Medical Image Processing for Interventional Applications

Random Walker – Properties

Online Course – Unit 42
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Topics

Properties and Effects

Neutral Segmentation

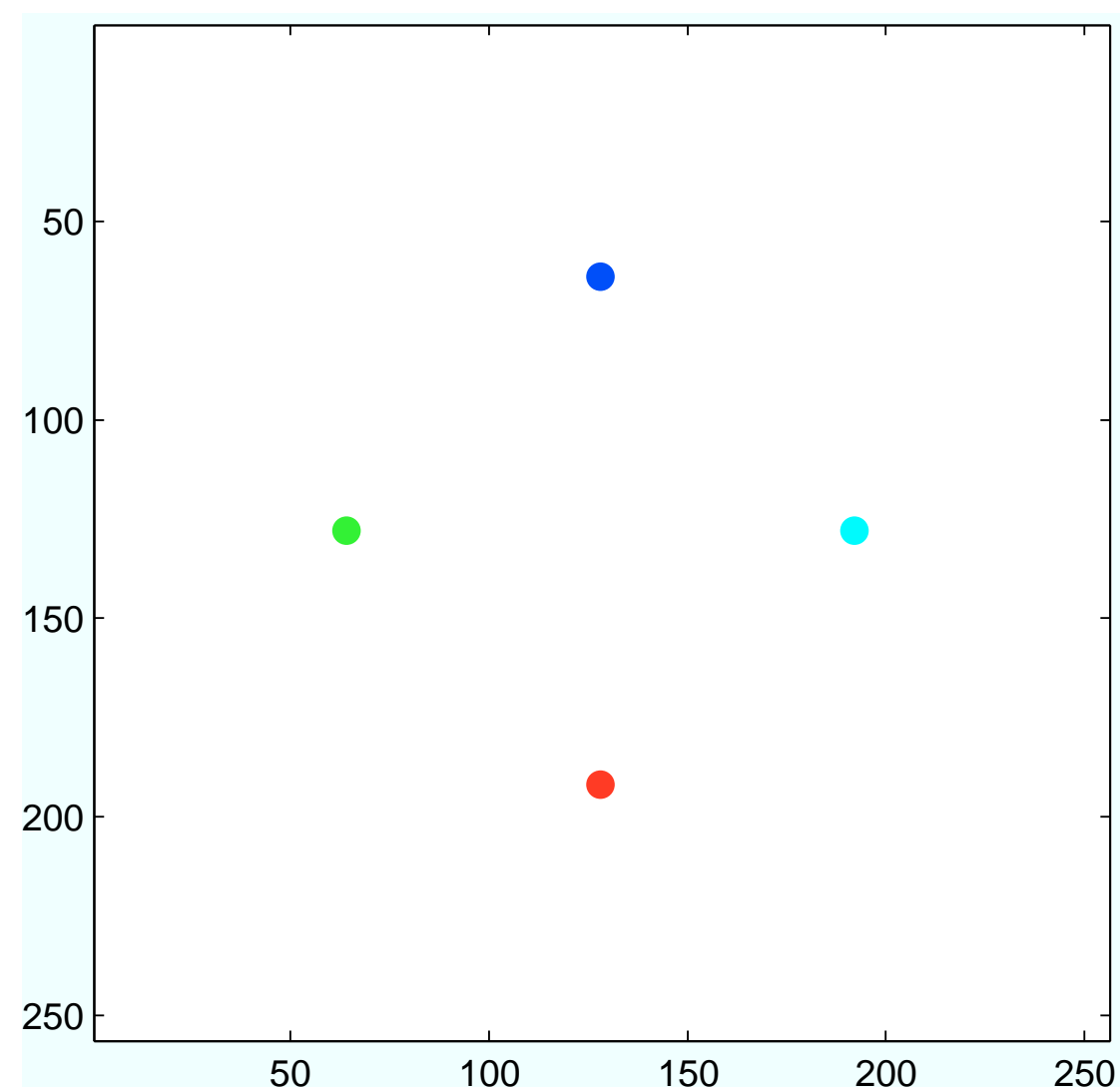→ Corresponds roughly to Voronoi cells

