



Ray Tracing

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I've learned about what render is and how it works. In computing, it's a process that draws a set of objects producing an array of pixels. From a material way, rendering means converting 3D objects to 2D images into realistic images, which considers how each object contributes to each pixel. So, if you want it, you need an image-order algorithm called Ray Tracing. Reversing reality, it takes an image based on the camera geometry, known as an array of pixels, running through each pixel in the image shoots rays through the normal surface, checking every object of the scene to see if it intersects with any of them. Also, it computes the pixel color based on the results of the ray intersection. My implementation of the algorithm in pseudocode, thanks to Appel [2]:

```
1 for each pixel on the scene based on the camera geometry do
2   compute the ray direction
3   find first object hit by ray and its surface normal
4   compute illumination
5   calculate color
```

Listing 1: Ray tracing

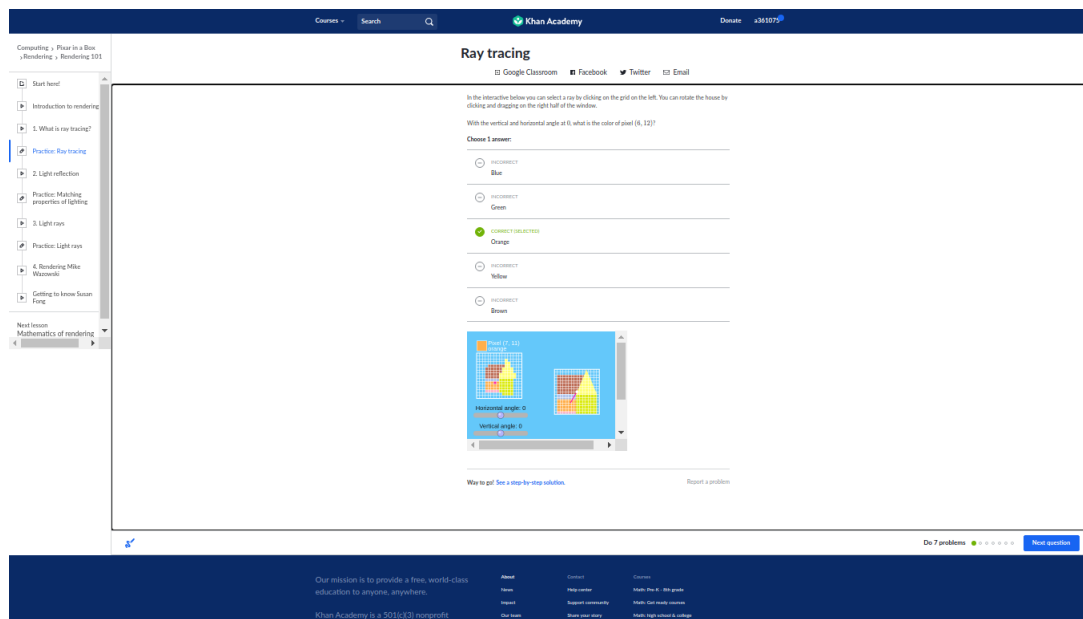


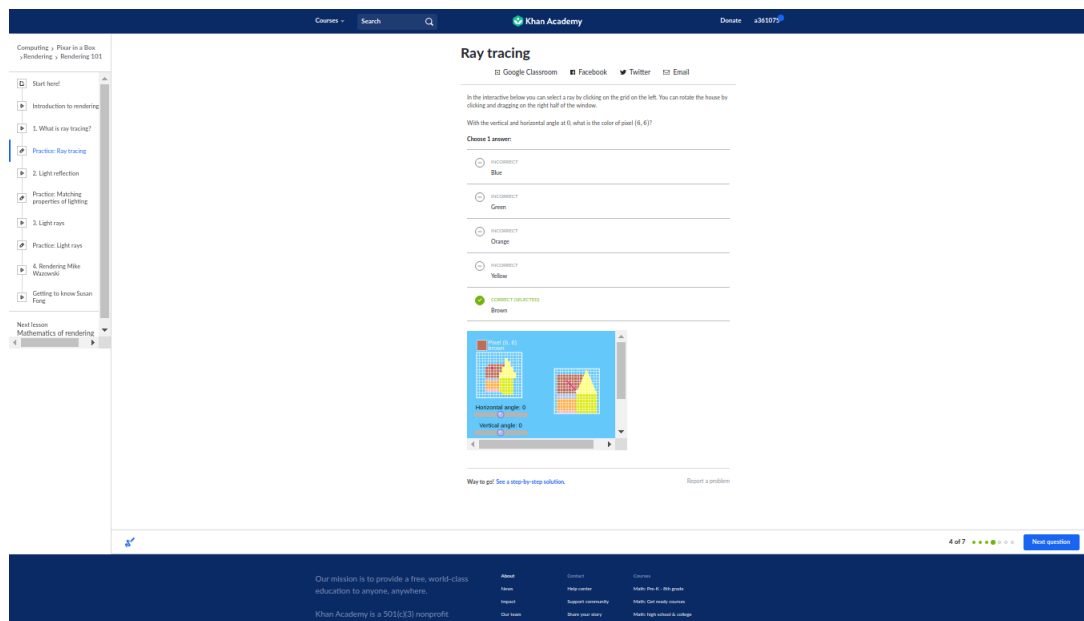
Figure 1: Ray Tracing 1

The screenshot shows the Khan Academy interface for the 'Ray tracing' exercise. The left sidebar lists the course structure: 'Computing > Pixar In a Box > Rendering > Rendering 101'. The main content area is titled 'Ray tracing' and includes social media links for Google Classroom, Facebook, Twitter, and Email. The instructions state: 