
Corrections to the Surface Area Metric with Respect to Mail-Boxing

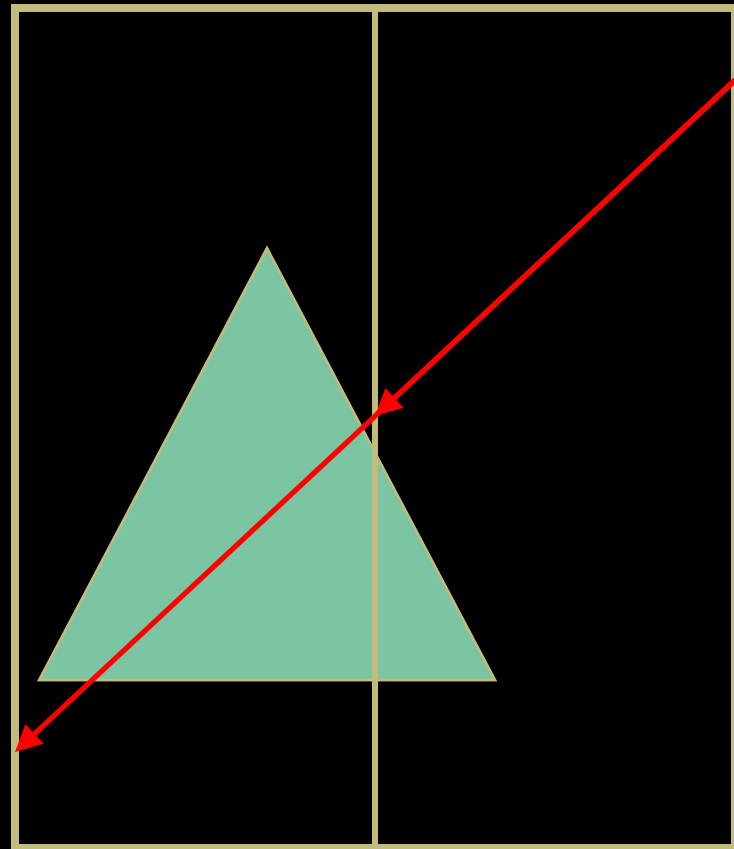
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Introduction

- The Surface Area Metric is the most common cost metric for acceleration structures
- The metric doesn't account for the effects of mail-boxing (when present)

What is Mail-boxing?

- Optimization for partitioning based acceleration structures
- Attempts to avoid multiple intersection tests between the same ray/object pair



Contribution Overview

- Present a correction to the surface area metric for mail-boxing
 - Extremely **simple to implement**
 - Significant reduction in intersection tests
 - Modest improvement in performance
 - Improves the effectiveness of mail-boxing

The Surface Area Metric

- $\text{Cost}(s) = P(s_{\text{left}})\text{Cost}(s_{\text{left}}) + P(s_{\text{right}})\text{Cost}(s_{\text{right}})$
- P is the probability function (based on surface area)
- During build, cost is estimated by the number of objects overlapping each side
 - Mail-boxing changes this cost!