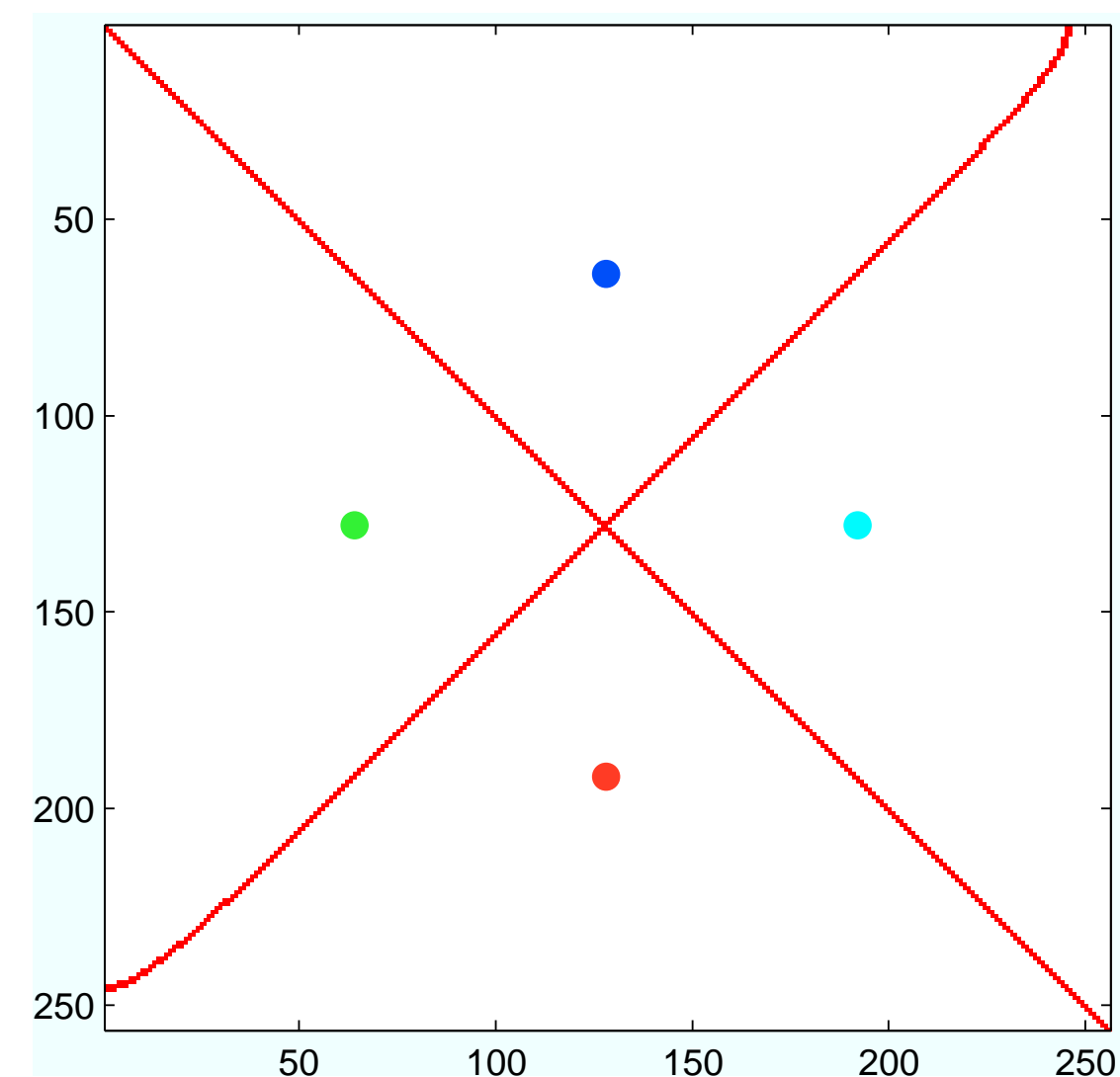

Figure 1: Original image with seed points

Figure 2: Outlined mask

Neutral Segmentation

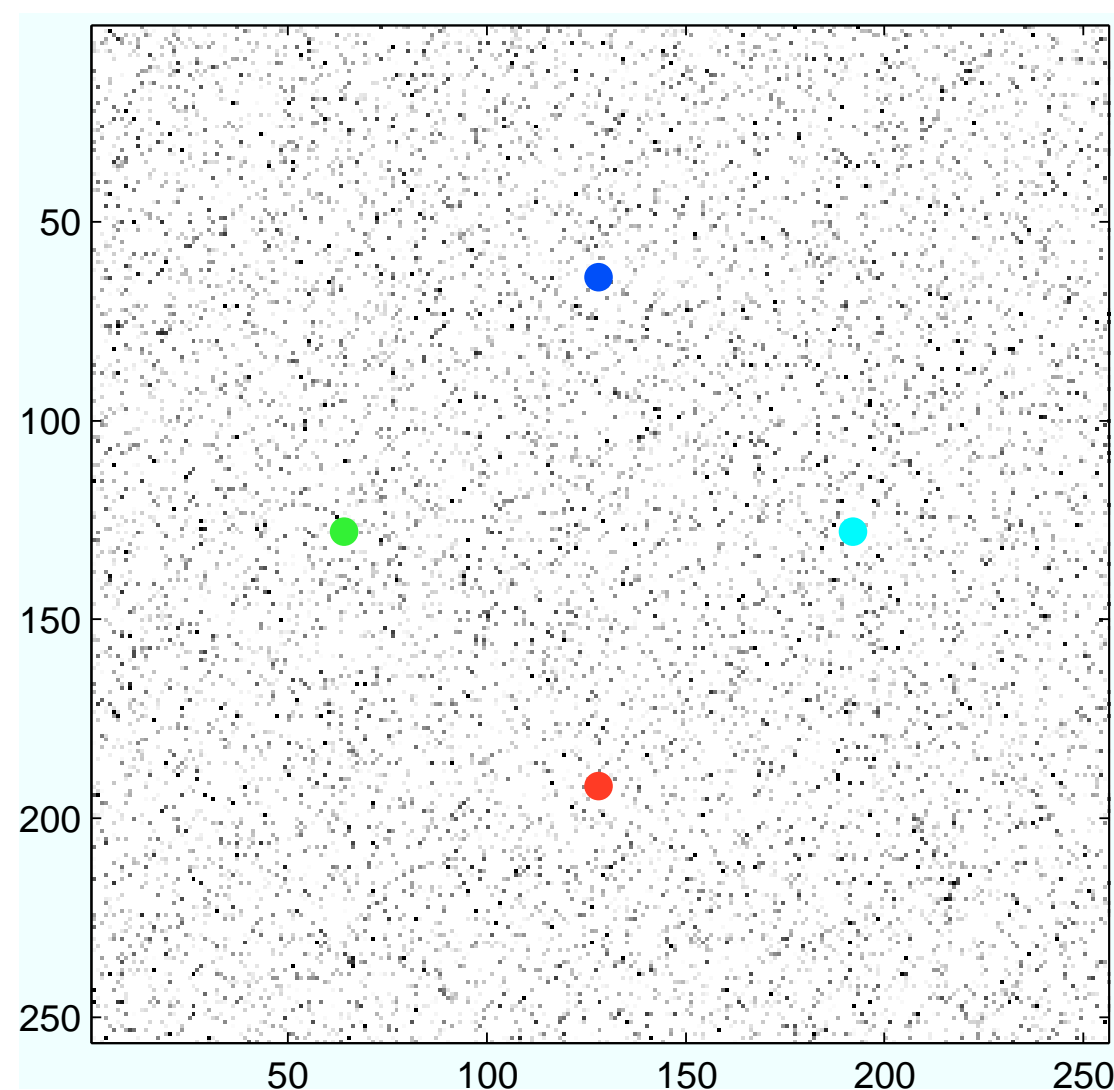$\rightarrow$ Corresponds roughly to Voronoi cells

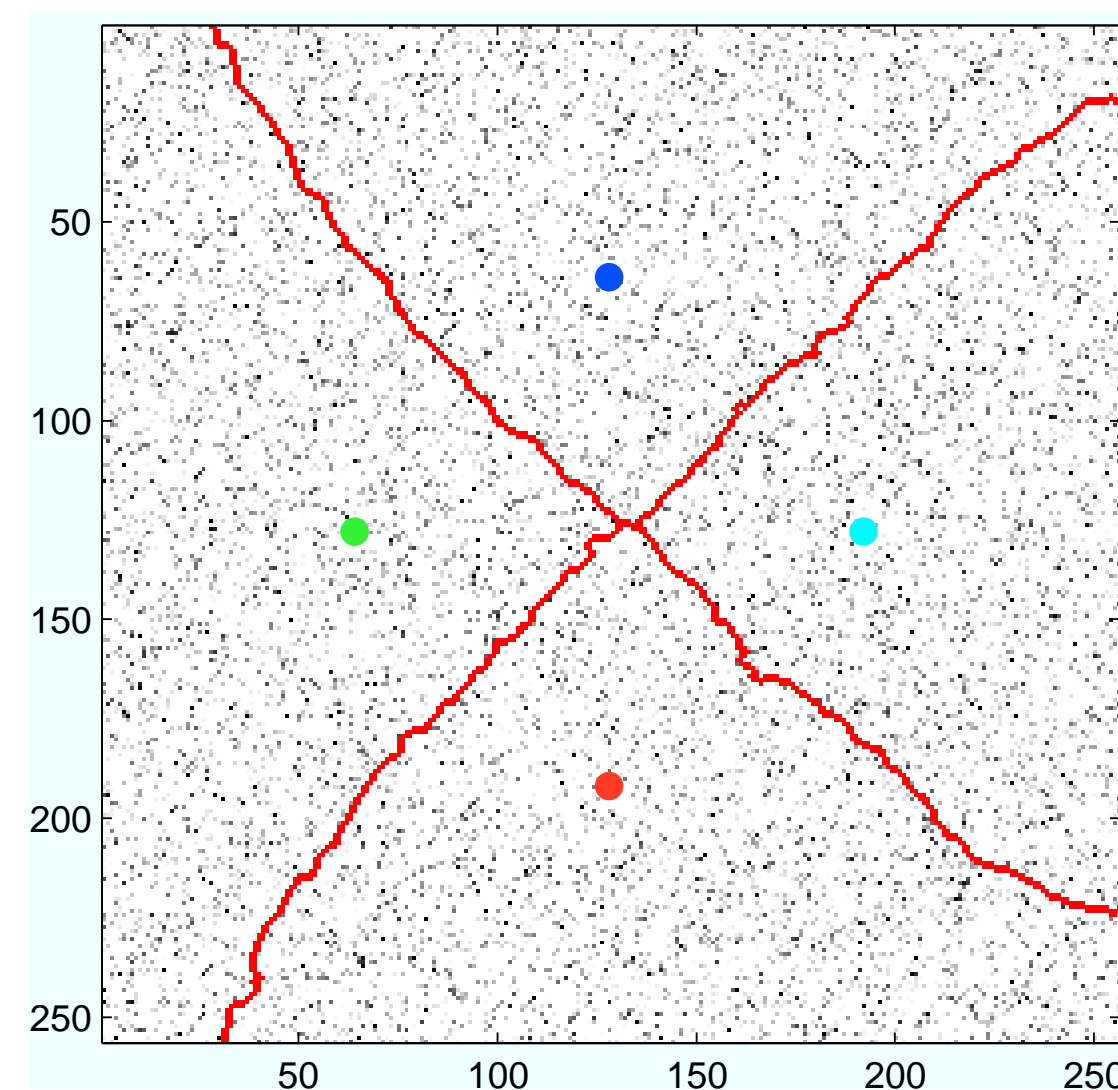Figure 3: Original image with seed points

