Tree Rotations for Improving Bounding Volume Hierarchies

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Surface Area Metric

$$C = \begin{cases} C_t + C_i N & \text{leaf nodes} \\ C_t + \dfrac{C_L S_L + C_R S_R}{S} & \text{interior nodes} \end{cases}$$

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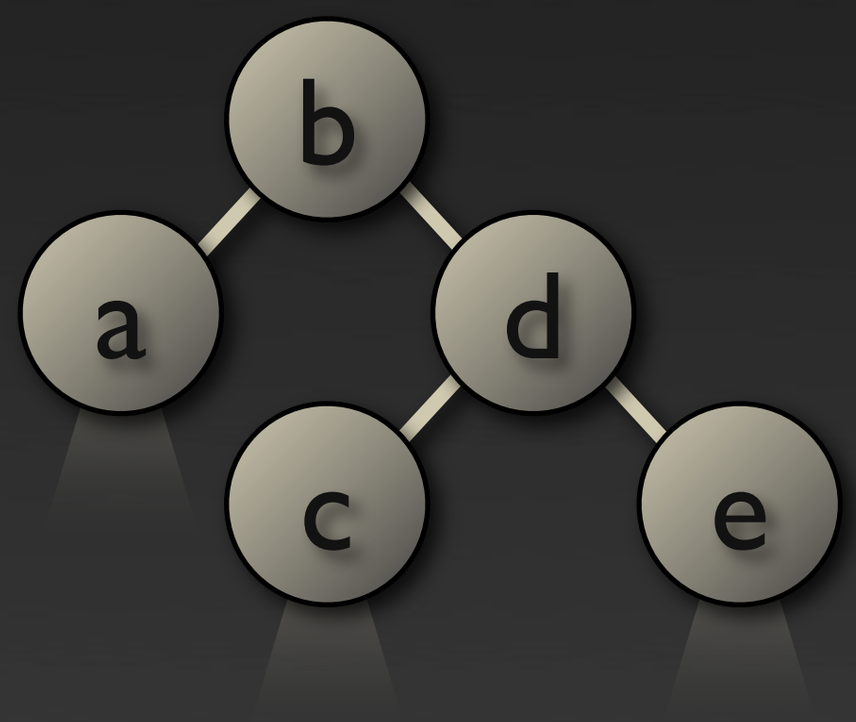
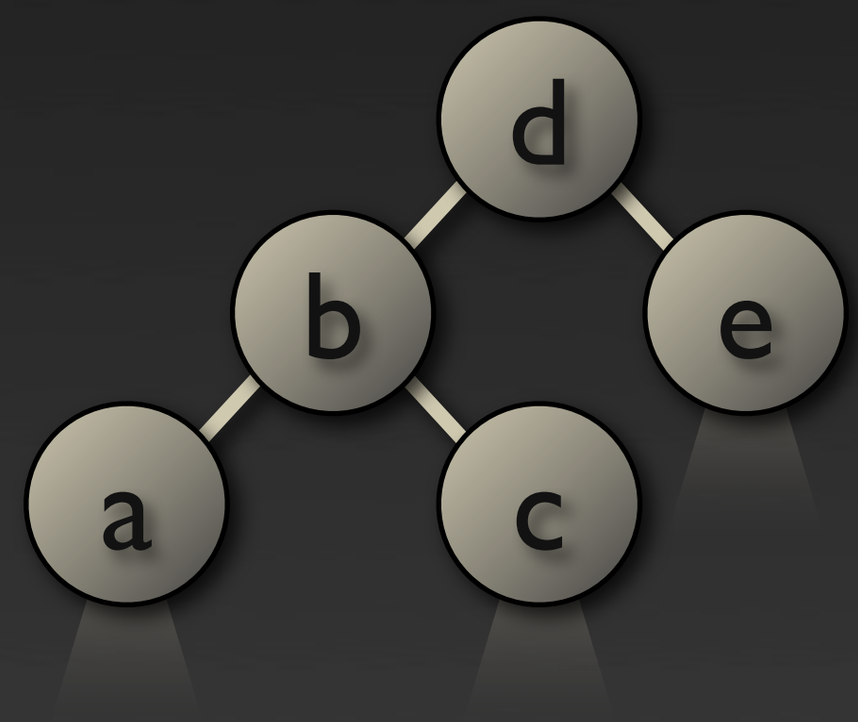
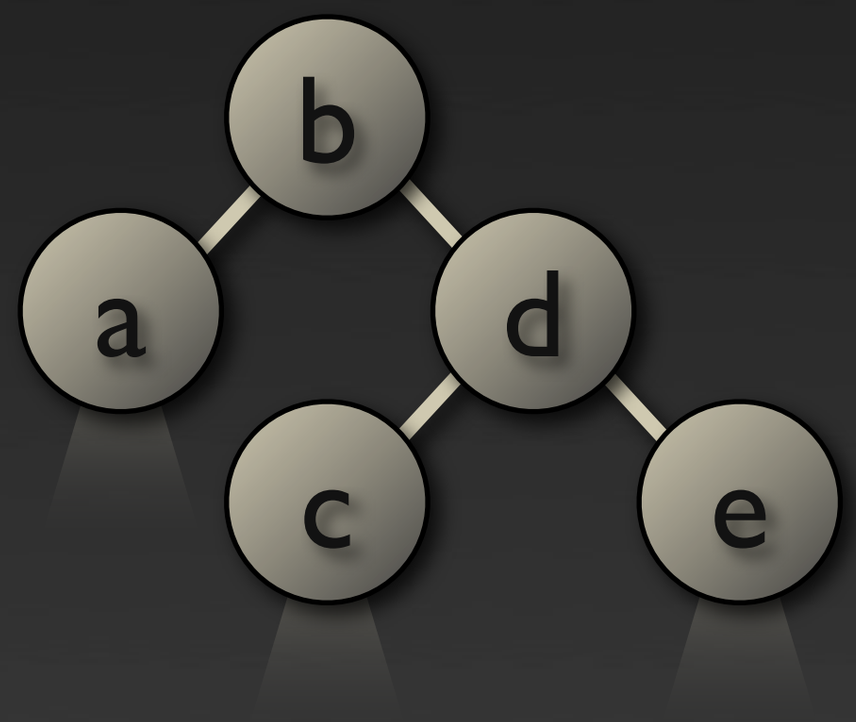
Ordered Tree Rotations

