Exploiting Temporal and Spatial Coherence in Hierarchical Visibility Algorithms

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- **Introduction, hierarchical visibility.**
- **Hierarchy updating, conservative hierarchy updating.**
- **Visibility propagation.**
- **Results, conclusion, future work.**

Hierarchical Visibility Algorithms

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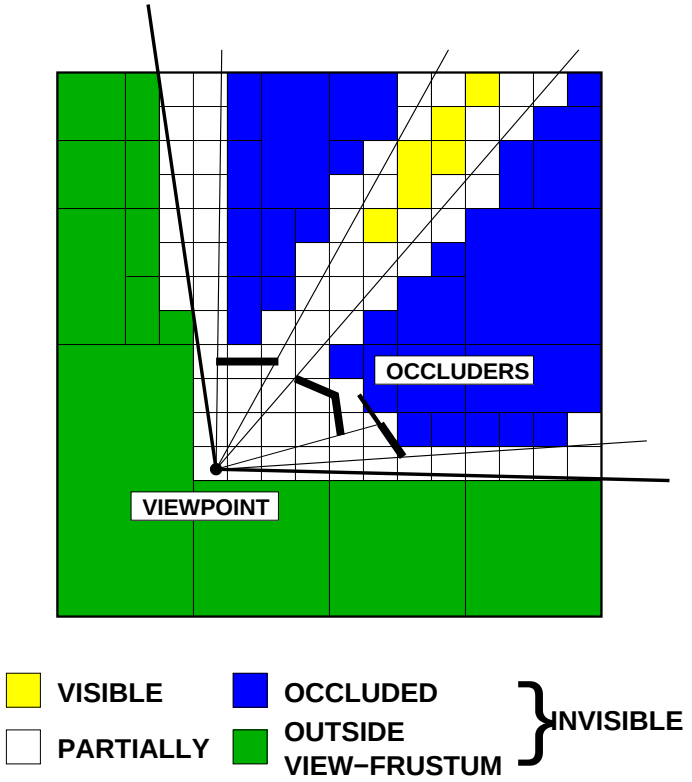
Speedup rendering of large scenes by visibility culling

Spatial hierarchy

- **kD–tree**, octree, OBB tree

Visibility test of a region:

- visible (V)
- invisible (I)
- partially visible (PV)



- for **each viewpoint** start at the root of the hierarchy
- recursivelly apply visibility test on **PV** regions

Hierarchical Visibility Algorithms

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Image space

- Hierarchical z–buffer. Greene ’93.
- Hierarchical occlusion maps. Manocha et al. ’96.
- Hierarchical polygon tiling. Greene ’96.

Object space

- Occlusion frusta. Zhang et al. ’97.
- Visual events. Coorg and Teller ’96, ’97.
- **Occlusion trees. Bittner et al. ’98.**

Hierarchy Updating

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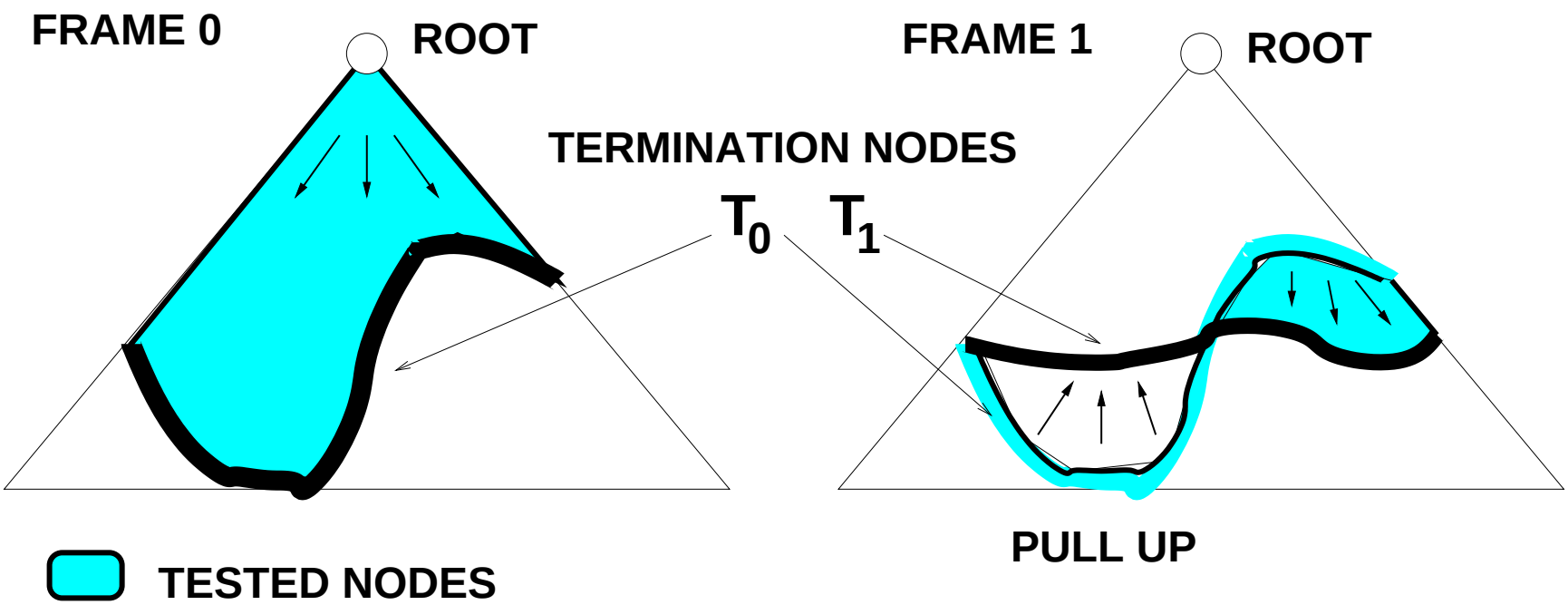
- idea: avoid repeated visibility tests of **interior** hierarchy nodes
- **cut of the hierachy** used as a starting level in next frame
- **propagate** visibility changes up the hierarchy



Conservative Hierarchy Updating

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Motivation

- hierarchy updating saves almost 50% of visibility tests
- we can save more:
  partially visible and visible nodes **marked visible** with certain probability p

Properties

- keeps conservative behaviour of the algorithm
- not all changes from **PV** or **V** to **I** are captured
- higher p – **less** visibility tests, but usually **more** visible nodes and more objects to render

Visibility Propagation

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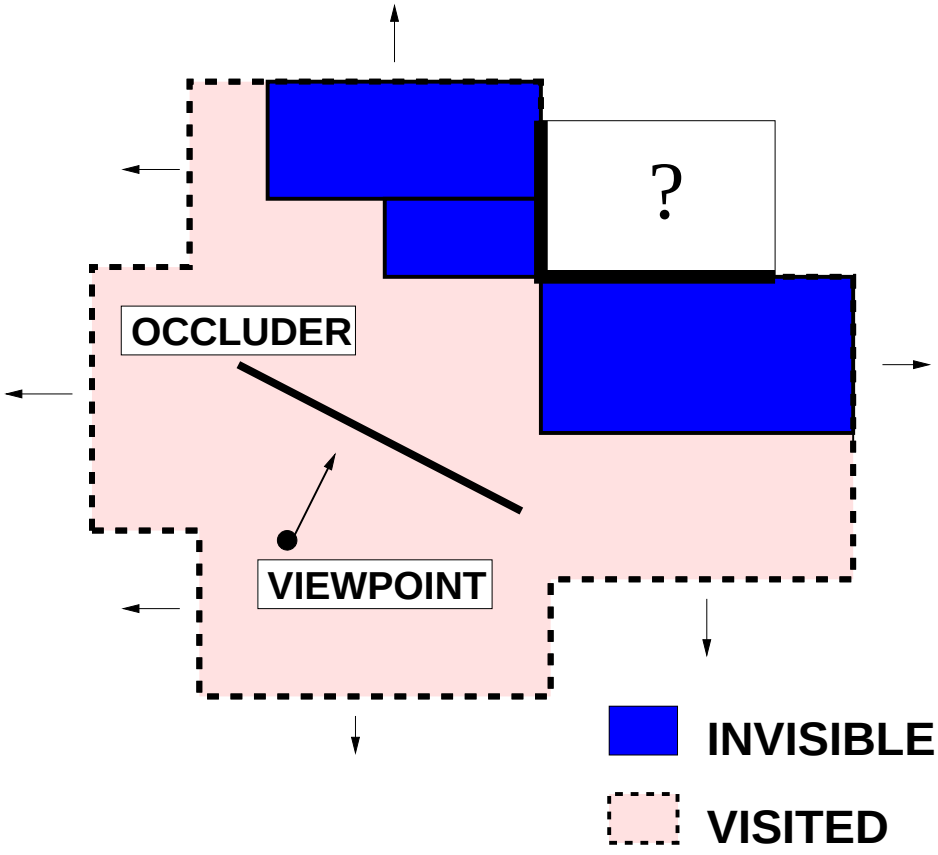
- **front–to–back** processing of the hierarchy nodes
- use visibility classification of already processed nodes
- combine their visibility – if **visible** or **invisible** we are done



Visibility Propagation – cont.