'In the interactive below you can select a ray by clicking on the grid on the left. You can rotate the house by clicking and dragging on the right half of the window.' The current task is: 'Select a ray that hits the house and creates a black pixel.' The interactive window shows a grid on the left with a selected pixel at (11, 3) labeled 'black'. Below the grid are sliders for 'Horizontal angle: 0' and 'Vertical angle: 90'. On the right, a 3D house is shown on a grid. At the bottom, there is a 'Way to go! See a step-by-step solution.' message and a 'Report a problem' link. The progress bar at the bottom indicates '2 of 7' questions completed, with a 'Next question' button.

Figure 2: Ray Tracing 2

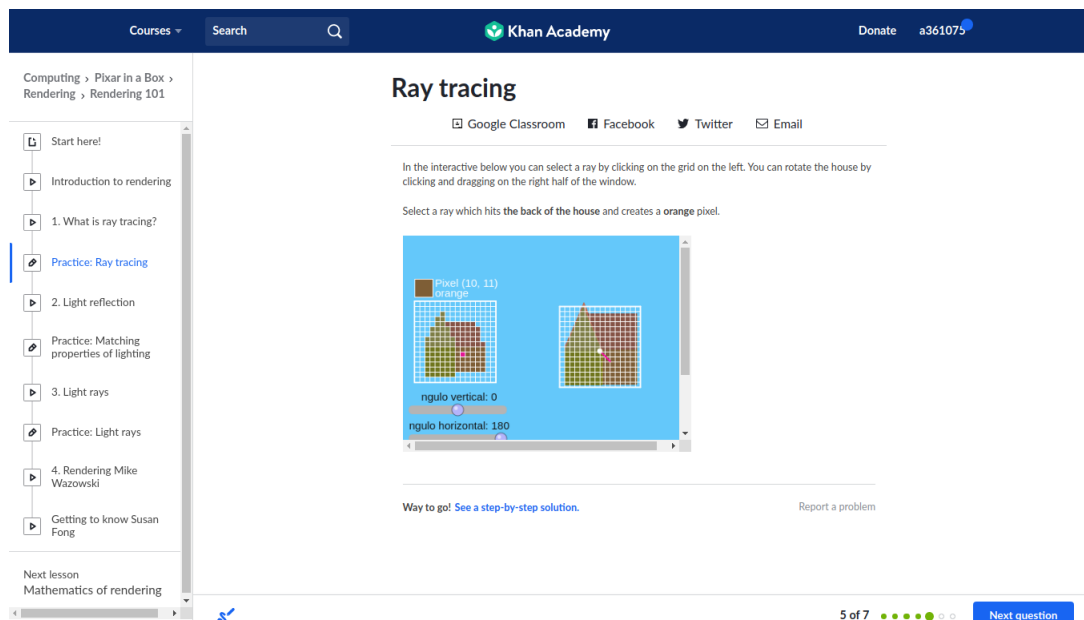
The screenshot shows the Khan Academy interface for the 'Ray tracing' exercise, question 3 of 7. The left sidebar is the same as in Figure 2. The main content area is titled 'Ray tracing' and includes social media links. The instructions are the same. The current task is: 'Select a ray that hits the house and creates a brown pixel.' The interactive window shows a grid on the left with a selected pixel at (6, 6) labeled 'brown'. Below the grid are sliders for 'Horizontal angle: 0' and 'Vertical angle: 0'. On the right, a 3D house is shown on a grid. At the bottom, there is a 'Way to go! See a step-by-step solution.' message and a 'Report a problem' link. The progress bar at the bottom indicates '3 of 7' questions completed, with a 'Next question' button.

