Now, let's take a look at a full example of a case.

This is a head and neck example, and the CT scans are shown on the right.

There are a total of 132,878 voxels.

The target, or tumor, has 9,777 voxels.

There are five critical structures that we want to minimize the dose to-- the spinal cord, the brain, the brain stem, the parotid glands, and the mandible or jaw.

We're using five beams, and each beam is composed of about 60 beamlets.

In total, there are 328 beamlets.

In this example, we want the dose to the whole tumor to be between 70 and 77 gray.

The spinal cord dose should be no more than 45 gray, since significant damage to any voxel in the spinal cord will result in loss of function.

The brain stem dose should be no more than 54 gray, and the mandible dose should be no more than 70 gray.

The average parotid gland dose should be at most 26 gray.

This constraint is a little different, since the parotid gland is a parallel structure.

Significant damage to any one voxel does not jeopardize function of the entire organ.

So what is our optimization problem now?

Again, our decisions are the intensities of the beamlets.

Our objective is to minimize the total dose to healthy tissue.

Our constraints are limits on the tumor dose and upper bounds for the spinal cord, brain stem, and mandible.

We also have a constraint to limit the average parotid dose to 26 gray.

Lastly, all of our intensities, or decision variables, should be non-negative.

We solved this optimization problem, and this plot shows the results.

On the x-axis is the dose, in gray, and on the y-axis is the fraction of voxels that received that dose or higher.

Each line corresponds to a different structure.

We can see that for the tumor, which is shown as the red line, 100% of the voxels get a dose of 70 gray, and 0% of the voxels get a dose of more than 77 gray.

This is what our constraint specified.

While none of the critical structures are getting very high doses, it looks like the mandible, which is shown as the blue line, is receiving the highest dose of the healthy organs.

In the next video, we'll explore different solutions and the shadow prices of our constraints.