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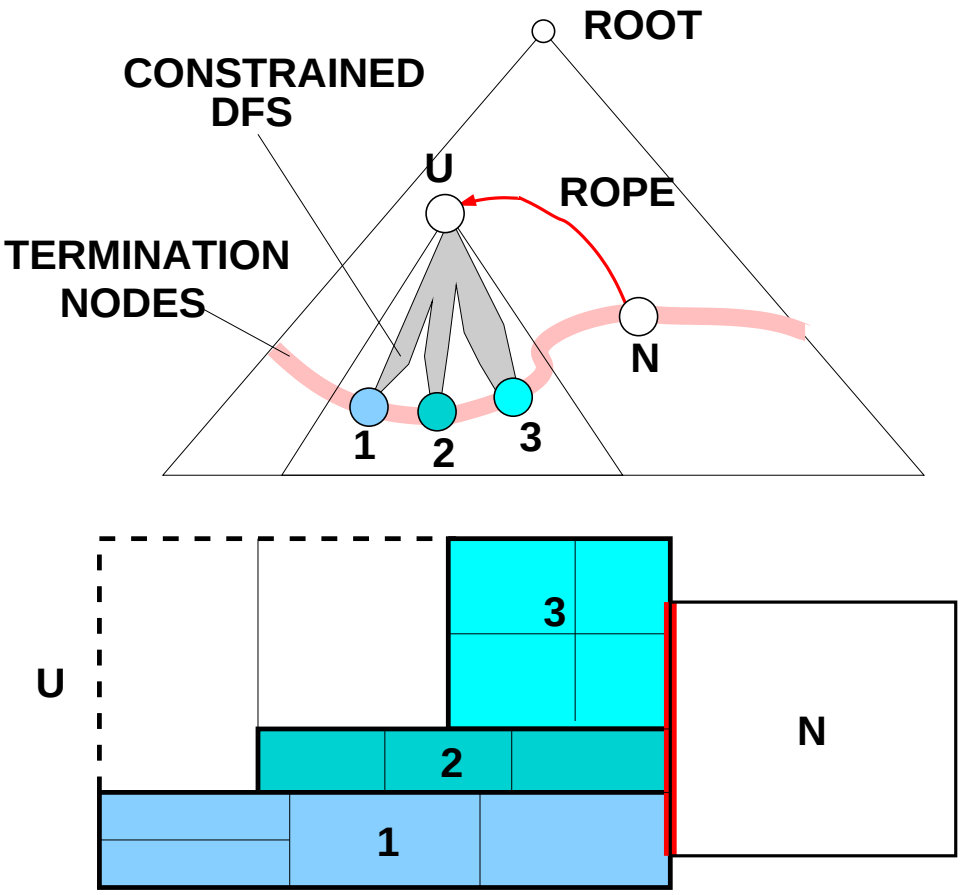
- use neighbour links (ropes) to locate all processed neighbours



Modified Visibility Pipeline

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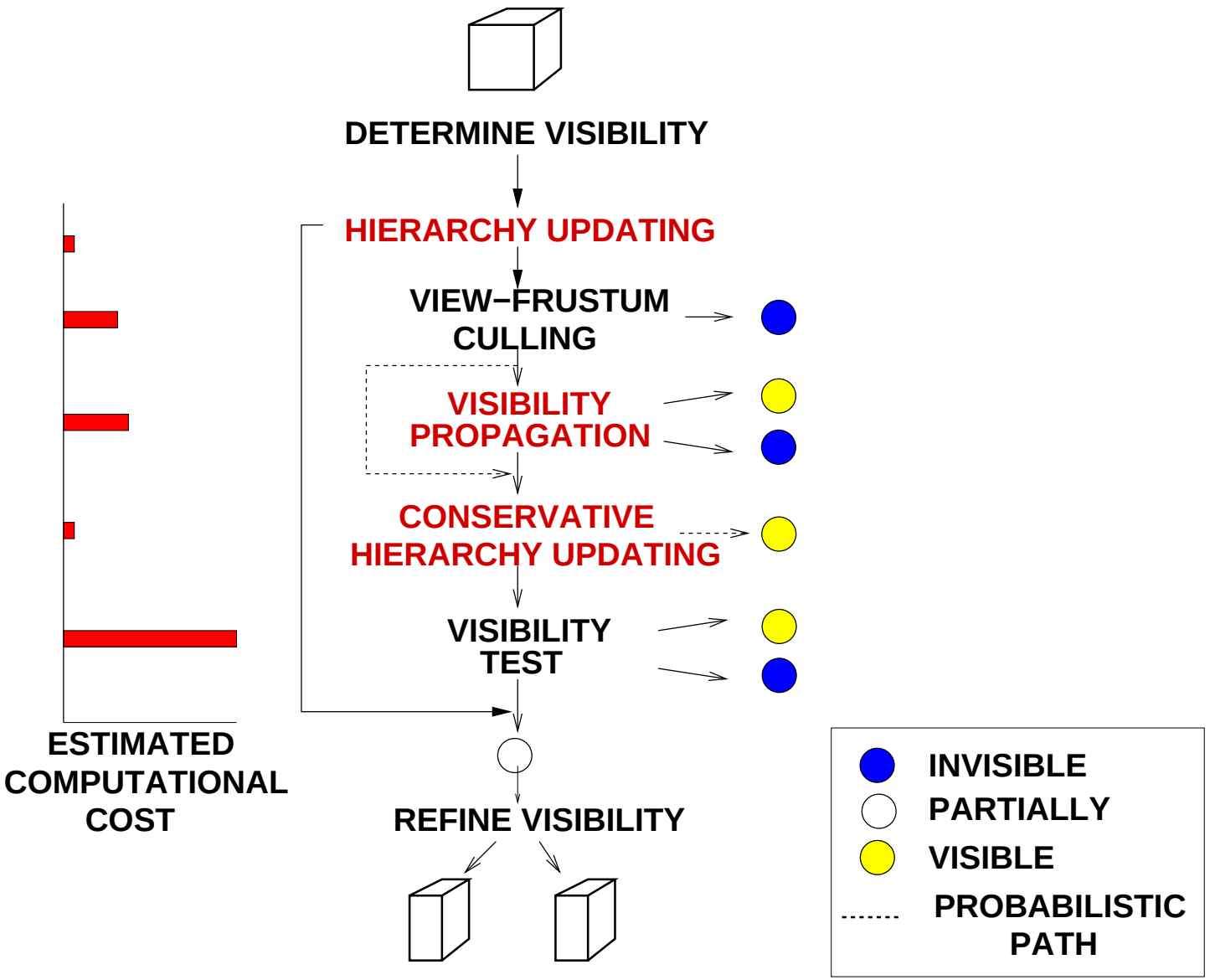

Results

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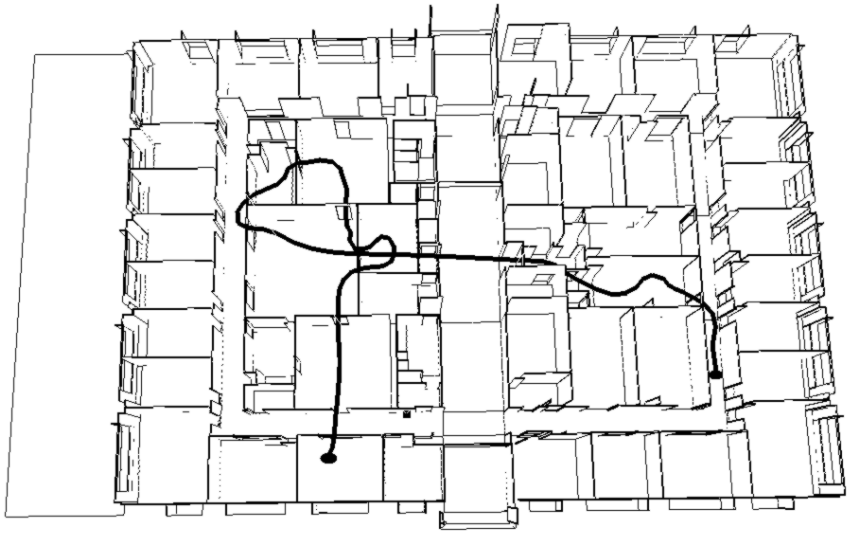
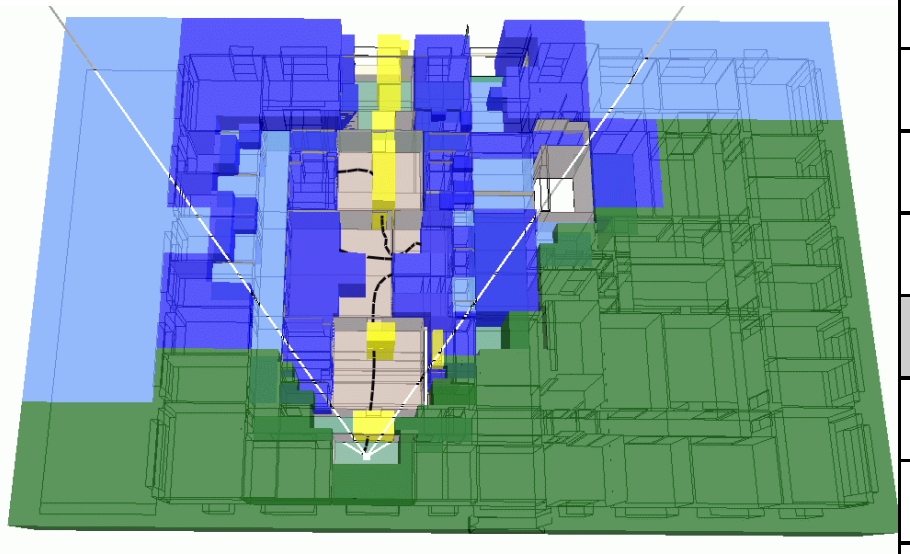
Test path through building interior



