

# Time-Critical Rendering

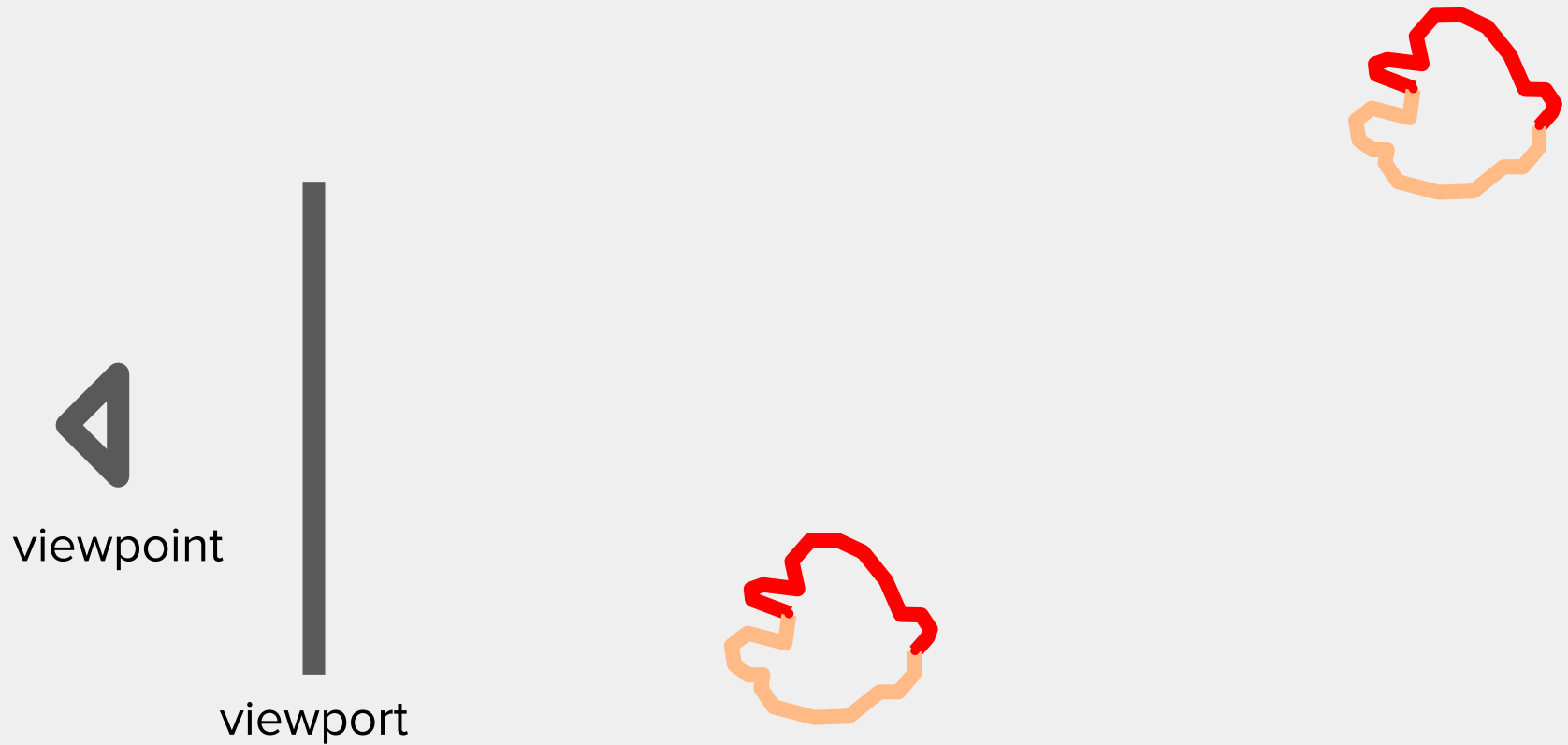
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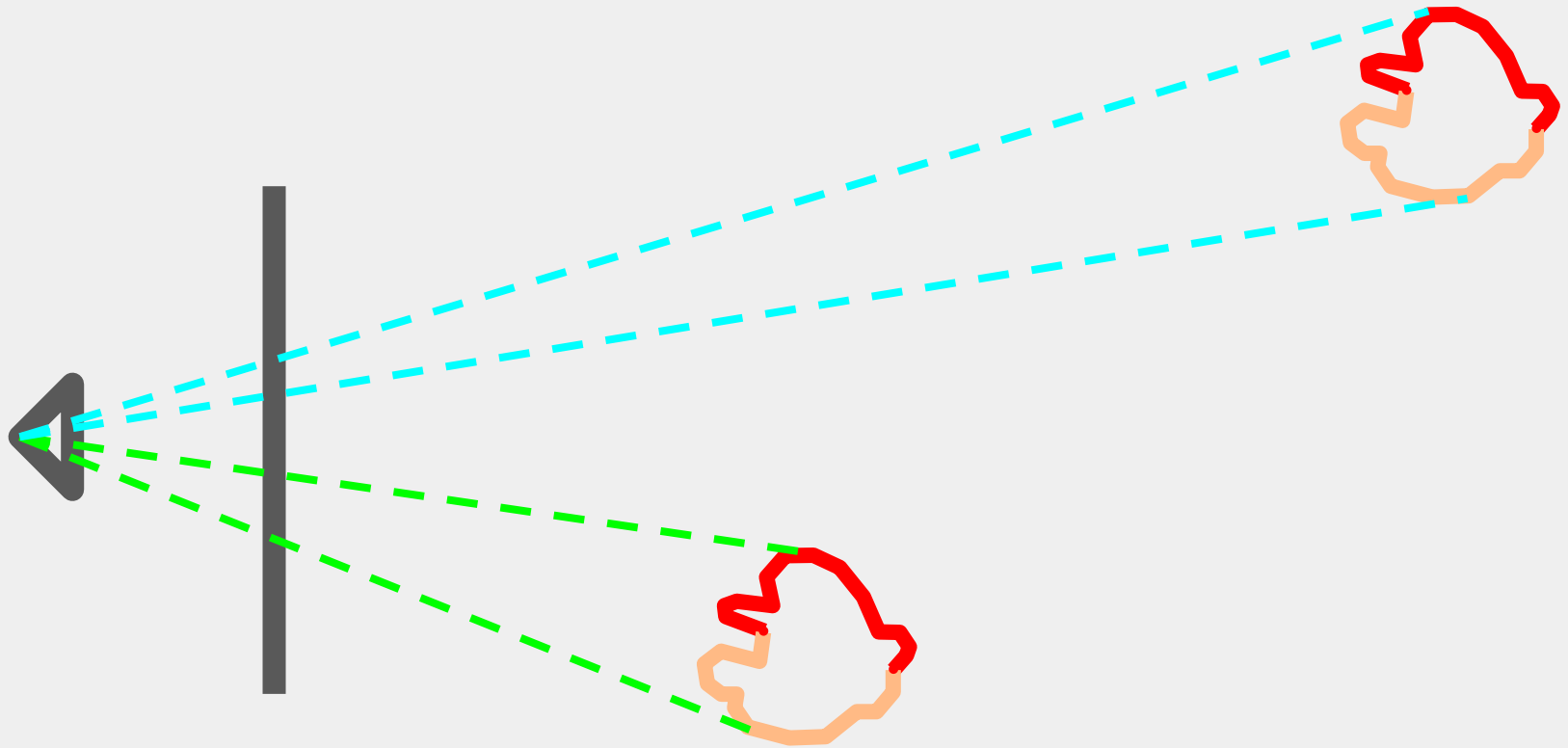
# Problem Formulation

