Assignment 1 - Foreground Segmentation and Poisson Blending

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1 GrabCut

Table 1: Metric Results table - `n_components = 5`

Image Name	**Accuracy**	**Jaccard**	**Runtime (in seconds)**
banana1.jpg	0.6701	0.4367	82.37
banana2.jpg	0.9925	0.9689	68.32
book.jpg	0.9563	0.8942	157.46
bush.jpg	0.8692	0.5591	42.05
cross.jpg	0.5519	0.4514	36.17
flower.jpg	0.9965	0.9821	36.30
fullmoon.jpg	0.9681	0.6543	16.03
grave.jpg	0.9877	0.9042	46.66
llama.jpg	0.9887	0.9359	48.89
memorial.jpg	0.9899	0.9453	37.46
sheep.jpg	0.9957	0.9227	38.95
stone2.jpg	0.9961	0.9842	85.81
teddy.jpg	0.9907	0.9580	24.22
		Average Runtime:	**55.44**

1.1 Examples where GrabCut worked decently well:

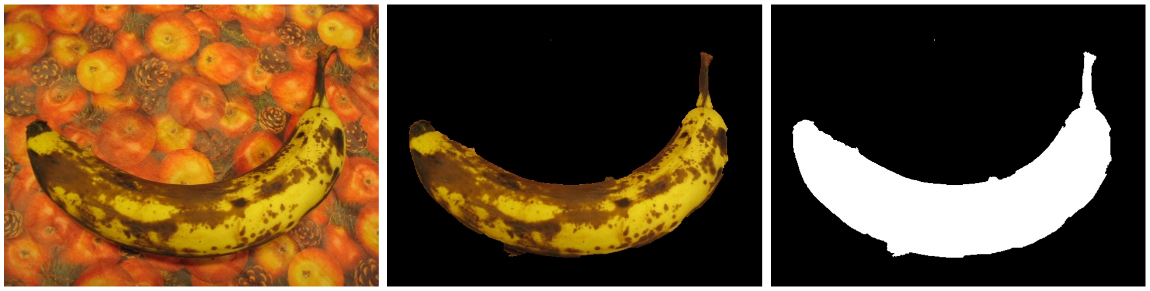


Figure 1: banana2.jpg

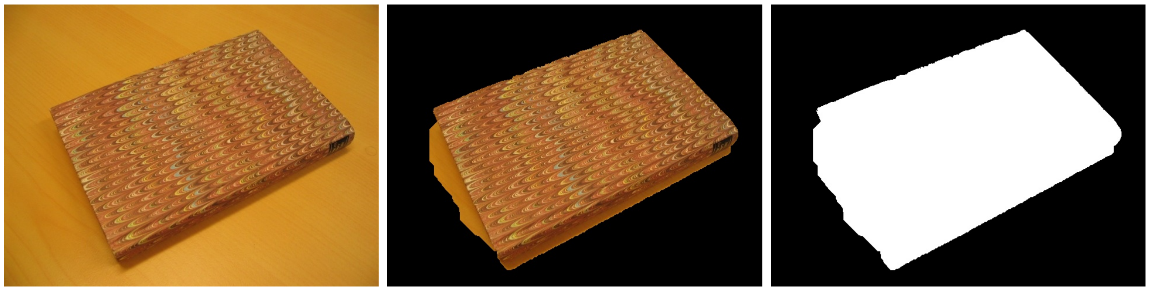


Figure 2: book.jpg