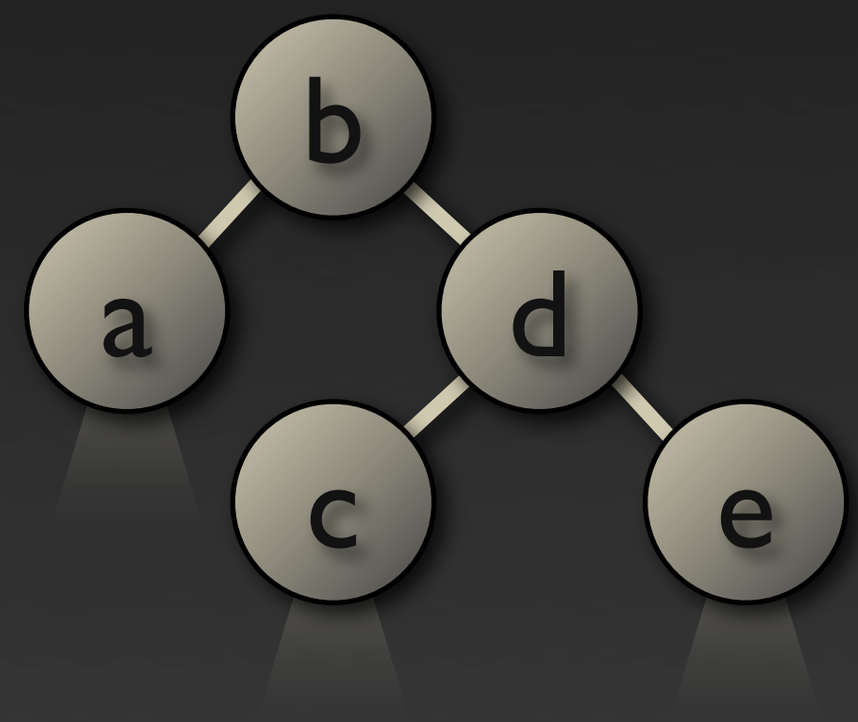




Ordered Tree Rotations

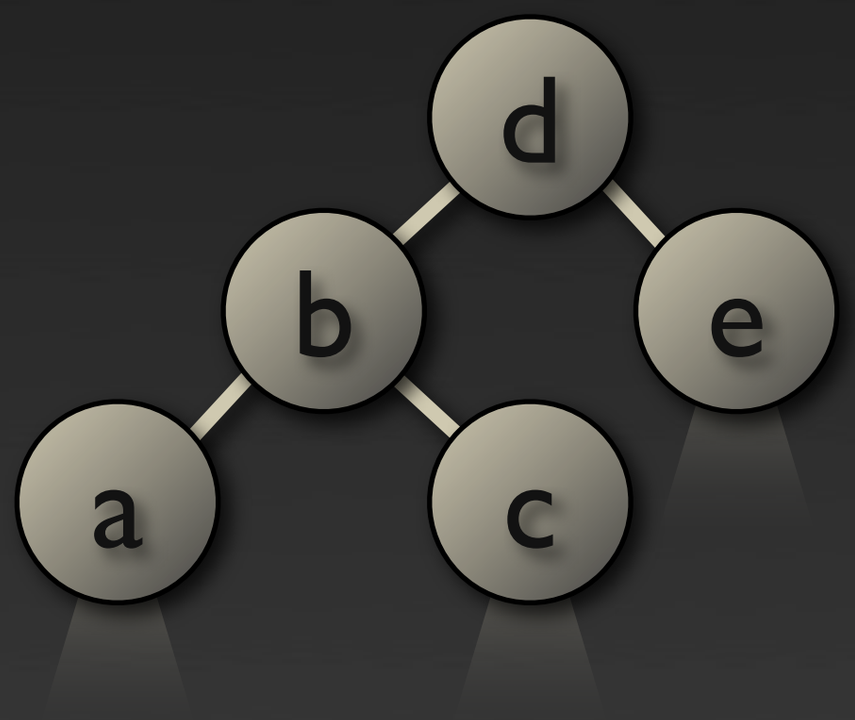
Right Rotation



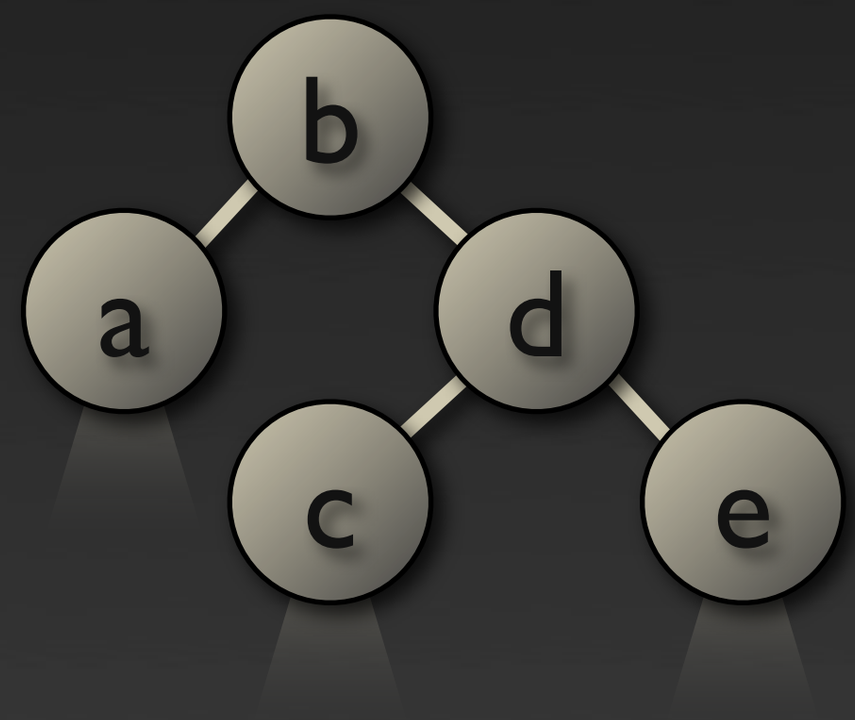


Ordered Tree Rotations

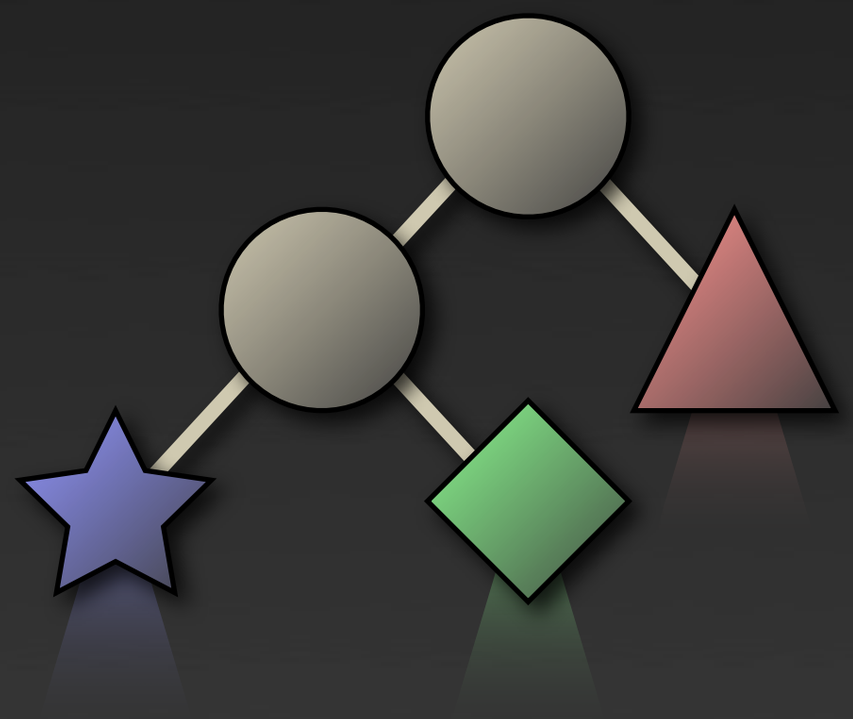
Left Rotation

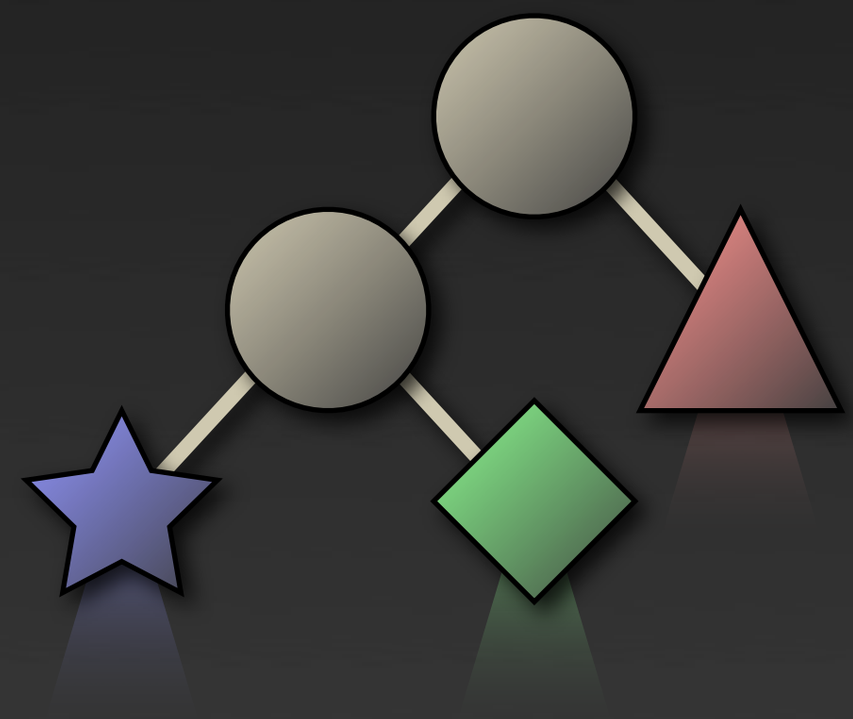


Right Rotation

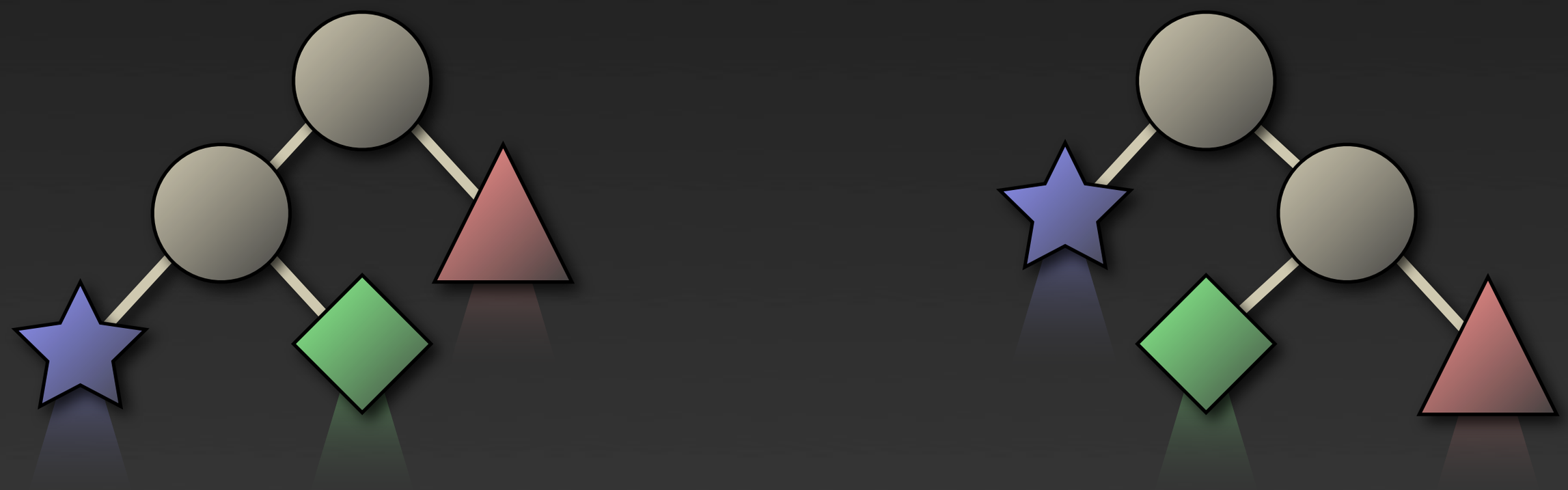


BVH Tree Rotations

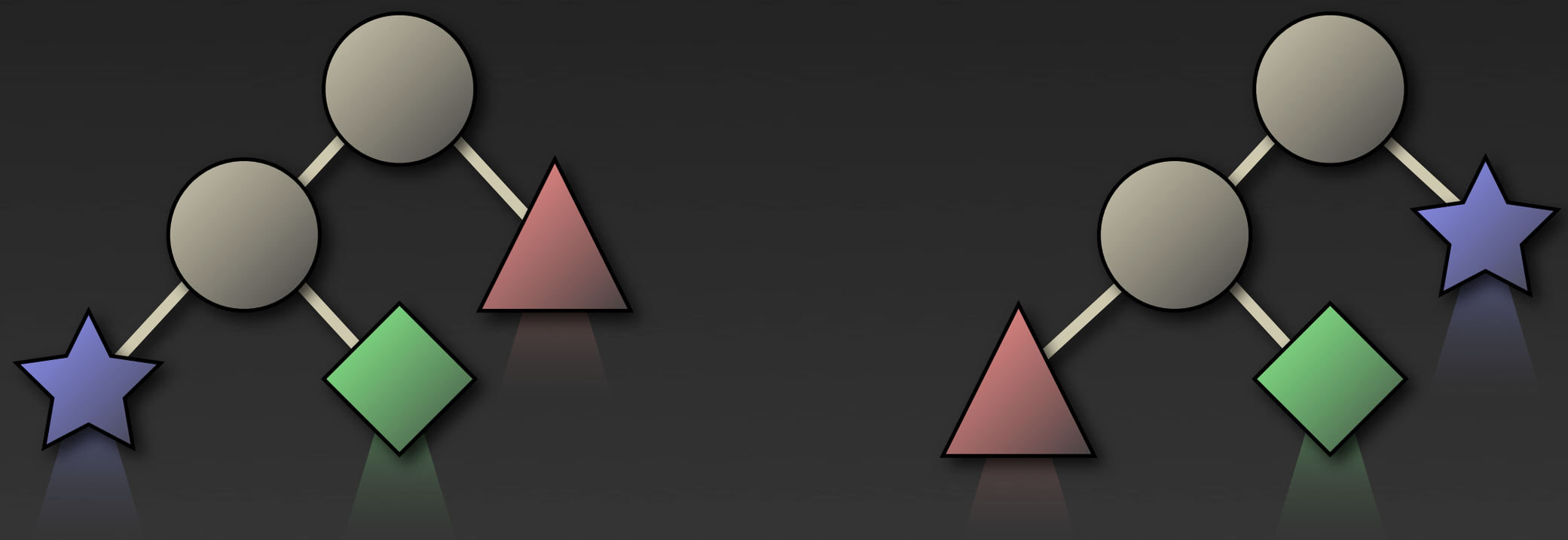




BVH Tree Rotations



BVH Tree Rotations



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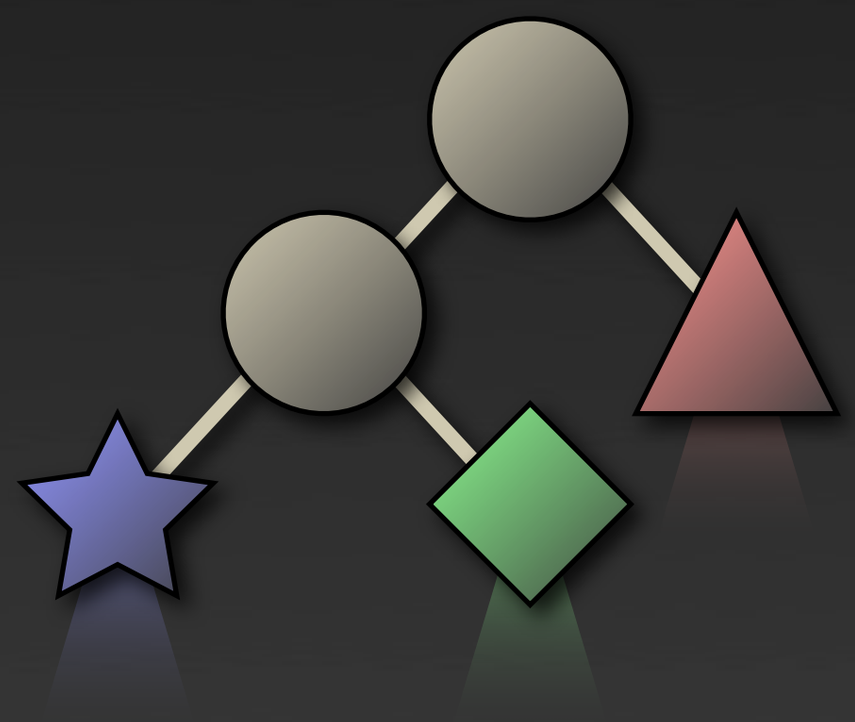

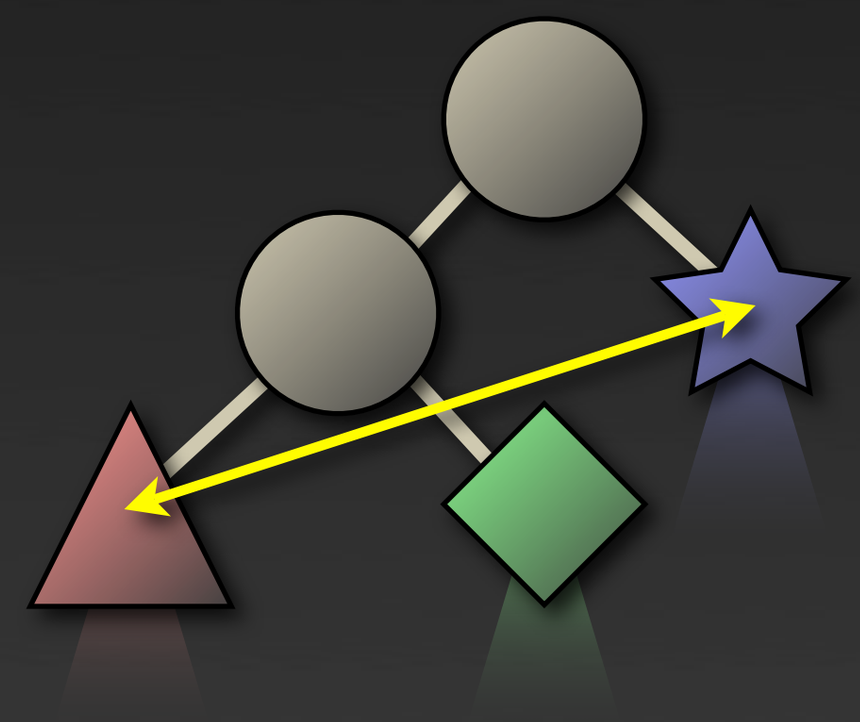

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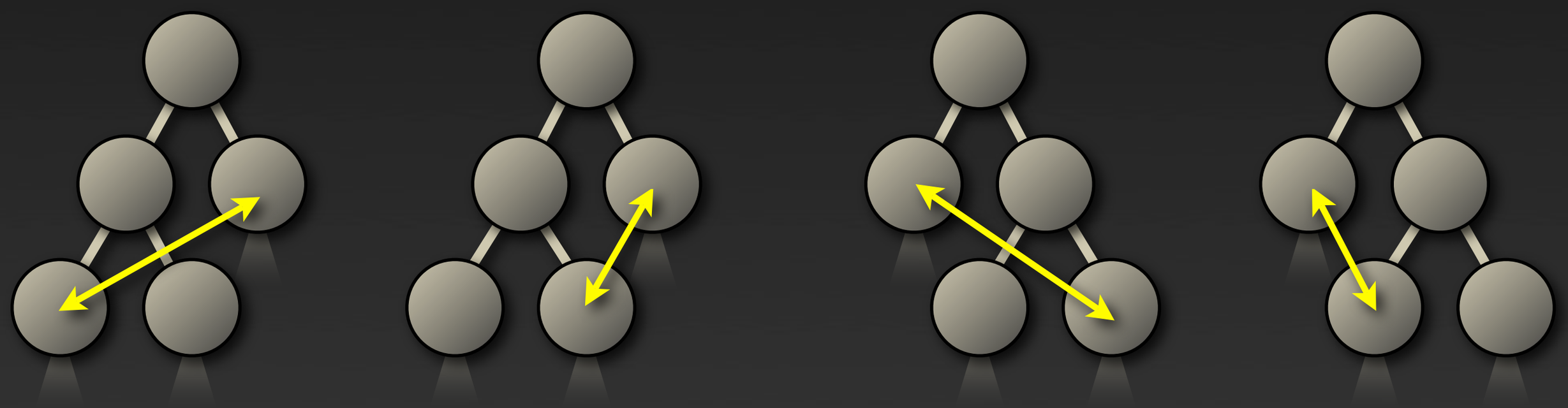