- We have an interactive application and we want to ensure a target frame-rate **(30fps)**
- We have an excessive amount of geometry to render.
- We need to decide the level-of-detail for each instance of a model based on its contribution (measured in pixels).

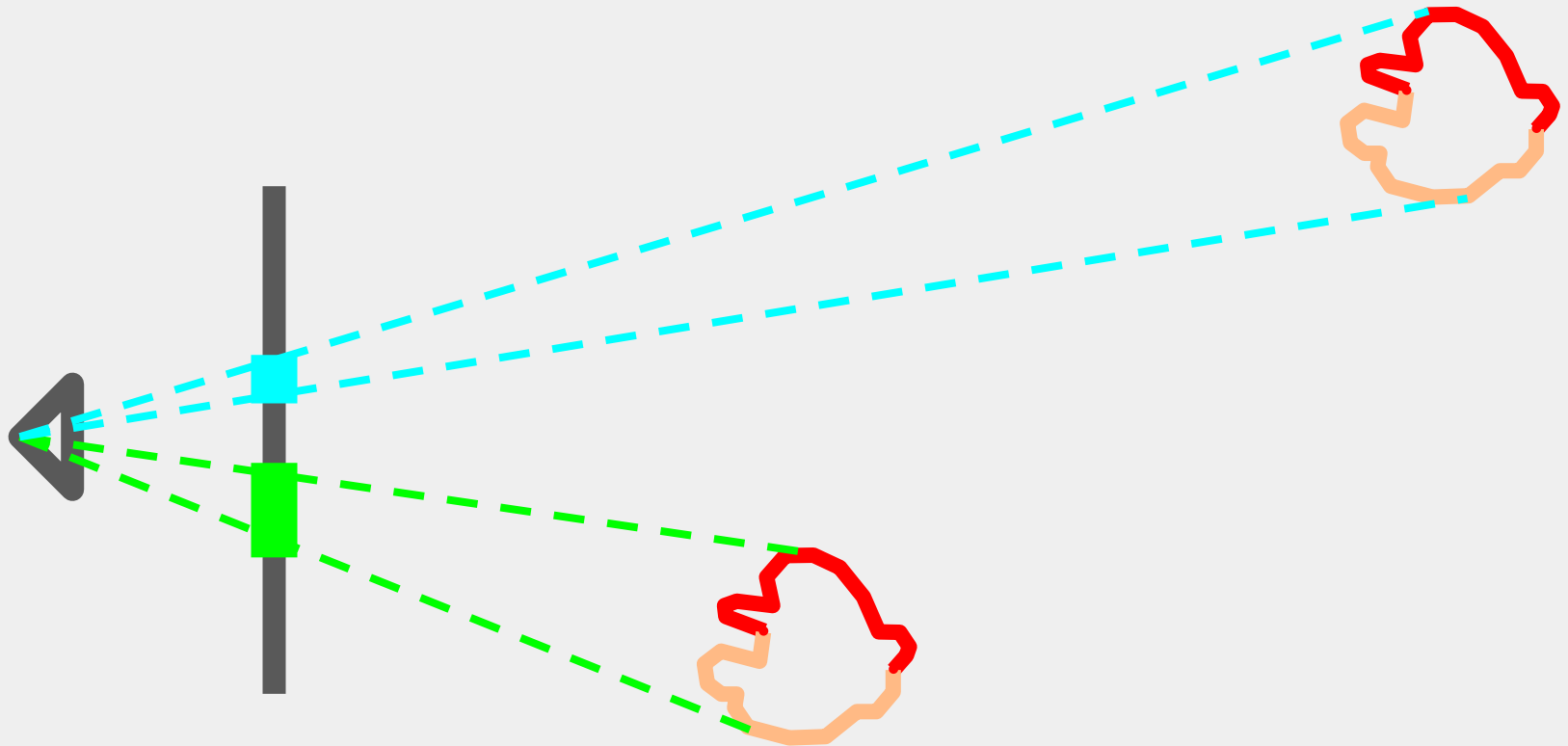
# How to measure contribution?