Visibility classification



Results – cont.

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Walk through a building interior

Results – cont.

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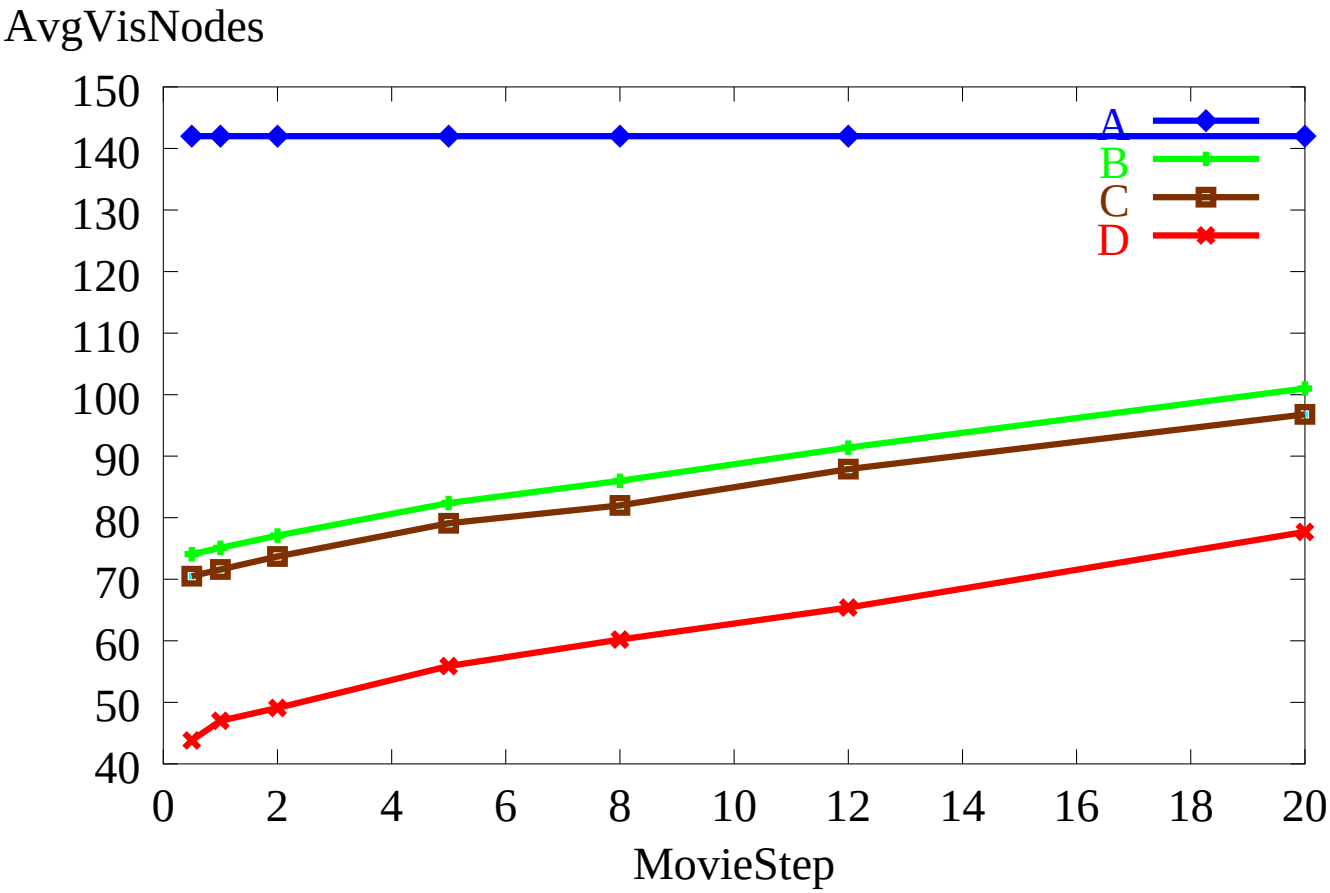
Avg. number of visibility tests vs. relative walking speed



Results – cont.

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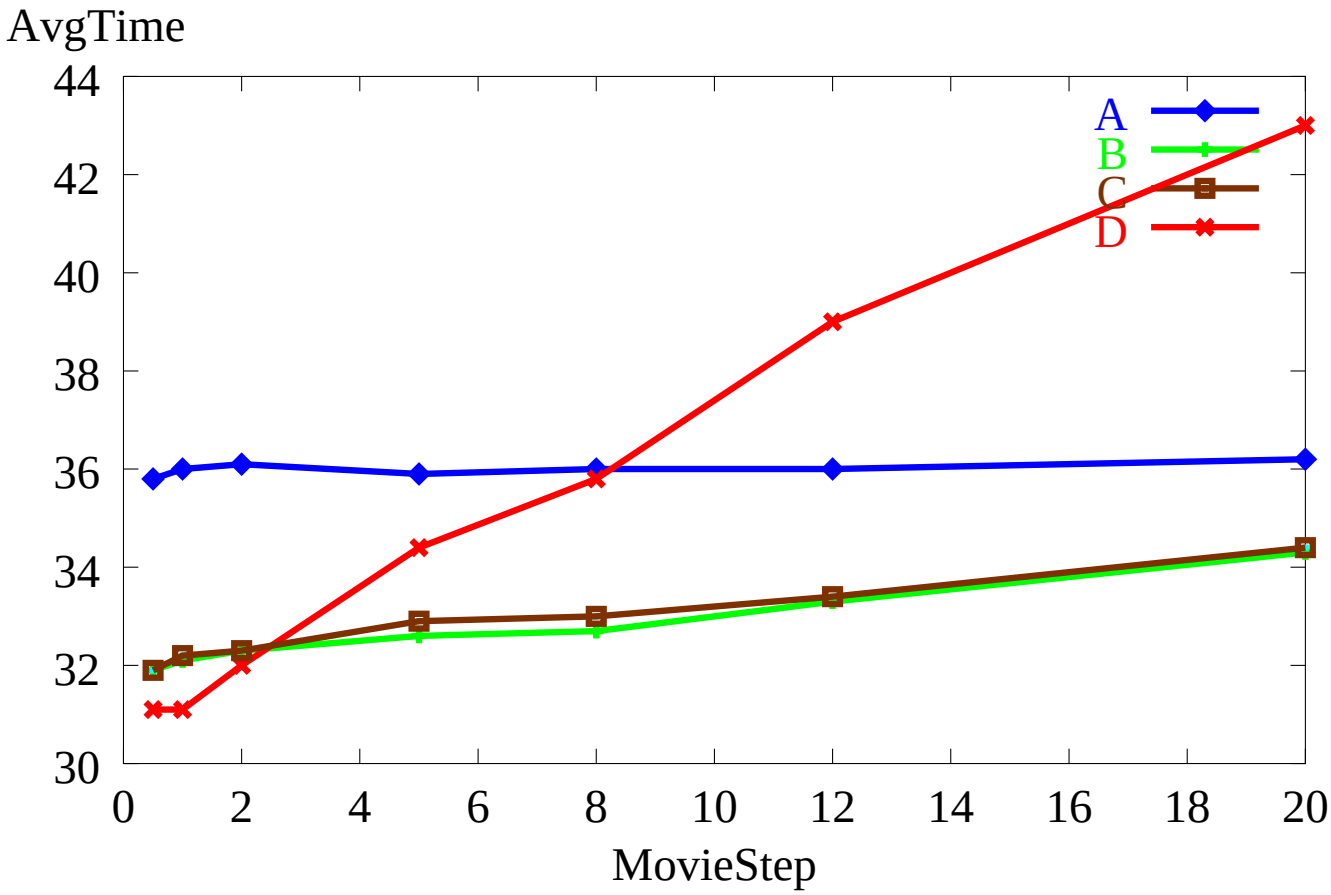
Avg. frame time [ms] vs. relative walking speed



Results – cont.