Figure 4: Outlined mask
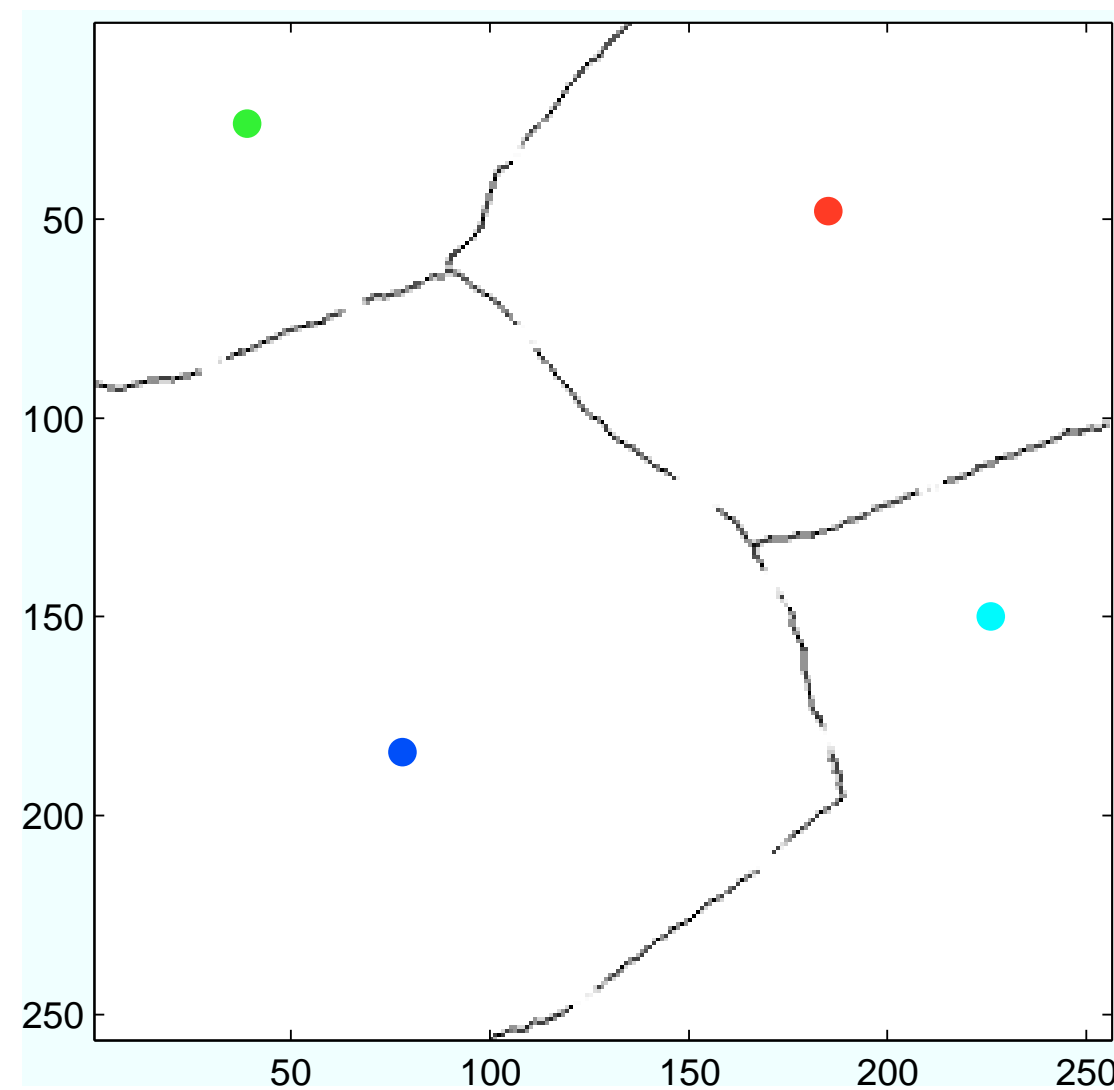
Weak Boundaries

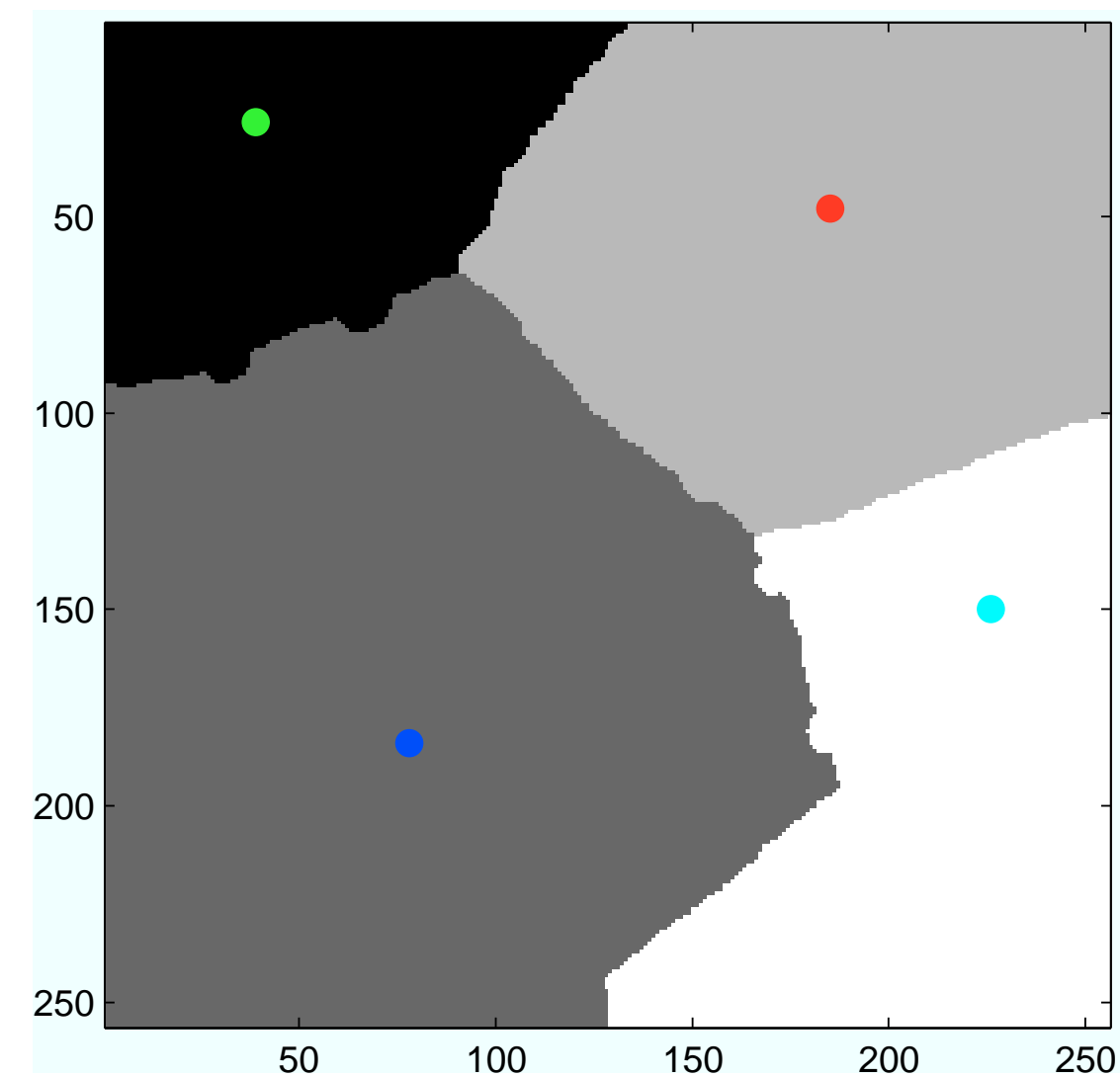
Figure 5: Original image with seed points