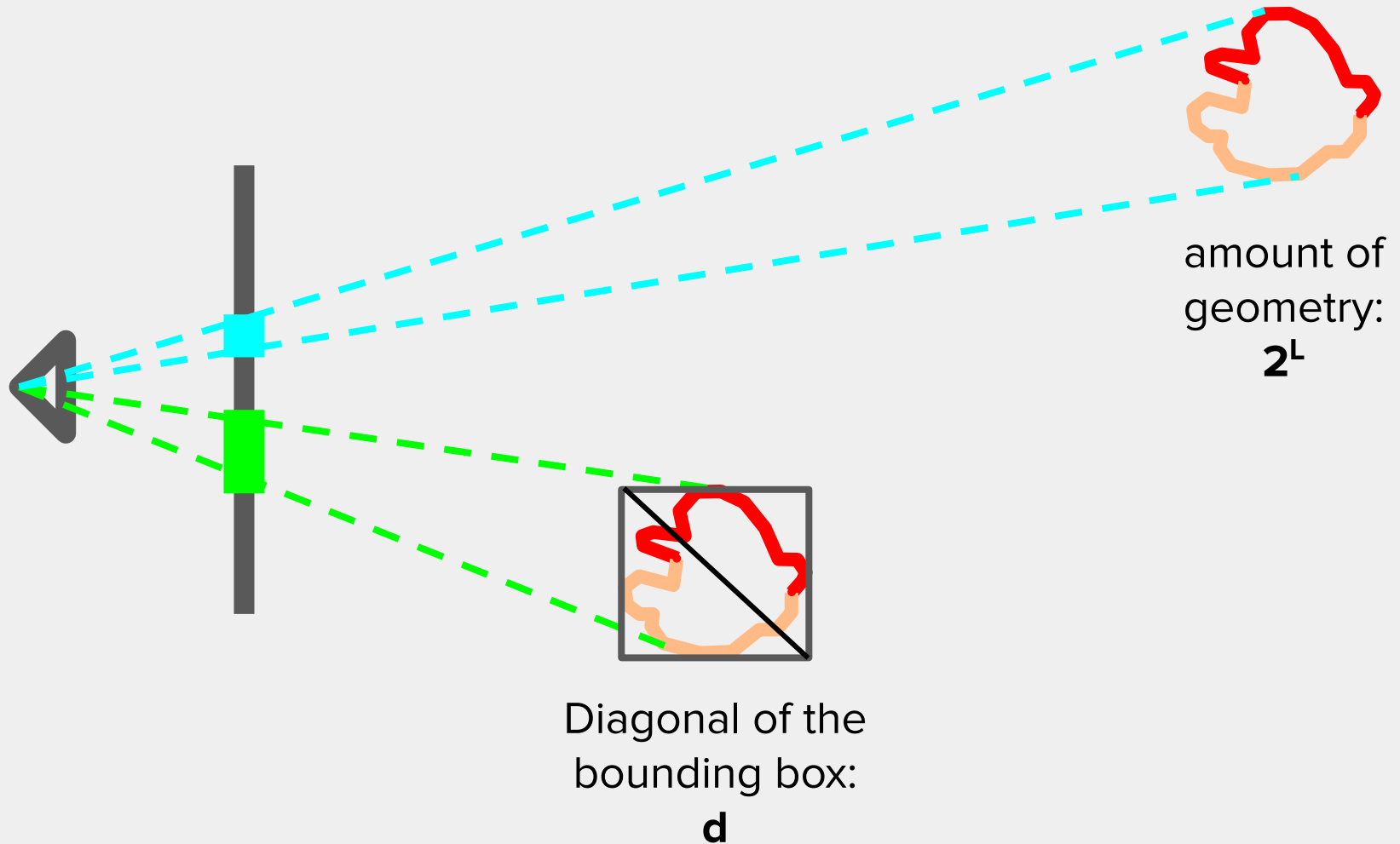
# How to measure contribution?



