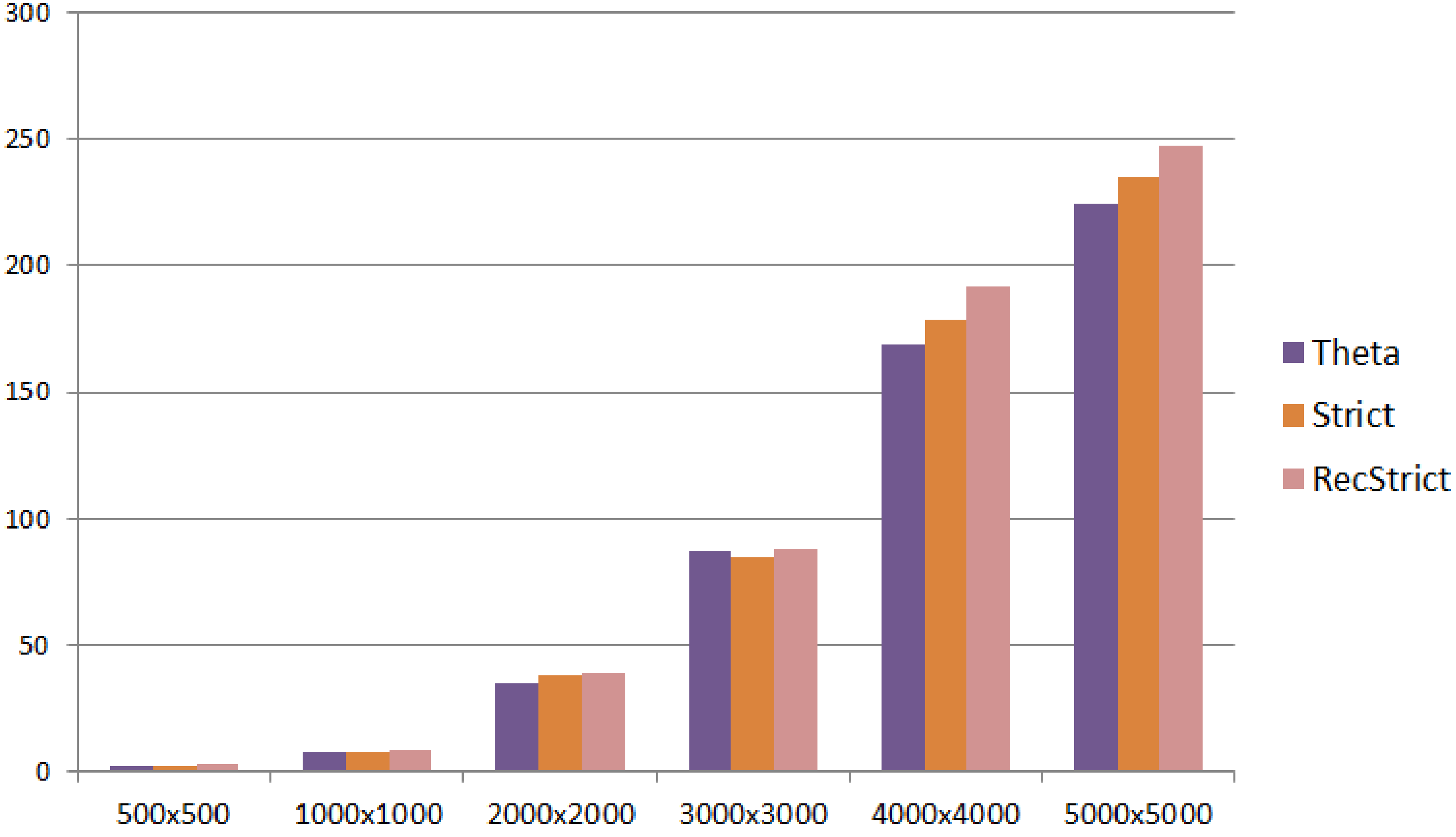
Path Length

40% Blocked Tiles

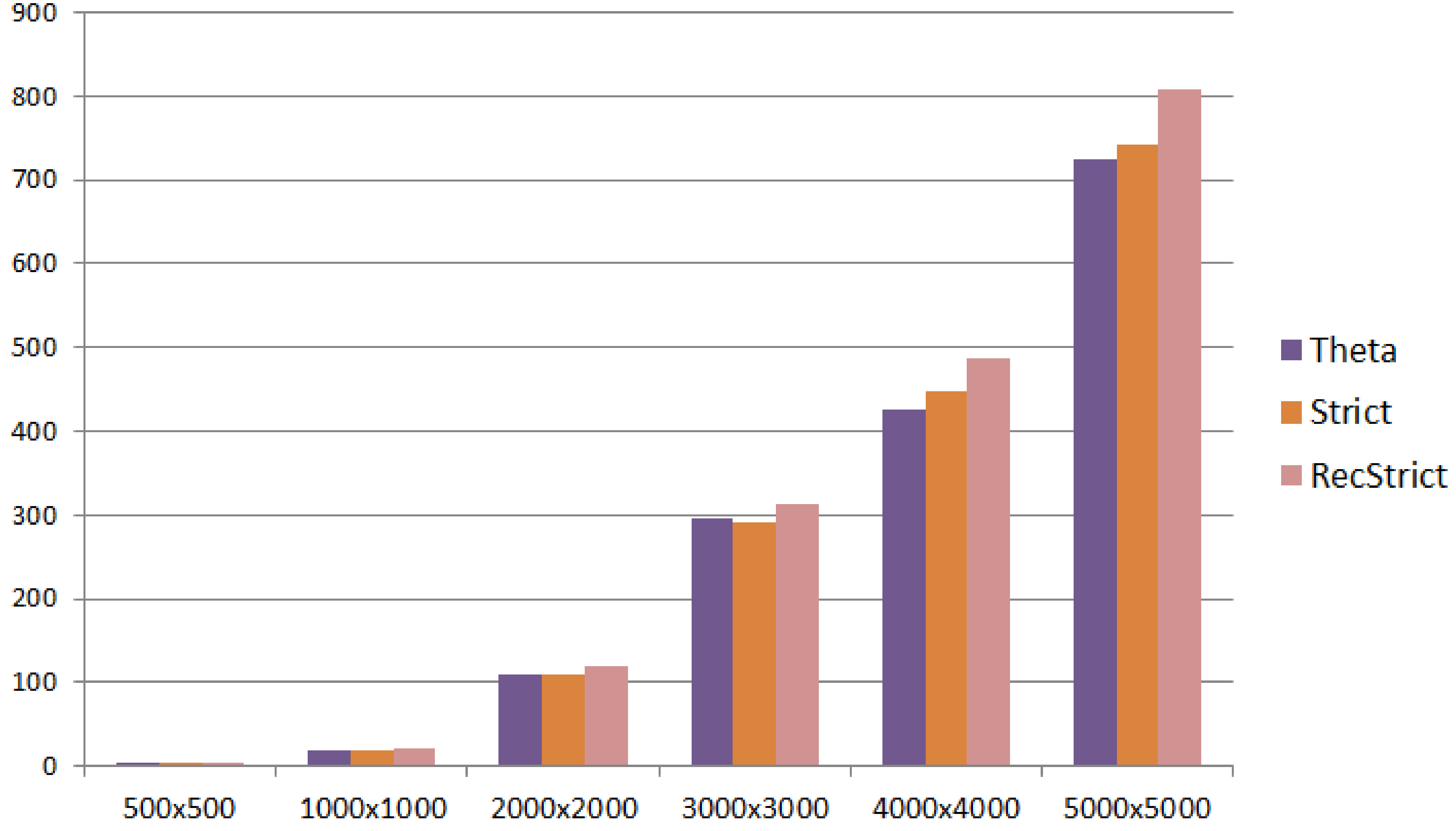


Running Time

6% Blocked Tiles

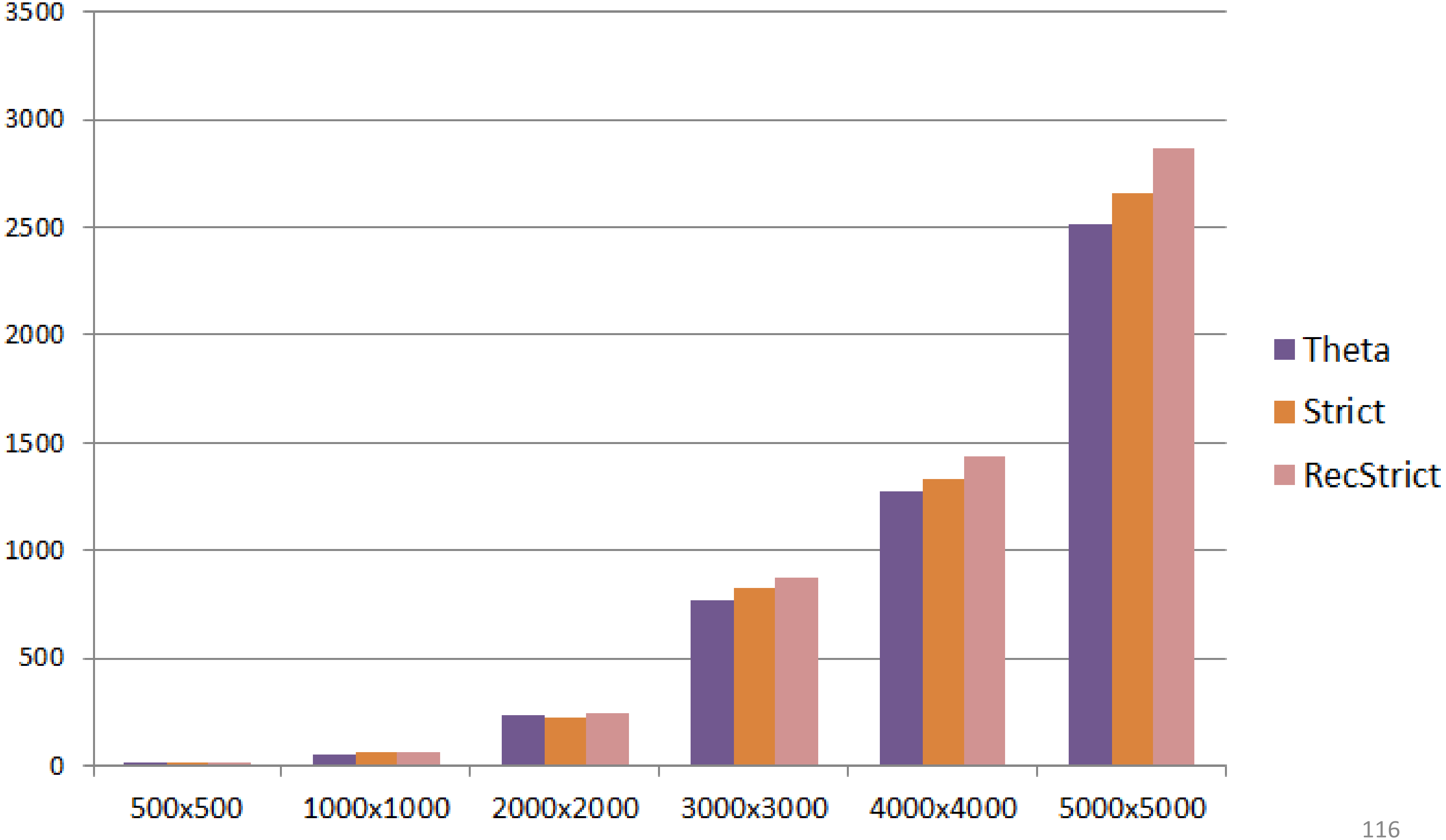


Running Time
20% Blocked Tiles



Running Time

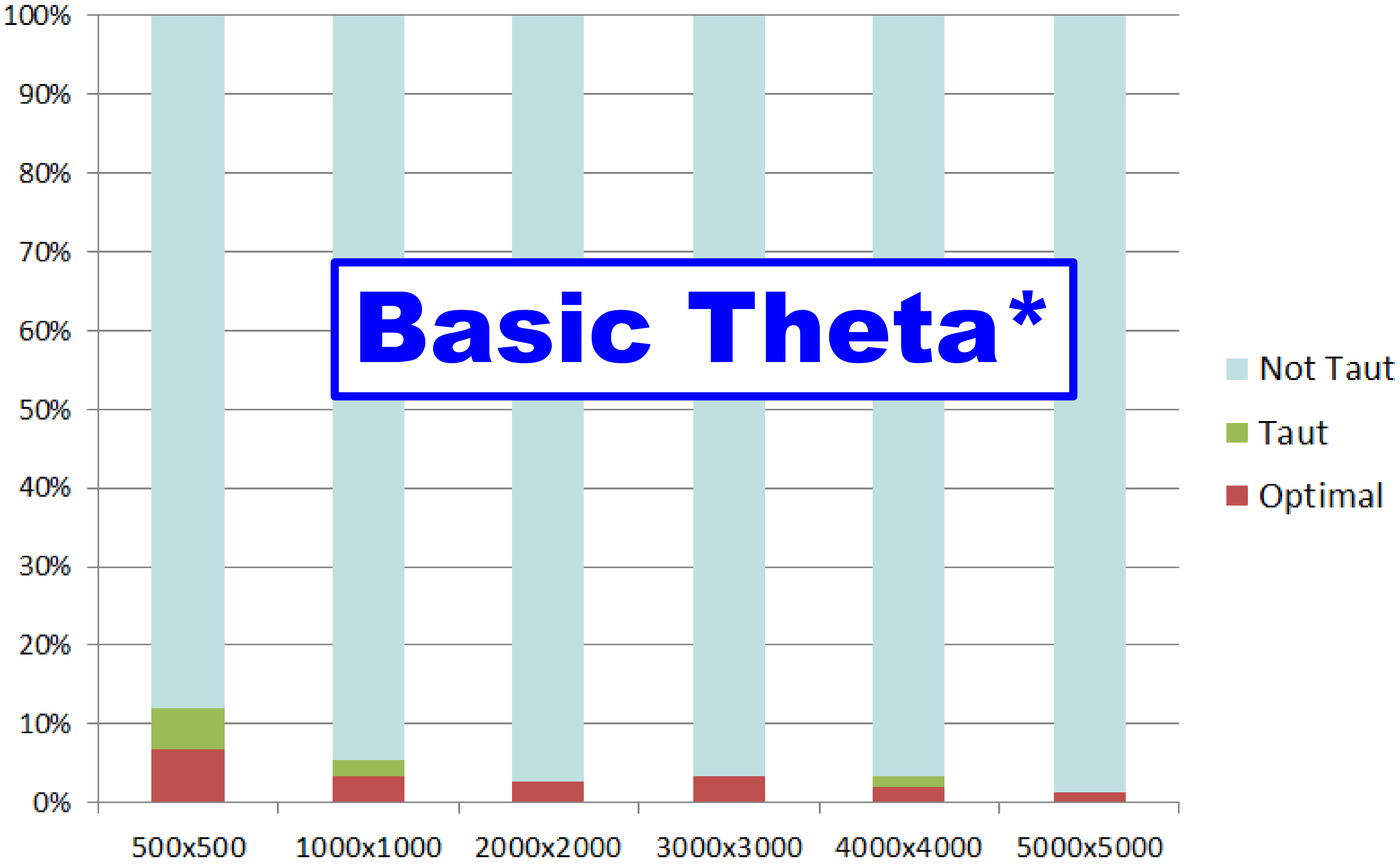
40% Blocked Tiles



Percentage Optimal / Taut

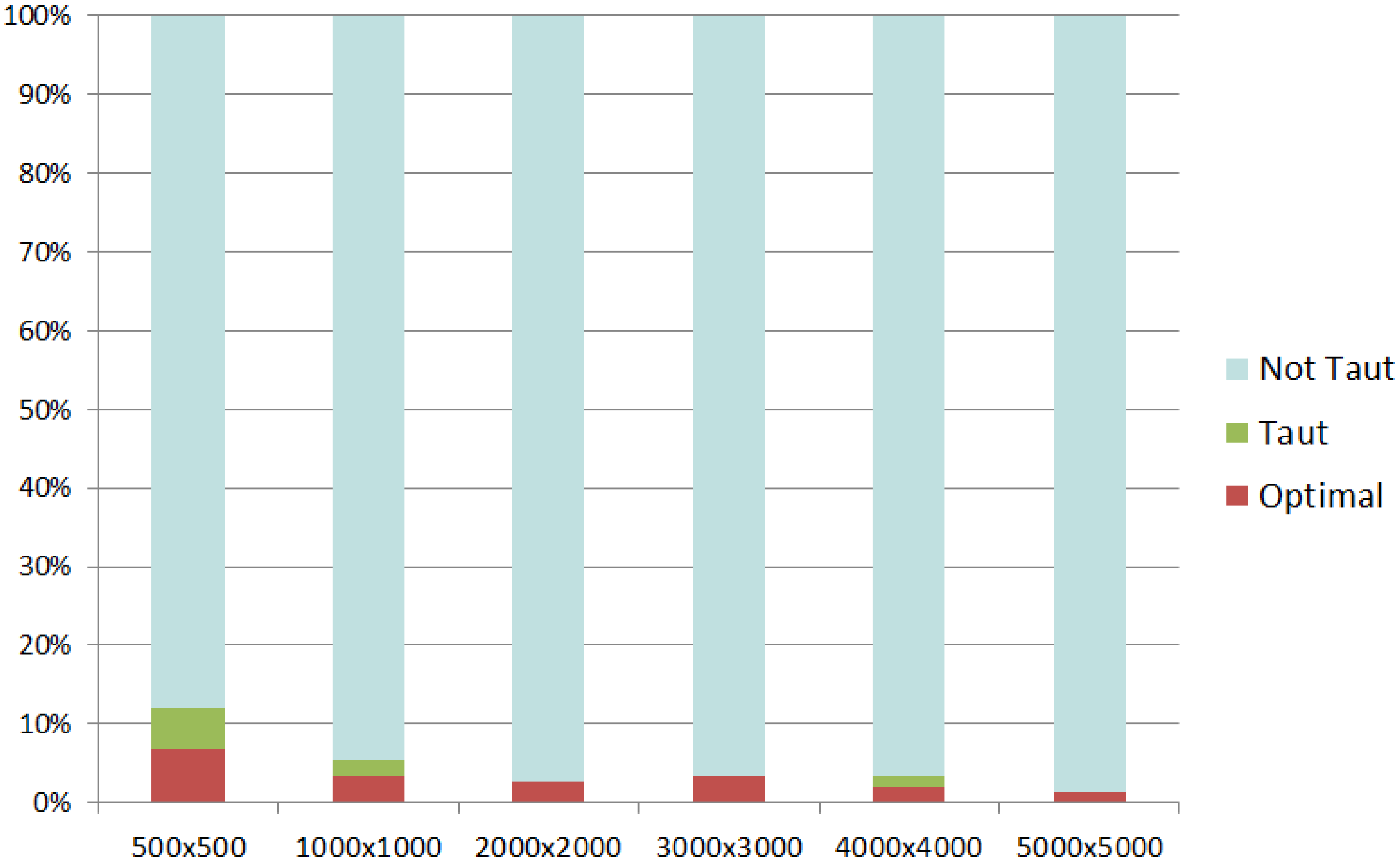
(Note: Optimal Paths are Always Taut)