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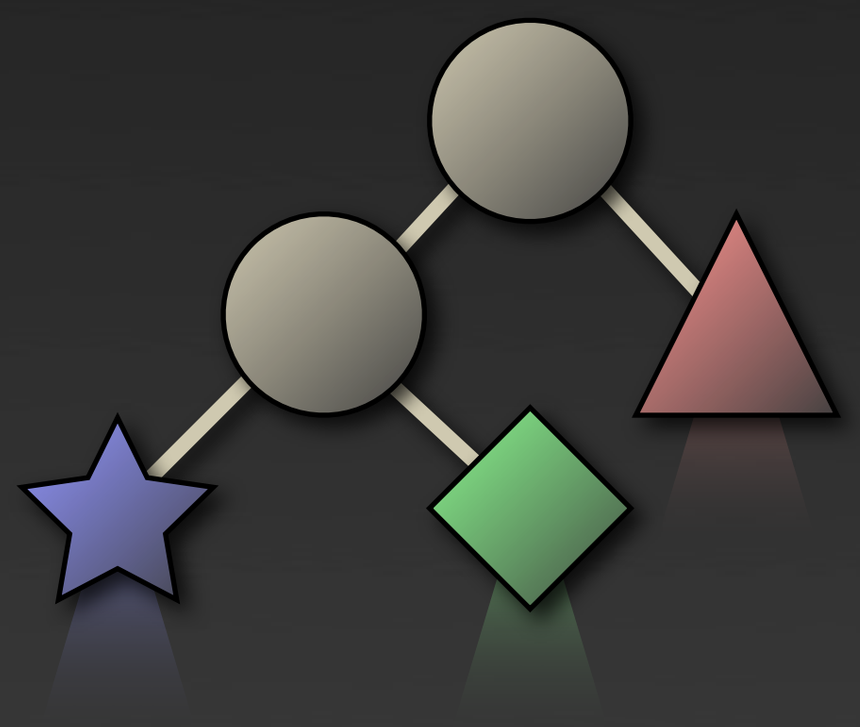

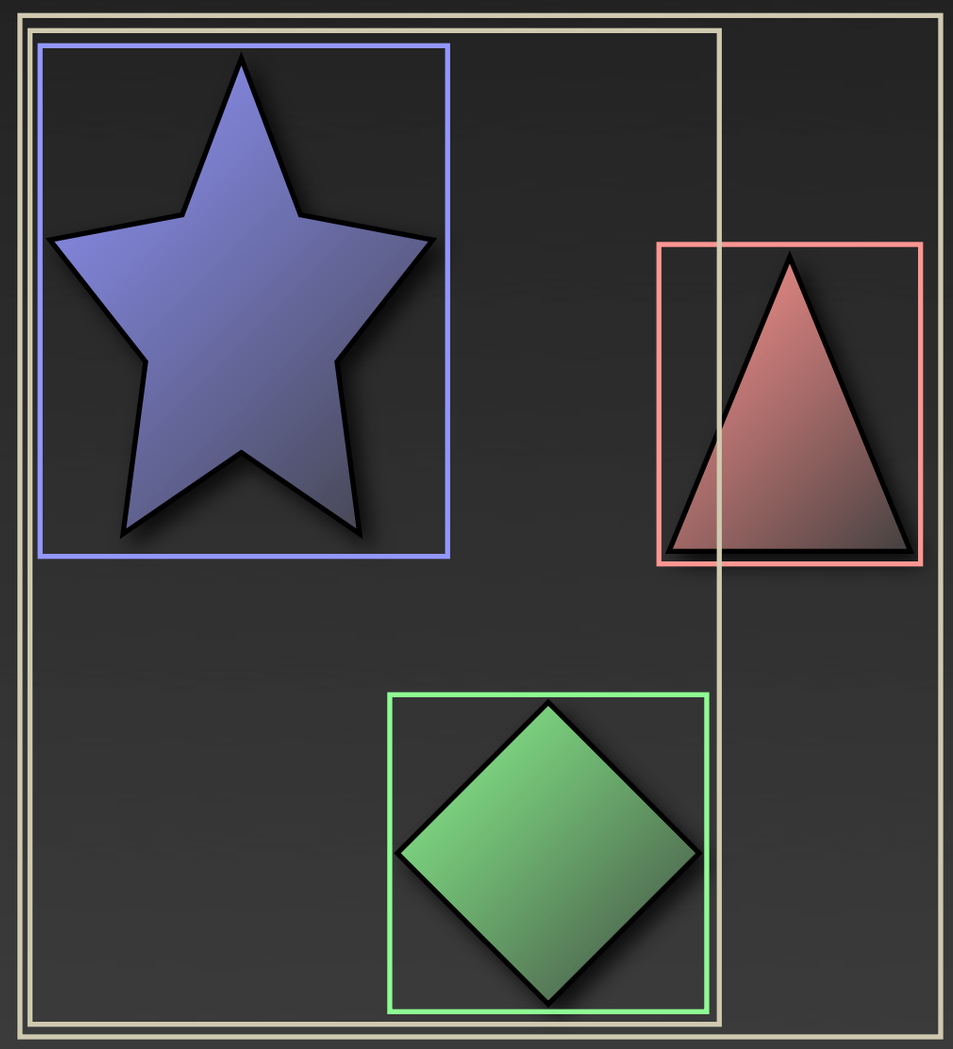

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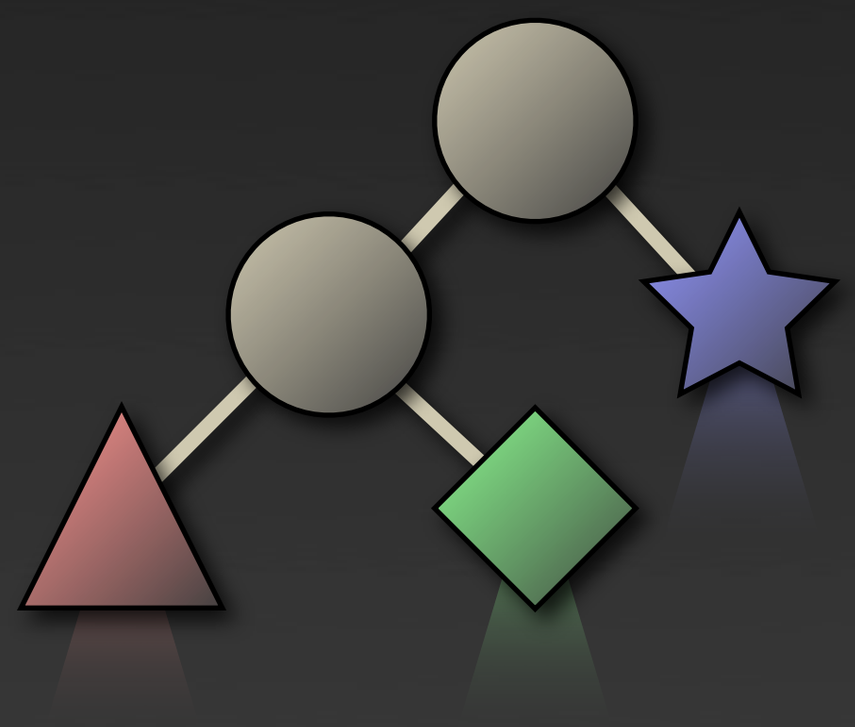
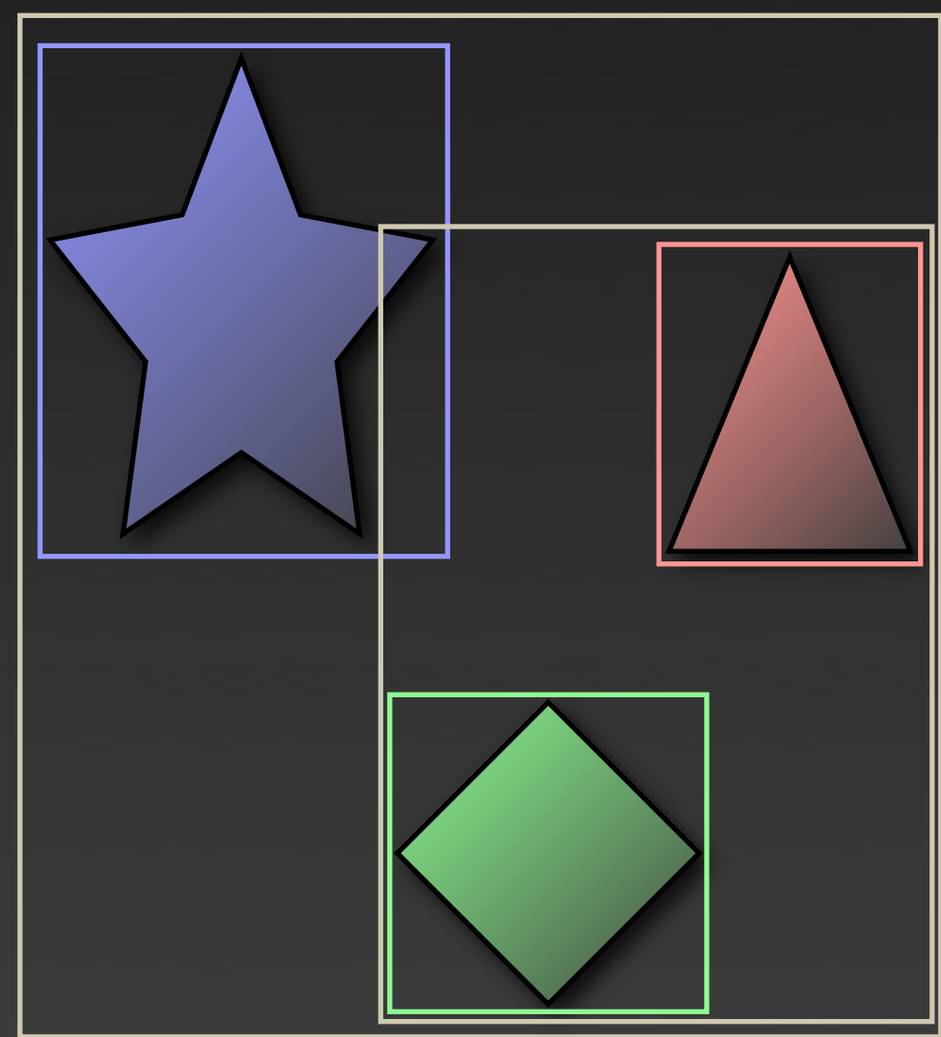
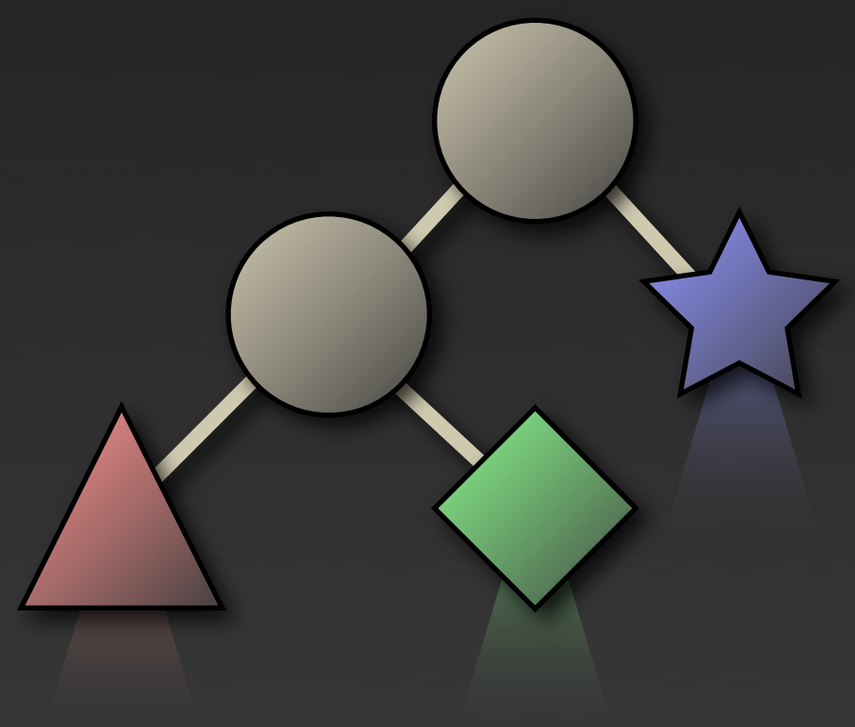
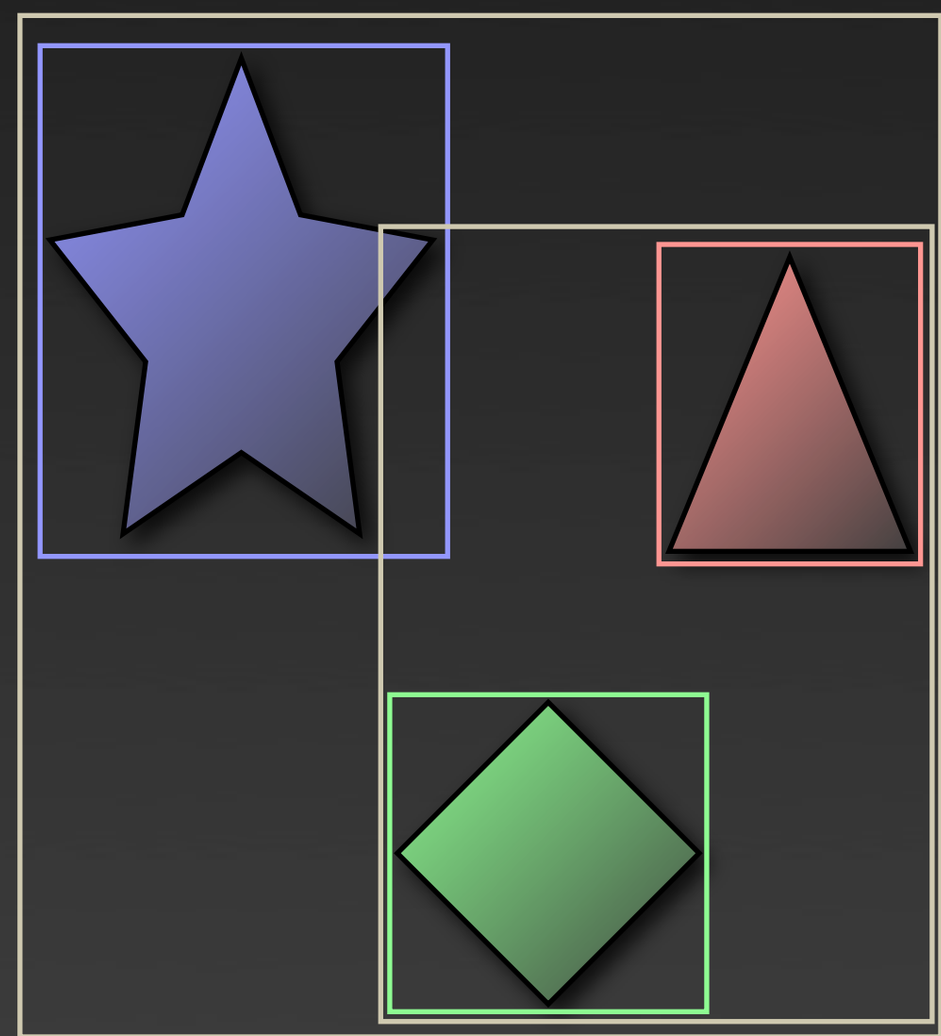