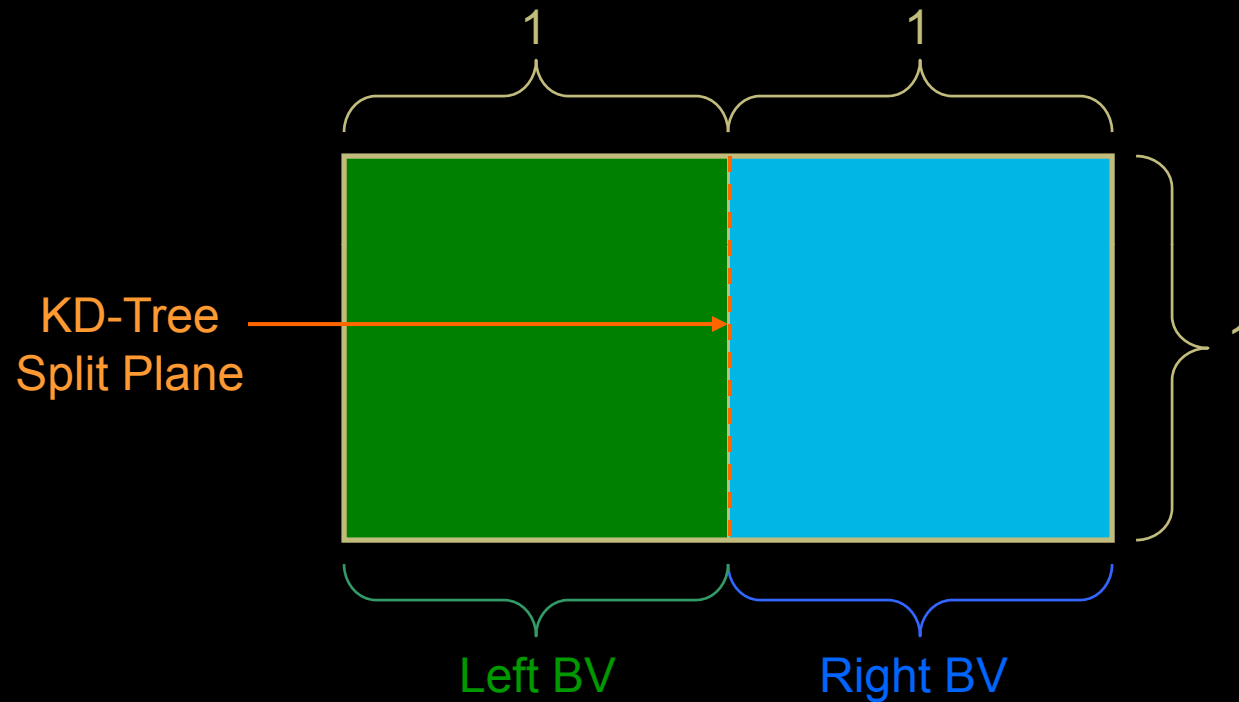
Corrected Surface Area Metric

- $\text{Cost}(s) = P(s_{\text{left}}) * \text{Cost}(s_{\text{left}})$
+ $P(s_{\text{right}}) * \text{Cost}(s_{\text{right}})$
- $P(s_{\text{right}^{\wedge}\text{left}}) * \text{Cost}(s_{\text{right}^{\wedge}\text{left}})$
- $P(s_{\text{left}^{\wedge}\text{right}})$ is the probability that a ray strikes both sides of the split
 - Partition is convex, use ratio of surface areas
- $\text{Cost}(s_{\text{left}^{\wedge}\text{right}})$ is the number of objects that occur on both sides of the split