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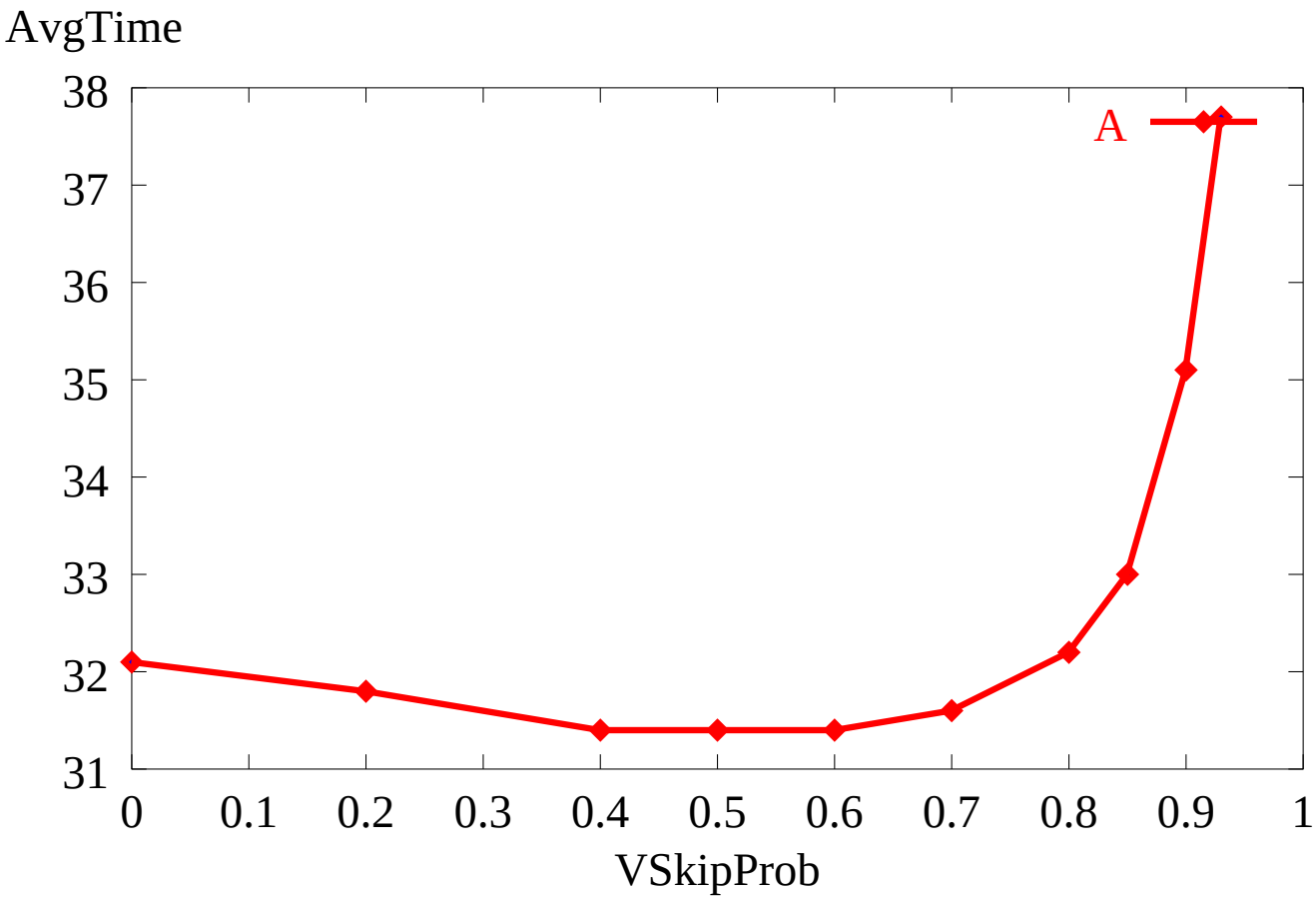
Avg. frame time [ms] vs. probability p



Results – summary

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Hierarchy updating

- saves almost **50**% of visibility tests

Conservative hierarchy updating

- another **20**% of visibility tests
- faster visibility changes $\Rightarrow$ more objects to render

Visibility propagation

- successful on only few rather large regions

Conclusion and Future Work

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Hierarchy updating

- very simple and useful
- eliminates overhead induced by hierachy, keeps advantages

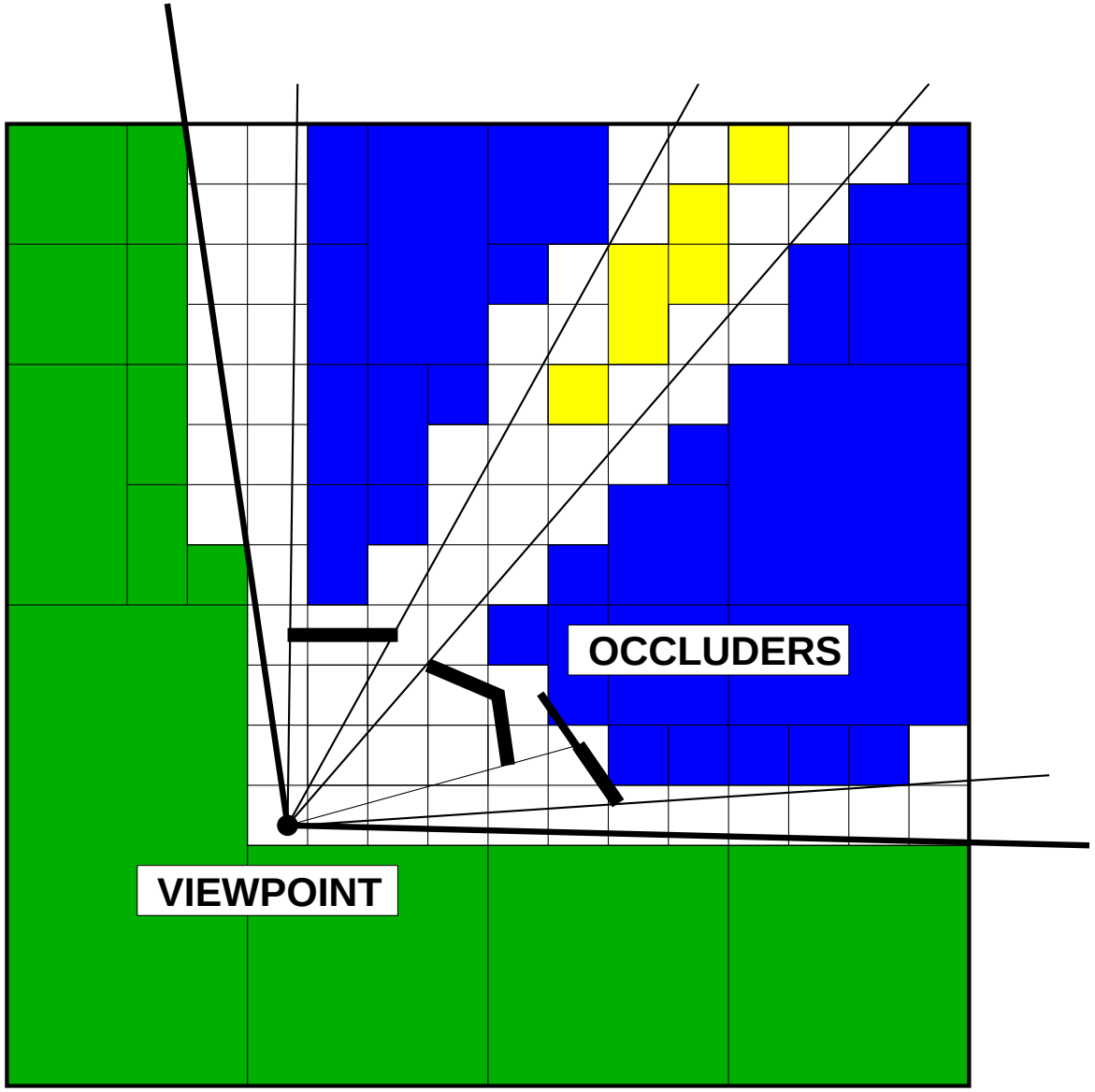
Conservative hierarchy updating

- useful for certain settings
- how to estimate **optimal probability** of skipping visibility test?