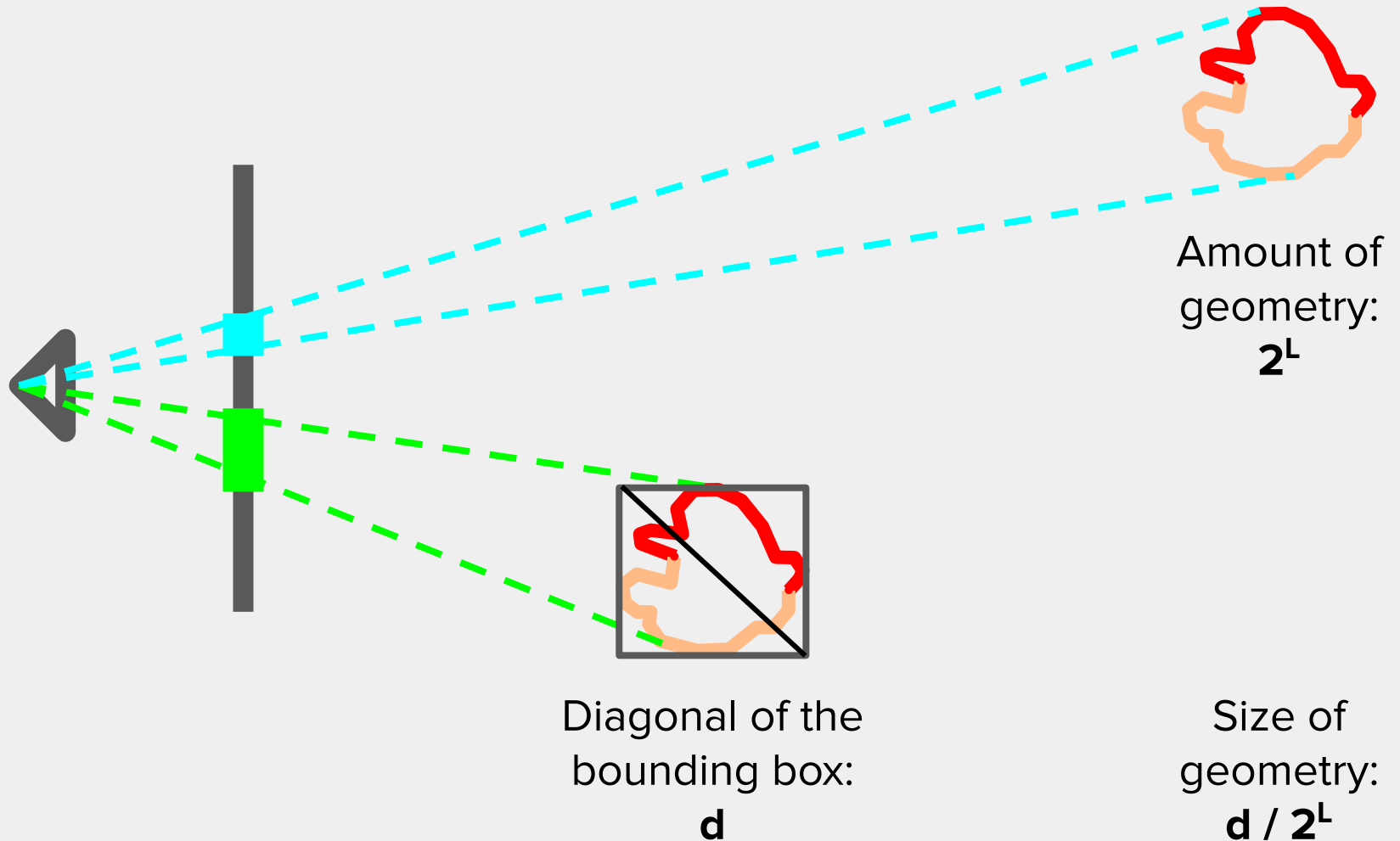
# How to measure contribution?