Figure 6: Output mask

Weak Boundaries

- On its initial step, the current pixel has 3 out of 4 chances to enter into the region that is likely to be labeled as belonging to the black circle.
- On the other side of the weak boundary, the same holds for the white circle.
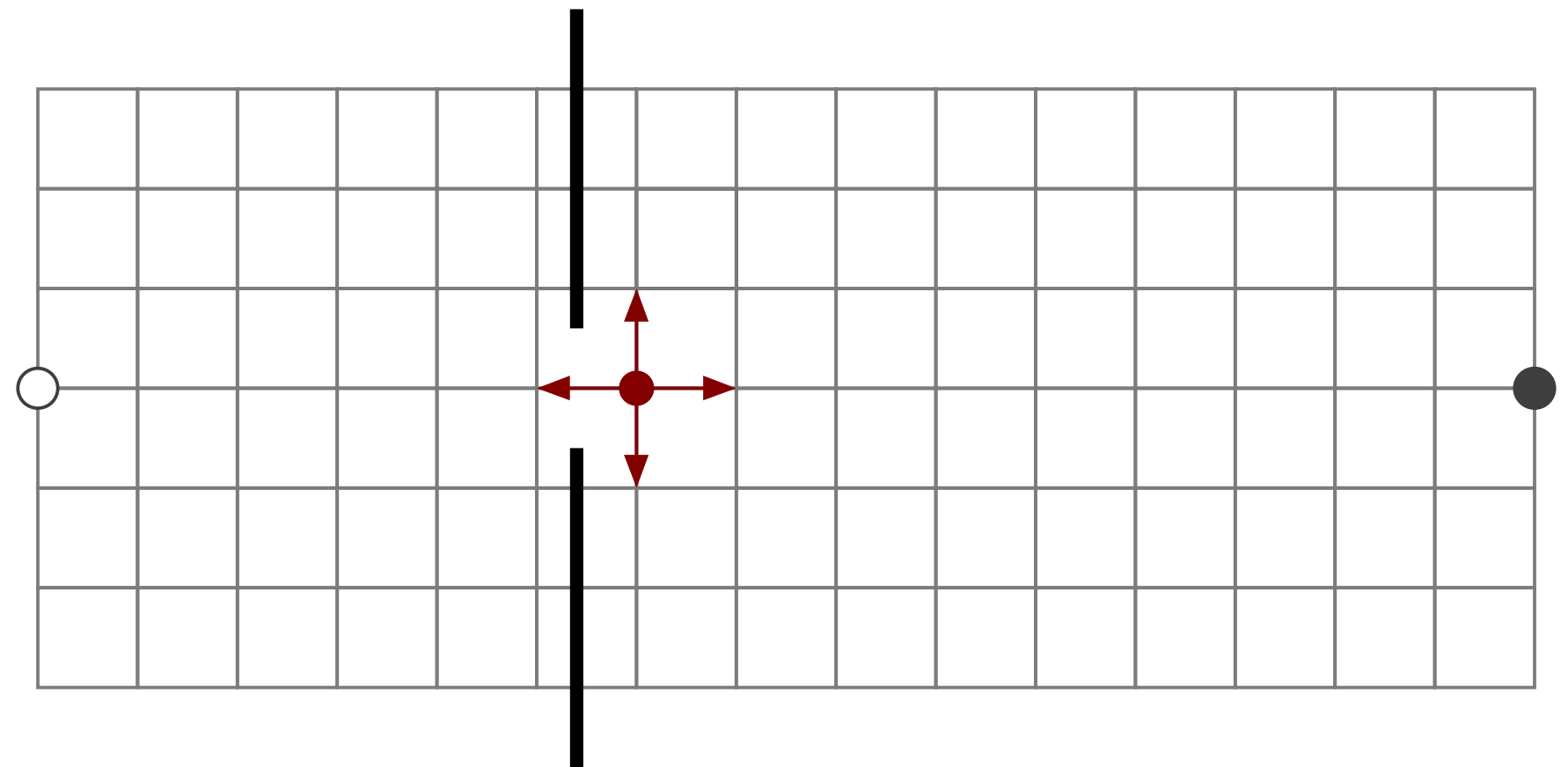- Due to the sharp drop in the probabilities, the segmentation will respect the weak boundary.