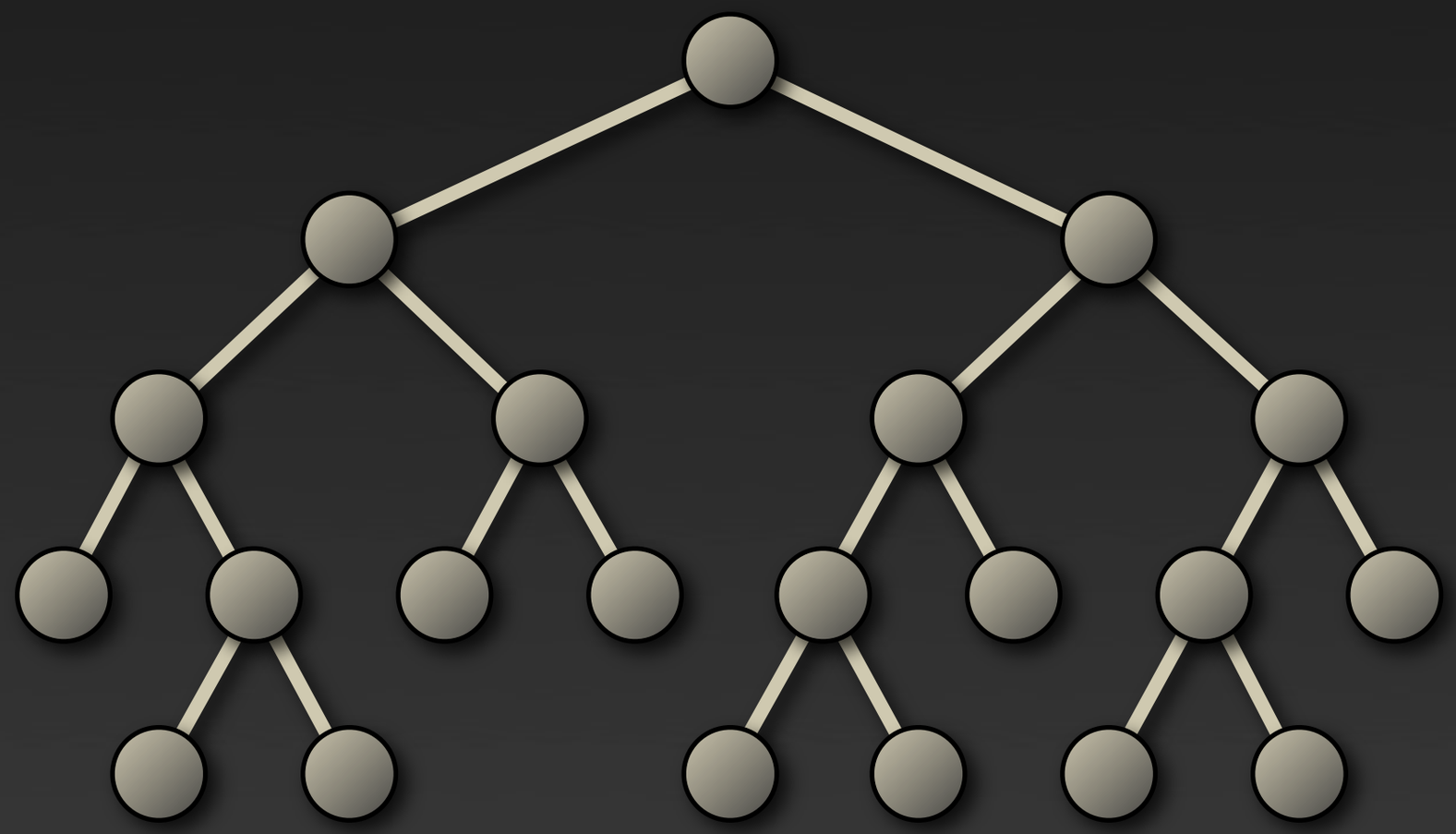
BVH Tree Rotations

$$C_t + \frac{C_L S_L + C_R S_R}{S}$$





Hill Climbing



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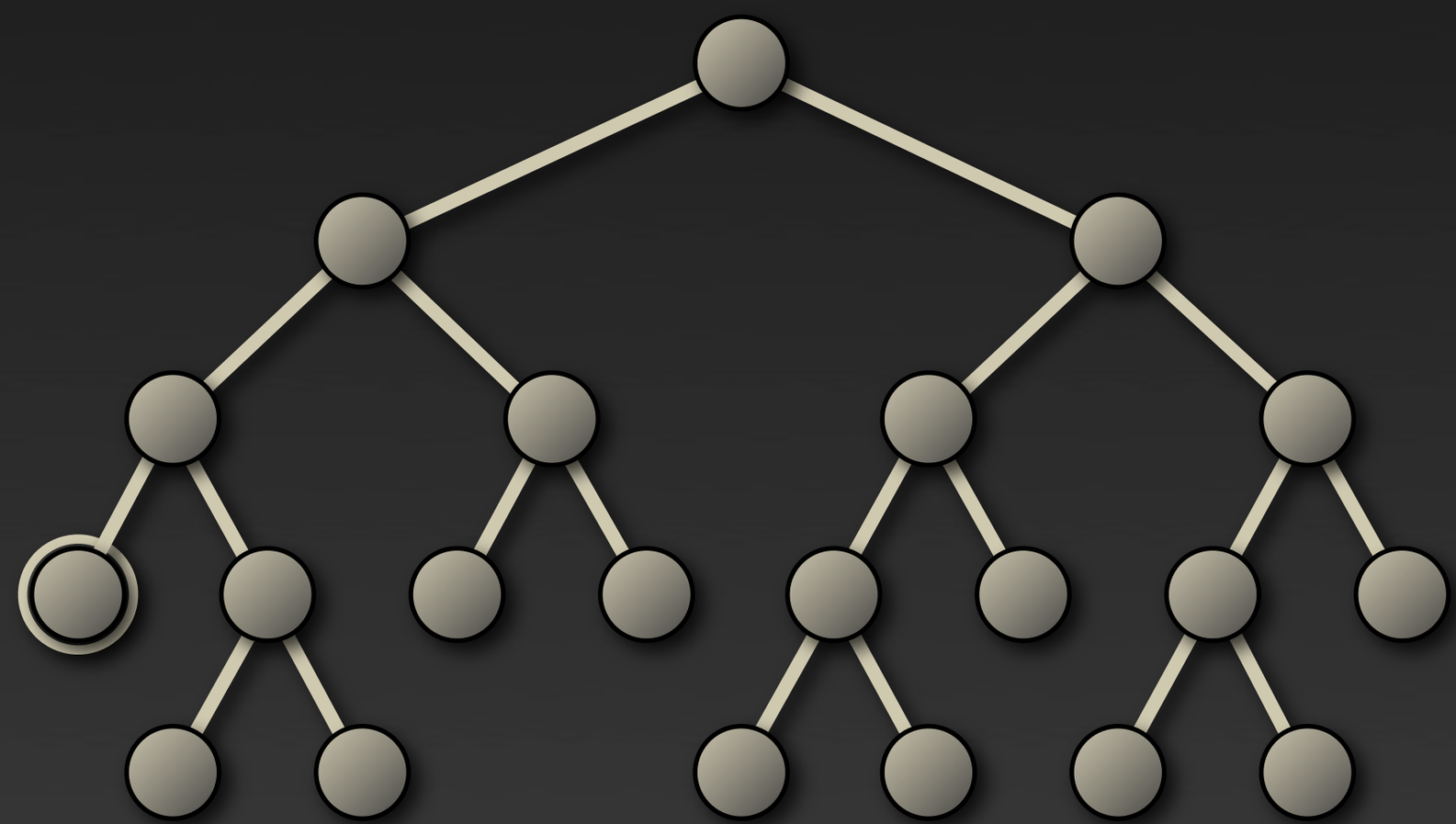