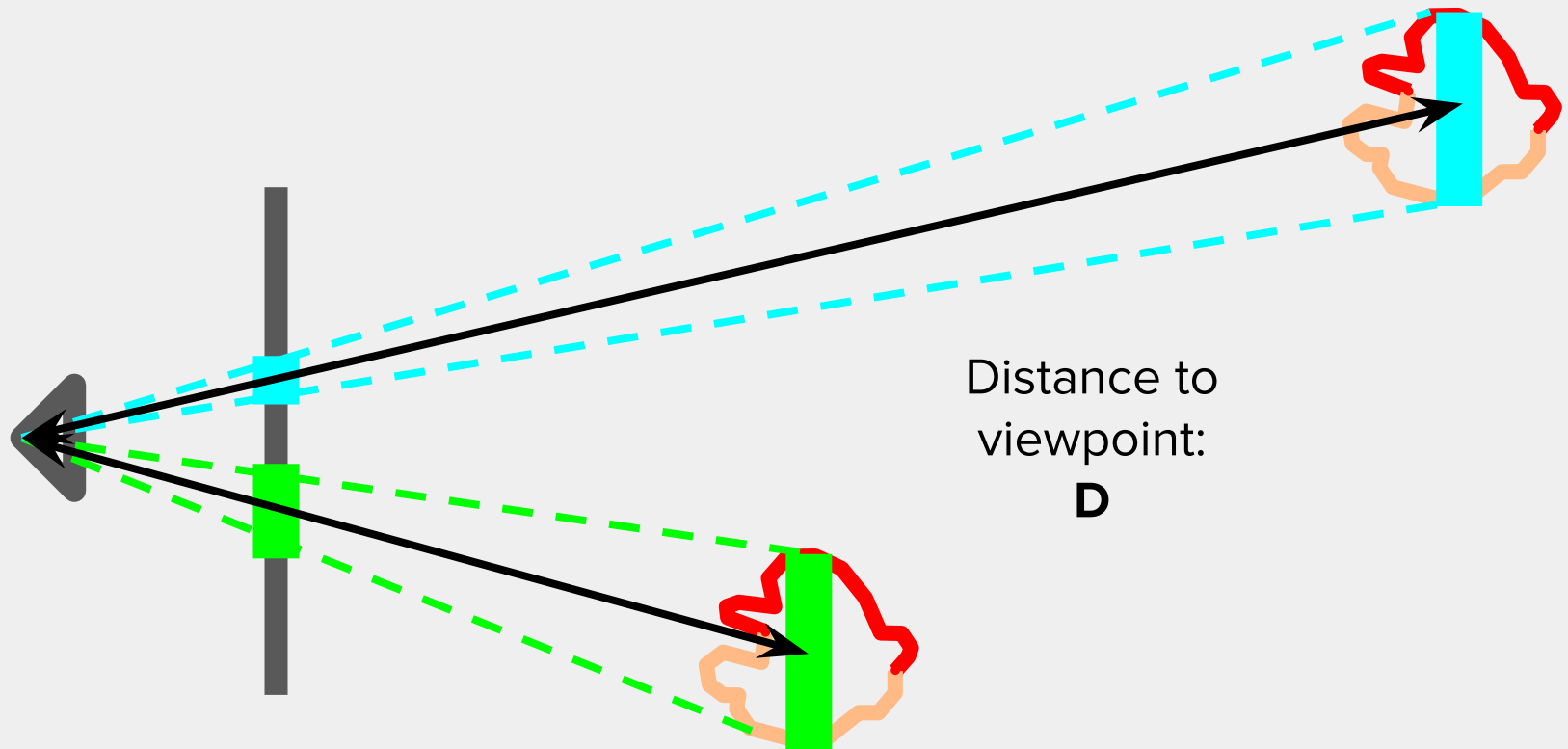
# How to measure contribution?