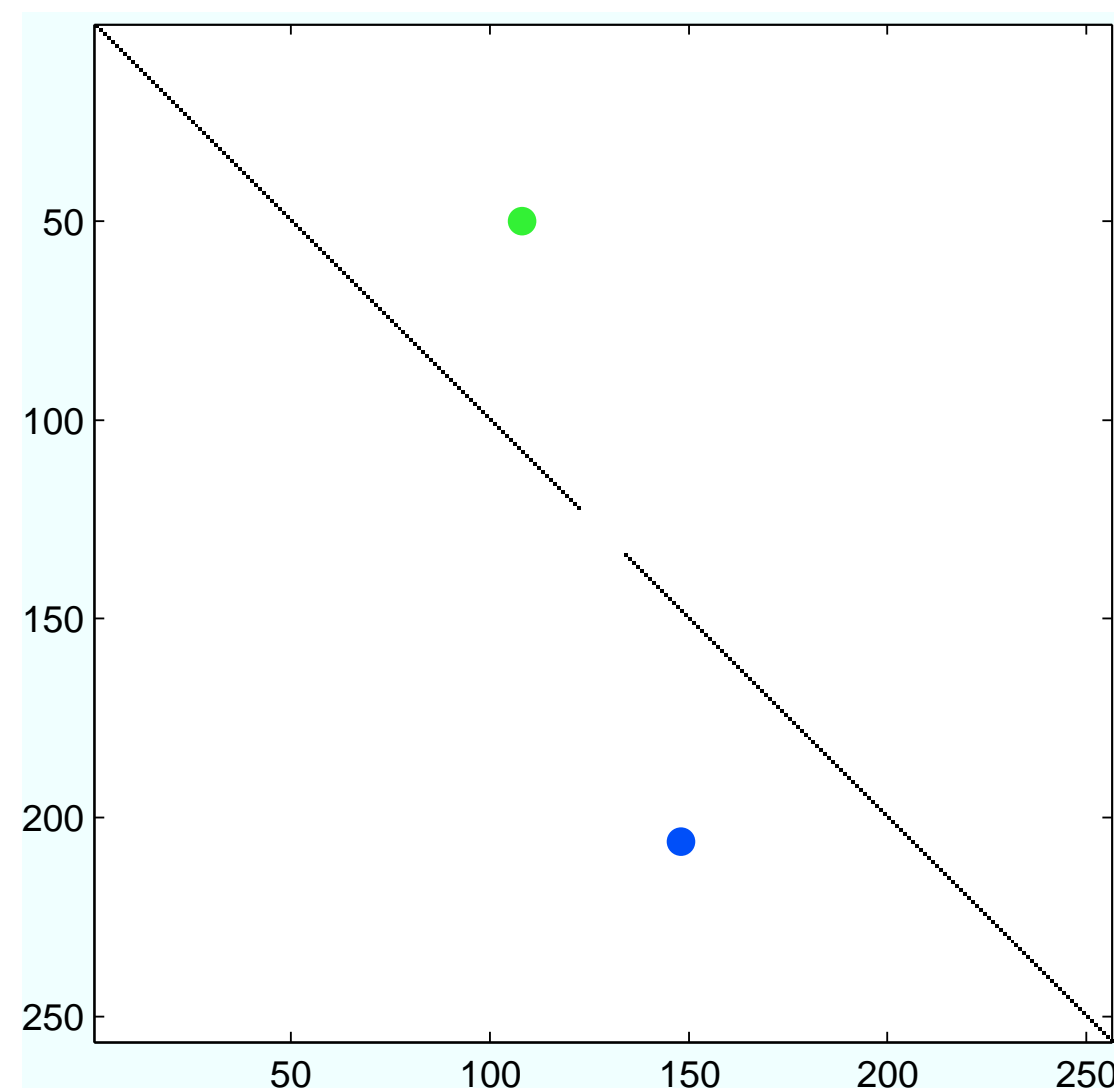Figure 7: Random walk at a region boundary

Weak Boundaries

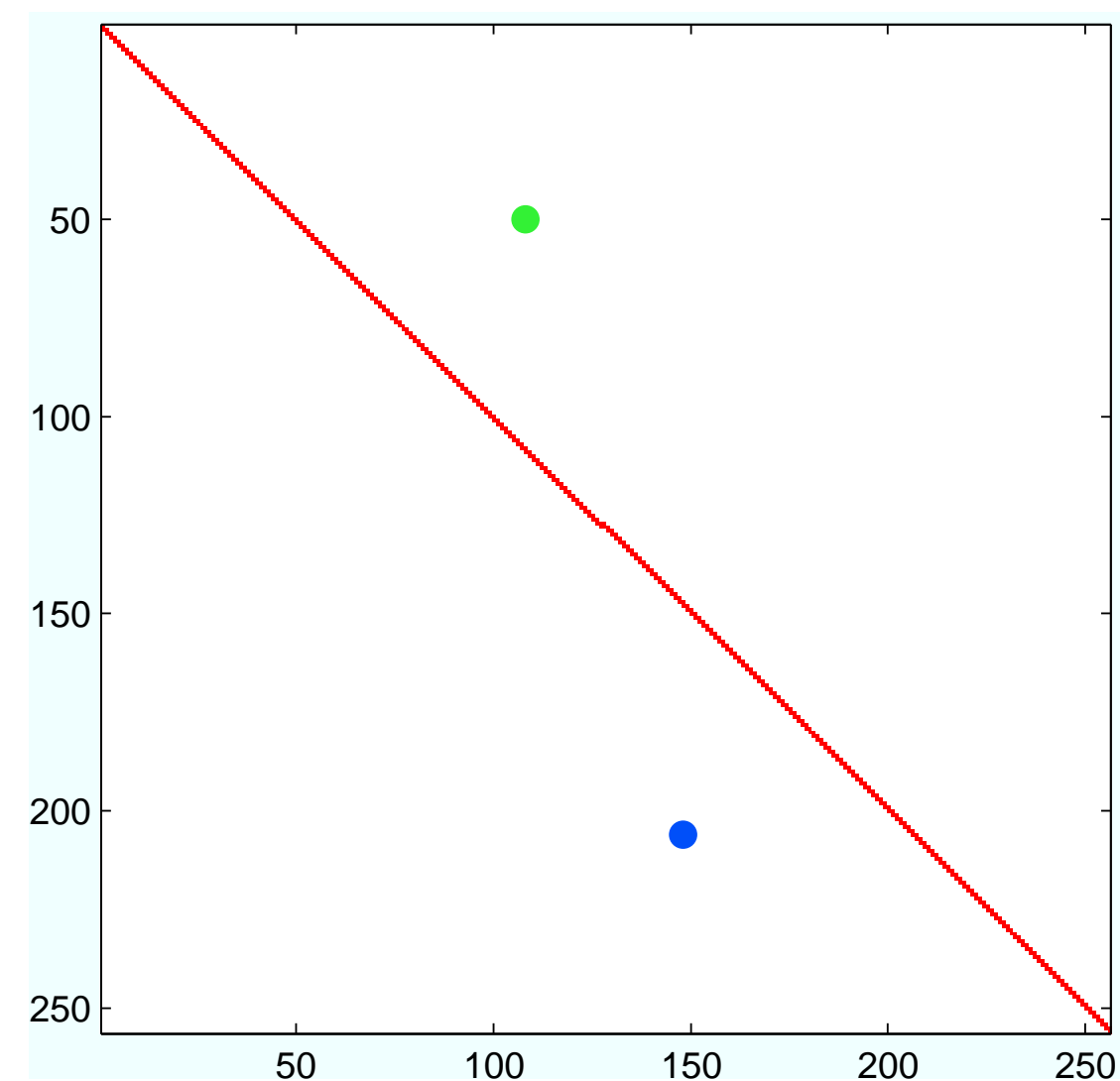Figure 8: Original image with seed points