Percentage Optimal / Taut

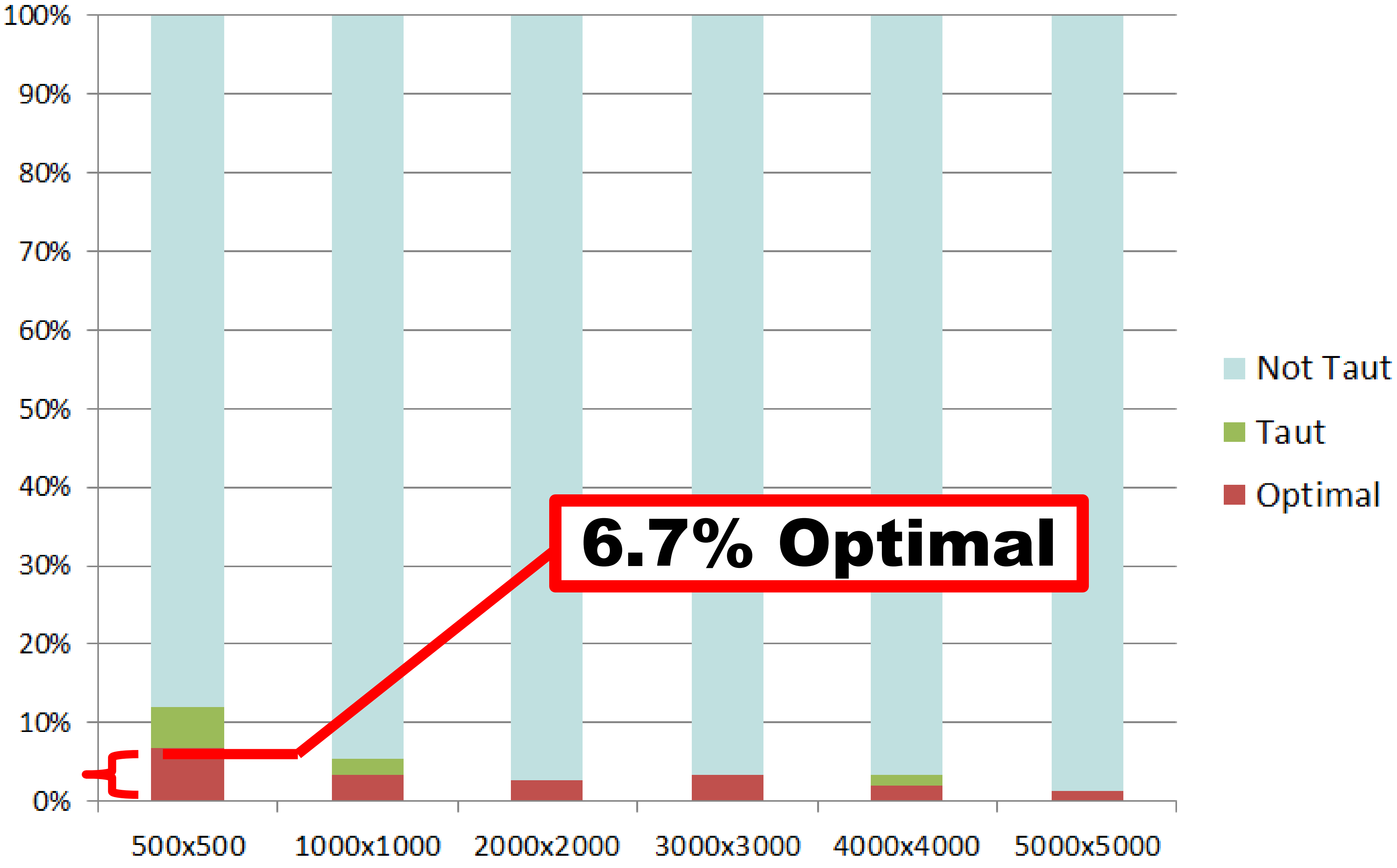


Basic Theta*

Percentage Optimal / Taut

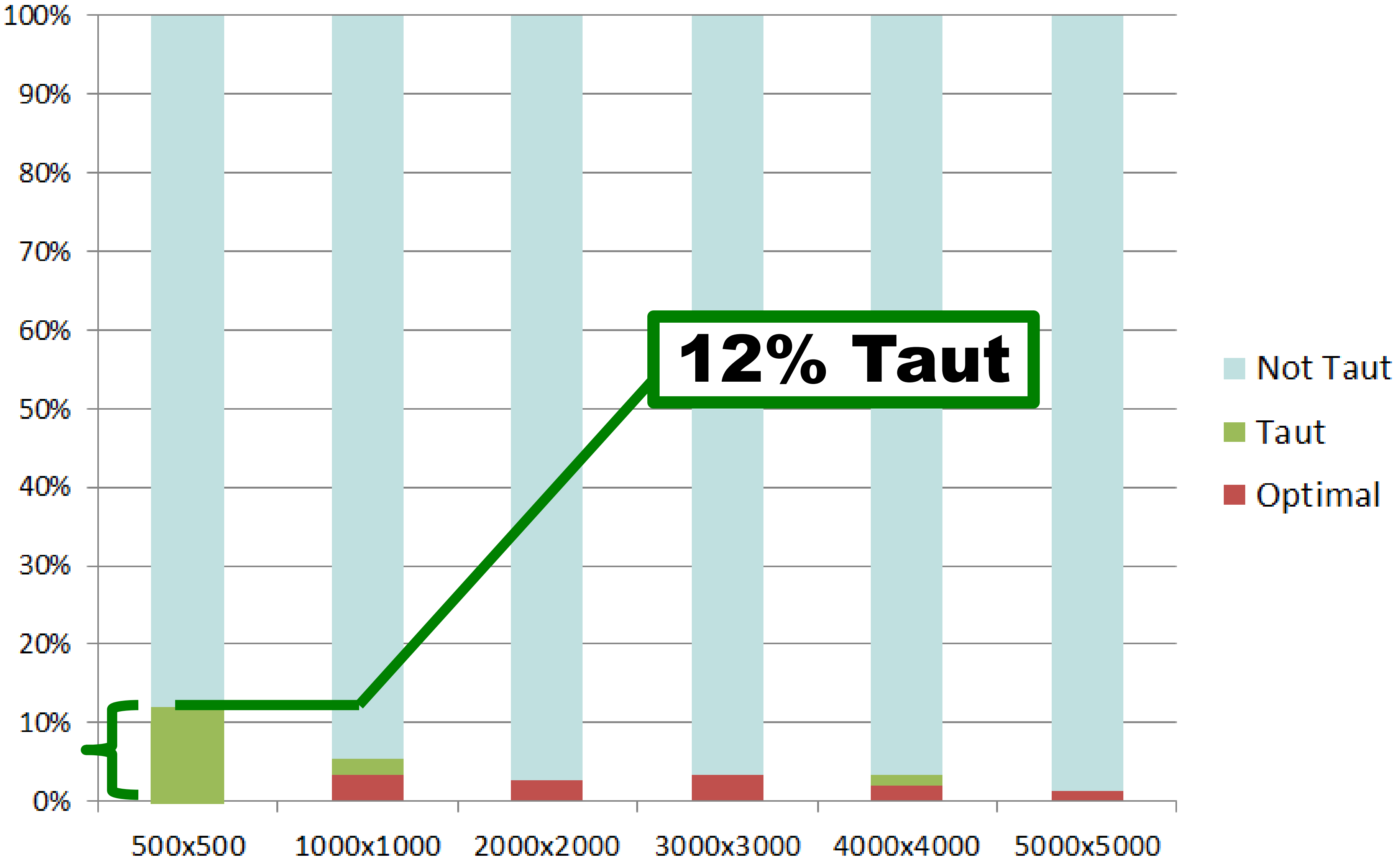


Percentage Optimal / Taut



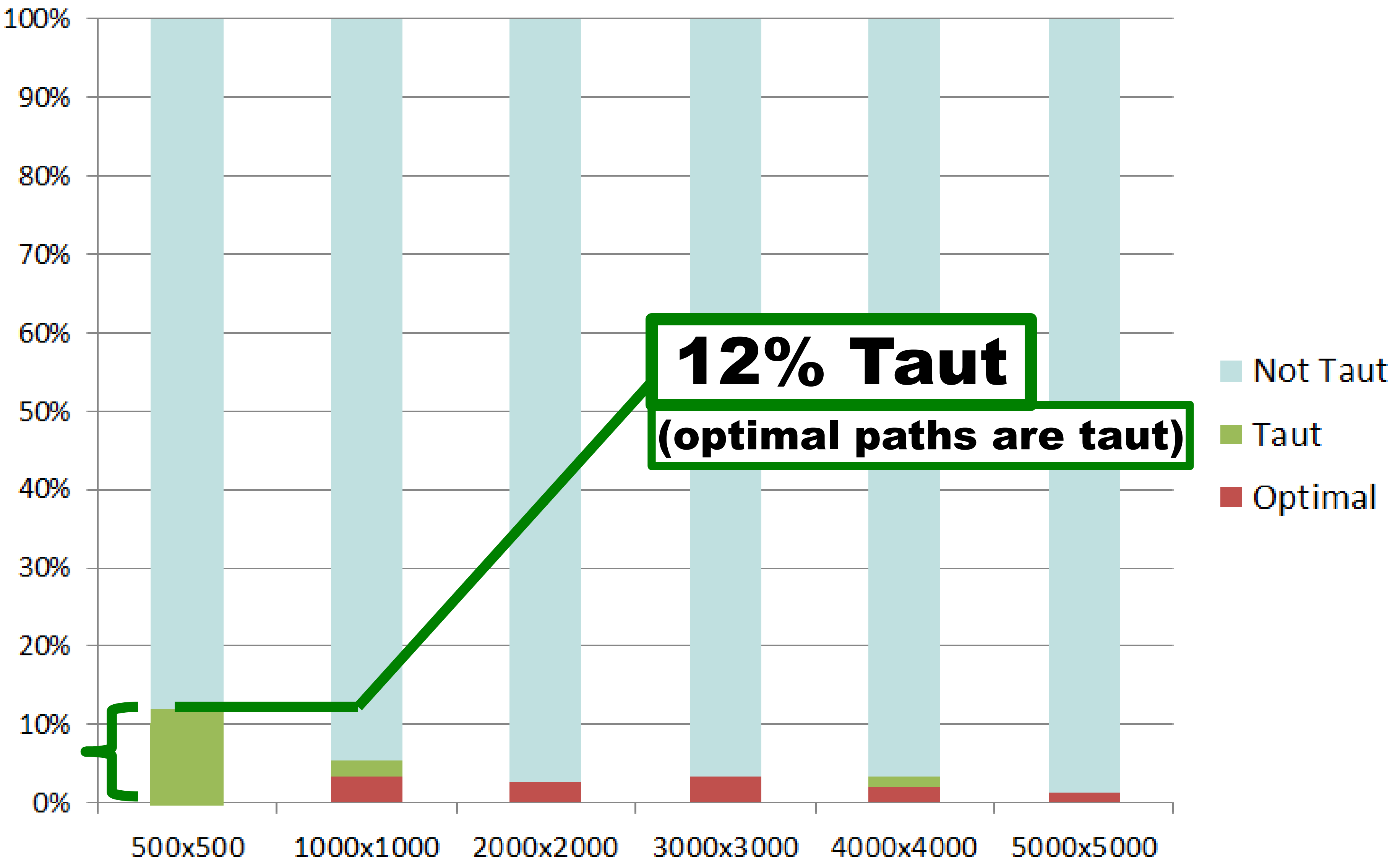
6.7% Optimal

Percentage Optimal / Taut



12% Taut

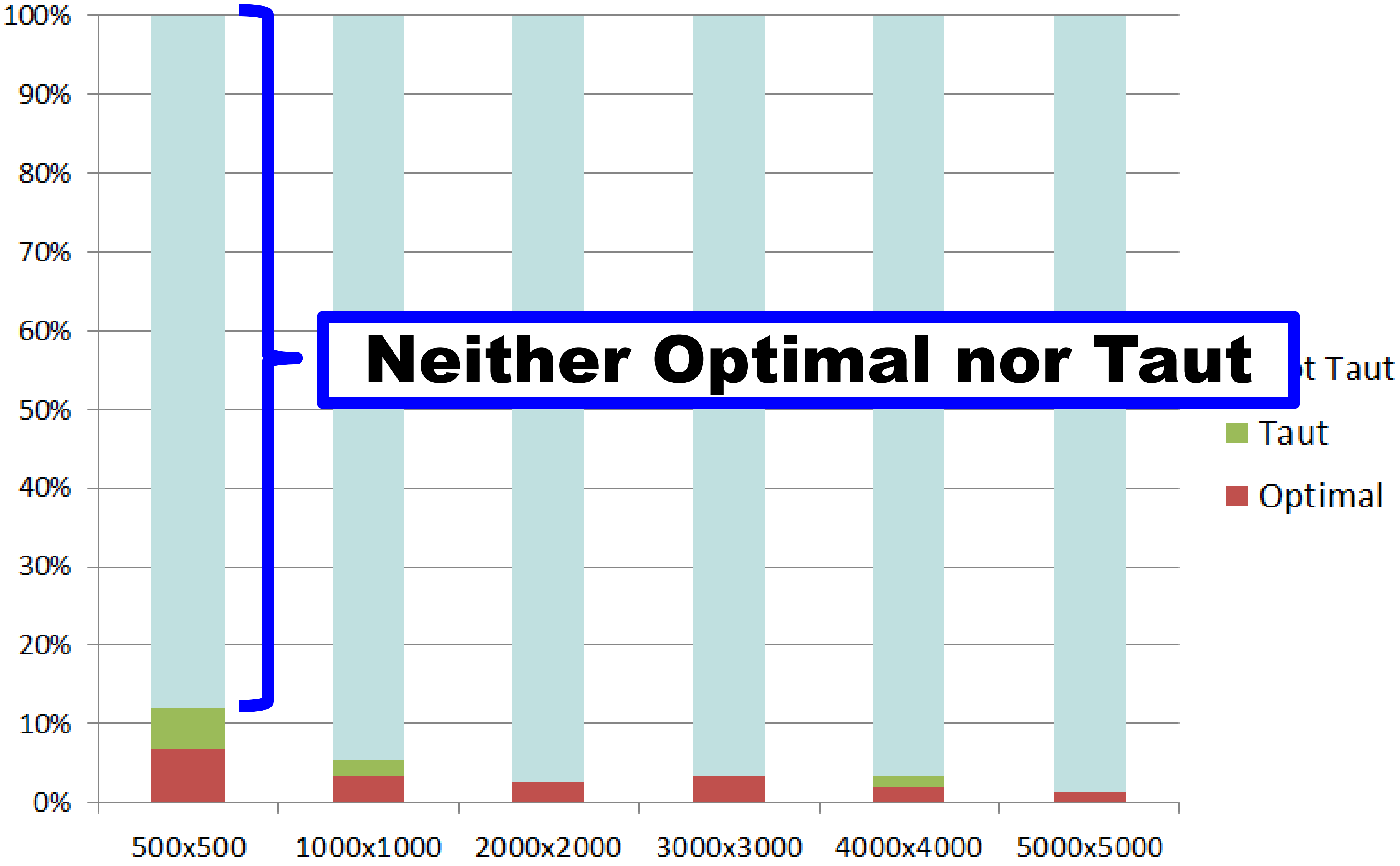
Percentage Optimal / Taut



12% Taut

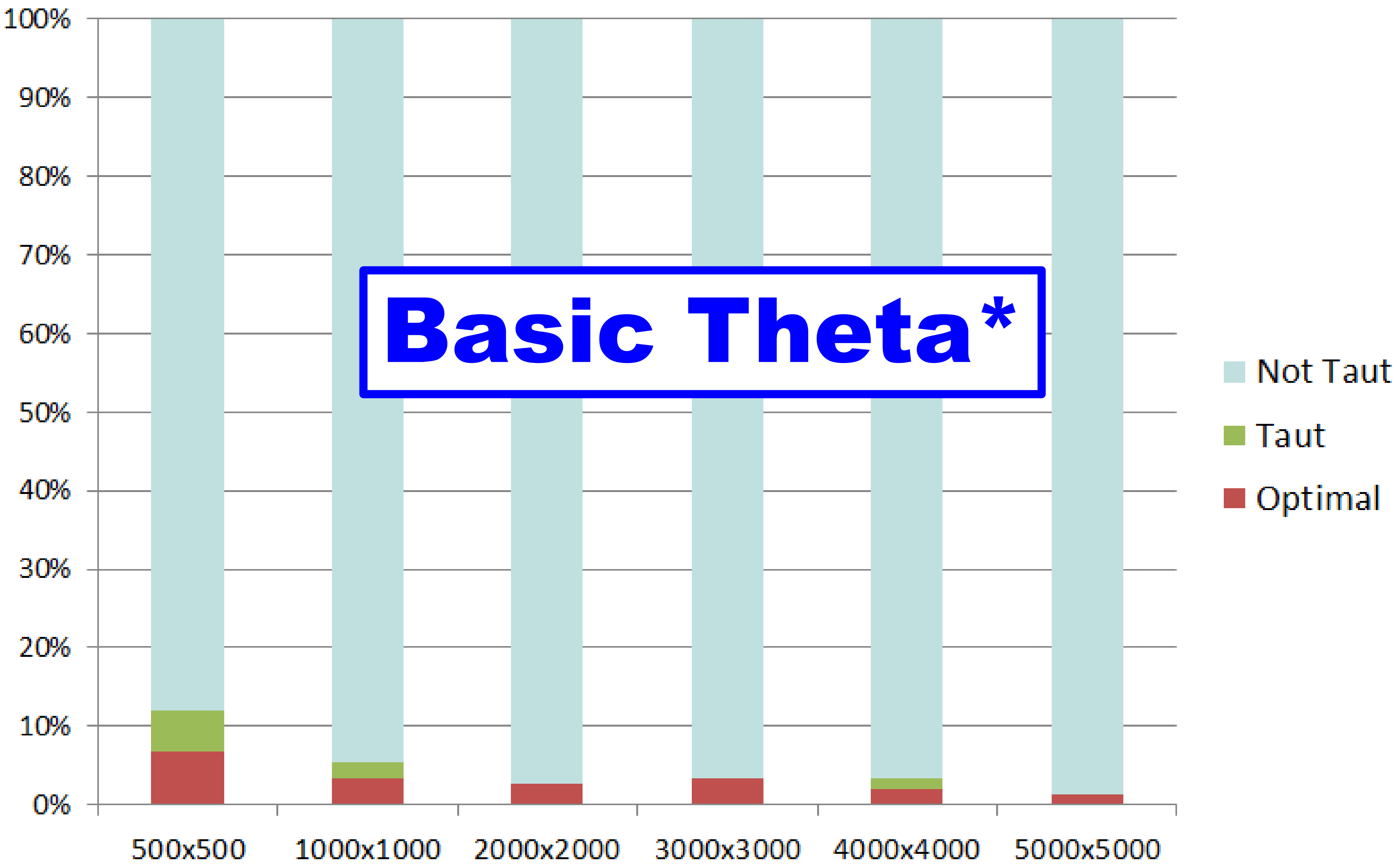
(optimal paths are taut)