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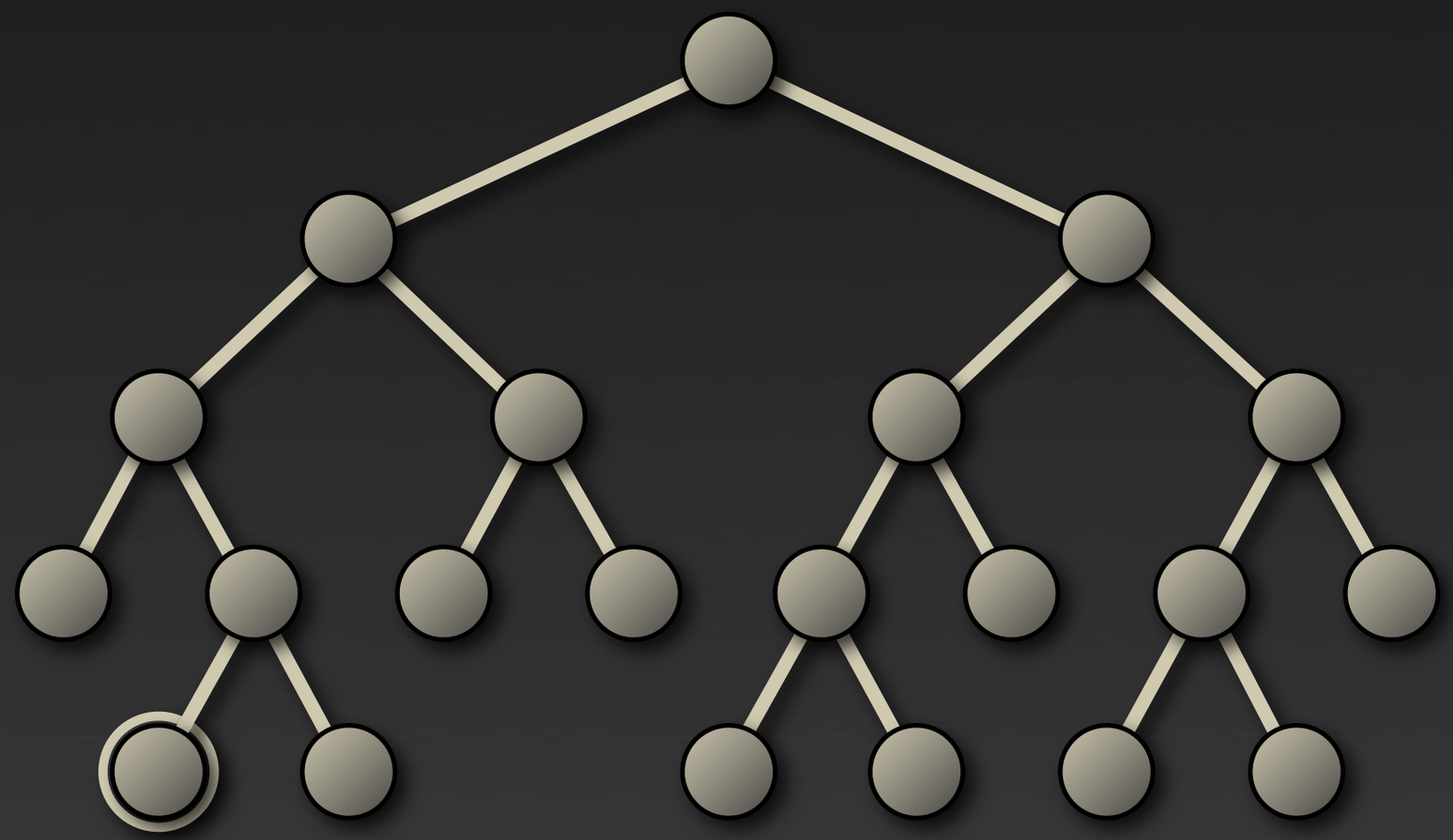

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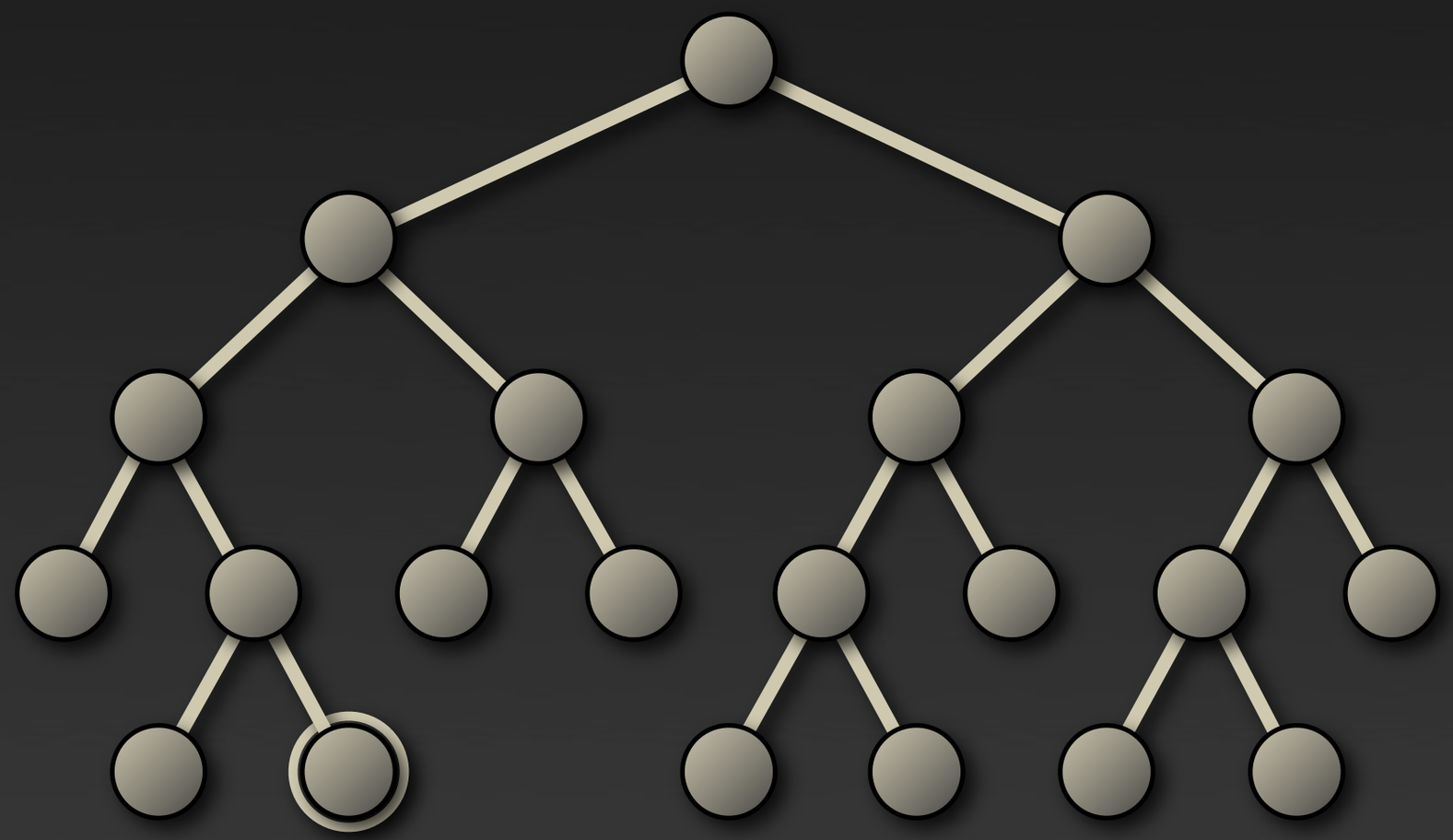

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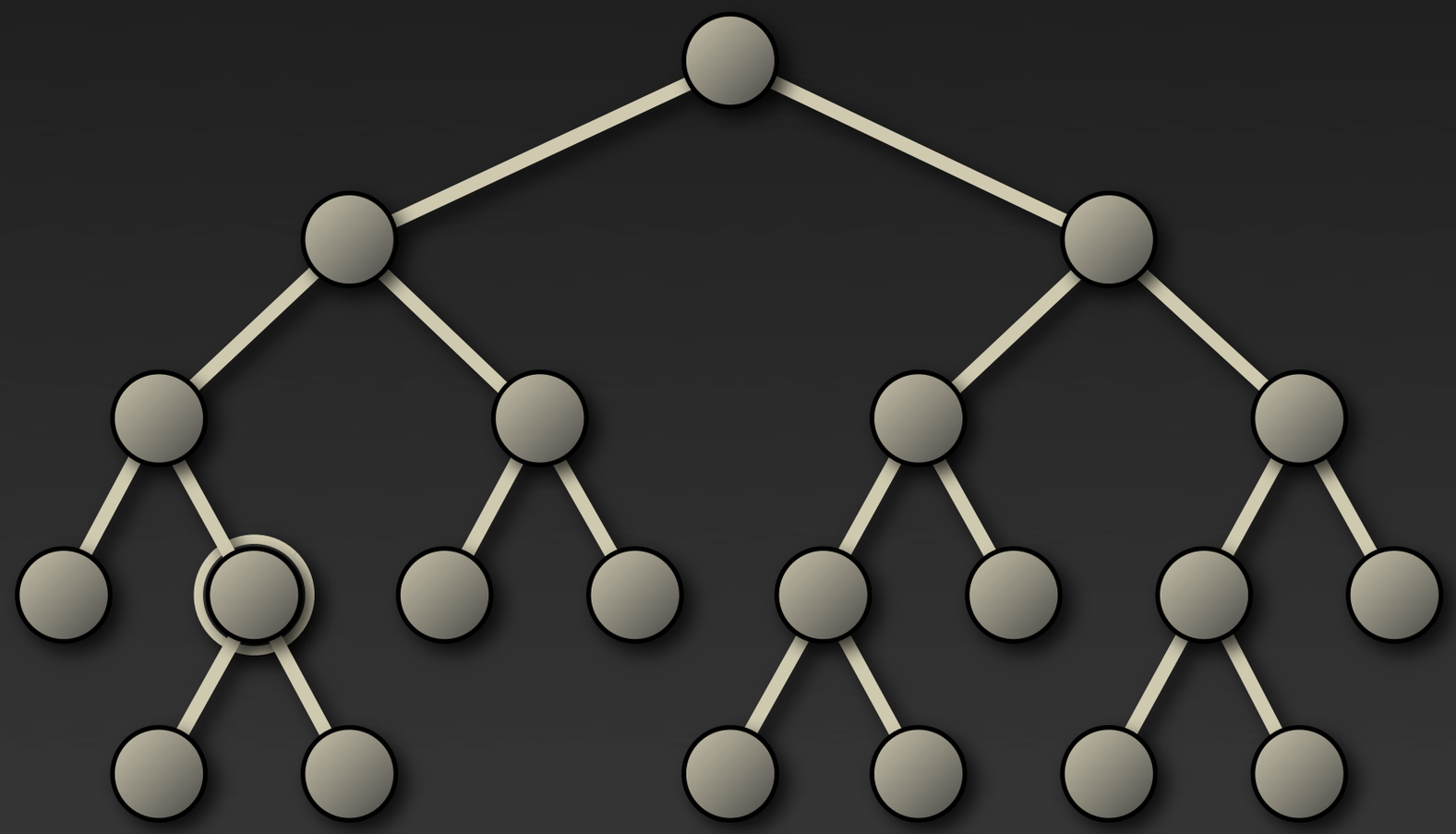

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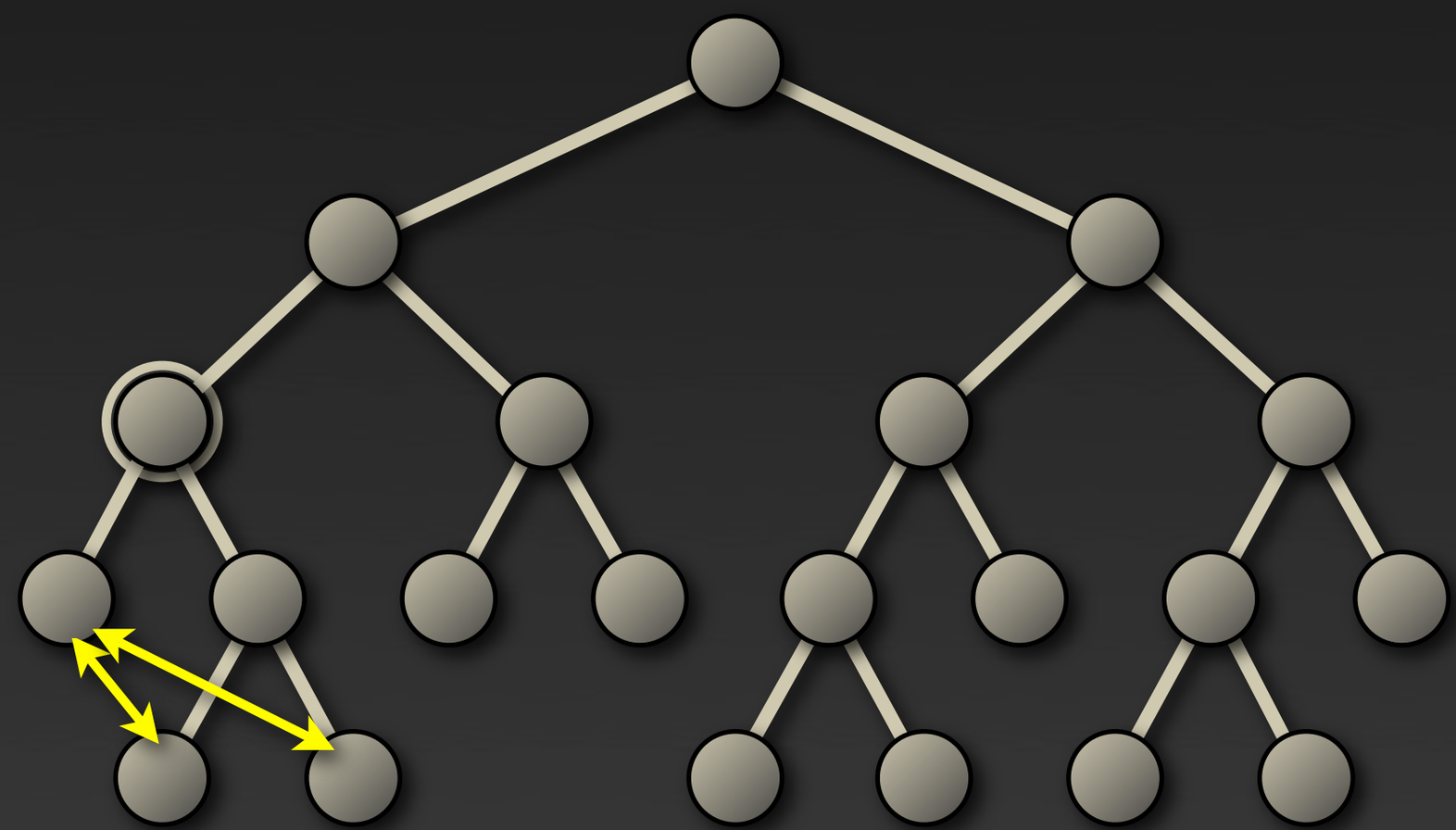