Figure 9: Outlined mask
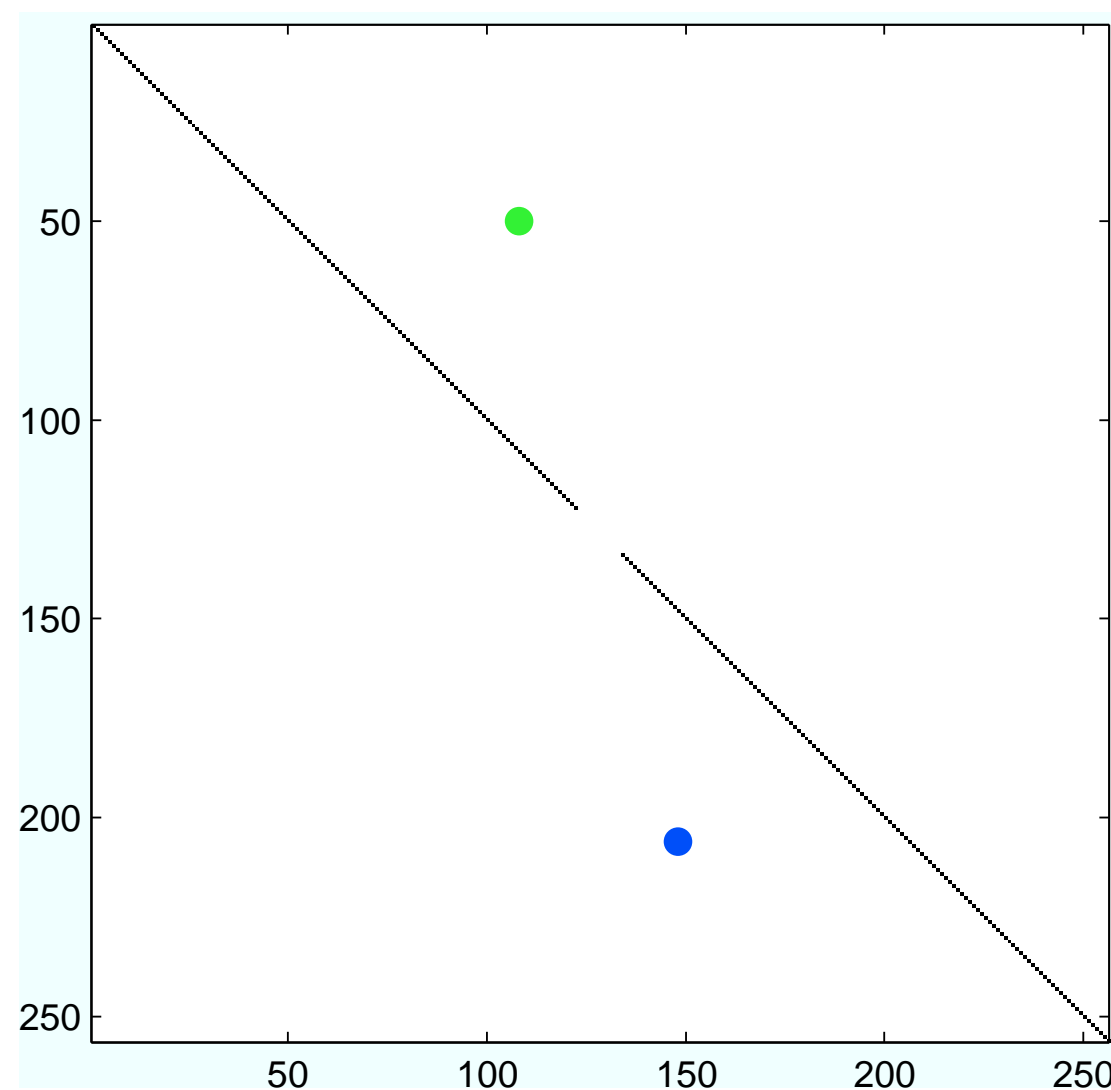
Weak Boundaries

Figure 8: Original image with seed points
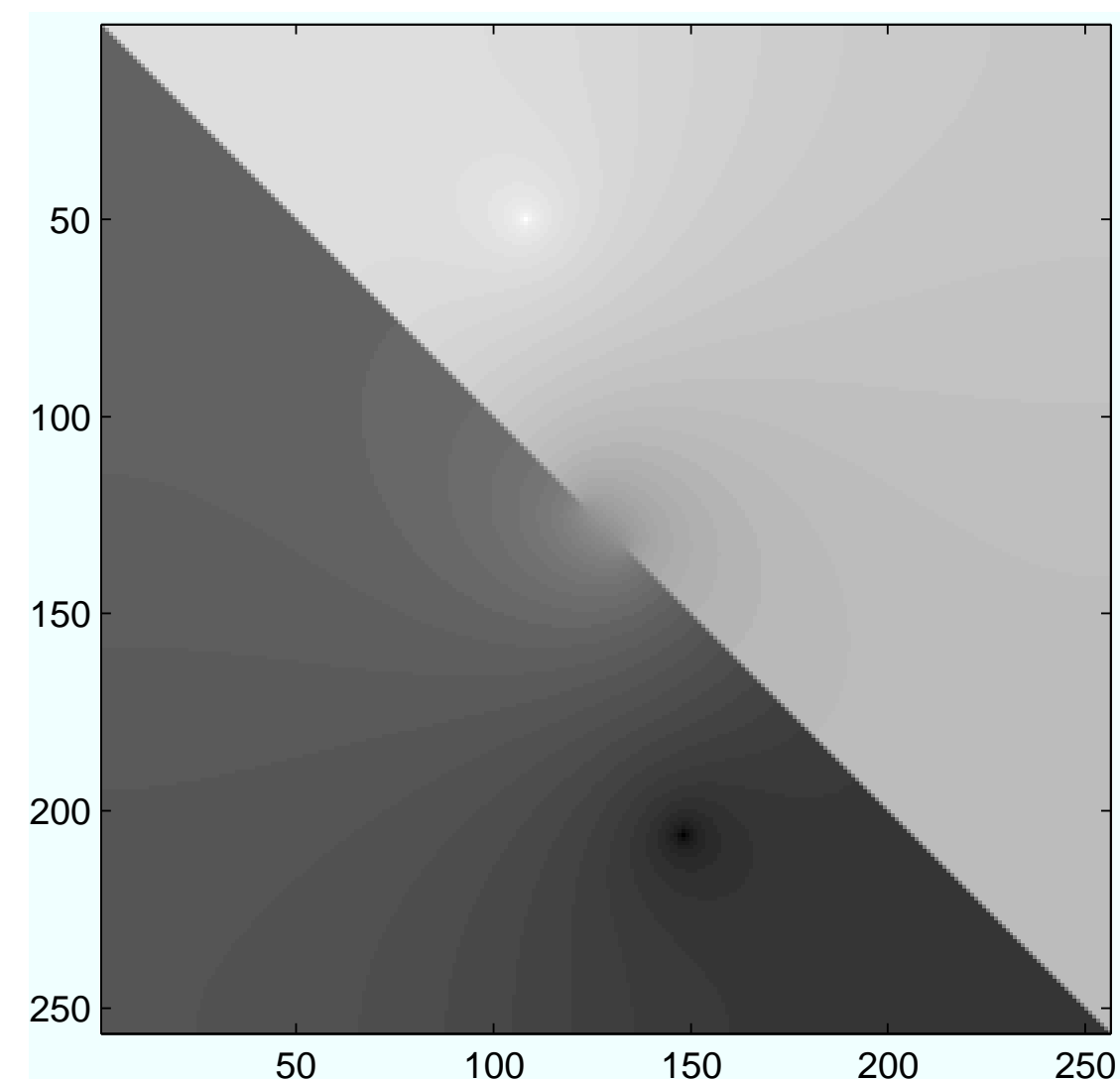