Figure 3: Ray Tracing 3



The screenshot shows the Khan Academy interface for the 'Ray tracing' exercise. The left sidebar lists the course structure, with 'Practice: Ray tracing' selected. The main content area is titled 'Ray tracing' and includes social media links for Google Classroom, Facebook, Twitter, and Email. Below this, there is an introductory text and a question: 'With the vertical and horizontal angle at 0, what is the color of pixel (8, 6)?'. The 'Choose 1 answer:' section shows five options: Blue, Green, Orange, Yellow, and Brown. The 'Brown' option is marked as 'CORRECT/EXACTED'. Below the options is a small grid showing a house and a pixel at (8, 6) with a red dot. The bottom of the page shows the Khan Academy logo and a footer with the text 'Our mission is to provide a free, world-class education to anyone, anywhere.' and 'Khan Academy is a 501(c)(3) nonprofit.'

Figure 4: Ray Tracing 4



The screenshot shows the Khan Academy interface for the 'Ray tracing' exercise. The left sidebar lists the course structure, with 'Practice: Ray tracing' selected. The main content area is titled 'Ray tracing' and includes social media links for Google Classroom, Facebook, Twitter, and Email. Below this, there is an introductory text and a question: 'Select a ray which hits the back of the house and creates an orange pixel.' The 'Choose 1 answer:' section shows five options: Blue, Green, Orange, Yellow, and Brown. The 'Orange' option is marked as 'CORRECT/EXACTED'. Below the options is a small grid showing a house and a pixel at (10, 11) with a red dot. The bottom of the page shows the Khan Academy logo and a footer with the text 'Our mission is to provide a free, world-class education to anyone, anywhere.' and 'Khan Academy is a 501(c)(3) nonprofit.'

Figure 5: Ray Tracing 5

The screenshot shows the Khan Academy interface for a Ray Tracing practice session. The left sidebar lists the course structure: Computing > Pixar in a Box > Rendering > Rendering 101. The main content area is titled "Ray tracing" and includes social media links for Google Classroom, Facebook, Twitter, and Email. The instructions state: "In the interactive below you can select a ray by clicking on the grid on the left. You can rotate the house by clicking and dragging on the right half of the window." The interactive shows a grid with a selected ray hitting a house, creating an orange pixel at (5, 12). The horizontal and vertical angles are both 0. The progress bar shows 6 of 7 questions completed. A "Next question" button is visible.

Figure 6: Ray Tracing 6

The screenshot shows the Khan Academy interface for a Ray Tracing practice session, question 7 of 7. The left sidebar is the same as in Figure 6. The main content area is titled "Ray tracing" and includes social media links. The instructions are the same. The interactive shows a grid with a selected ray hitting a house, creating a yellow pixel at (12, 6). The horizontal and vertical angles are both 0. Below the interactive, there is a multiple-choice question: "With the vertical and horizontal angle at 0, what is the color of pixel (12, 6)?" The options are: Blue (Incorrect), Green (Incorrect), Orange (Incorrect), Yellow (Correct/Selected), and Brown (Incorrect). The progress bar shows 7 of 7 questions completed. A "Next question" button is visible.

Figure 7: Ray Tracing 7

References

- [1] “Ray Tracing,” Khanacademy.org, 2022. [Online]. Available: <https://www.khanacademy.org/computing/pixar/rendering/rendering1/tracing>. [Accessed: 16-Feb-2022]
- [2] “Some techniques for shading machine renderings of solids — Proceedings of the April 30–May 2, 1968, spring joint computer conference,” ACM Other conferences, 2022. [Online]. Available: <https://dl.acm.org/doi/10.1145/1468075.1468082>. [Accessed: 16-Feb-2022]