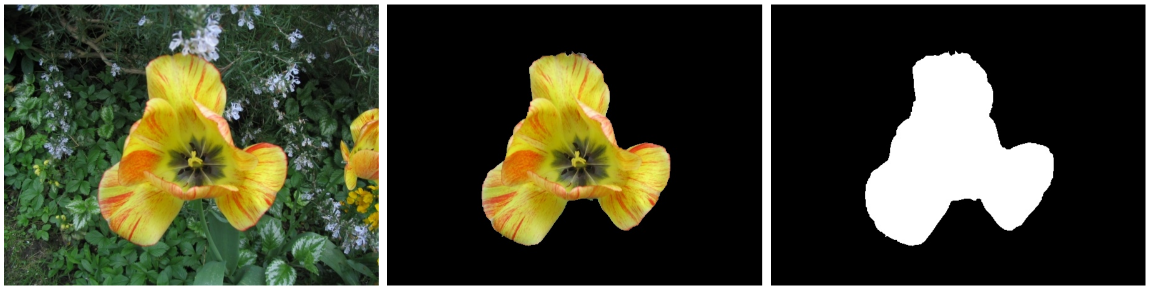


Figure 3: flower.jpg

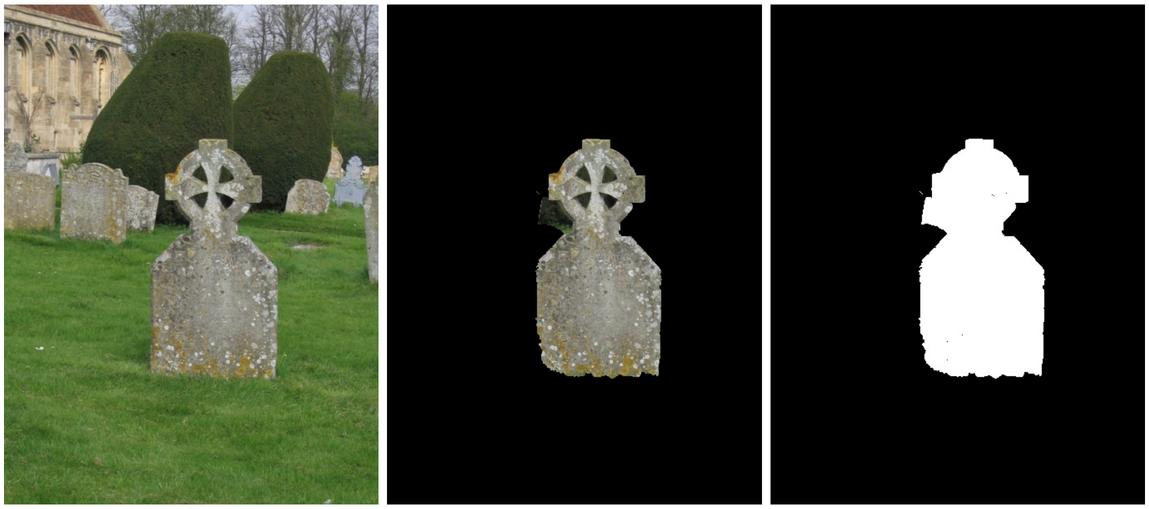


Figure 4: grave.jpg

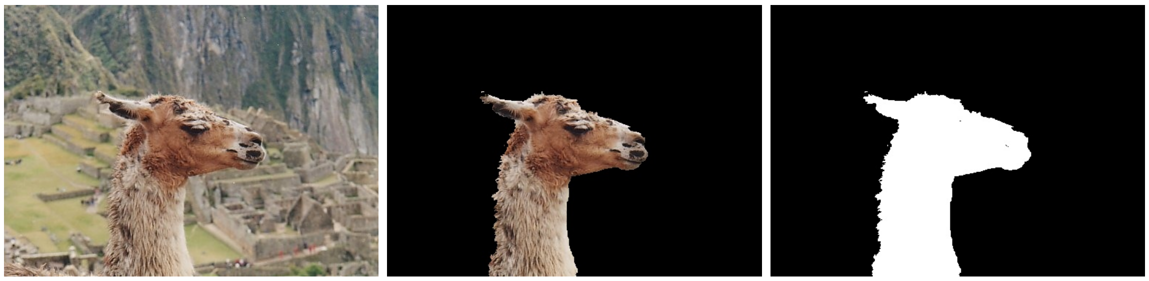


Figure 5: llama.jpg

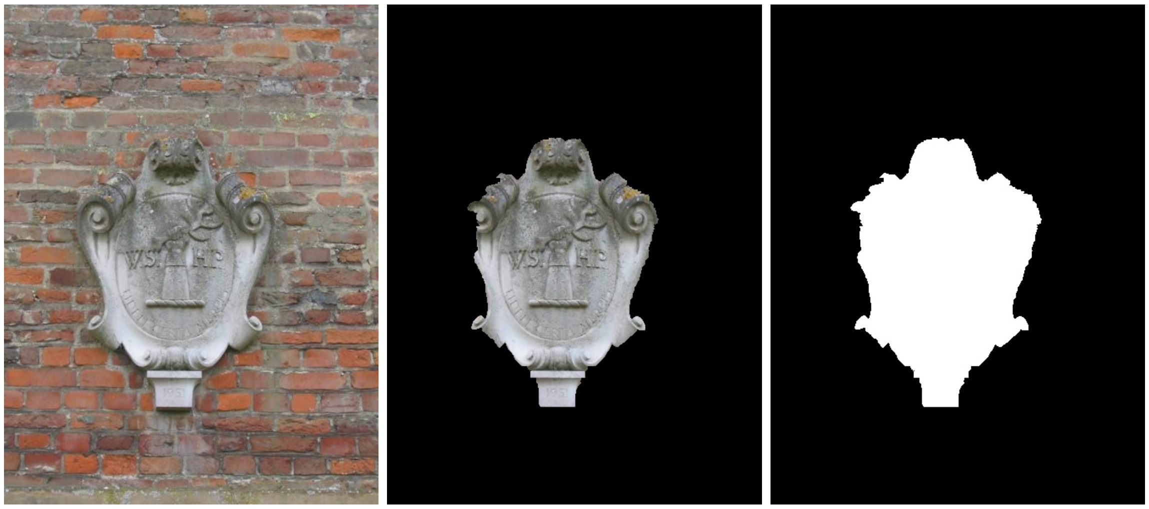


Figure 6: memorial.jpg

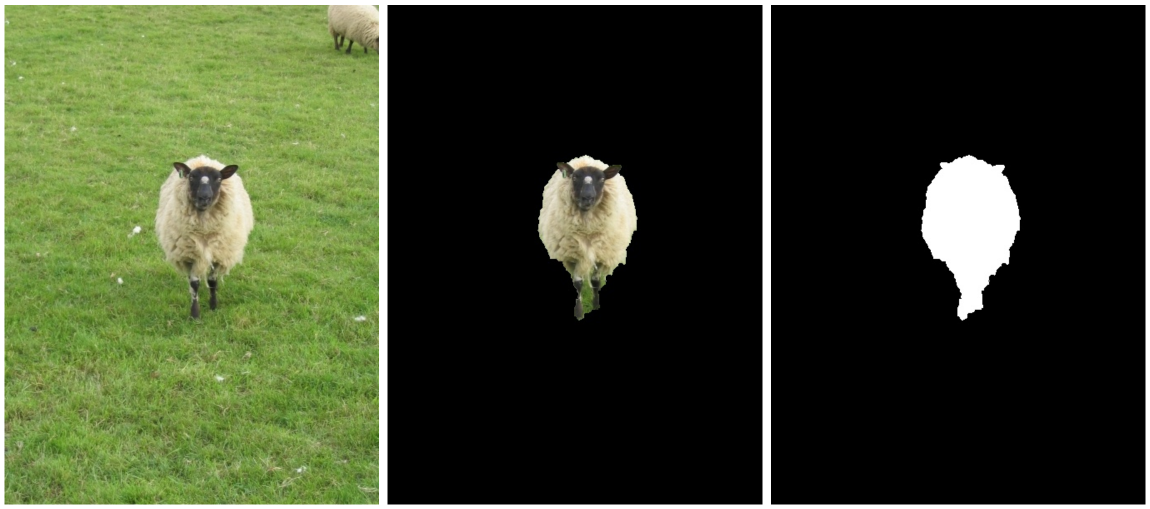


Figure 7: sheep.jpg

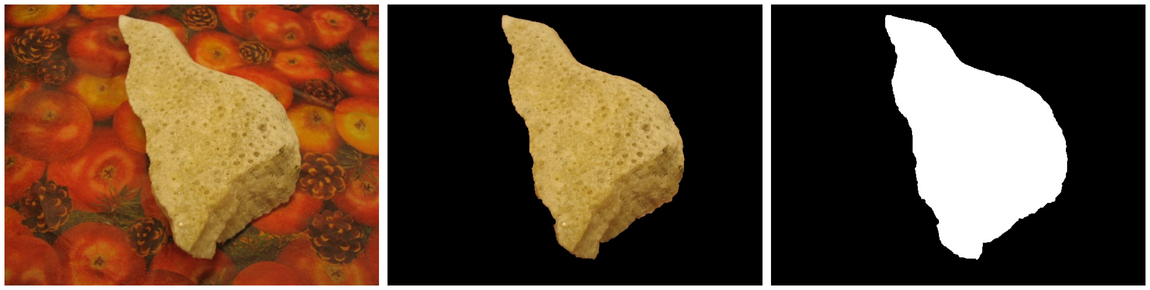


Figure 8: stone2.jpg

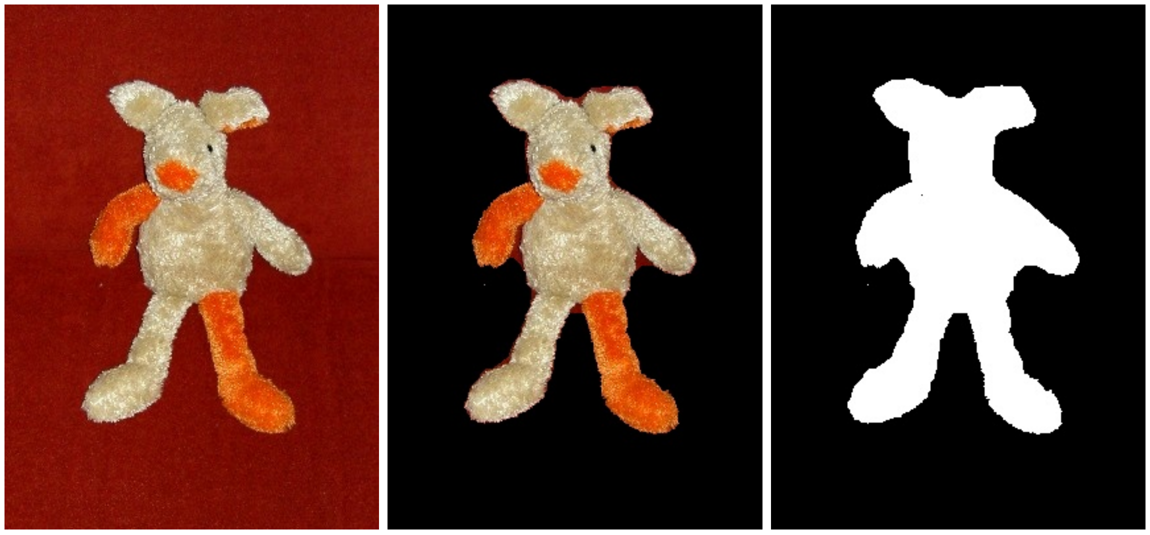