Visibility propagation

- not very succesful
- spatial coherence already exploited well by using the hierarchy!
- determine that region is **PV** with high probability?

QUESTIONS ?



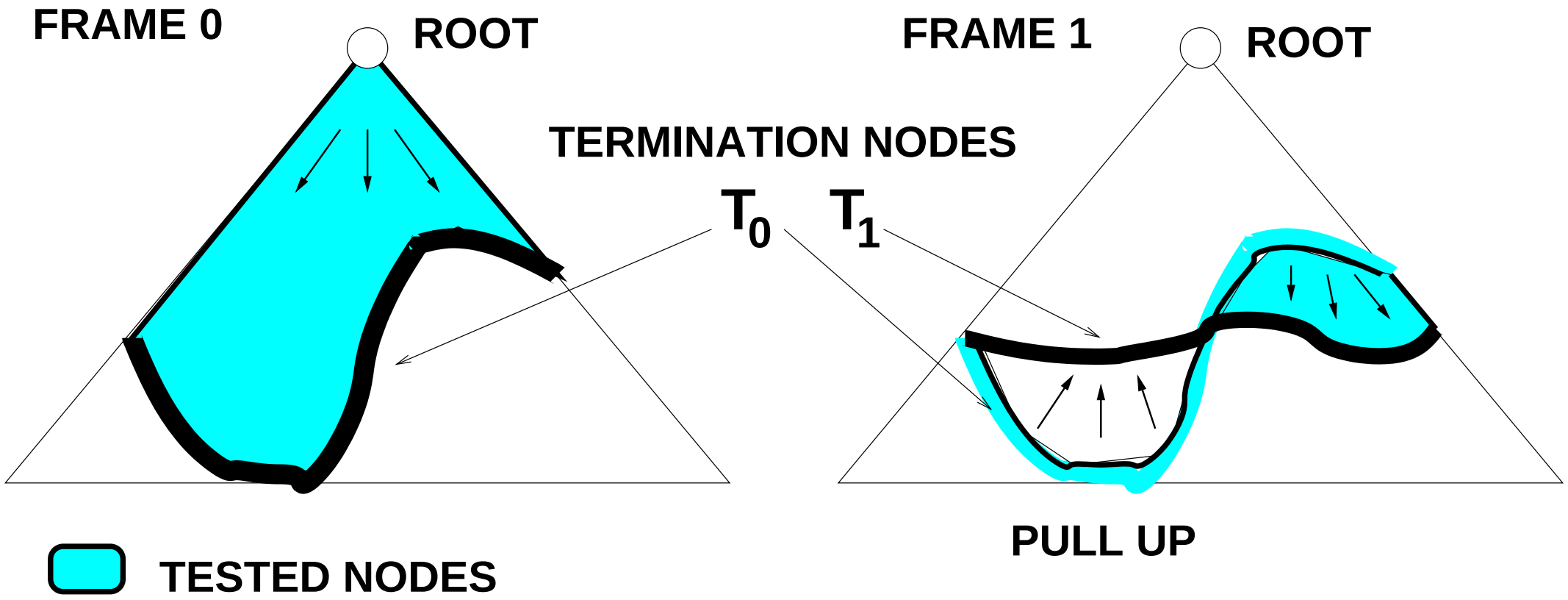
VISIBLE

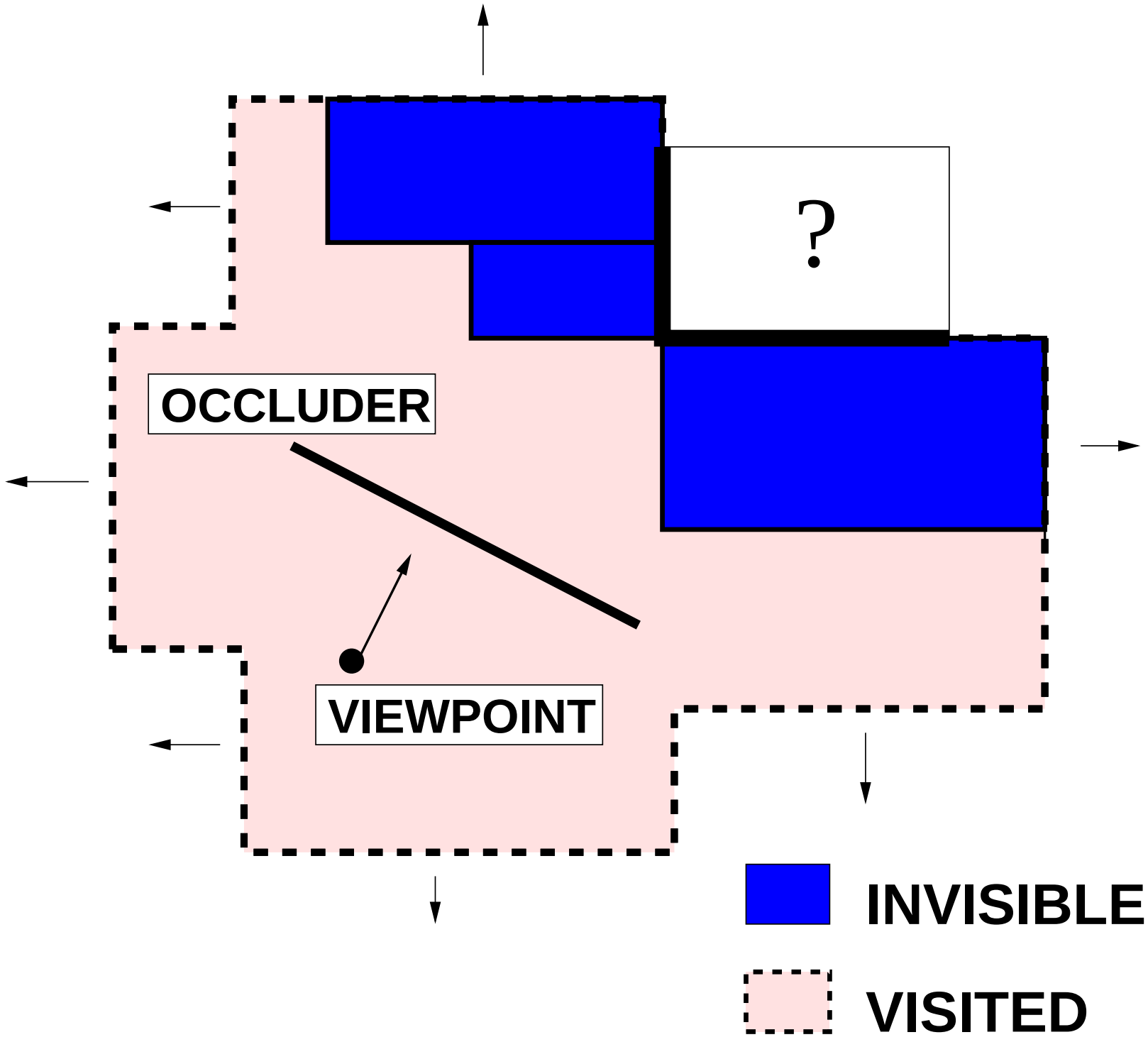
PARTIALLY

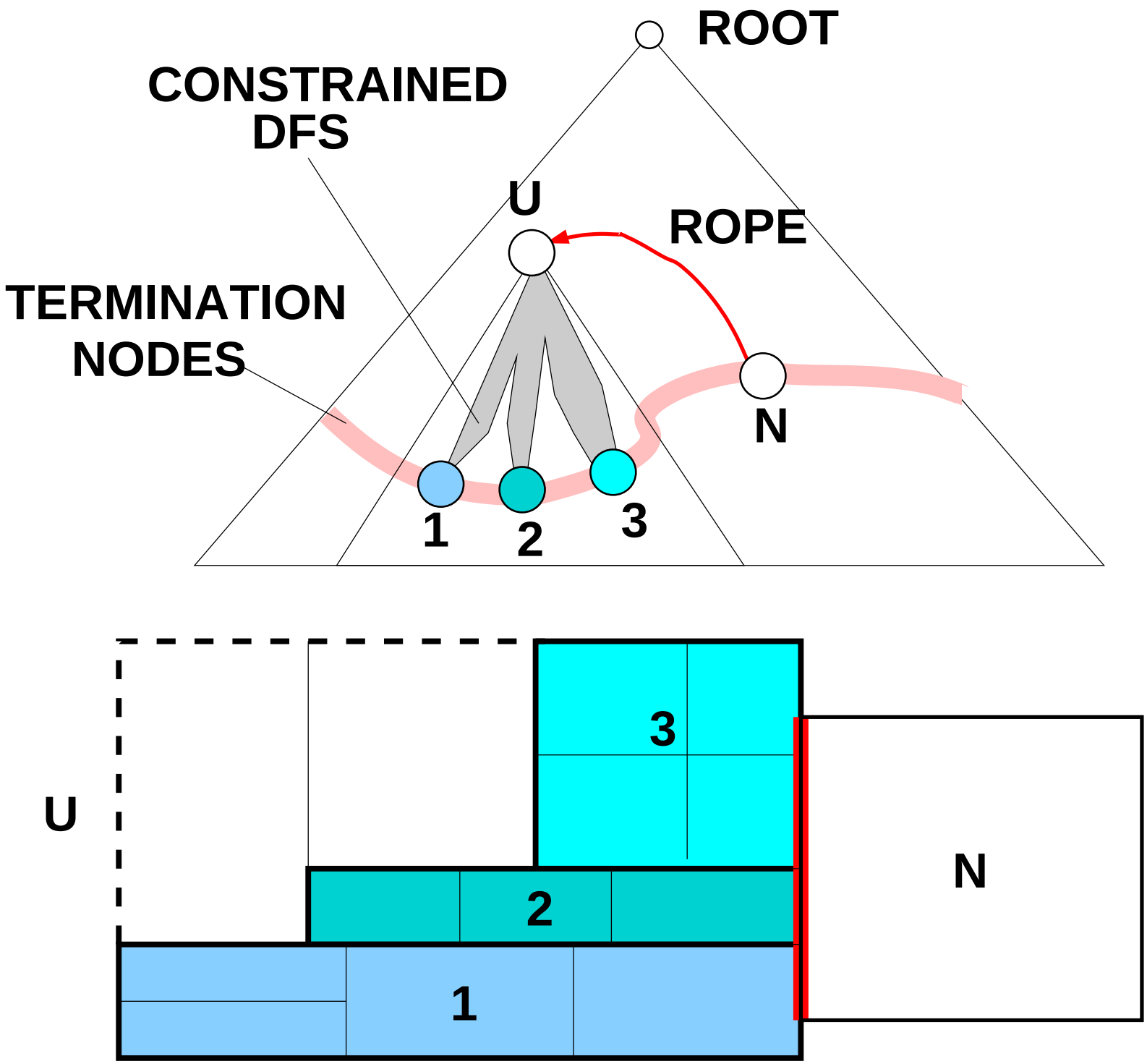