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# How to measure contribution?



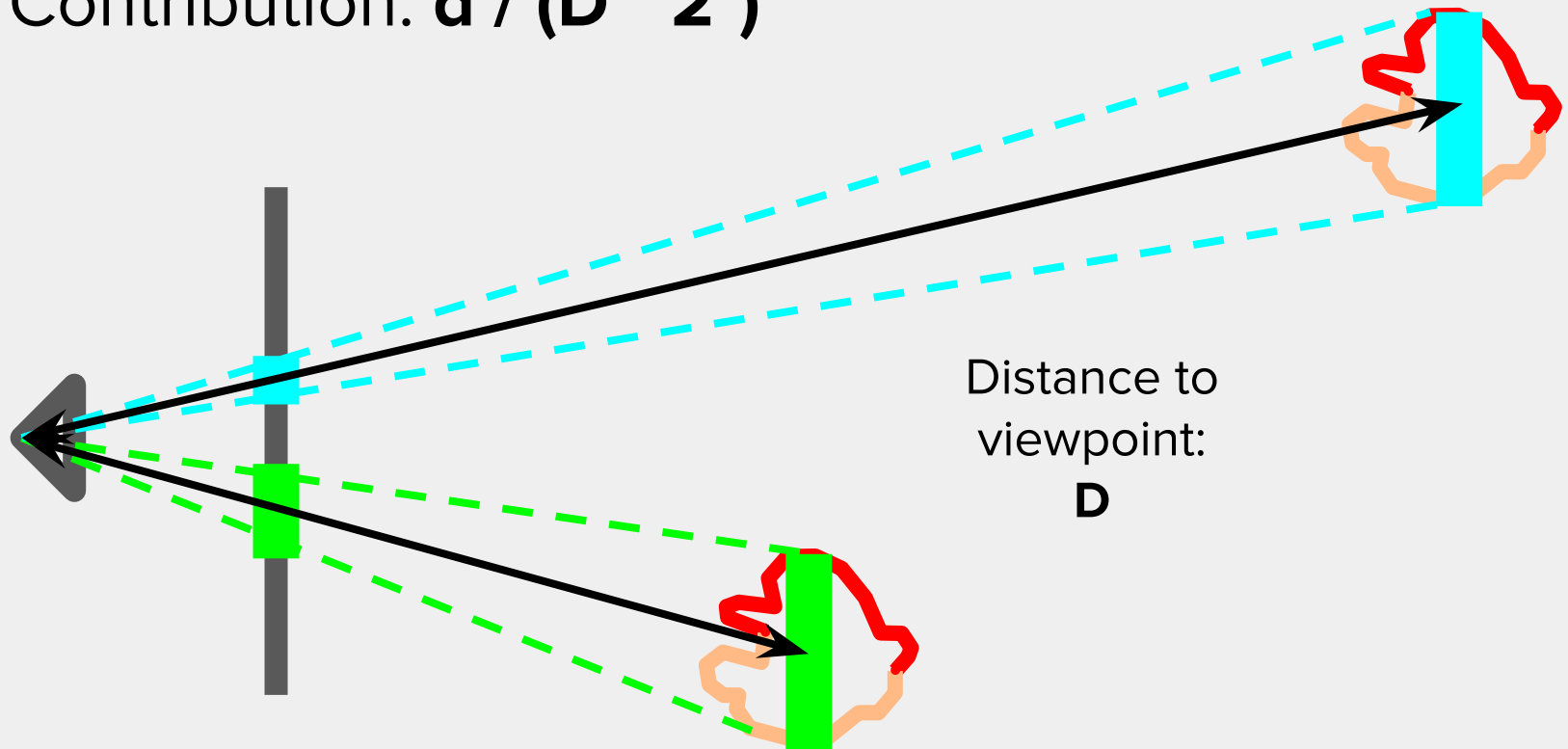
Distance to  
viewpoint:  
**D**

Size of  
geometry:  
 **$d / 2^L$**



# How to measure contribution?

- Contribution:  $d / (D * 2^L)$



Size of  
geometry:  
 $d / 2^L$


# Greedy Algorithm

- We initialize all models to the lowest LOD level.

	LOD 1	LOD 2	LOD 3	LOD 4
Bunny 1	X			
Bunny 2	X			
Bunny 3	X			
Mario 1	X			
Mario 2	X			
Armadillo 1	X			
Armadillo 2	X			
...				
Total Triangles	1000	Max Triangles:	3000	

# Greedy Algorithm

- At each frame decide which LOD increment provides the biggest contribution increment.



	LOD 1	LOD 2	$\Delta$ Contribution
Bunny 1	X		$\text{Ctrb}(\text{LOD } 2) - \text{Ctrb}(\text{LOD } 1) = 1$
Bunny 2	X		$\text{Ctrb}(\text{LOD } 2) - \text{Ctrb}(\text{LOD } 1) = 2$
Bunny 3	X		$\text{Ctrb}(\text{LOD } 2) - \text{Ctrb}(\text{LOD } 1) = 16$
Mario 1	X		$\text{Ctrb}(\text{LOD } 2) - \text{Ctrb}(\text{LOD } 1) = 4$
Mario 2	X		$\text{Ctrb}(\text{LOD } 2) - \text{Ctrb}(\text{LOD } 1) = 2$
Armadillo 1	X		$\text{Ctrb}(\text{LOD } 2) - \text{Ctrb}(\text{LOD } 1) = 3$
Armadillo 2	X		$\text{Ctrb}(\text{LOD } 2) - \text{Ctrb}(\text{LOD } 1) = 2$
...			
Total Triangles	1000	Max Triangles:	3000

# Greedy Algorithm

- At each frame decide which LOD increment provides the biggest contribution increment.

	LOD 1	LOD 2	$\Delta$ Contribution