Figure 10: Probabilities for reaching seed 1
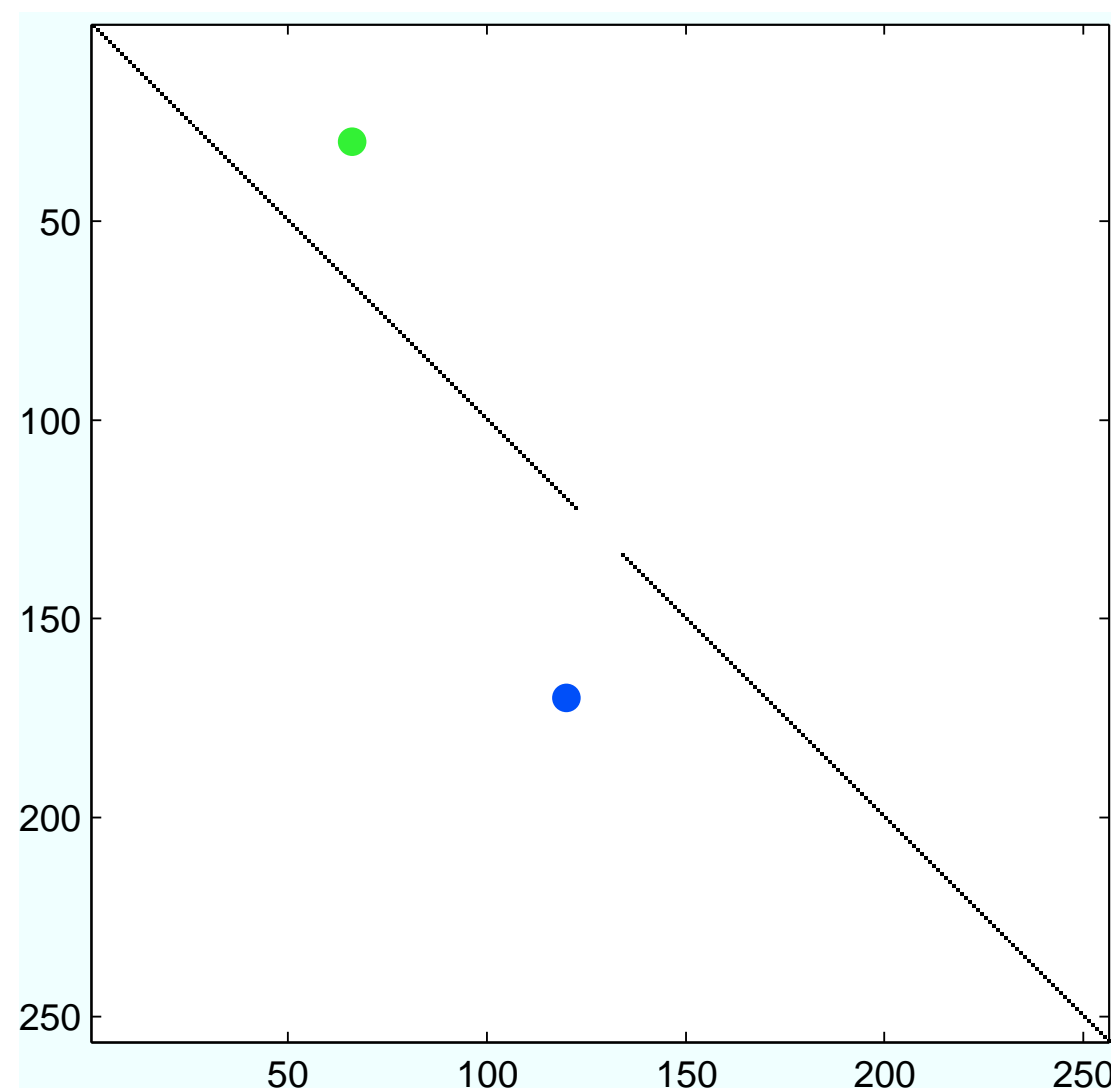
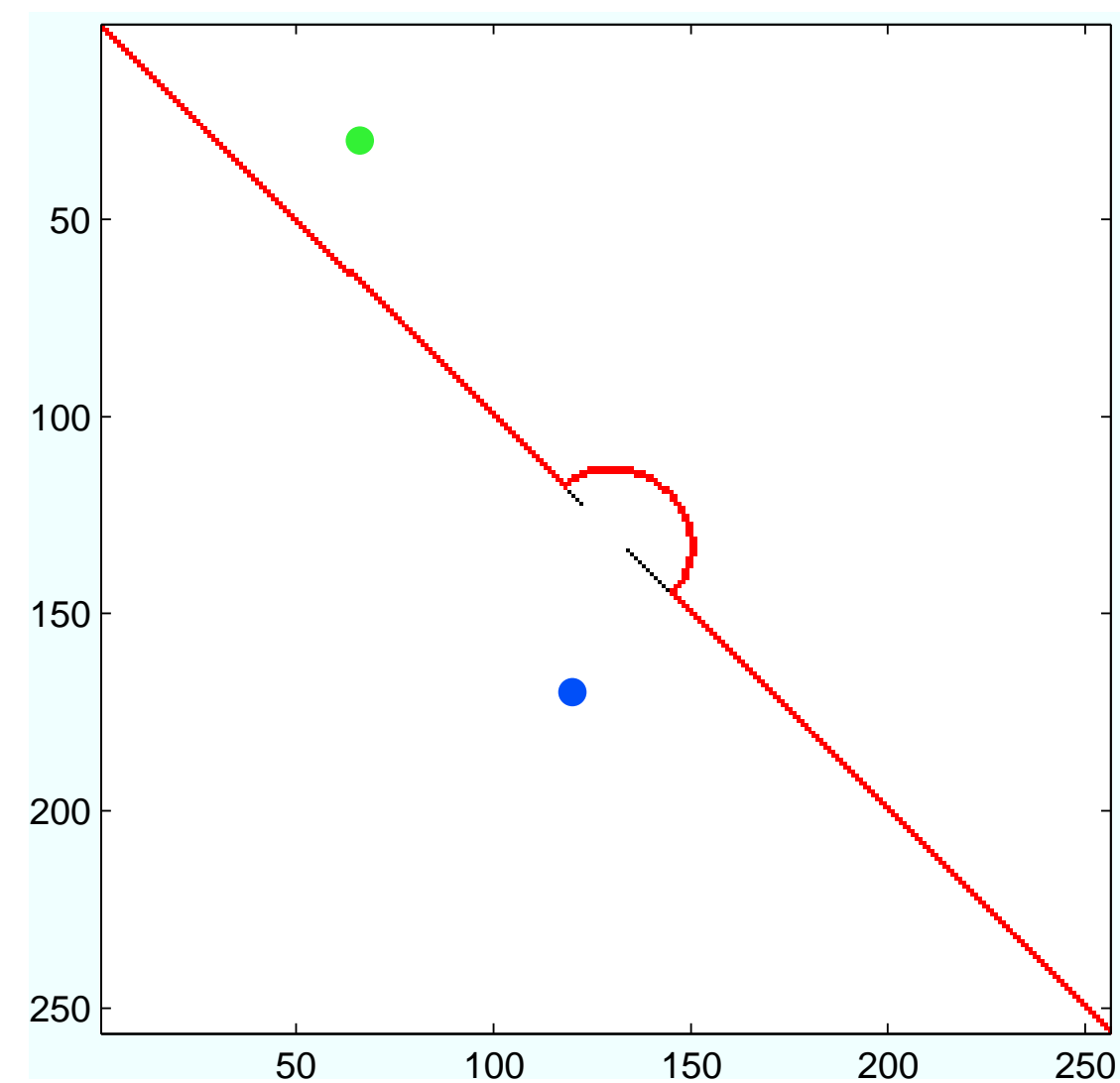# Weak Boundaries