OCCLUDED

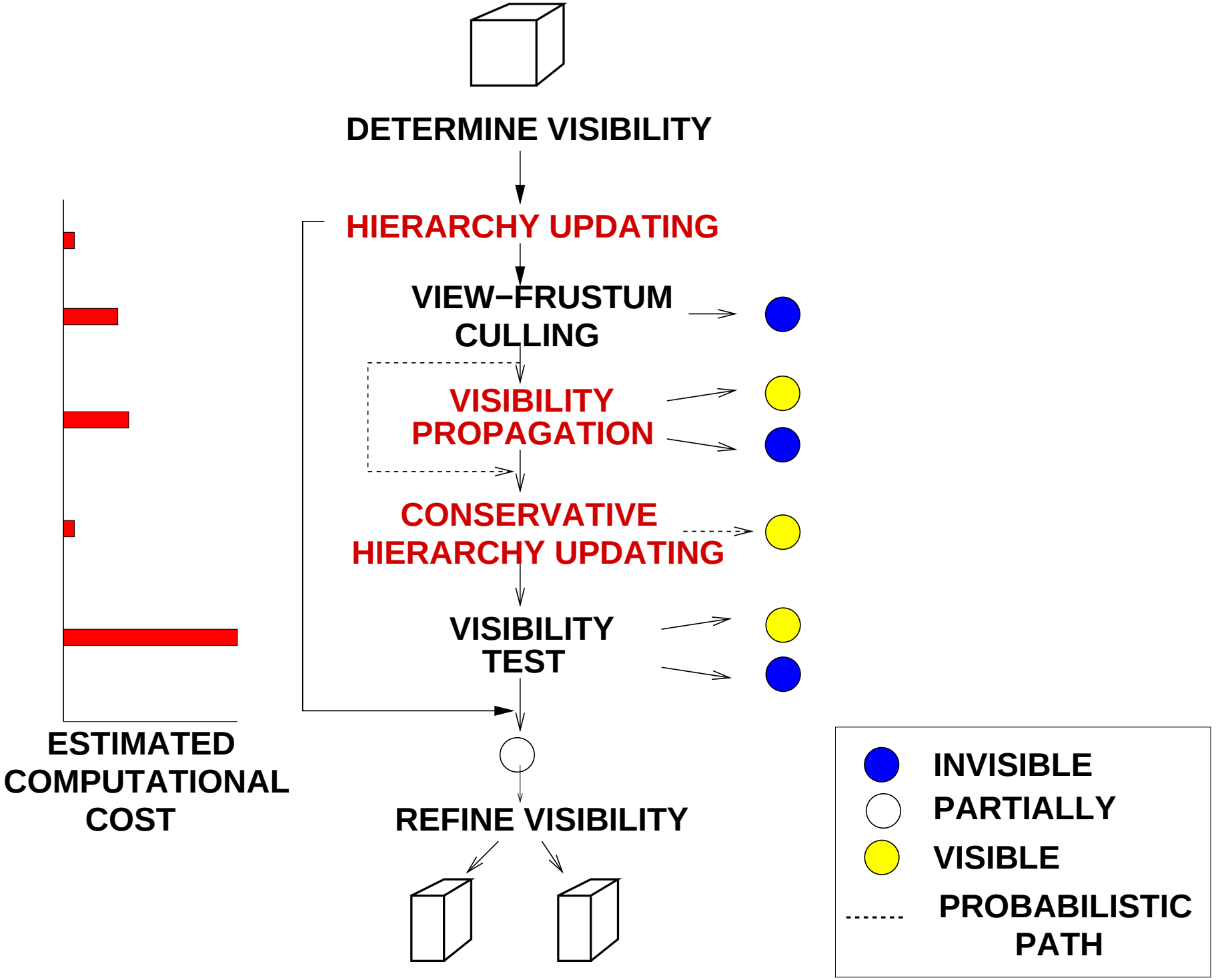
OUTSIDE VIEW−FRUSTUM

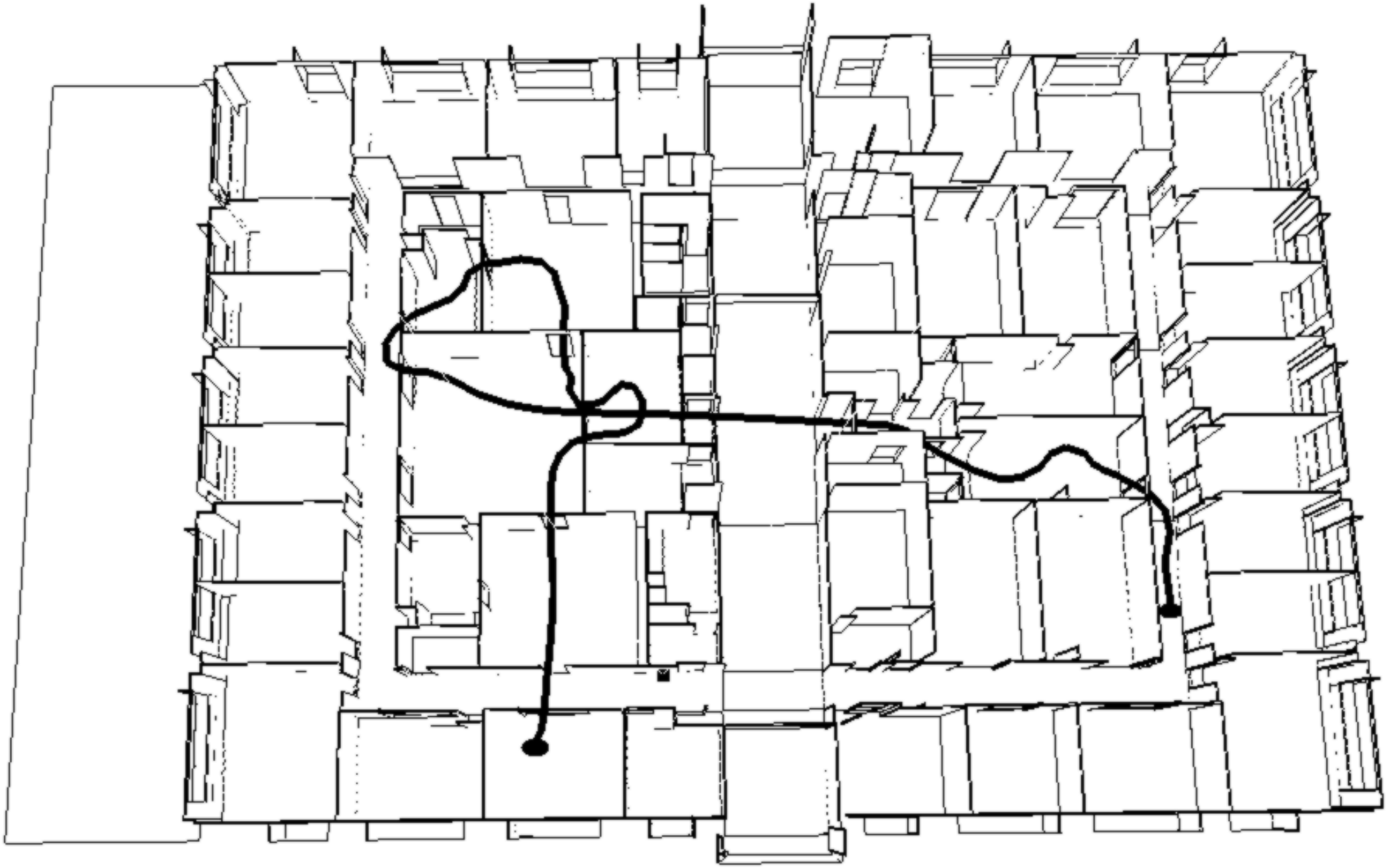
INVISIBLE

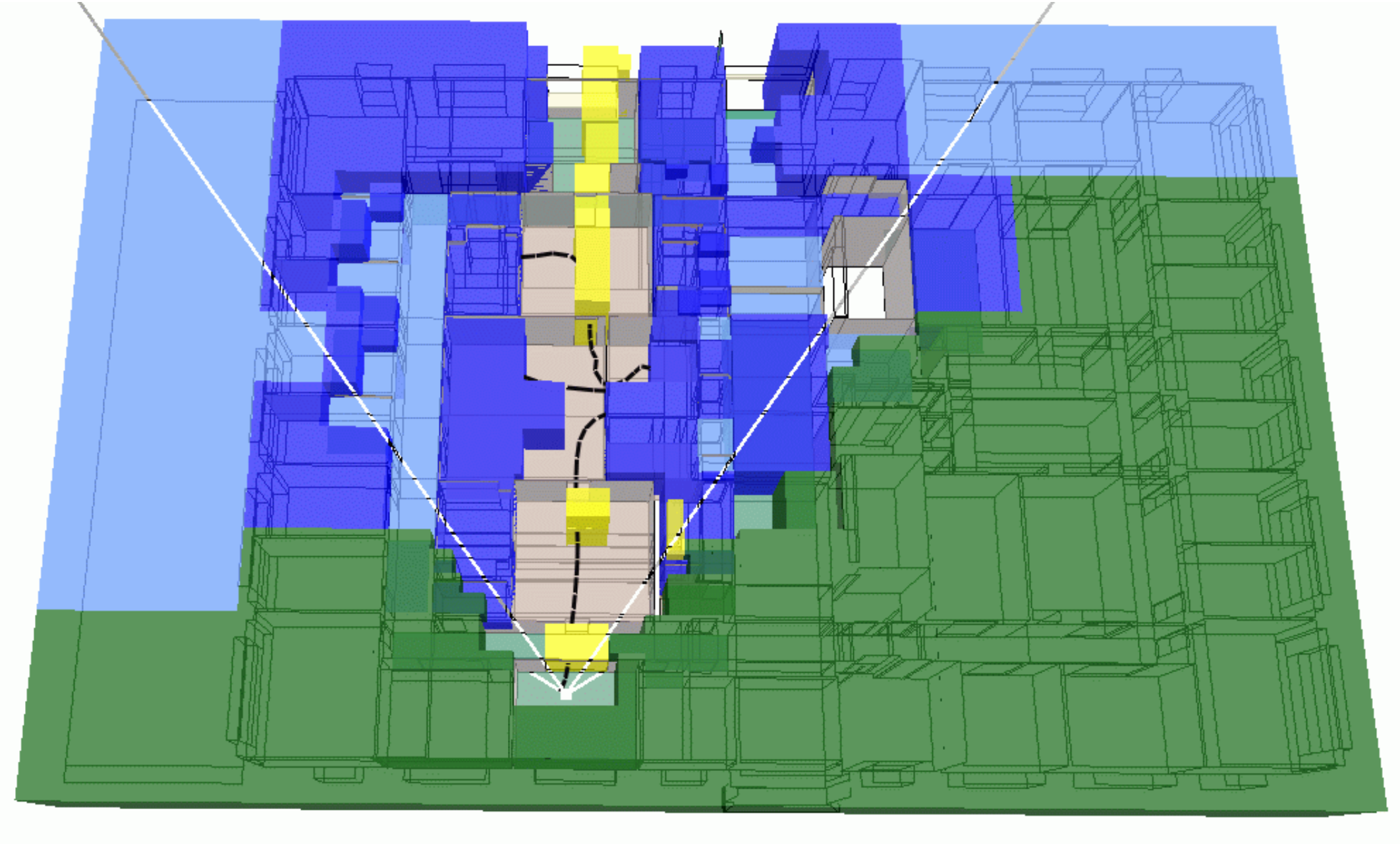

FRAME 0
ROOT
TERMINATION NODES
T_0
T_1
FRAME 1
ROOT
PULL UP
TESTED NODES

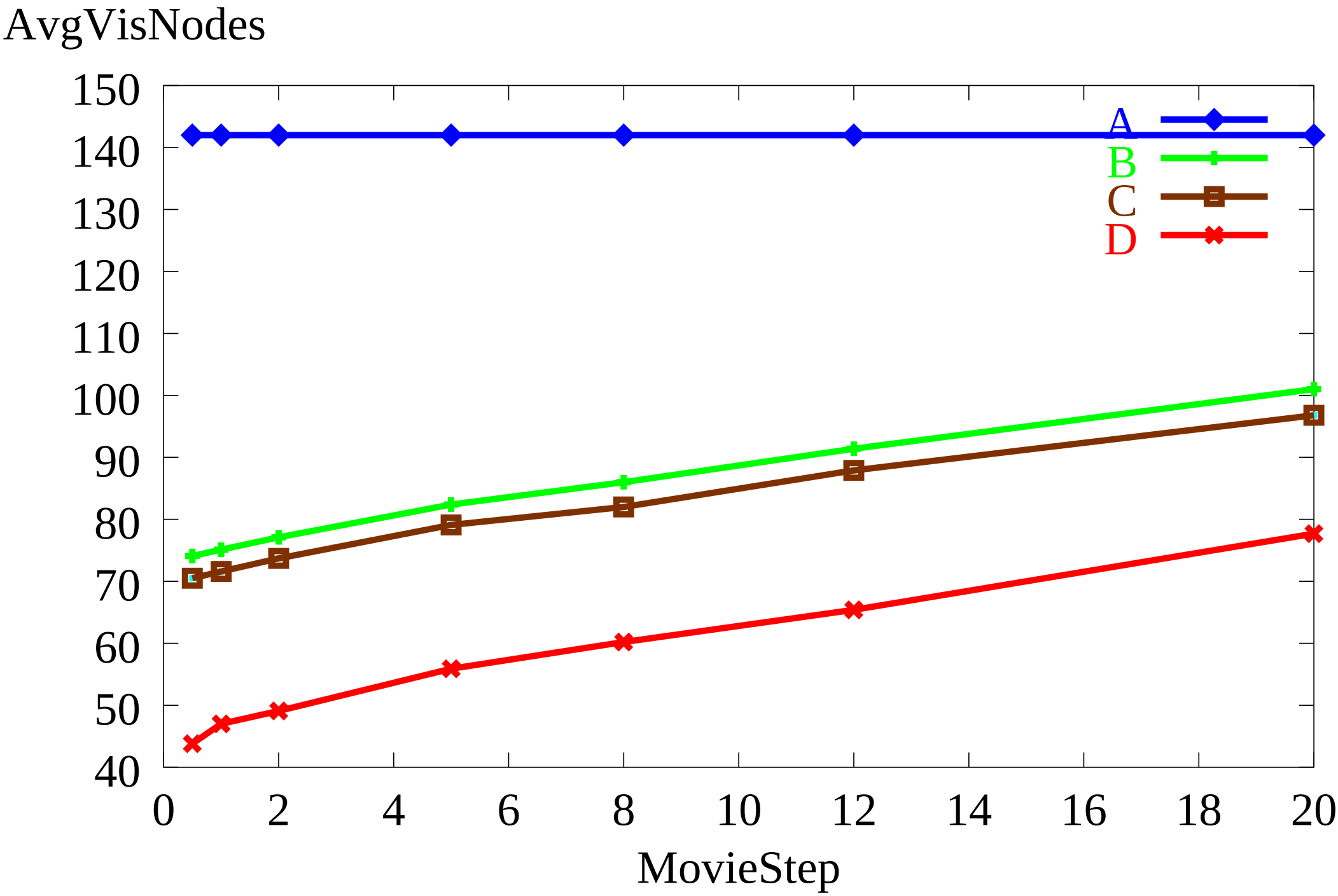

?
OCCLUDER
VIEWPOINT
INVISIBLE
VISITED


ROOT
CONSTRAINED
DFS
U
ROPE
TERMINATION
NODES
N
1
2
3
U
3
2
1
N


DETERMINE VISIBILITY
HIERARCHY UPDATING
VIEW−FRUSTUM CULLING
VISIBILITY PROPAGATION
CONSERVATIVE HIERARCHY UPDATING
VISIBILITY TEST
REFINE VISIBILITY
ESTIMATED COMPUTATIONAL COST
INVISIBLE
PARTIALLY
VISIBLE
PROBABILISTIC PATH