Bunny 1	X		$\text{Ctrb}(\text{LOD } 2) - \text{Ctrb}(\text{LOD } 1) = 1$
Bunny 2	X		$\text{Ctrb}(\text{LOD } 2) - \text{Ctrb}(\text{LOD } 1) = 2$
Bunny 3		X	$\text{Ctrb}(\text{LOD } 3) - \text{Ctrb}(\text{LOD } 2) = 1$
Mario 1	X		$\text{Ctrb}(\text{LOD } 2) - \text{Ctrb}(\text{LOD } 1) = 4$
Mario 2	X		$\text{Ctrb}(\text{LOD } 2) - \text{Ctrb}(\text{LOD } 1) = 2$
Armadillo 1	X		$\text{Ctrb}(\text{LOD } 2) - \text{Ctrb}(\text{LOD } 1) = 3$
Armadillo 2	X		$\text{Ctrb}(\text{LOD } 2) - \text{Ctrb}(\text{LOD } 1) = 2$
...			
Total Triangles	1500	Max Triangles:	3000

# Greedy Algorithm

- At each frame decide which LOD increment provides the biggest contribution increment.

	LOD 1	LOD 2	$\Delta$ Contribution
Bunny 1	X		$\text{Ctrb}(\text{LOD } 2) - \text{Ctrb}(\text{LOD } 1) = 1$
Bunny 2	X		$\text{Ctrb}(\text{LOD } 2) - \text{Ctrb}(\text{LOD } 1) = 2$
Bunny 3		X	$\text{Ctrb}(\text{LOD } 3) - \text{Ctrb}(\text{LOD } 2) = 1$
Mario 1		X	$\text{Ctrb}(\text{LOD } 3) - \text{Ctrb}(\text{LOD } 2) = 2$
Mario 2	X		$\text{Ctrb}(\text{LOD } 2) - \text{Ctrb}(\text{LOD } 1) = 2$
Armadillo 1	X		$\text{Ctrb}(\text{LOD } 2) - \text{Ctrb}(\text{LOD } 1) = 3$
Armadillo 2	X		$\text{Ctrb}(\text{LOD } 2) - \text{Ctrb}(\text{LOD } 1) = 2$
...			
Total Triangles	2100	Max Triangles:	3000

# Greedy Algorithm

- At each frame decide which LOD increment provides the biggest contribution increment.