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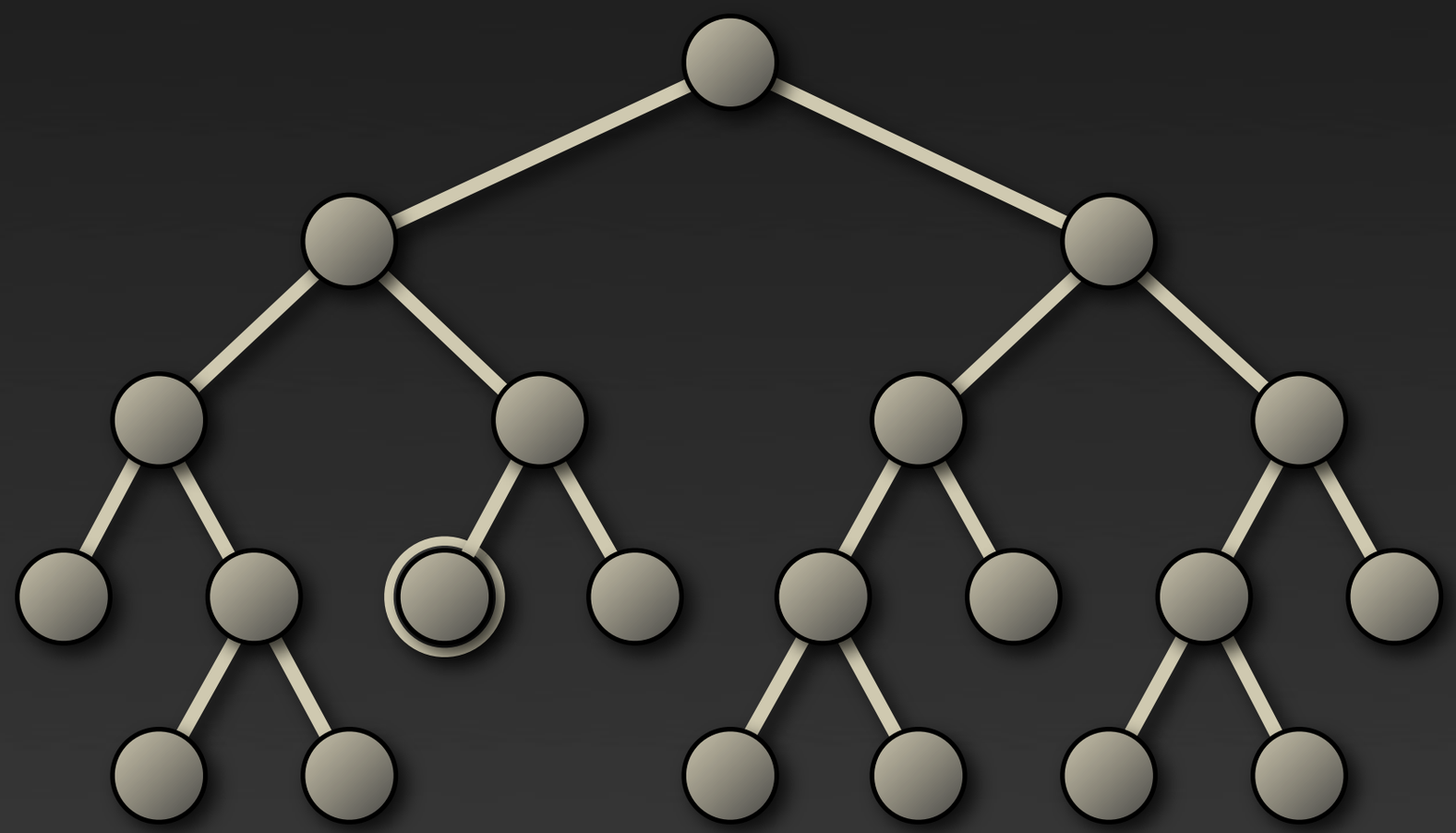

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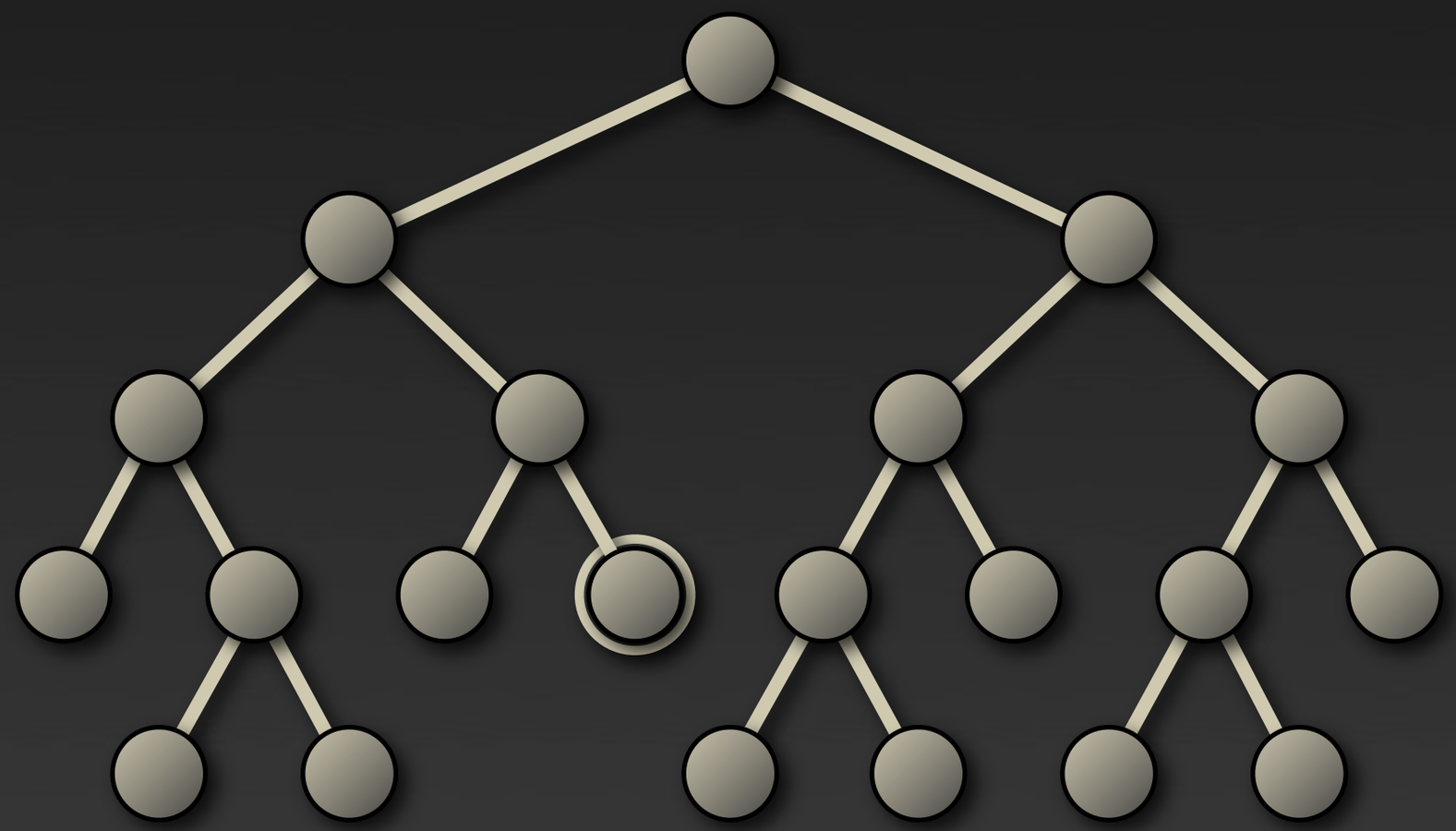

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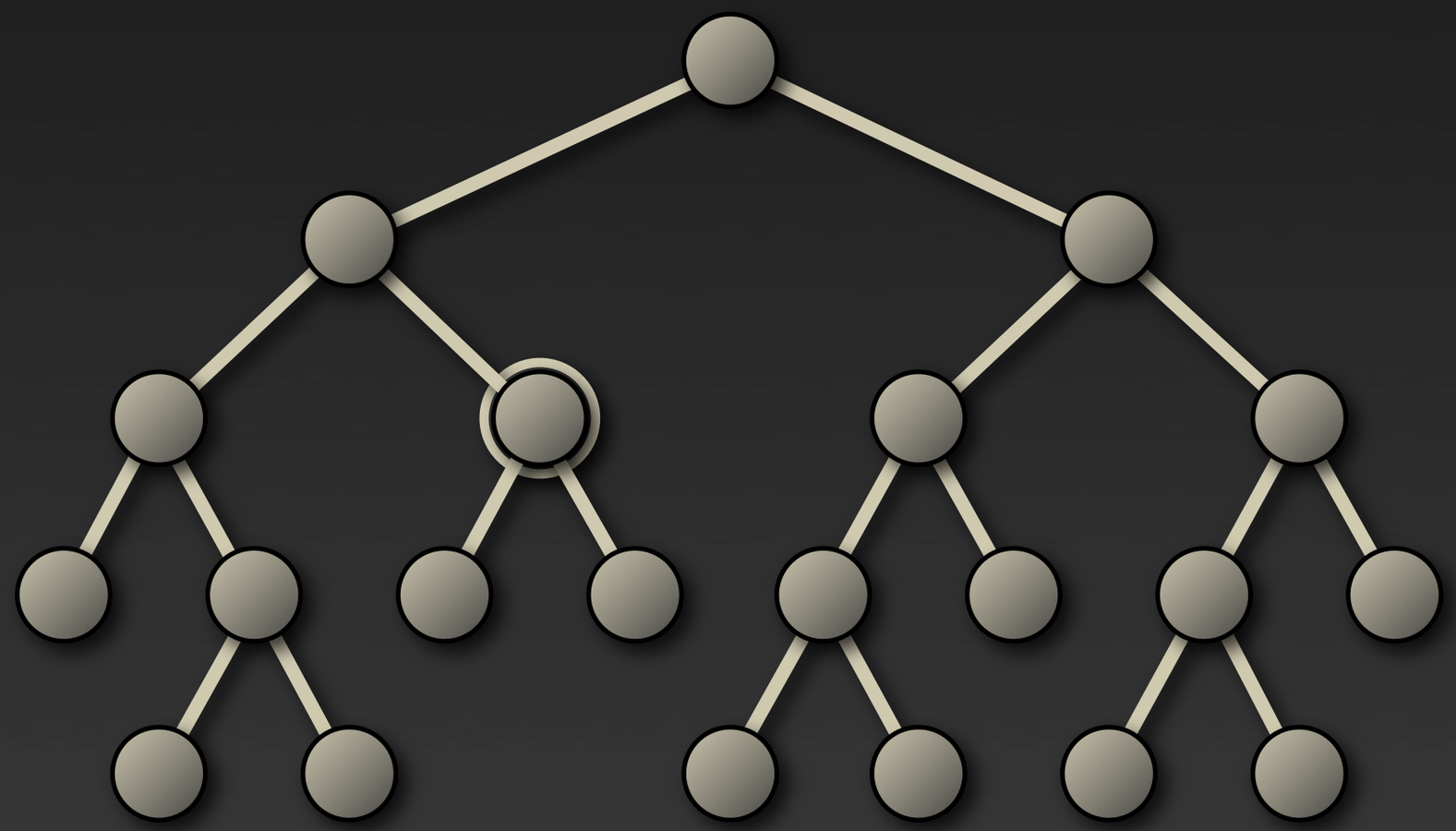