Figure 9: teddy.jpg

1.2 Examples where GrabCut did not work well:

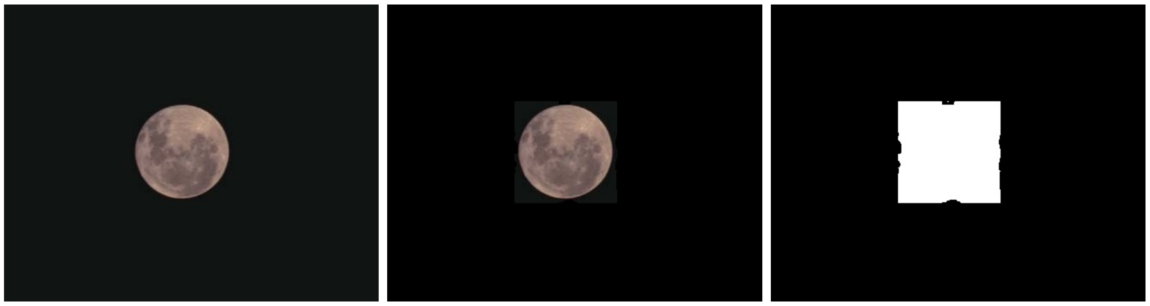


Figure 10: fullmoon.jpg

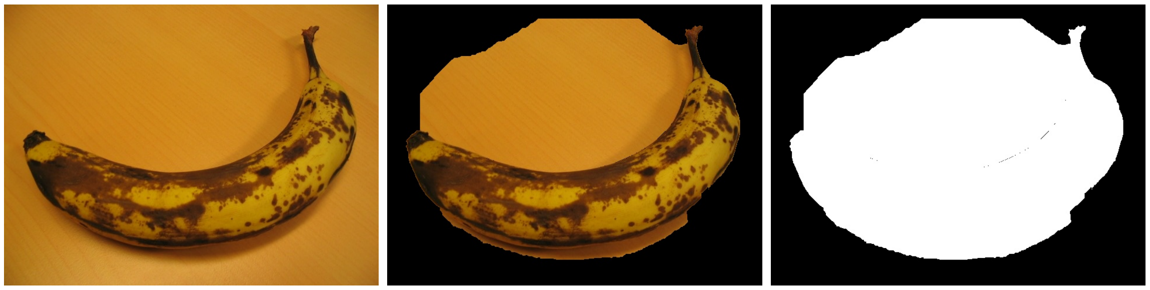


Figure 11: banana1.jpg

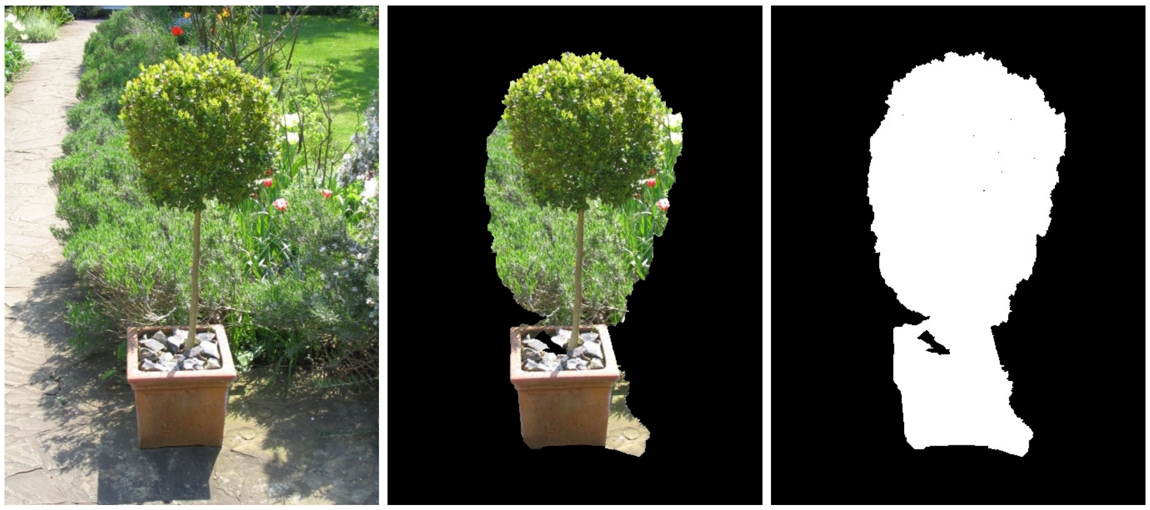


Figure 12: bush.jpg

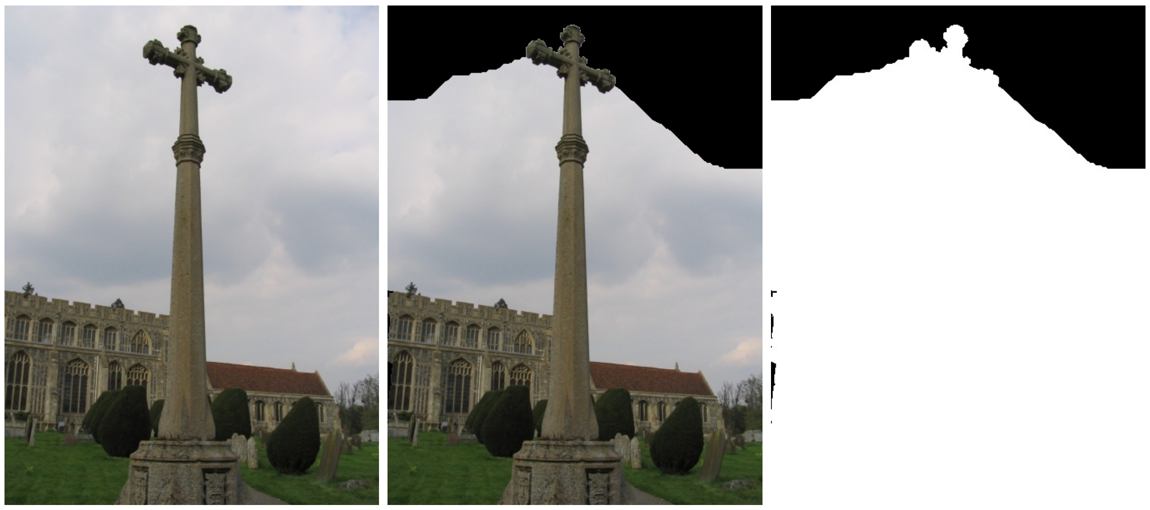


Figure 13: cross.jpg

For `bush.jpg` what I assume happened is that the background had too similar a color to the foreground, so it was difficult to truly separate the thin trunk and leaves from the background grasses. Regarding `banana1.jpg`, `cross.jpg` and `fullmoon.jpg` I suspect that the issue is that the GMMs have too many components. Perhaps too many components also played a part of the failure of `bush.jpg`

1.3 Effect of various parameters on GrabCut:

We'll first test the effect of a different number of `n_components` on GrabCut:

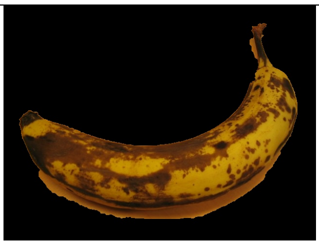
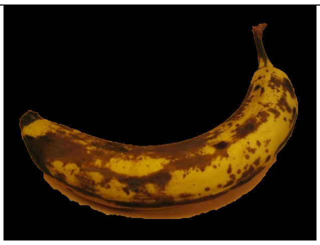
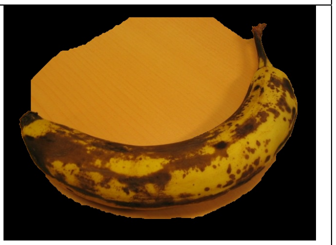
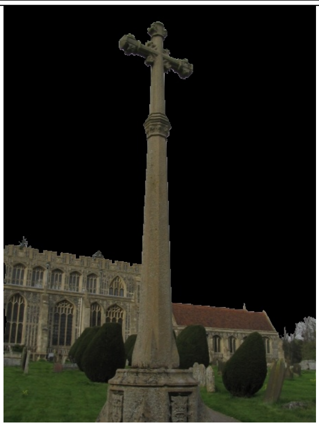
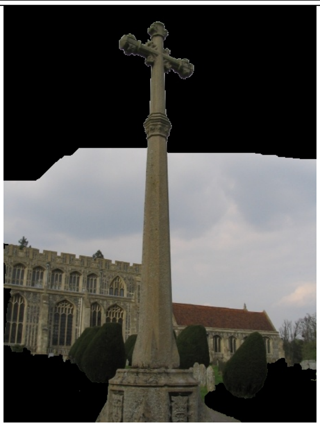
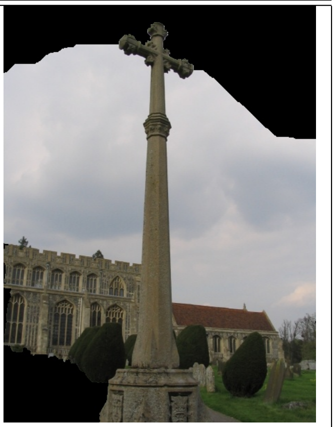
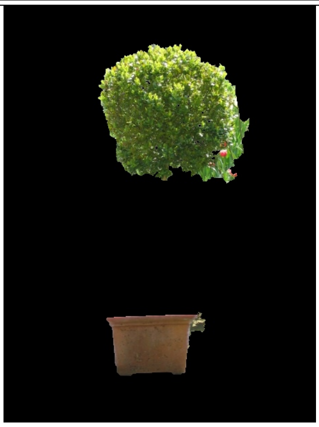
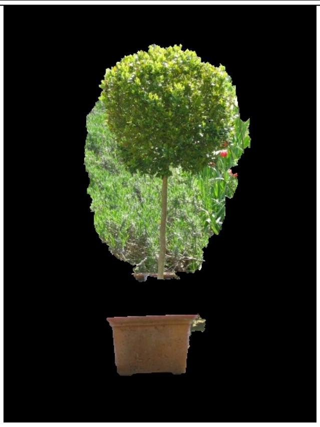
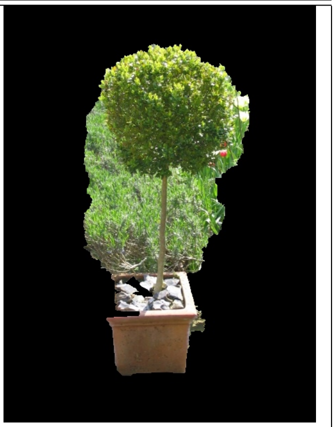
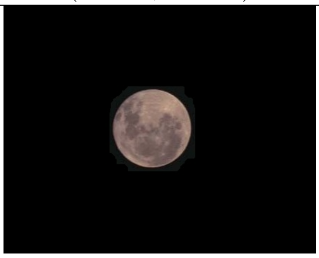
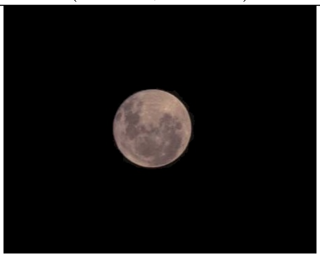
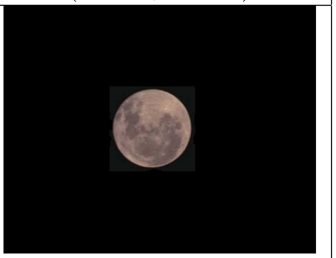
Img Name	n_components		
	1	**3**	**5**
banana1.jpg			
(Accuracy, Jaccard)	(0.9610, 0.8677)	(0.9661, 0.8830)	(0.6562, 0.4266)
cross.jpg			
(Accuracy, Jaccard)	(0.9869, 0.9657)	(0.5475, 0.4490)	(0.5454, 0.4478)
bush.jpg			
(Accuracy, Jaccard)	(0.9513, 0.7363)	(0.9449, 0.7110)	(0.8693, 0.5595)
fullmoon.jpg			
(Accuracy, Jaccard)	(0.9479, 0.7063)	(0.9930, 0.8837)	(0.9675, 0.6501)