Percentage Optimal / Taut



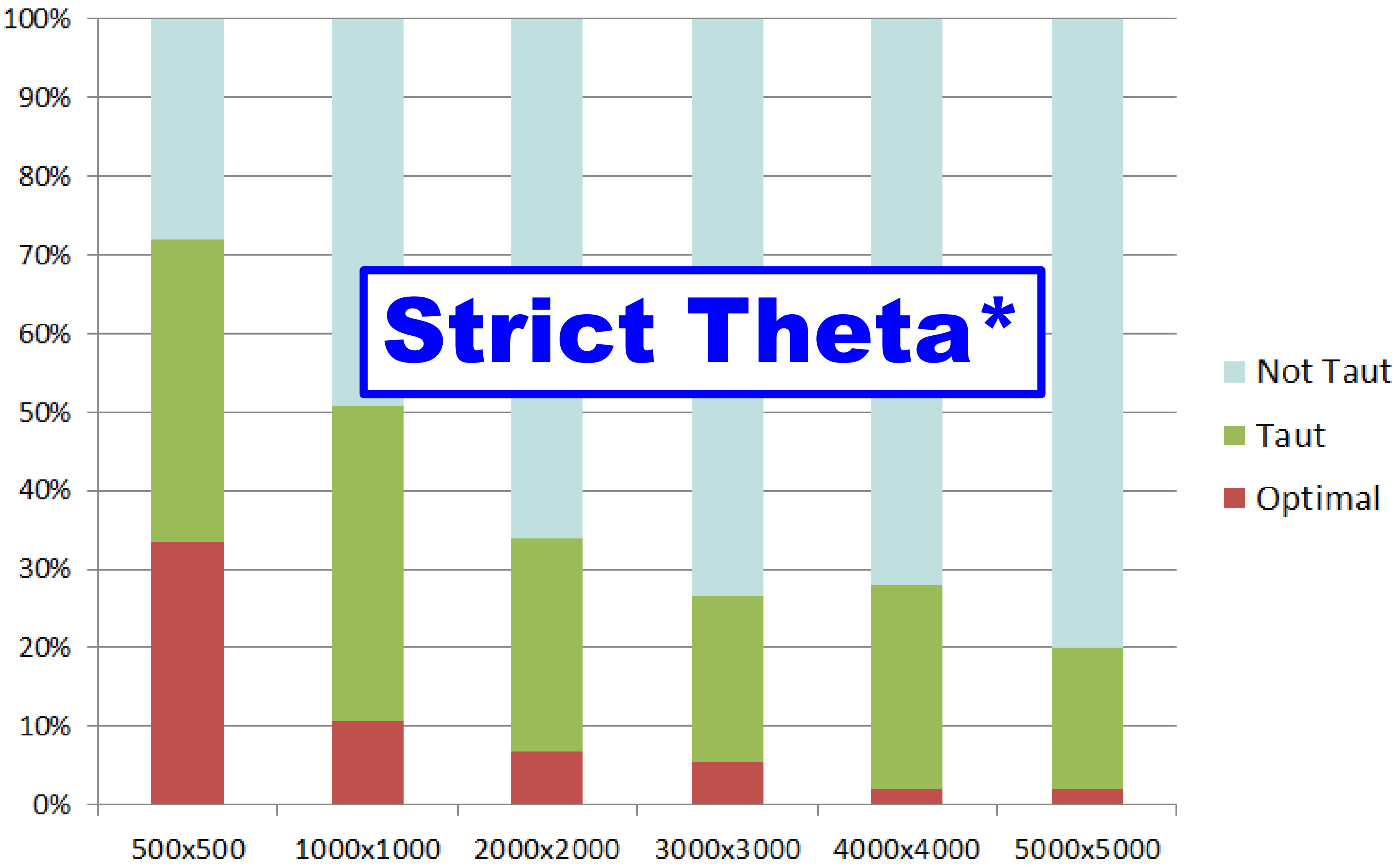
Neither Optimal nor Taut

Percentage Optimal / Taut



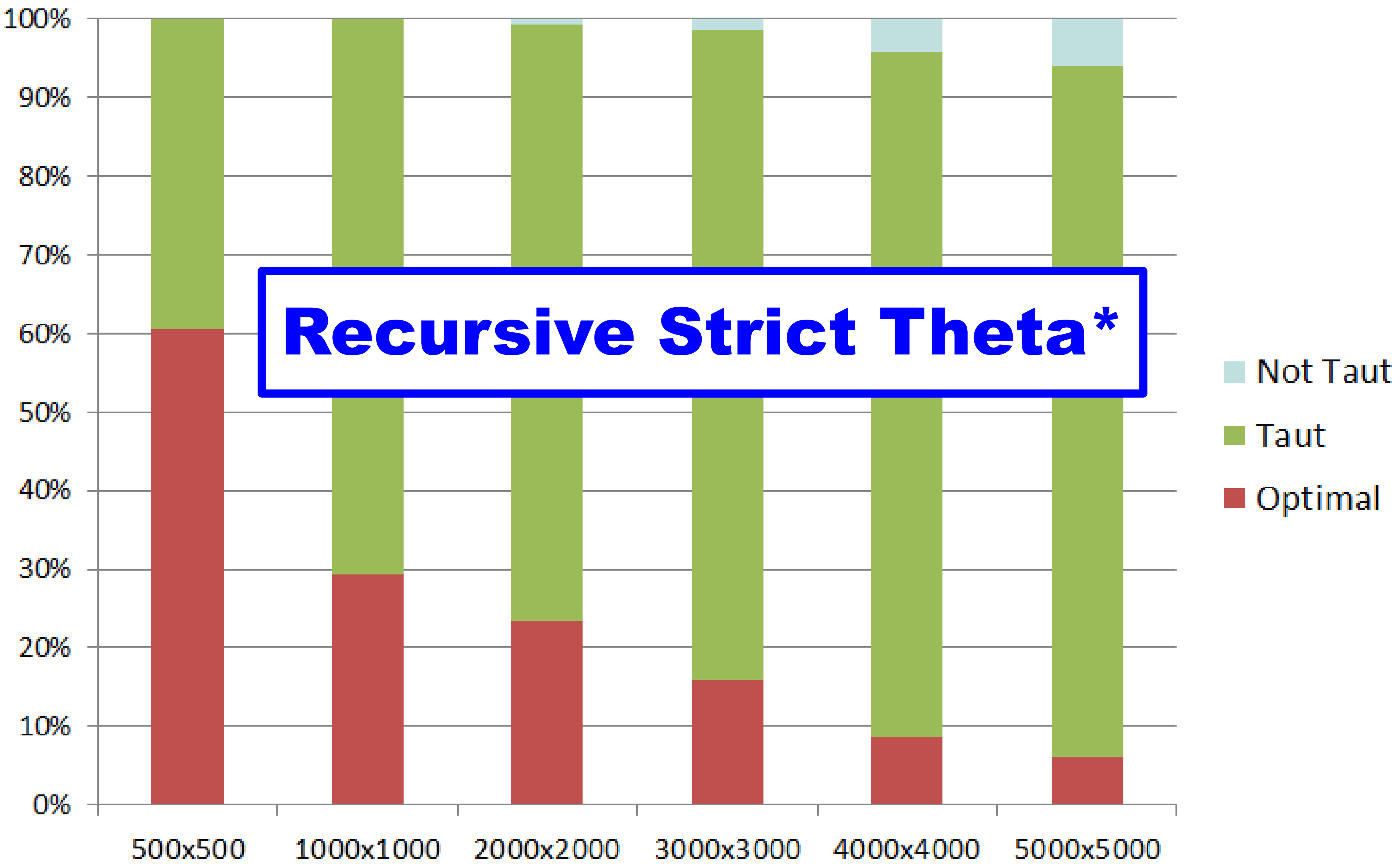
Basic Theta*

Percentage Optimal / Taut



Strict Theta*

Percentage Optimal / Taut



Recursive Strict Theta*

Strict Theta*

Easy to implement

Much shorter paths

Low runtime overhead

Implementation

github.com/Ohohcakester/Any-Angle-Pathfinding

Implementation

github.com/Ohohcakester/Any-Angle-Pathfinding

Google for "Any Angle Pathfinding"

Strict Theta*

Shorter Motion Planning Using Taut Paths

Shunhao Oh
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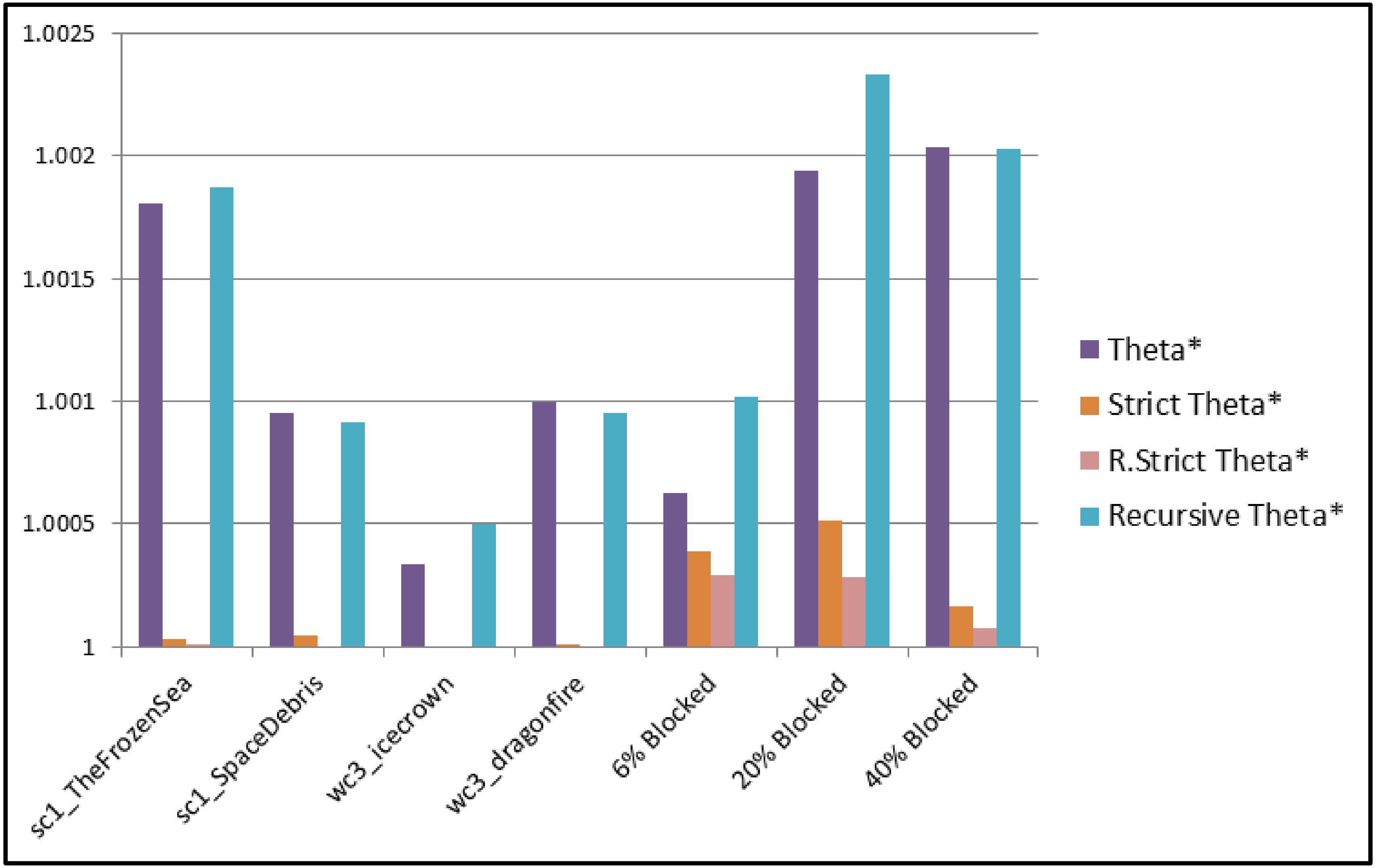
Hon Wai Leong
leonghw@comp.nus.edu.sg

Department of Computer Science
National University of Singapore

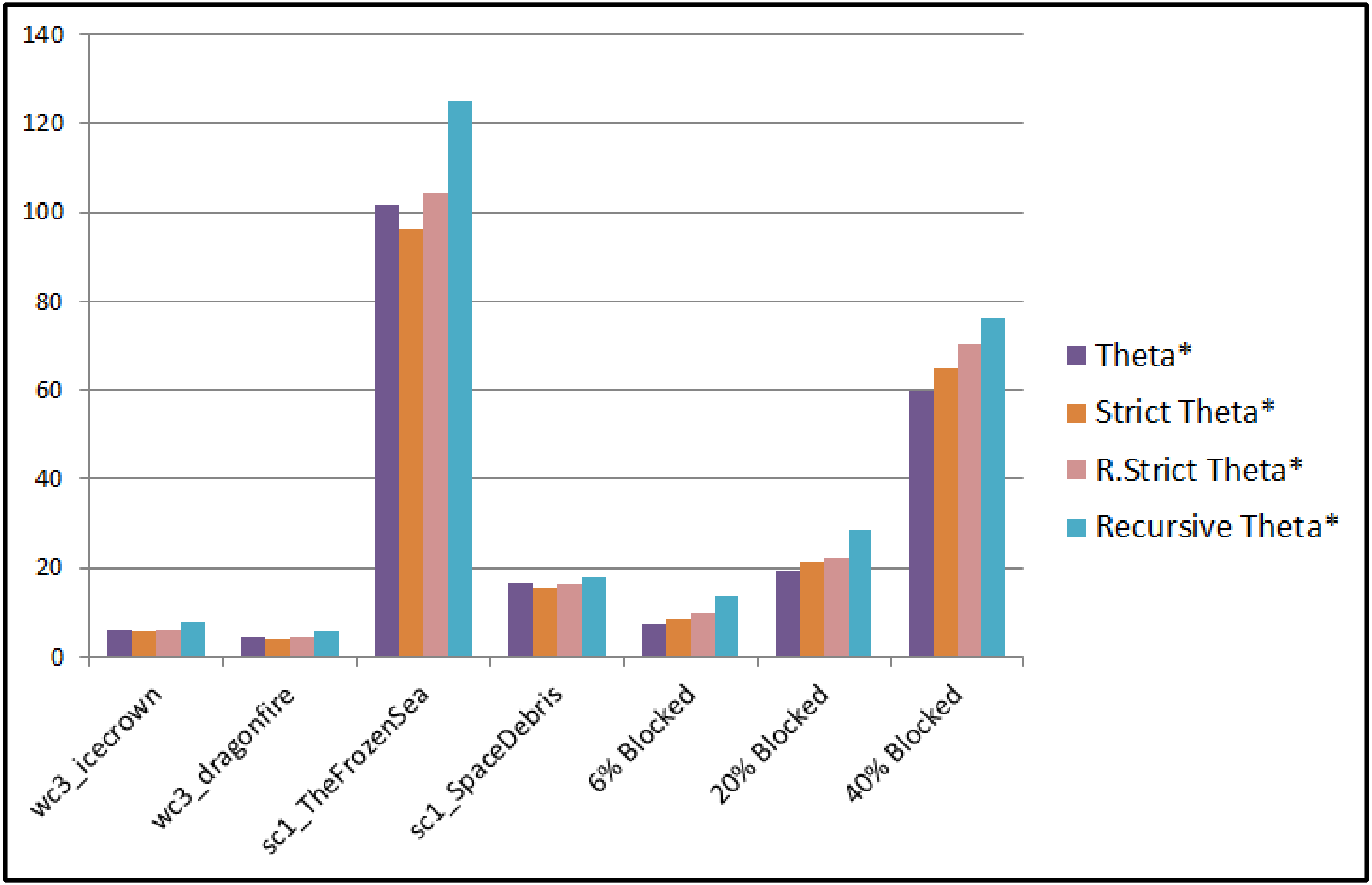
Implementation:

github.com/Ohohcakester/Any-Angle-Pathfinding

Path Length

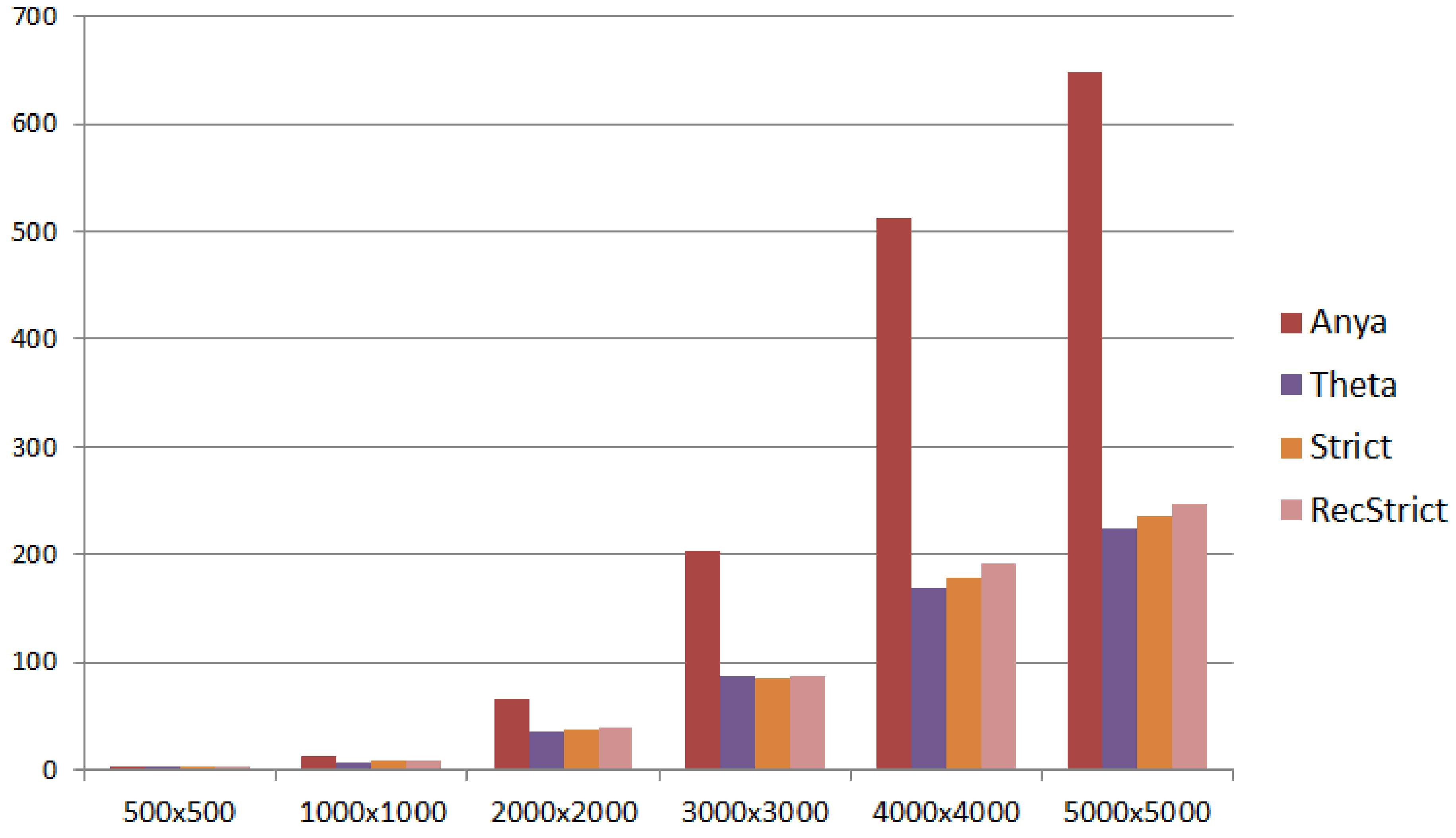

1.0025
1.002
1.0015
1.001
1.0005
1
sc1_TheFrozenSea
sc1_SpaceDebris
wc3_icecrown
wc3_dragonfire
6% Blocked
20% Blocked
40% Blocked
Theta*
Strict Theta*
R.Strict Theta*
Recursive Theta*