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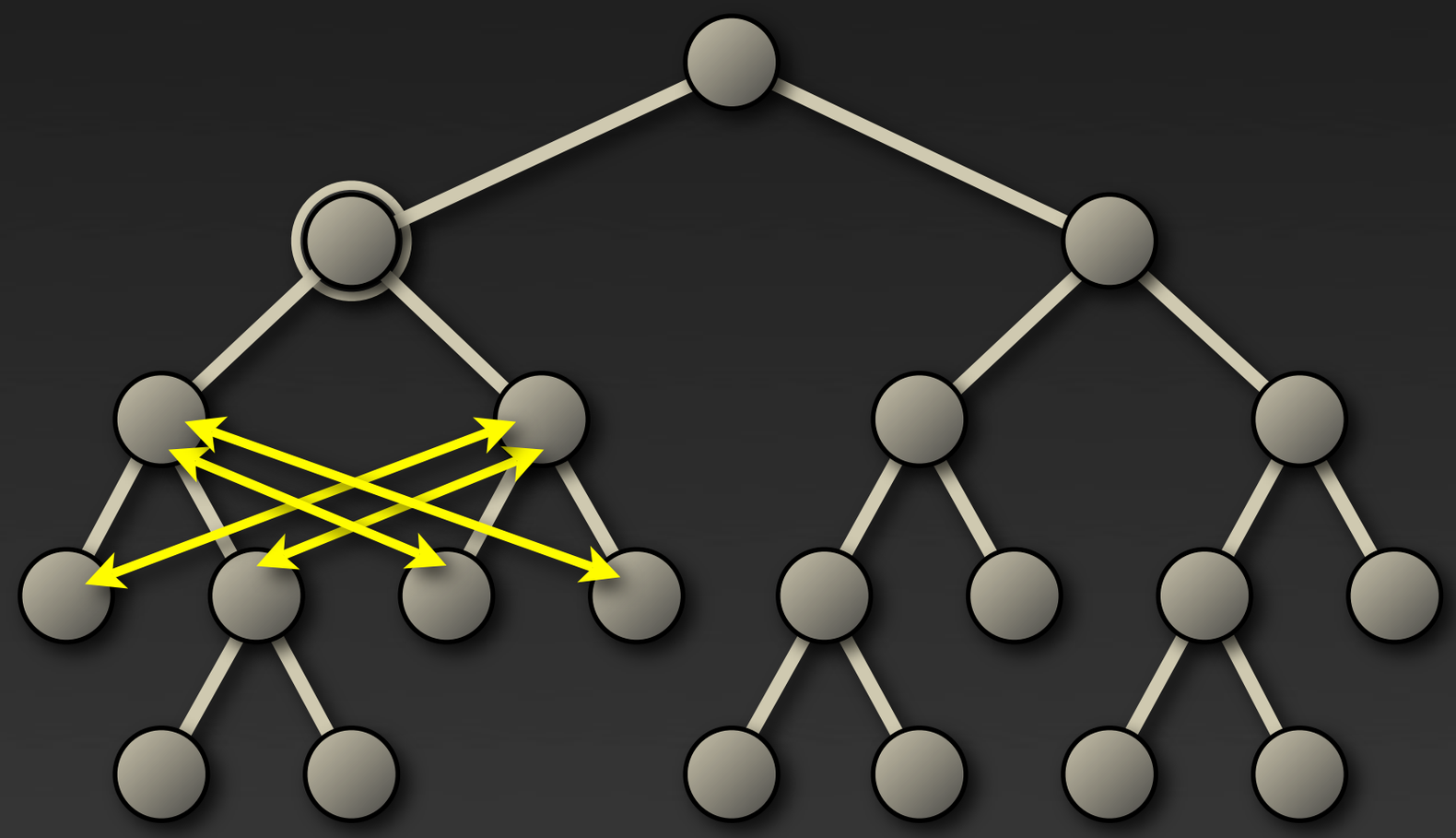

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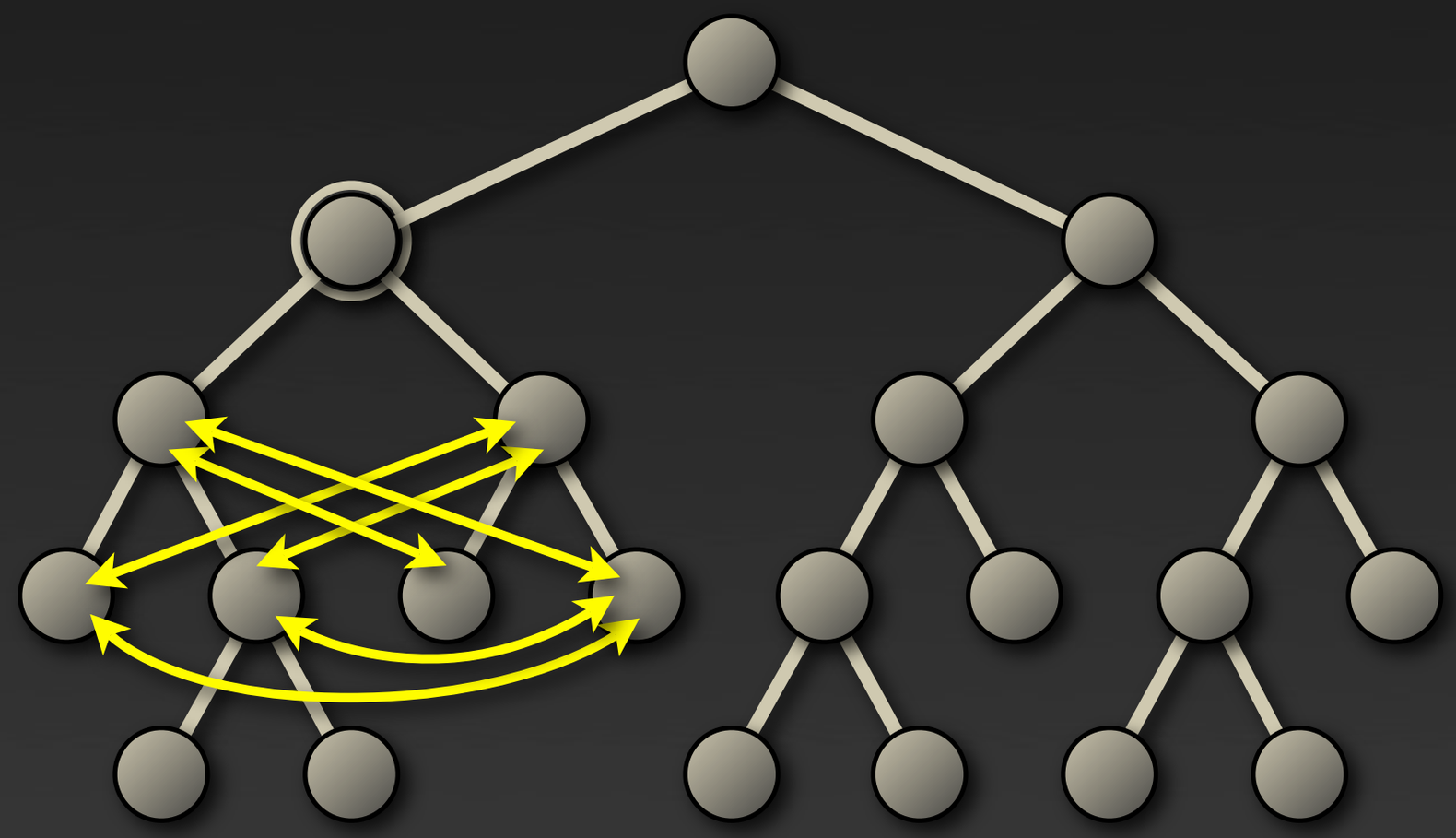
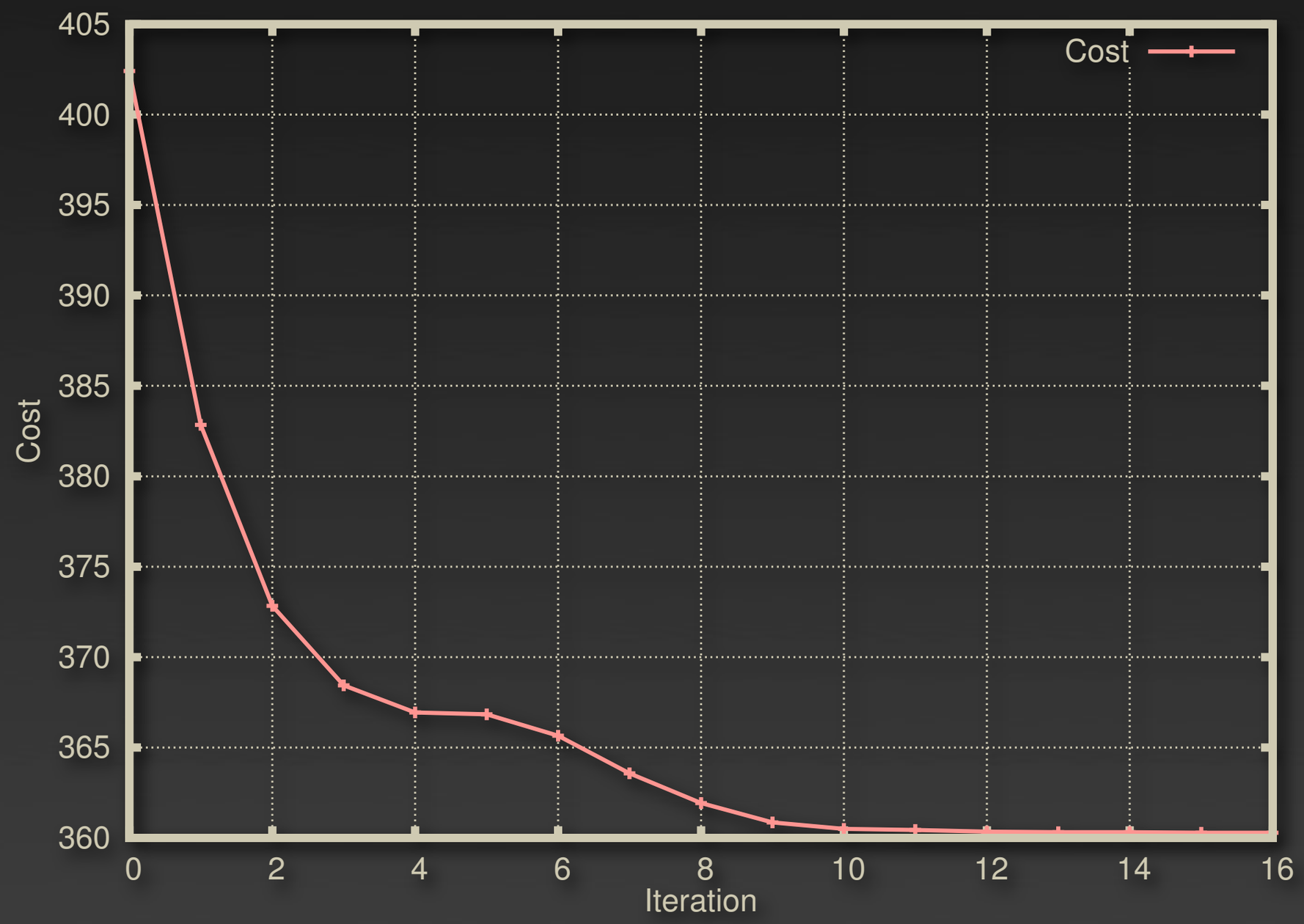