Table 2: Comparison of Accuracy and Jaccard across n_components

It seems that for `banana1.jpg` and `fullmoon.jpg` the optimal number of `n_components` is 3, while for `cross.jpg` and `bush.jpg` the optimal number is 1. Although the segmentation in `bush.jpg` is still quite bad.
Now we'll look at the effect of different amounts of blur on GrabCut's performance:

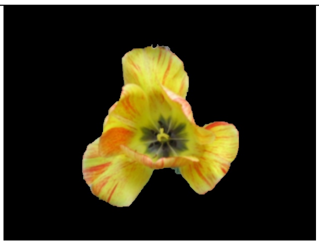
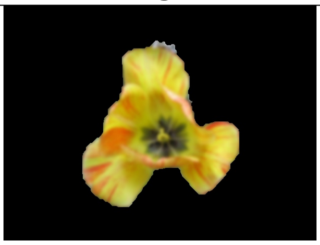
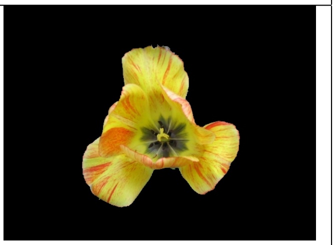
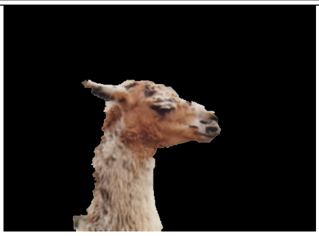
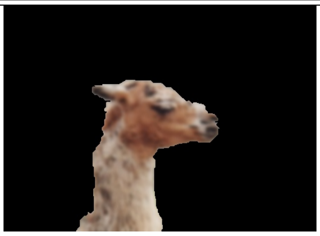
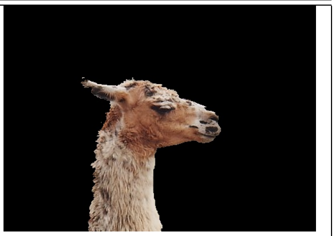
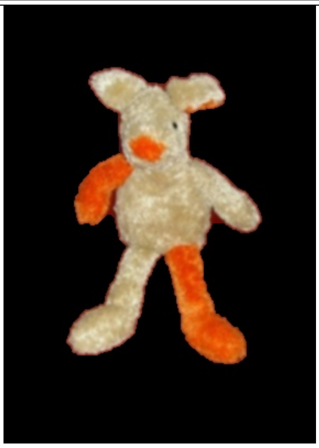
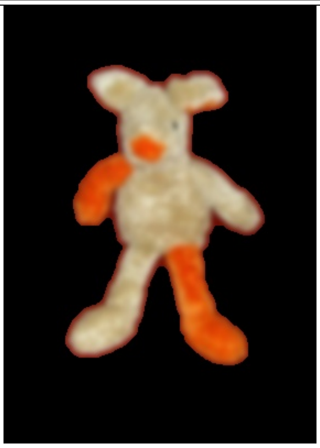
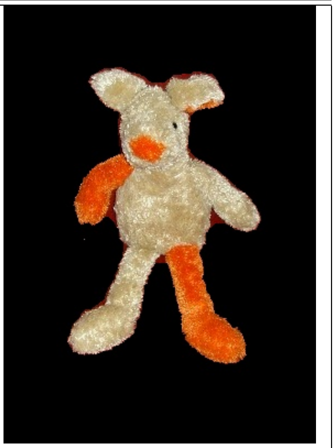
Img Name	**blur**		
	low	**high**	**no blur**
flower.jpg			
(Accuracy, Jaccard)	(0.9957, 0.9782)	(0.9925, 0.9782)	(0.9925, 0.9629)
llama.jpg			
(Accuracy, Jaccard)	(0.9874, 0.9297)	(0.9865, 0.9245)	(0.9902, 0.9444)
teddy.jpg			
(Accuracy, Jaccard)	(0.9899, 0.9549)	(0.9739, 0.8912)	(0.9906. 0.9572)