Running Time



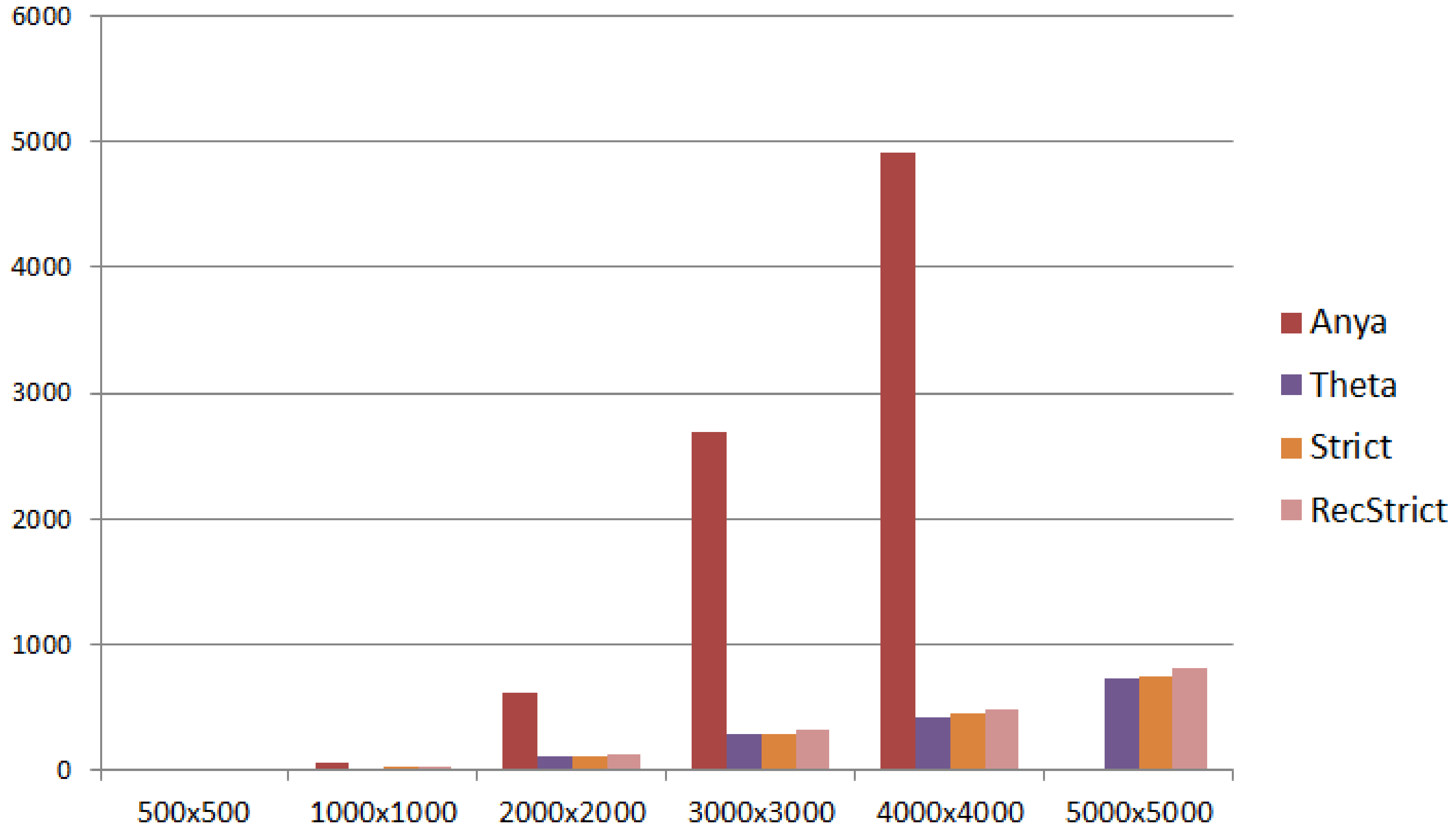
Running Time

6% Blocked Tiles



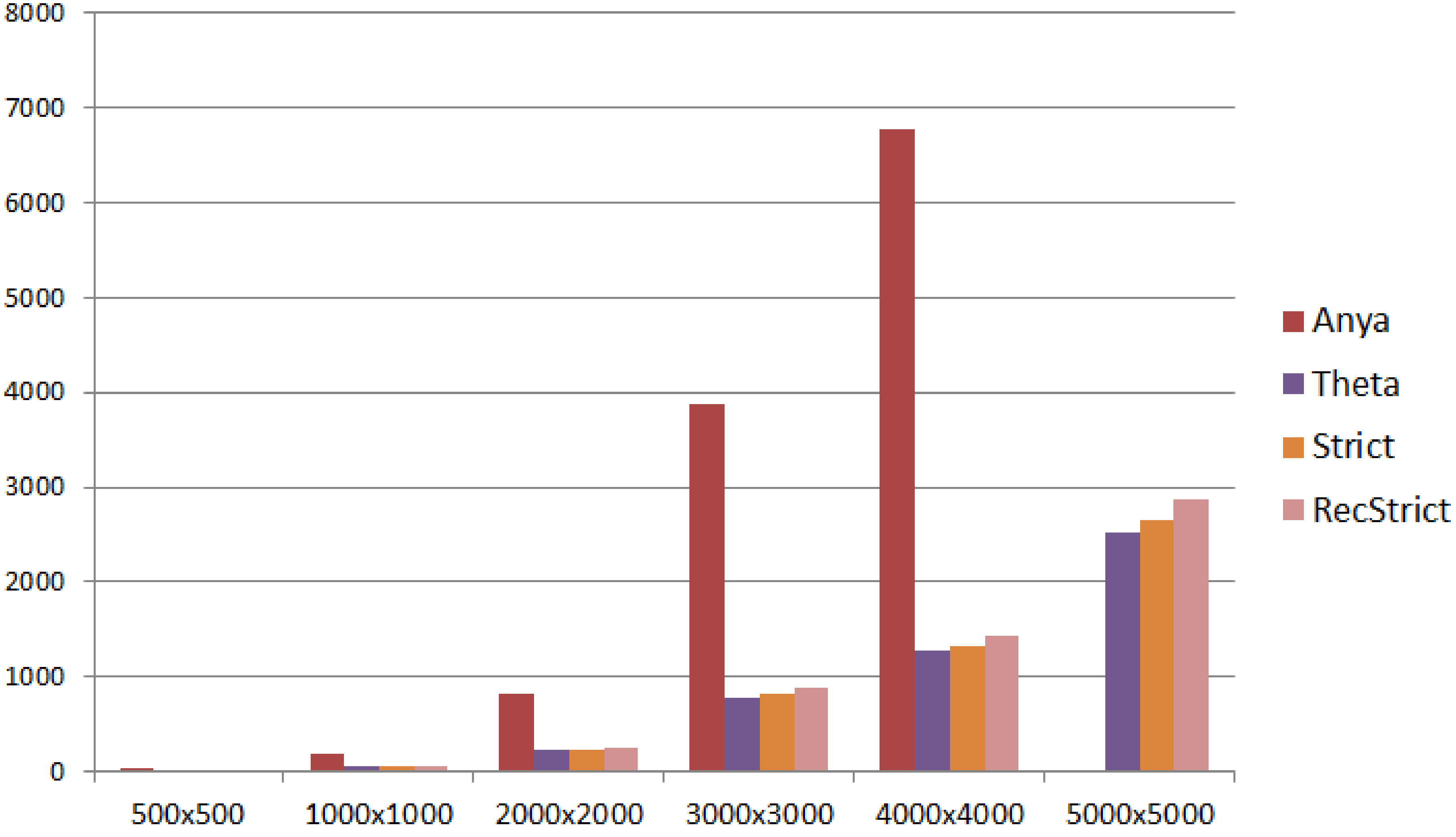
Running Time

20% Blocked Tiles

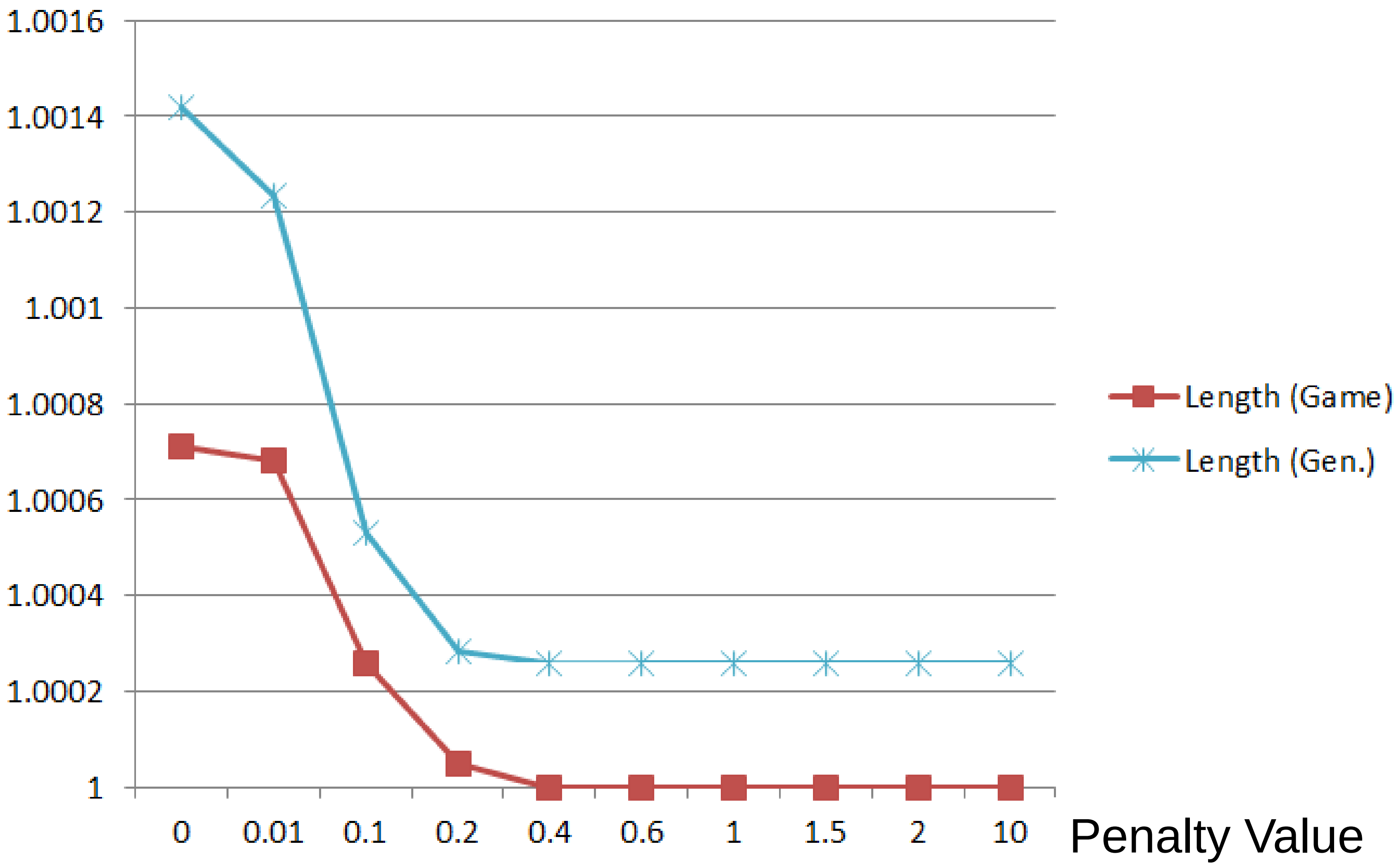


Running Time

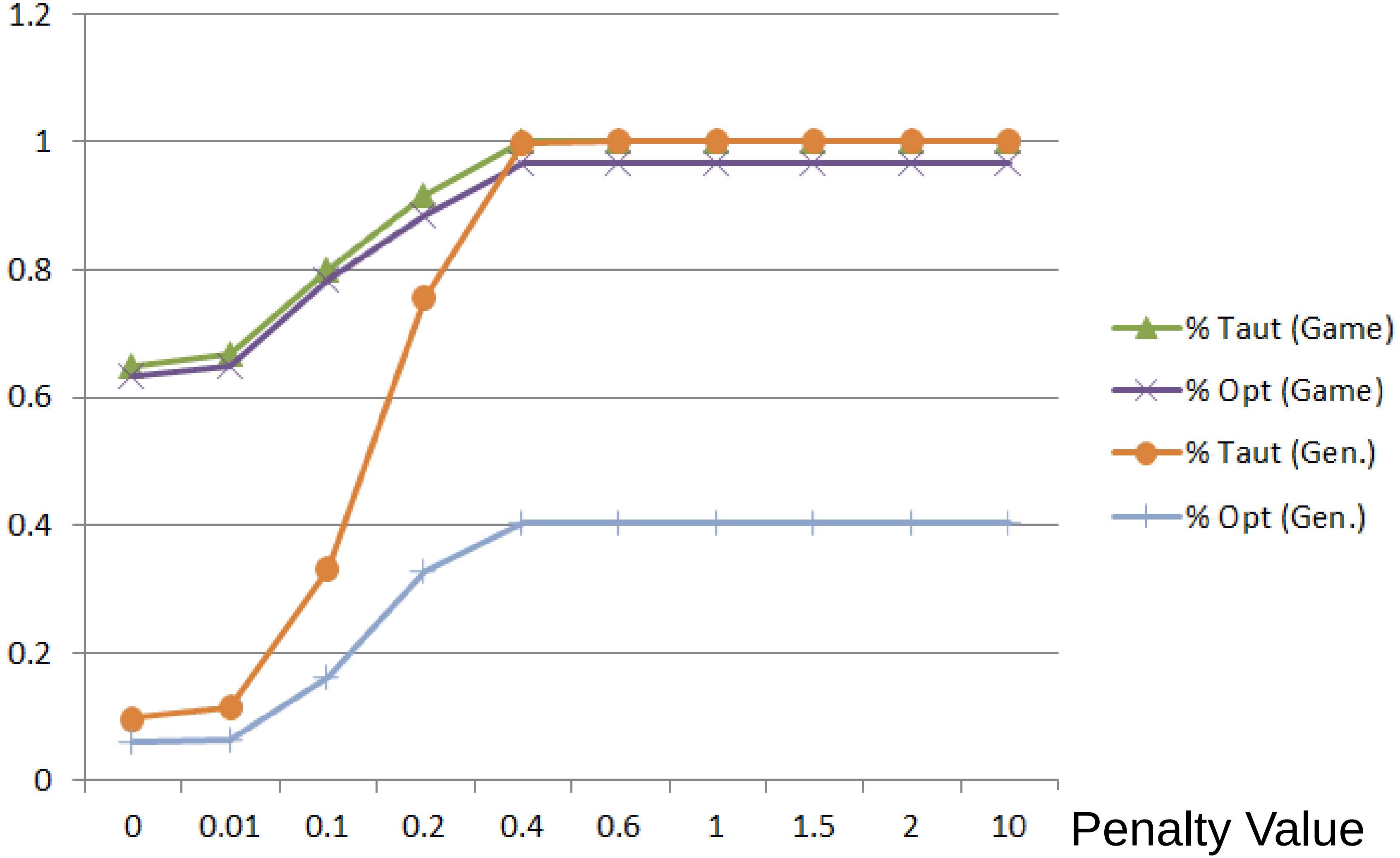
40% Blocked Tiles