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130
120
110
100
90
80
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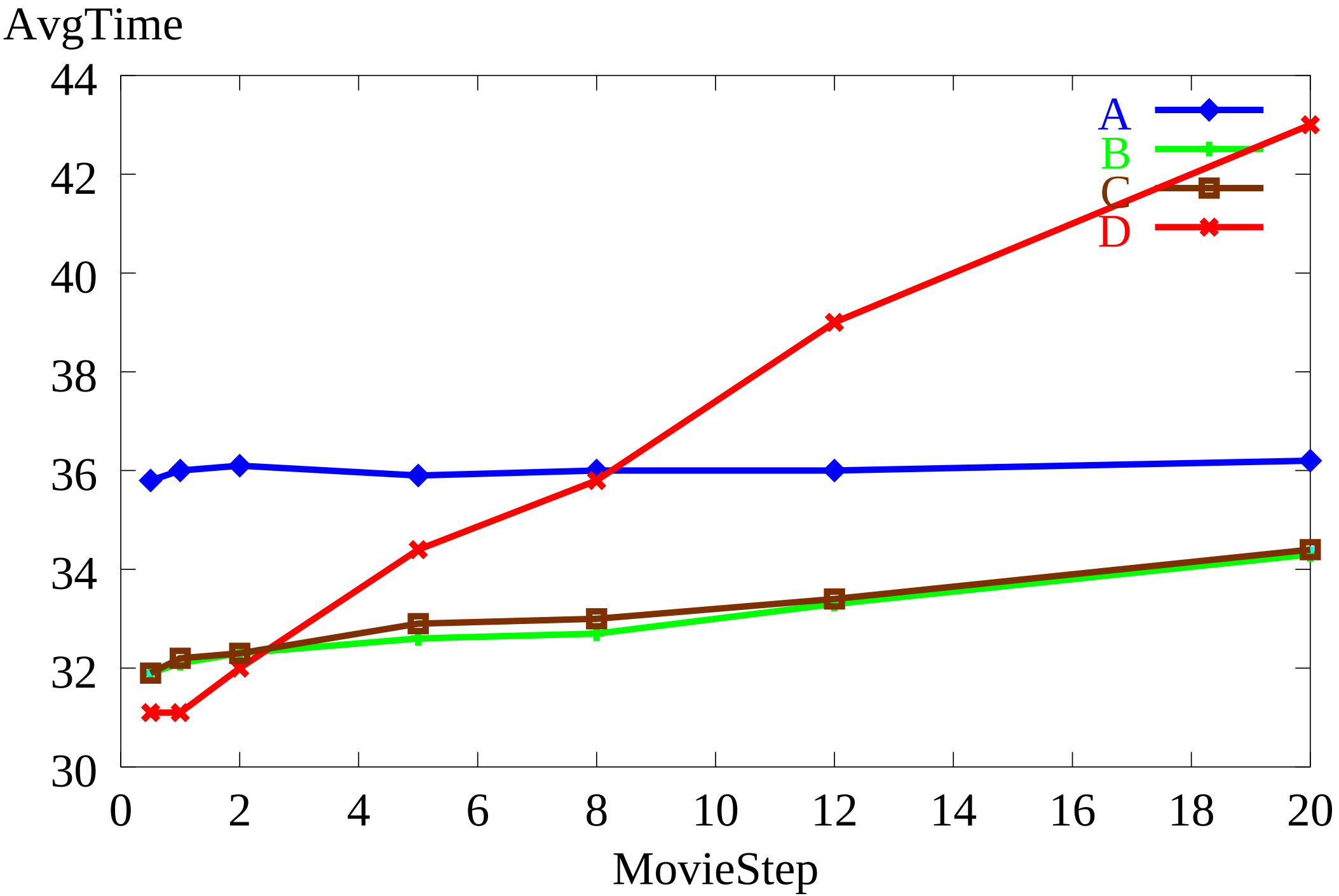
14
16
18
20
MovieStep
A
B
C
D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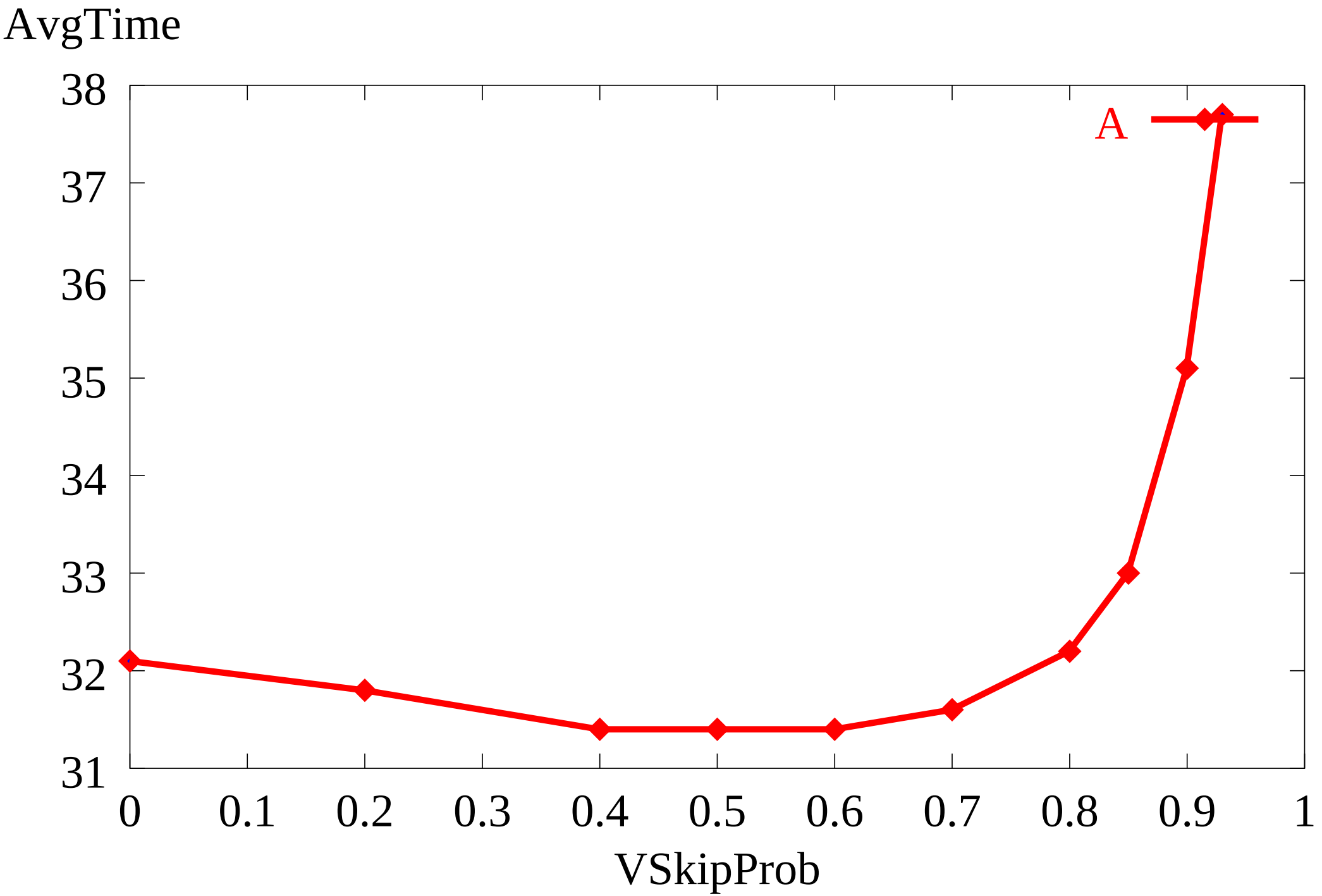
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0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
VSkipProb

[back]