	LOD 1	LOD 2	$\Delta$ Contribution
Bunny 1	X		$\text{Ctrb}(\text{LOD } 2) - \text{Ctrb}(\text{LOD } 1) = 1$
Bunny 2	X		$\text{Ctrb}(\text{LOD } 2) - \text{Ctrb}(\text{LOD } 1) = 2$
Bunny 3		X	$\text{Ctrb}(\text{LOD } 3) - \text{Ctrb}(\text{LOD } 2) = 1$
Mario 1		X	$\text{Ctrb}(\text{LOD } 3) - \text{Ctrb}(\text{LOD } 2) = 2$
Mario 2	X		$\text{Ctrb}(\text{LOD } 2) - \text{Ctrb}(\text{LOD } 1) = 2$
Armadillo 1		X	$\text{Ctrb}(\text{LOD } 3) - \text{Ctrb}(\text{LOD } 2) = 2$
Armadillo 2	X		$\text{Ctrb}(\text{LOD } 2) - \text{Ctrb}(\text{LOD } 1) = 2$
...			
Total Triangles	2800	Max Triangles:	3000

# Greedy Algorithm

- When we reach the maximum triangle capacity we start decreasing the LODs.

	LOD 1	LOD 2		$\Delta$ Contribution
Bunny 1	X			$\text{Ctrb}(\text{LOD } 2) - \text{Ctrb}(\text{LOD } 1) = 1$
Bunny 2		X		$\text{Ctrb}(\text{LOD } 3) - \text{Ctrb}(\text{LOD } 2) = 1$
Bunny 3		X		$\text{Ctrb}(\text{LOD } 3) - \text{Ctrb}(\text{LOD } 2) = 1$
Mario 1		X		$\text{Ctrb}(\text{LOD } 3) - \text{Ctrb}(\text{LOD } 2) = 2$
Mario 2	X			$\text{Ctrb}(\text{LOD } 2) - \text{Ctrb}(\text{LOD } 1) = 2$
Armadillo 1		X		$\text{Ctrb}(\text{LOD } 3) - \text{Ctrb}(\text{LOD } 2) = 2$
Armadillo 2	X			$\text{Ctrb}(\text{LOD } 2) - \text{Ctrb}(\text{LOD } 1) = 2$
...				
Total Triangles	3300	Max Triangles:	3000	

# Greedy Algorithm

- When we reach the maximum triangle capacity we start decreasing the LODs.

	LOD 1	LOD 2	$\Delta$ Contribution
Bunny 1	X		NA
Bunny 2		X	$\text{Ctrb}(\text{LOD } 1) - \text{Ctrb}(\text{LOD } 2) = -5$
Bunny 3		X	$\text{Ctrb}(\text{LOD } 1) - \text{Ctrb}(\text{LOD } 2) = -7$
Mario 1		X	$\text{Ctrb}(\text{LOD } 1) - \text{Ctrb}(\text{LOD } 2) = -1$
Mario 2	X		NA
Armadillo 1		X	$\text{Ctrb}(\text{LOD } 1) - \text{Ctrb}(\text{LOD } 2) = -4$
Armadillo 2	X		NA
...			
Total Triangles	3300	Max Triangles:	3000



# Greedy Algorithm

- We continuously iterate increasing and decreasing steps to adapt to a changing viewpoint.

	LOD 1	LOD 2	$\Delta$ Contribution
Bunny 1	X		NA
Bunny 2		X	$\text{Ctrb}(\text{LOD } 1) - \text{Ctrb}(\text{LOD } 2) = -5$
Bunny 3		X	$\text{Ctrb}(\text{LOD } 1) - \text{Ctrb}(\text{LOD } 2) = -7$
Mario 1	X		$\text{Ctrb}(\text{LOD } 1) - \text{Ctrb}(\text{LOD } 2) = -1$
Mario 2	X		NA
Armadillo 1		X	$\text{Ctrb}(\text{LOD } 1) - \text{Ctrb}(\text{LOD } 2) = -4$
Armadillo 2	X		NA
...			
Total Triangles	2700	Max Triangles:	3000