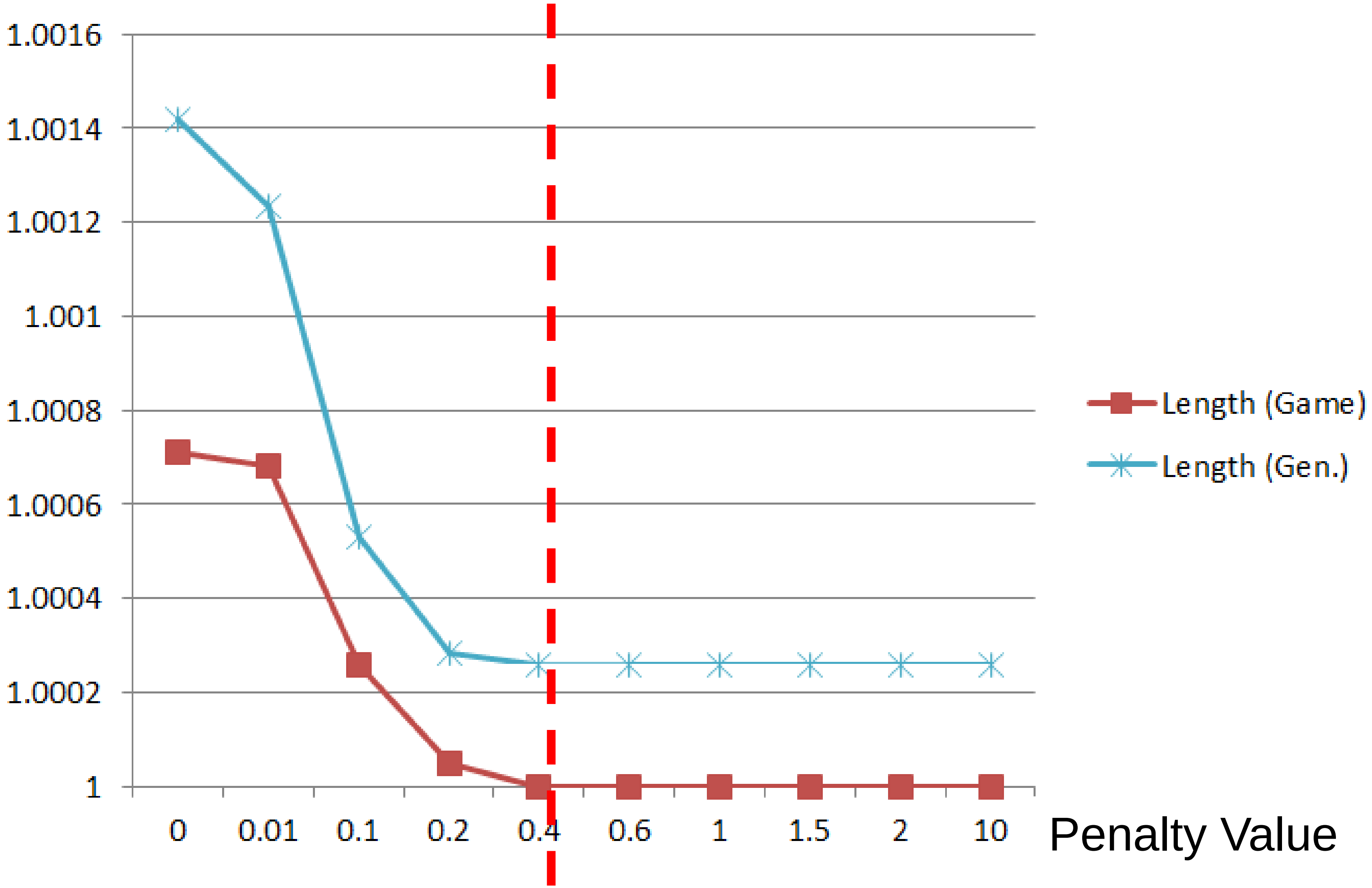
Path Length vs Penalty Value



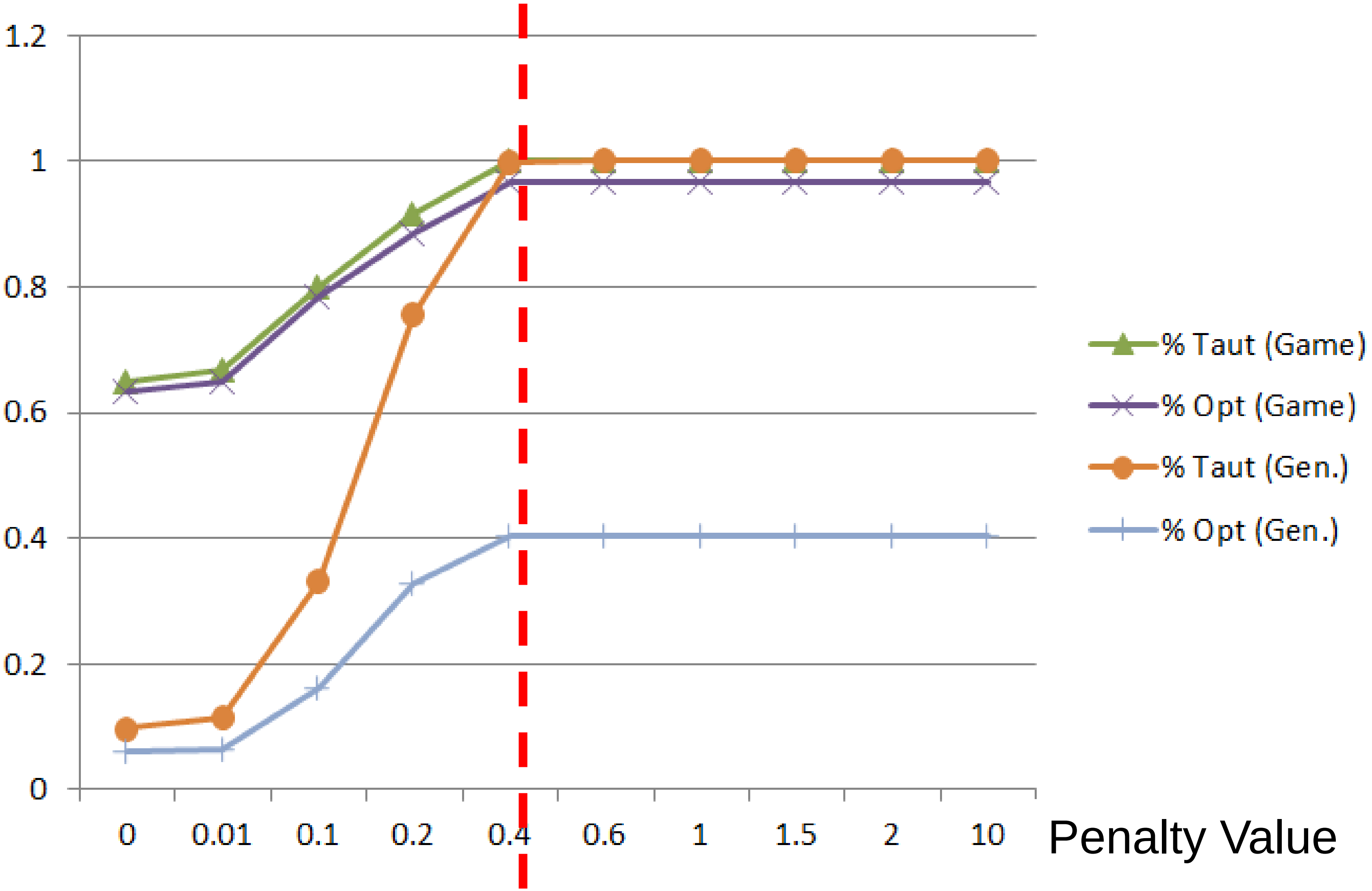
% Optimal/Taut vs Penalty Value

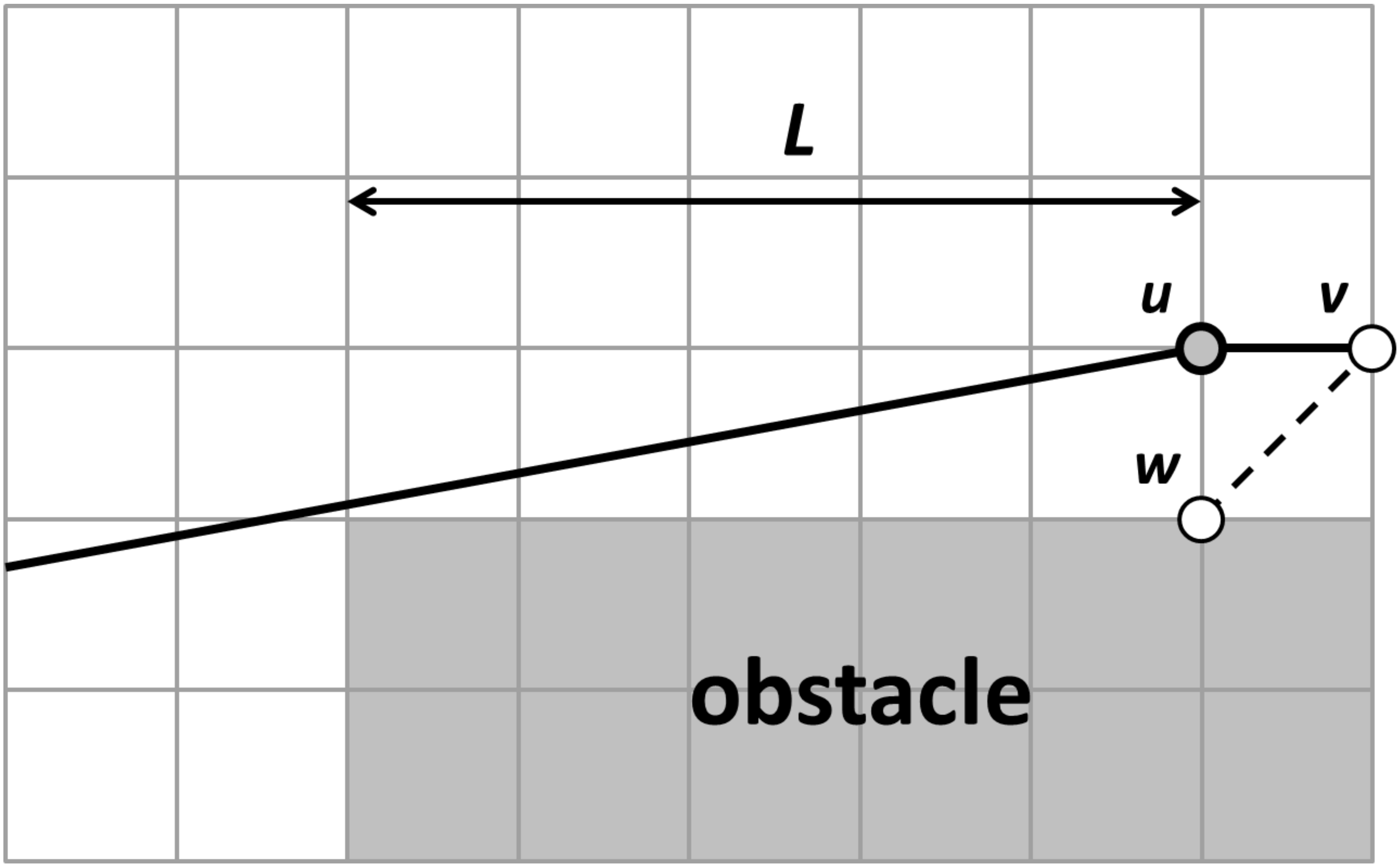


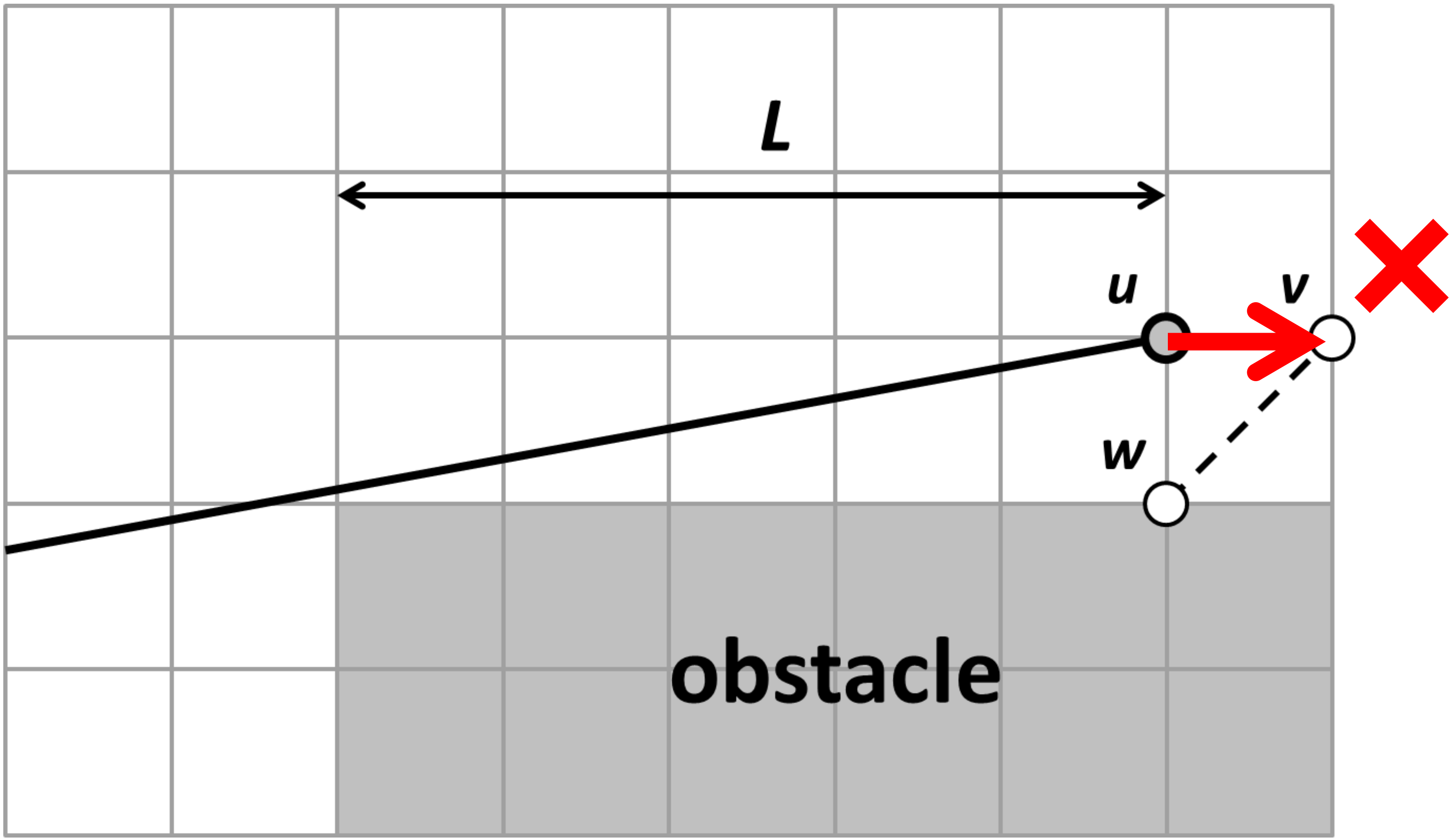
Path Length vs Penalty Value

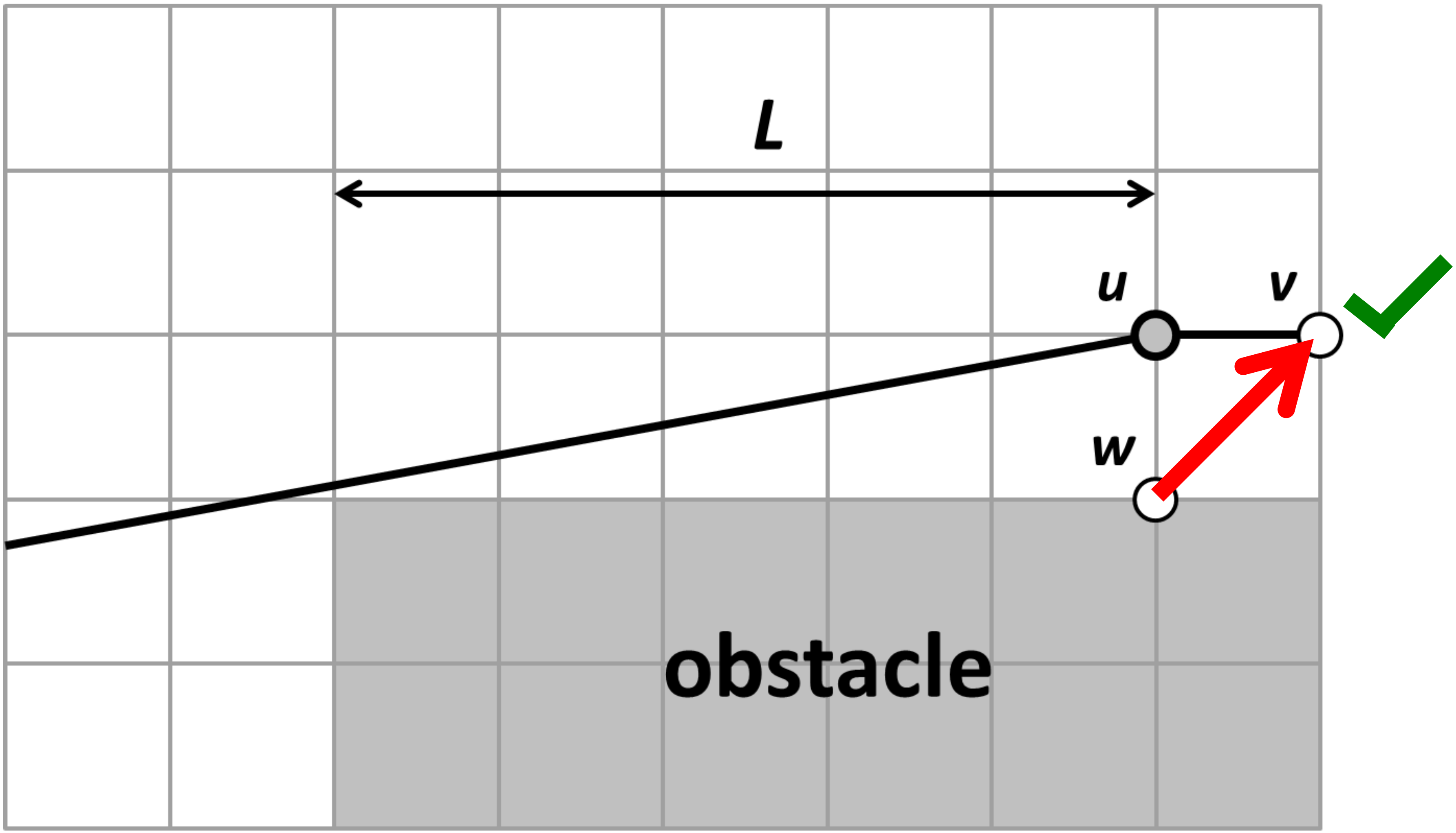