Table 3: Comparison of Accuracy and Jaccard across different levels of blur

It seems like blurring the image resulted in a worse outcome than not blurring the image. Specifically, higher levels of blur resulted in worse results than low levels of blur which in turn was worse than no blur at all.

Now we'll test different initializations of rectangles on the final result of GrabCut. We'll use the default rectangle that's defined in `\data\bboxes\image_name.txt`, a larger rectangle and a rectangle that covers almost the whole image (its x and y are both zeros, and its width and height are 1 pixel less than the image's width and height) and see whether it has an effect on the final result or the runtime. It should be noted that in the unmodified skeleton, the pre-defined rectangles go past the width and height of the image, meaning the rectangle's bottom edge and right edge are below and to the right of image's edges respectively. I modified the skeleton such that it subtracts the x and y coordinates from the rectangles w and h. This makes the pre-defined rectangles much tighter and prevents some bugs.

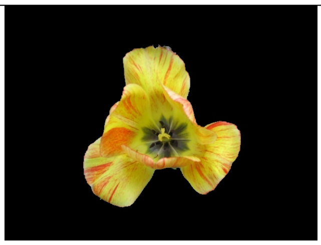
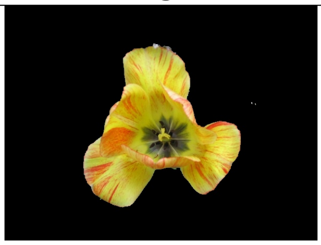
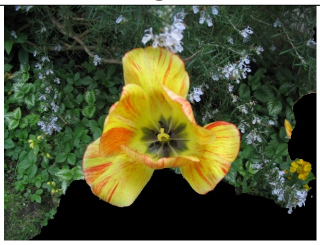
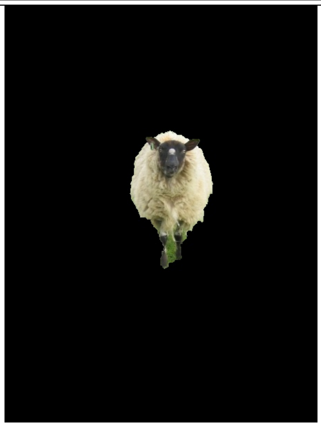
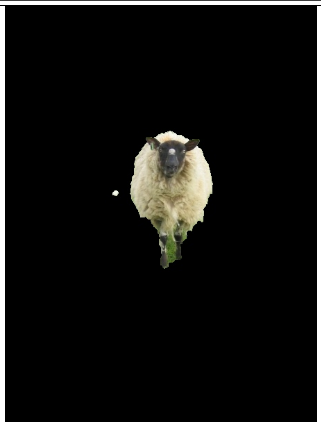
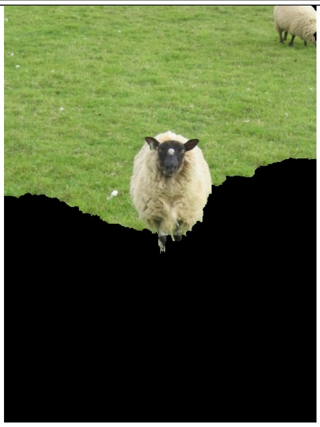
Img Name	**rectangle**		
	default	**larger**	**largest**
flower.jpg			
(Acc, Jaccard, Runtime)	(0.9965, 0.9821, 37.51s)	(0.9961, 0.9805, 52.86s)	(0.3953, 0.2426, 37.80s)
sheep.jpg			
(Acc, Jaccard, Runtime)	(0.9957, 0.9226, 38.51s)	(0.9956, 0.9210, 42.61s)	(0.3953, 0.2426, 36.80s)

Table 4: Comparison of Accuracy, Jaccard similarity and runtime with different rectangles

We can clearly see that a tighter rectangle is better. Larger rectangles mean more chance of noise, which lowers accuracy. And the largest possible rectangle just gives terrible results. Regarding runtime, it doesn't seem like rectangle size affects runtime in any meaningful way.