Hill Climbing – Conference



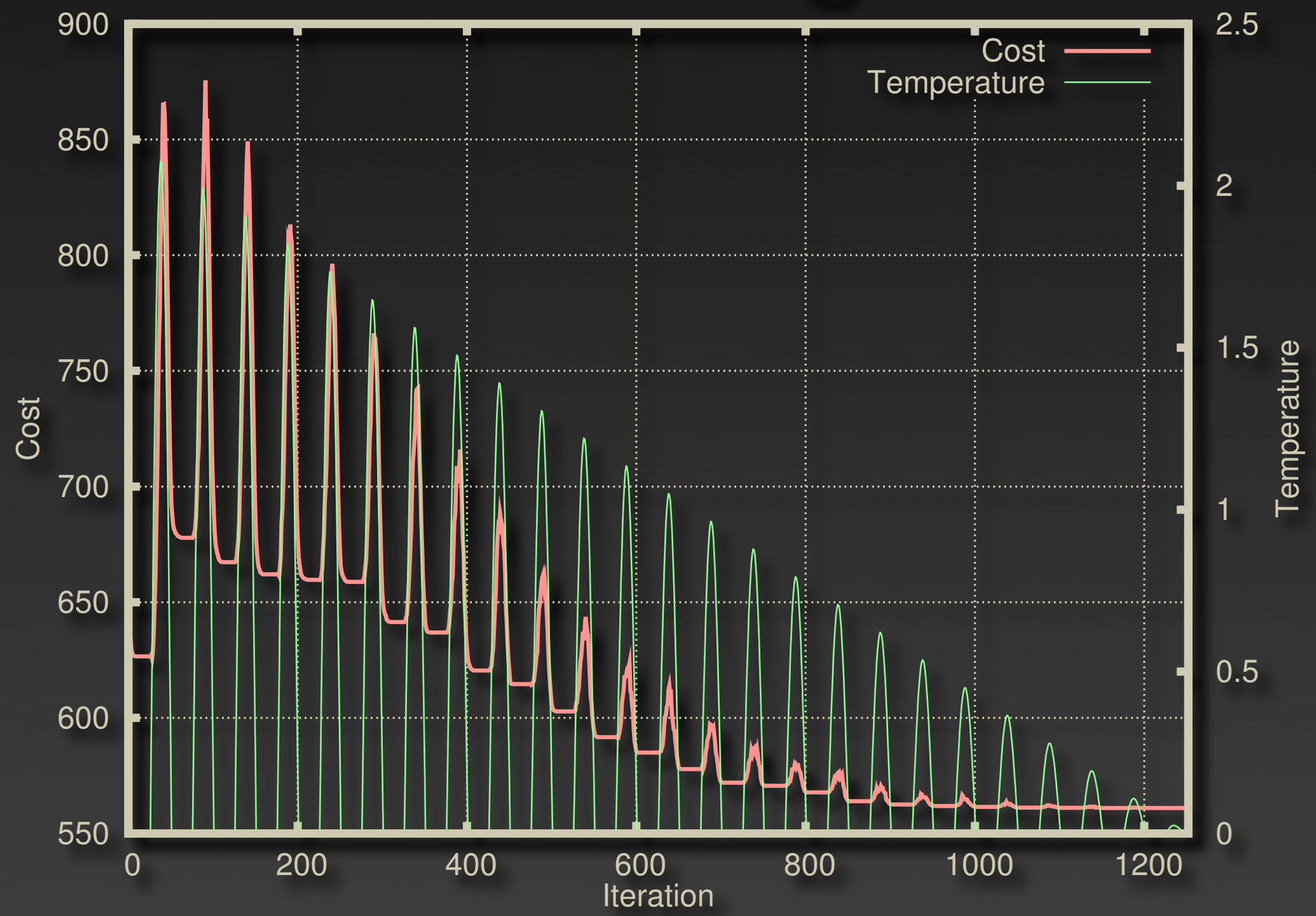
Simulated Annealing

- Energy function
- Candidate proposal mechanism
- Acceptance probability function
- Annealing schedule

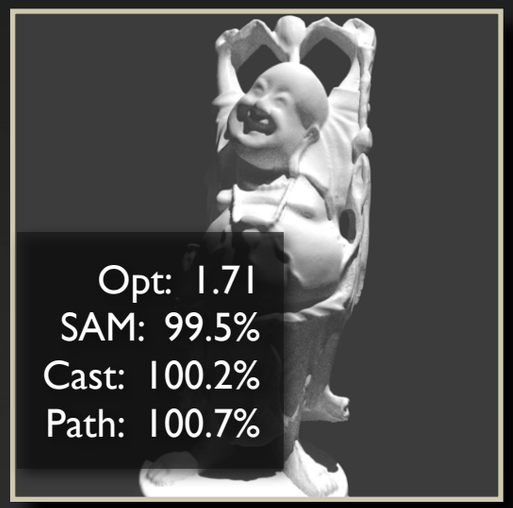
Simulated Annealing

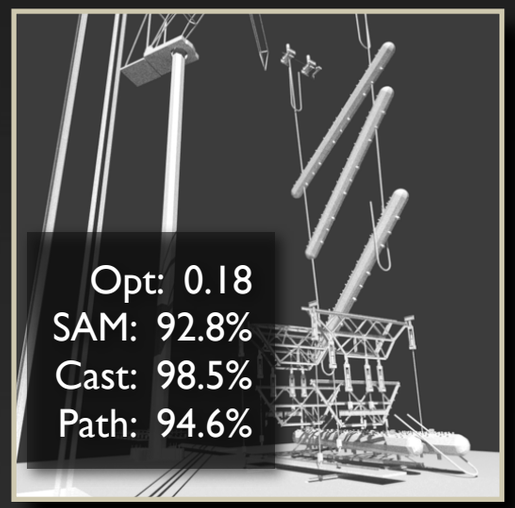
- Energy function → SAM
- Candidate proposal mechanism → Tree rotations
- Acceptance probability function → Boltzman factor: $P(\Delta e, T) = e^{-\Delta e/T}$
- Annealing schedule → Ramped, clamped sinusoid

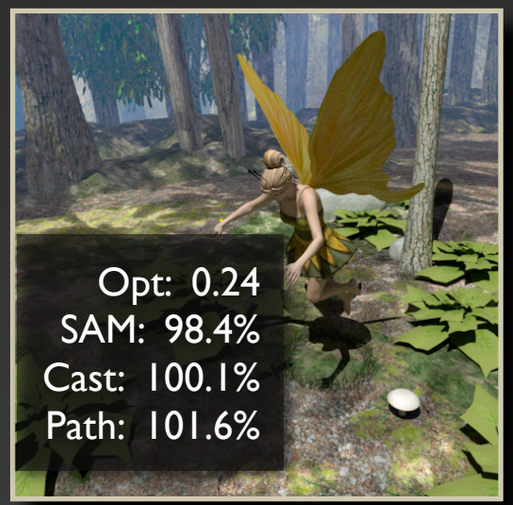
Simulated Annealing – Soda Hall

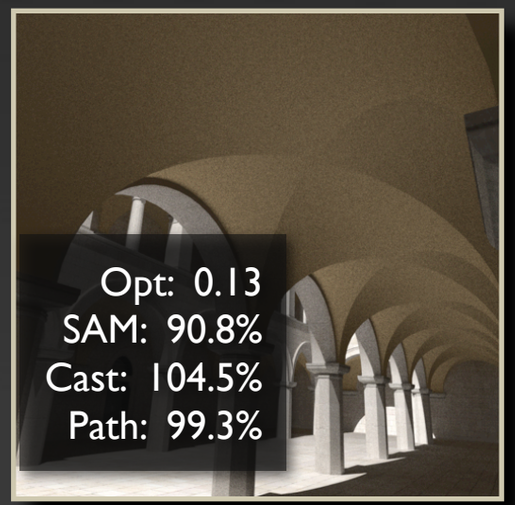


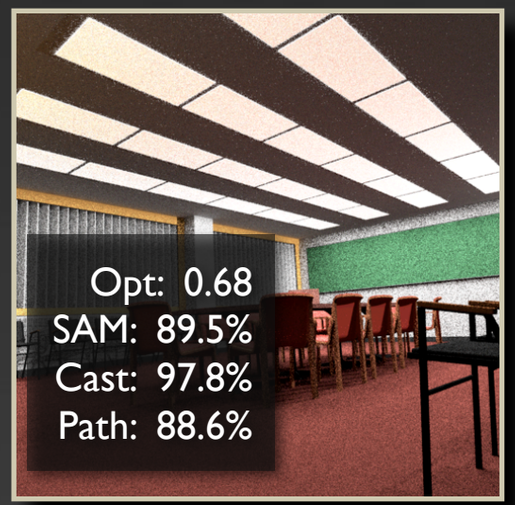
Results – Hill Climbing

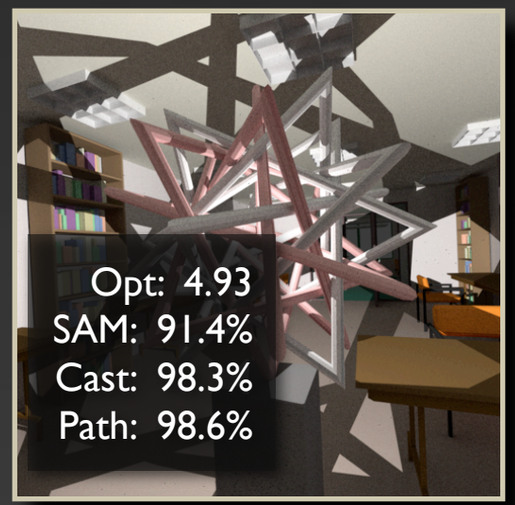




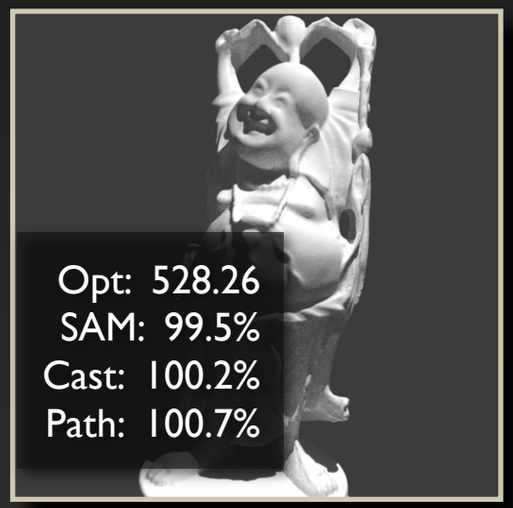


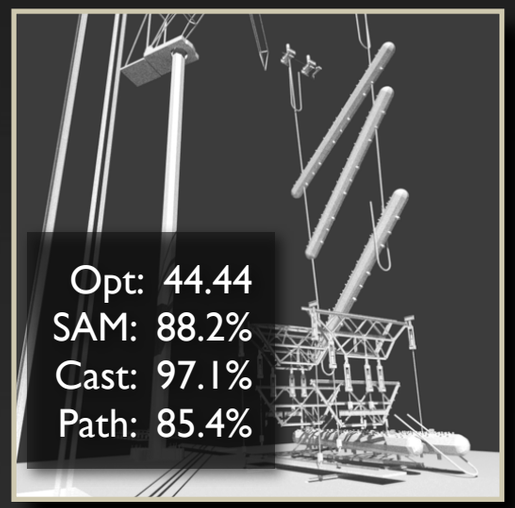


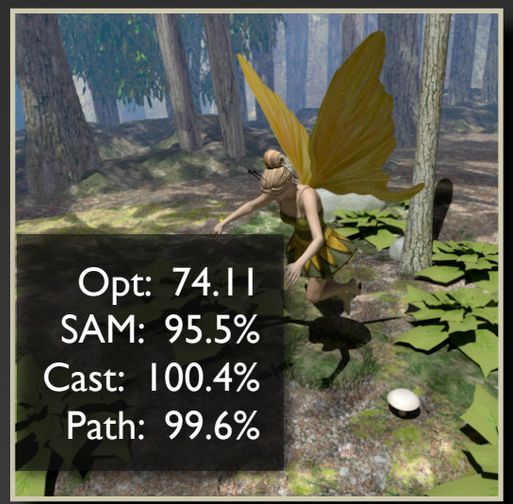


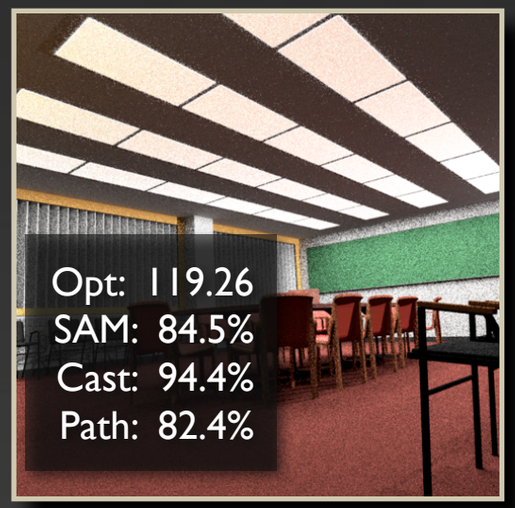


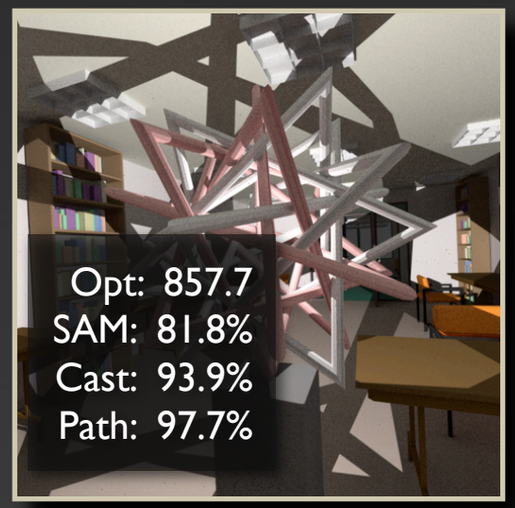
Results – Simulated Annealing











Conclusion

- Limitations
  - Leaves treated atomically
  - Modifies only existing nodes
- Results
  - New post-process optimization algorithms for BVHs
  - Verification of tree quality on densely tessellated meshes
- Future Work
  - SAM tuned for packets?
  - Combine with refitting for animation