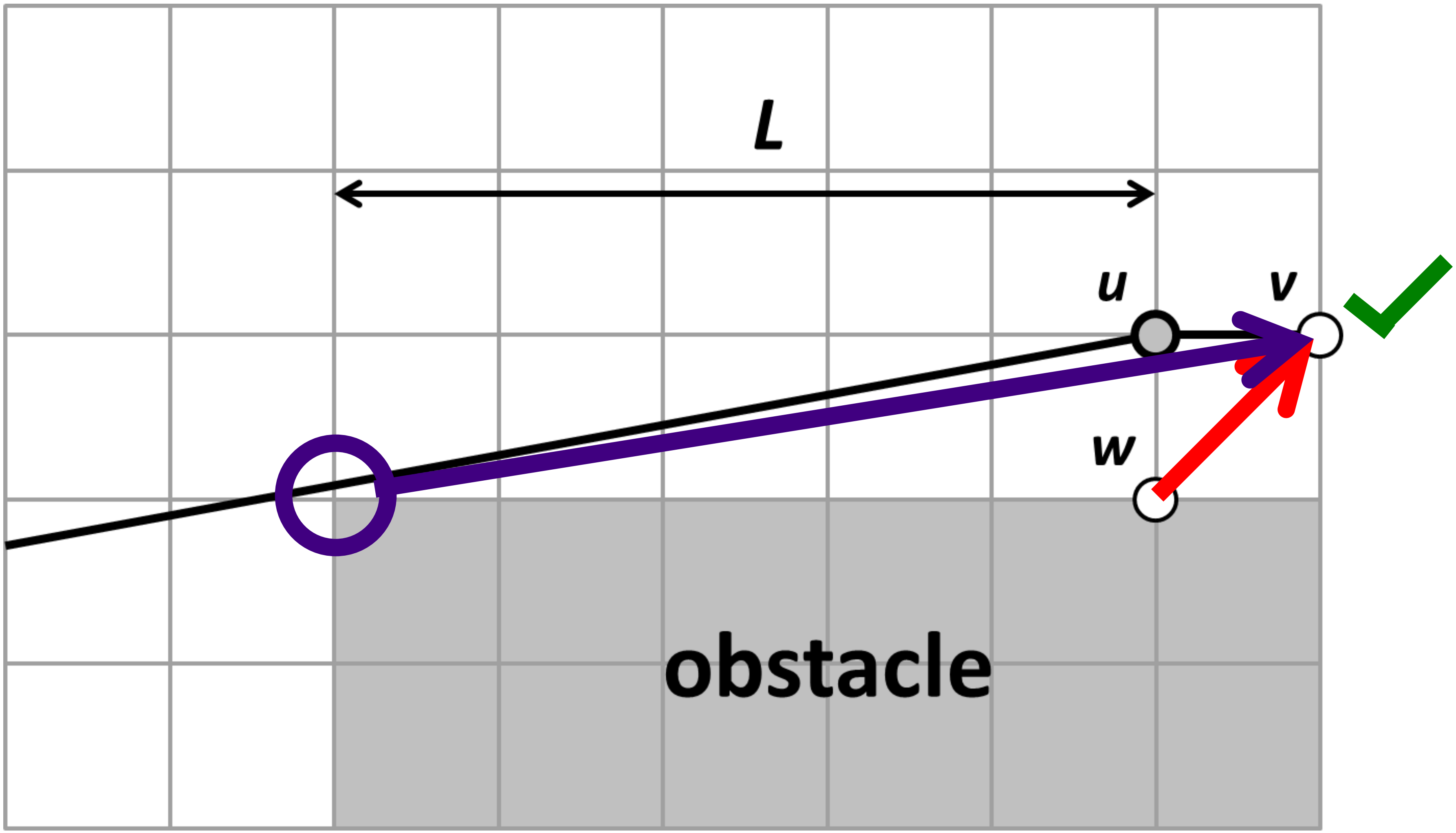
% Optimal/Taut vs Penalty Value

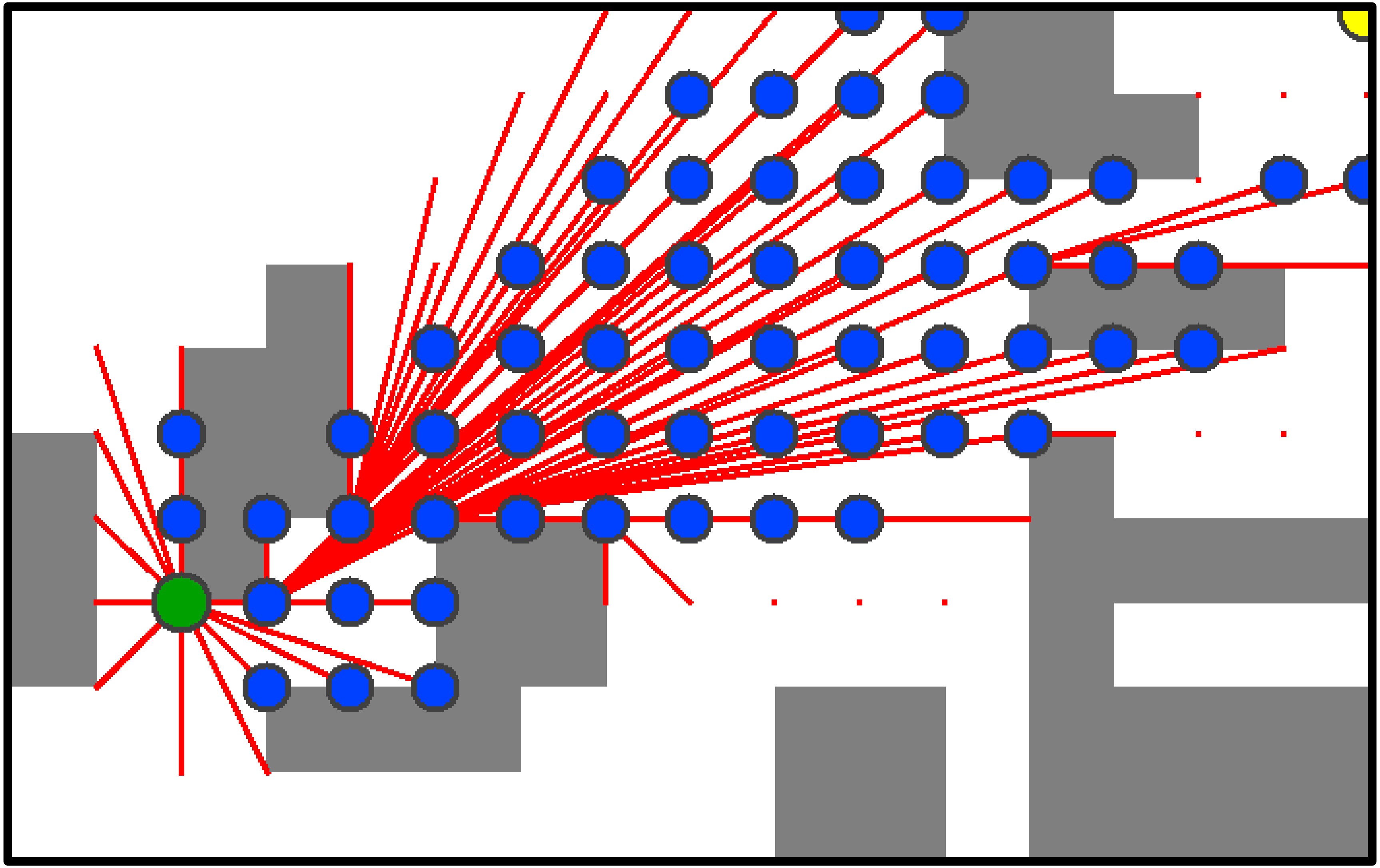



L
u
v
w
obstacle

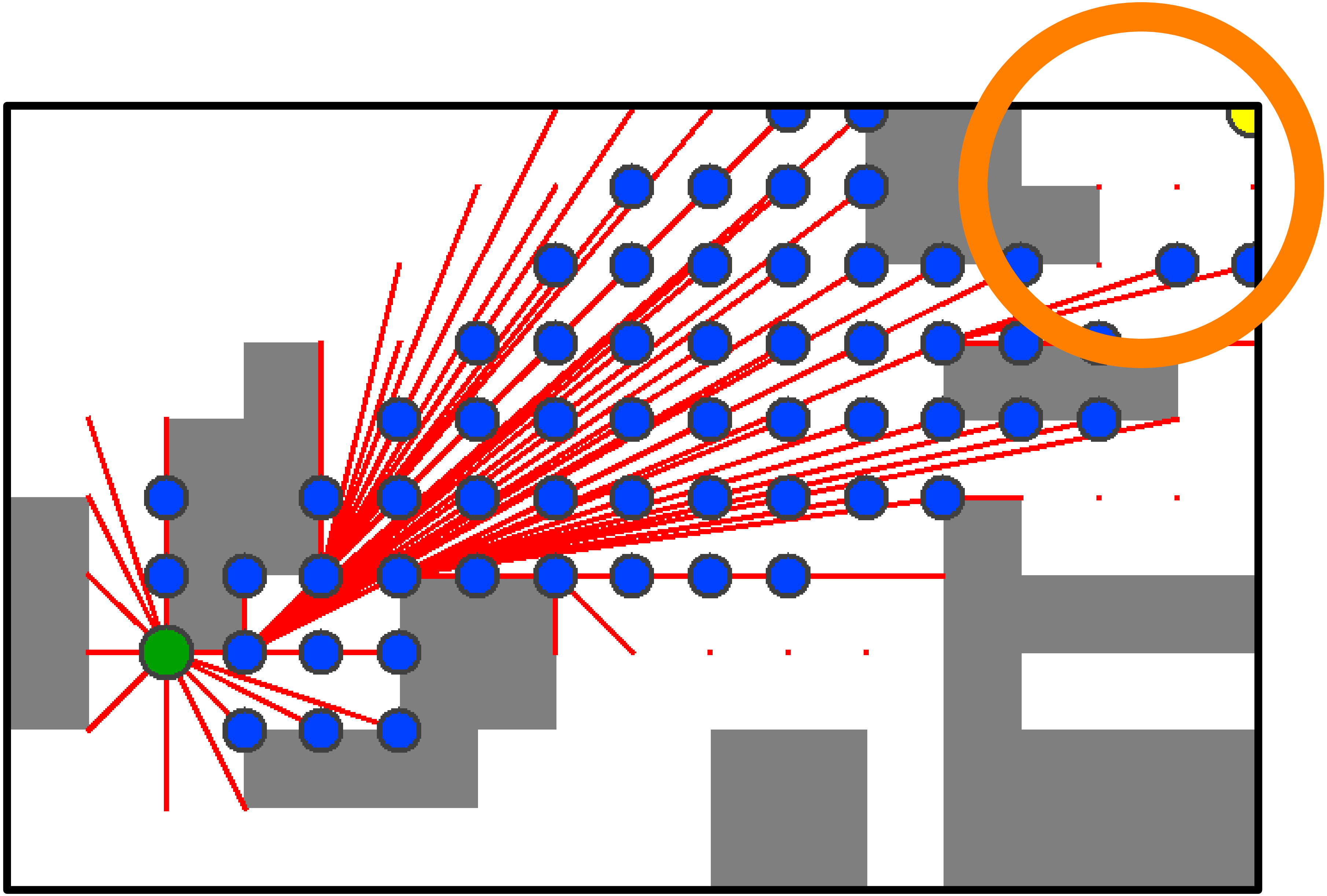

L
u
v
w
obstacle


L
u
v
w
obstacle

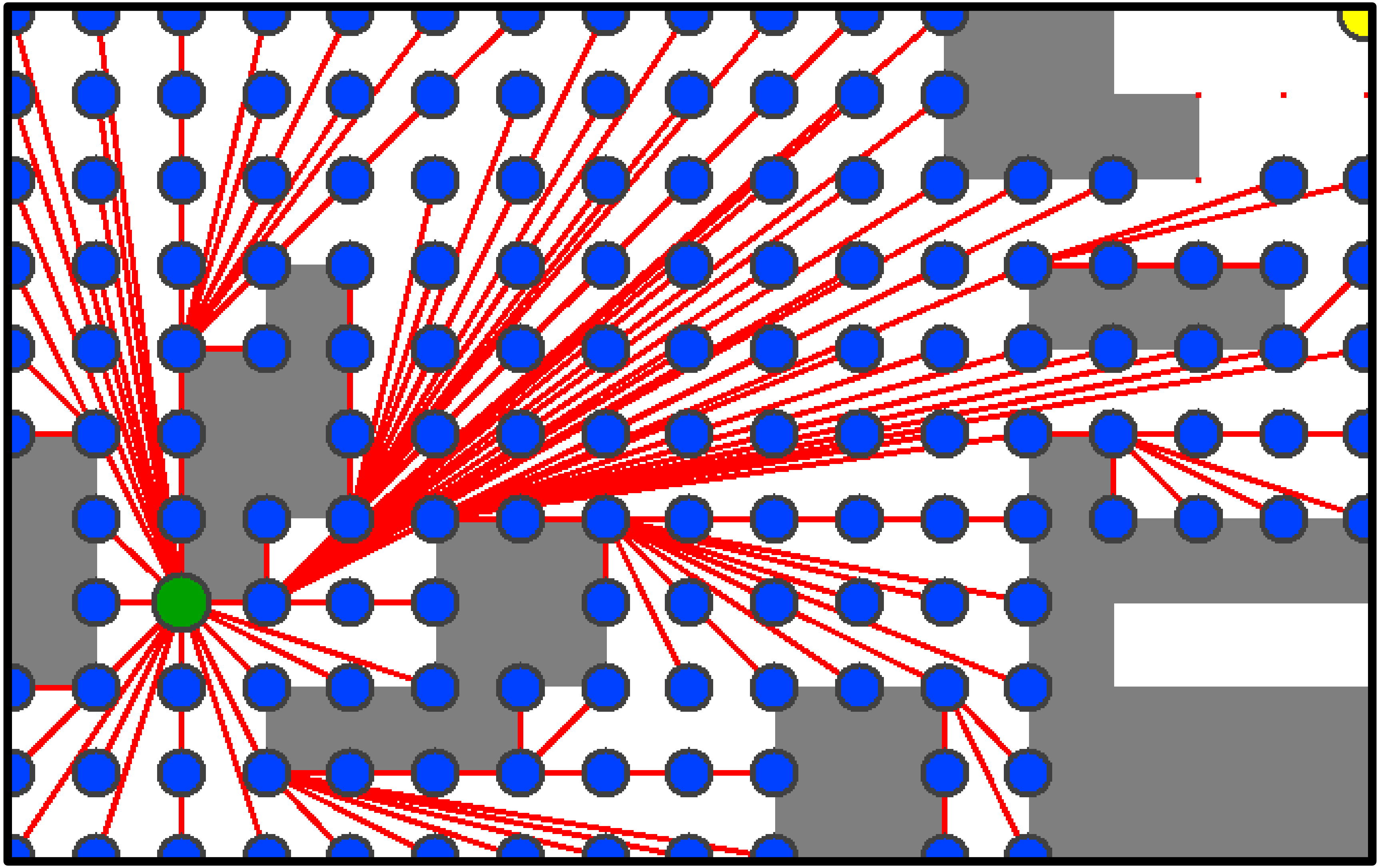

L
u
v
w
obstacle



Strict Theta*



Strict Theta*



Strict Theta*

ACKNOWLEDGEMENT

This presentation benefitted from

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a PowerPoint plugin for creating
better presentations with less effort.

PowerPointLabs
is available for free at
http://PowerPointLabs.info