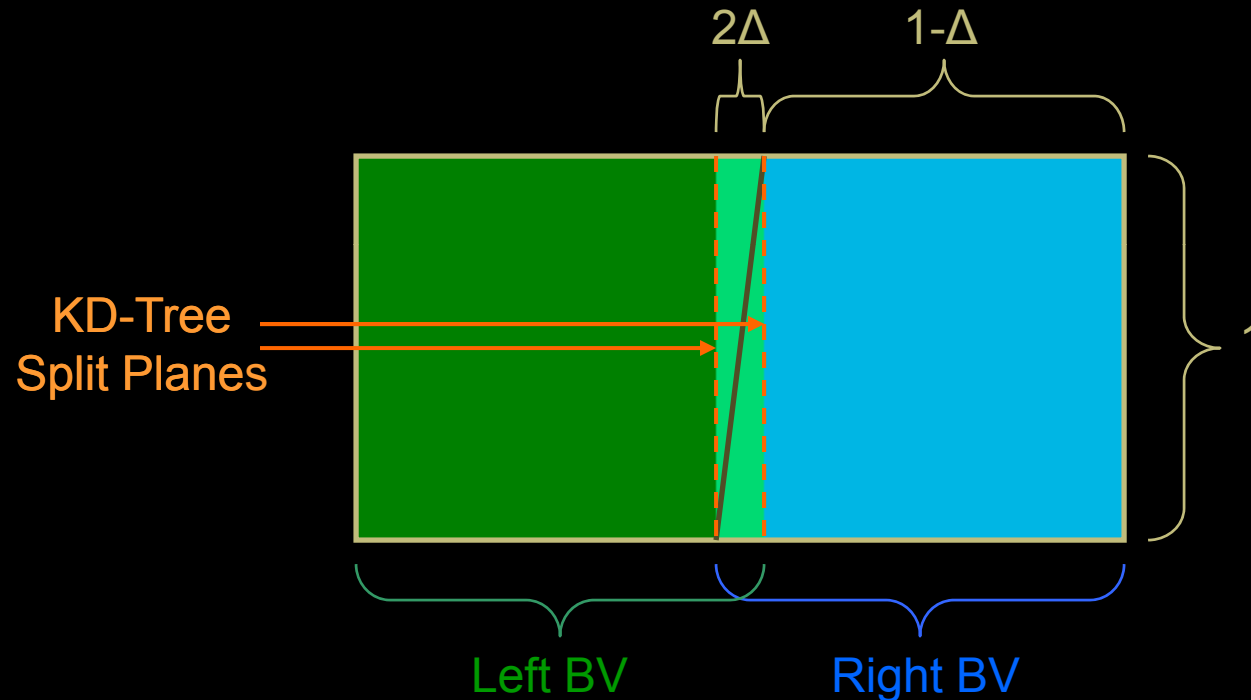
Effects of the Modification

- **Fundamentally changes** the effectiveness of kd-trees when using mail-boxing
 - Allows splits that the SAH wouldn't previously allow
 - Allows mail-boxing to fully address the integral duplication problem in kd-trees (explained shortly!)

Example: Abutted Cells



Example: Overlapping Cells



- Original SAM wouldn't allow either of these splits!
- Detailed explanation in the paper

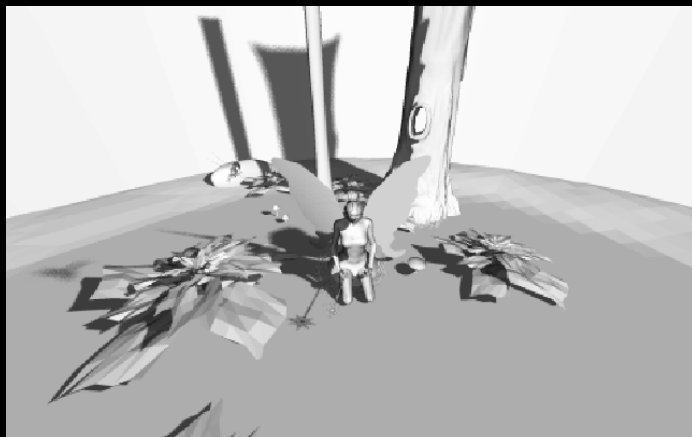
Results

- ~30% reduction in intersection tests when compared to the uncorrected SAM
- ~5% reduction in overall render-time
- ~5% increase in traversal steps

- Results are fairly consistent between off-line and real-time ray-tracers

Specific Results Teaser

FForest020	Intersections	Time	Steps
Original	29.43 M	3.359 s	96.10 M
Modified	21.60 M	3.006 s	99.54 M
Difference	-27%	-10.2%	+3.58%



- Using an interactive ray-tracer

Conclusions

- Presented a correction to the surface area metric for mail-boxing
 - Extremely **simple to implement**
 - Significant reduction in intersection tests
 - Modest improvement in performance
 - Improves the effectiveness of mail-boxing

Questions?

Advertisement!

- I'm graduating this fall and looking for a **job!**
 - Formally as of now
 - Willing to relocate etc.

Perspective Questions?