Figure 11: Original image with seed points

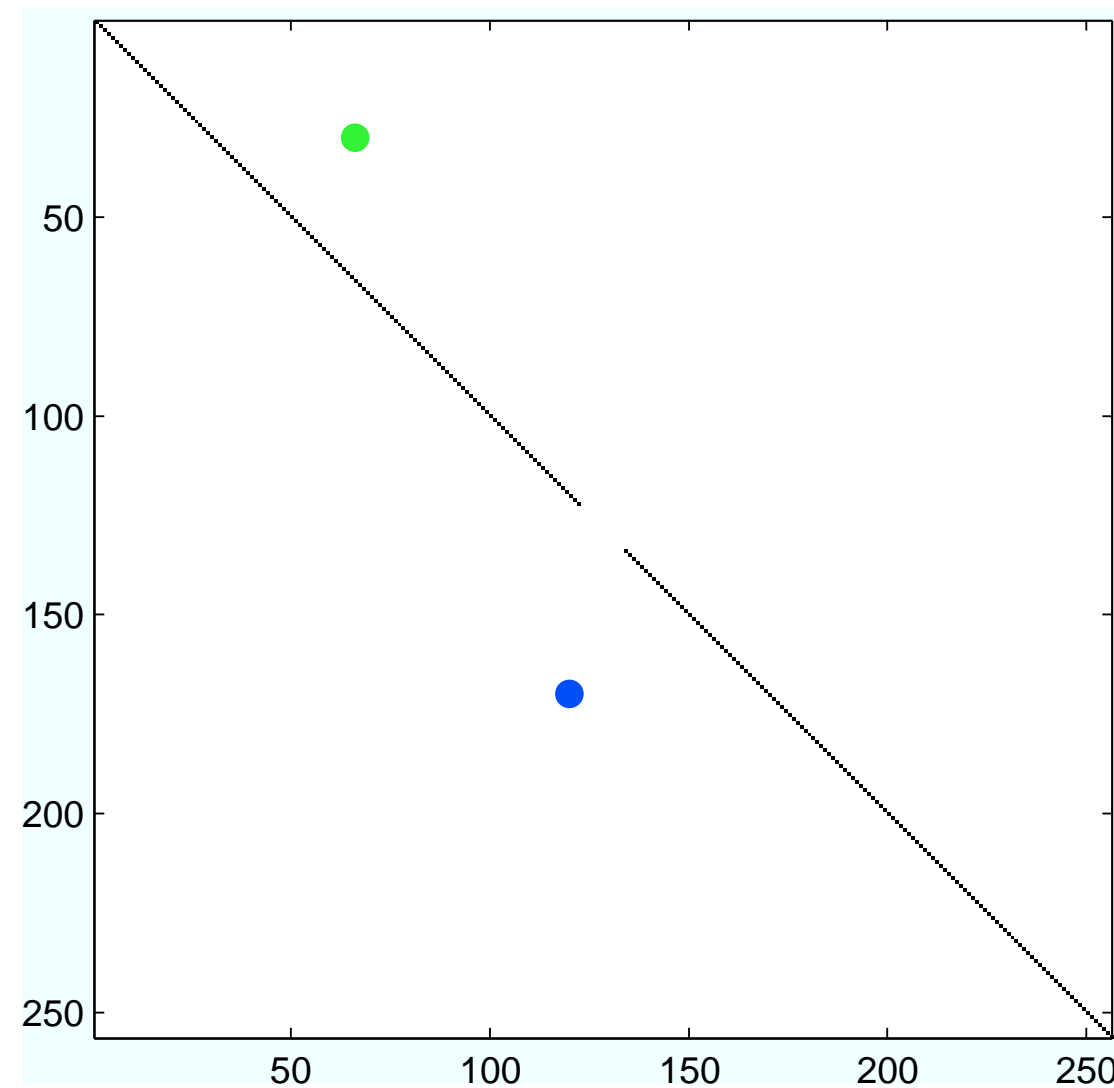Figure 12: Outlined mask

Weak Boundaries
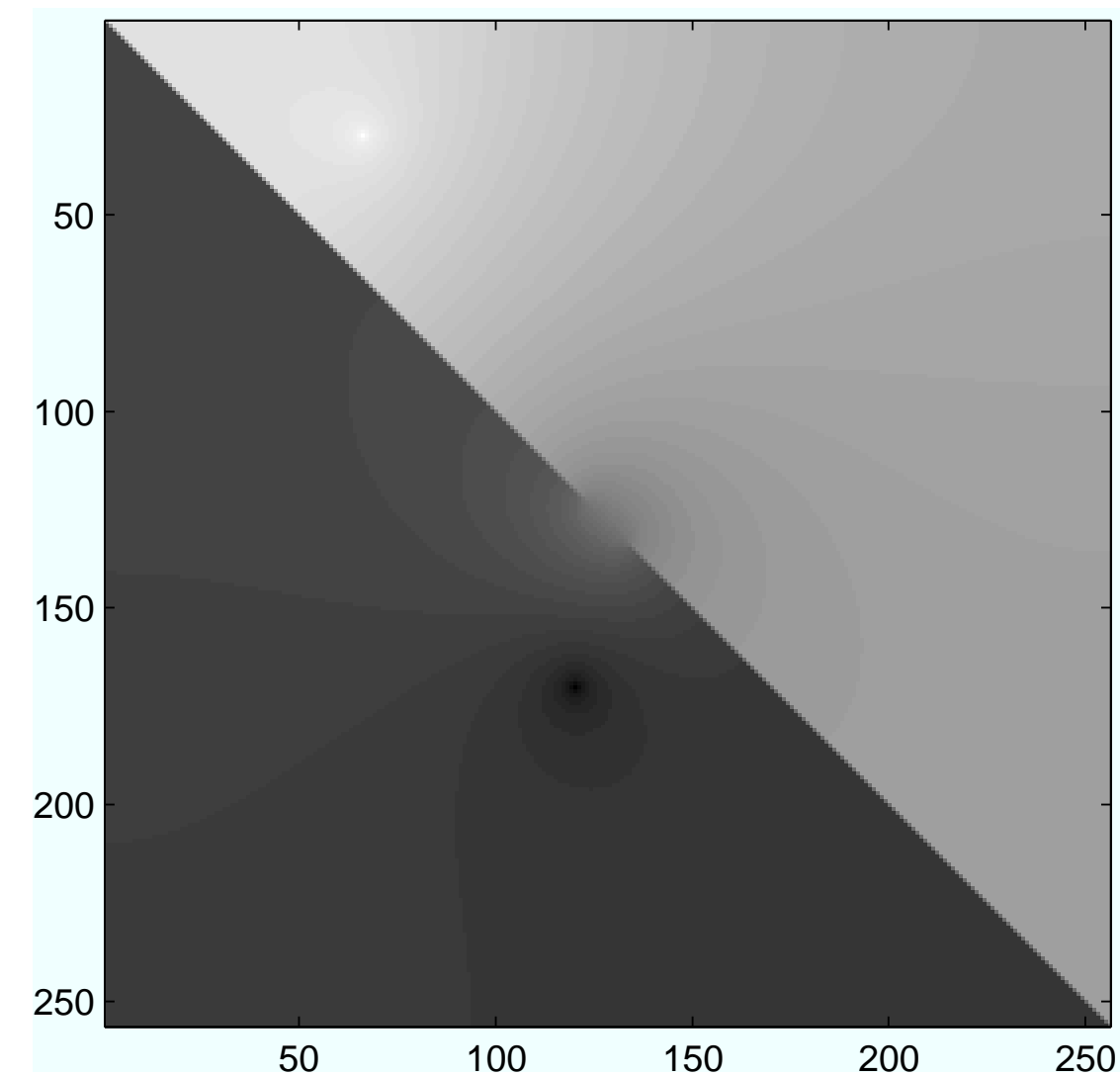

Figure 11: Original image with seed points

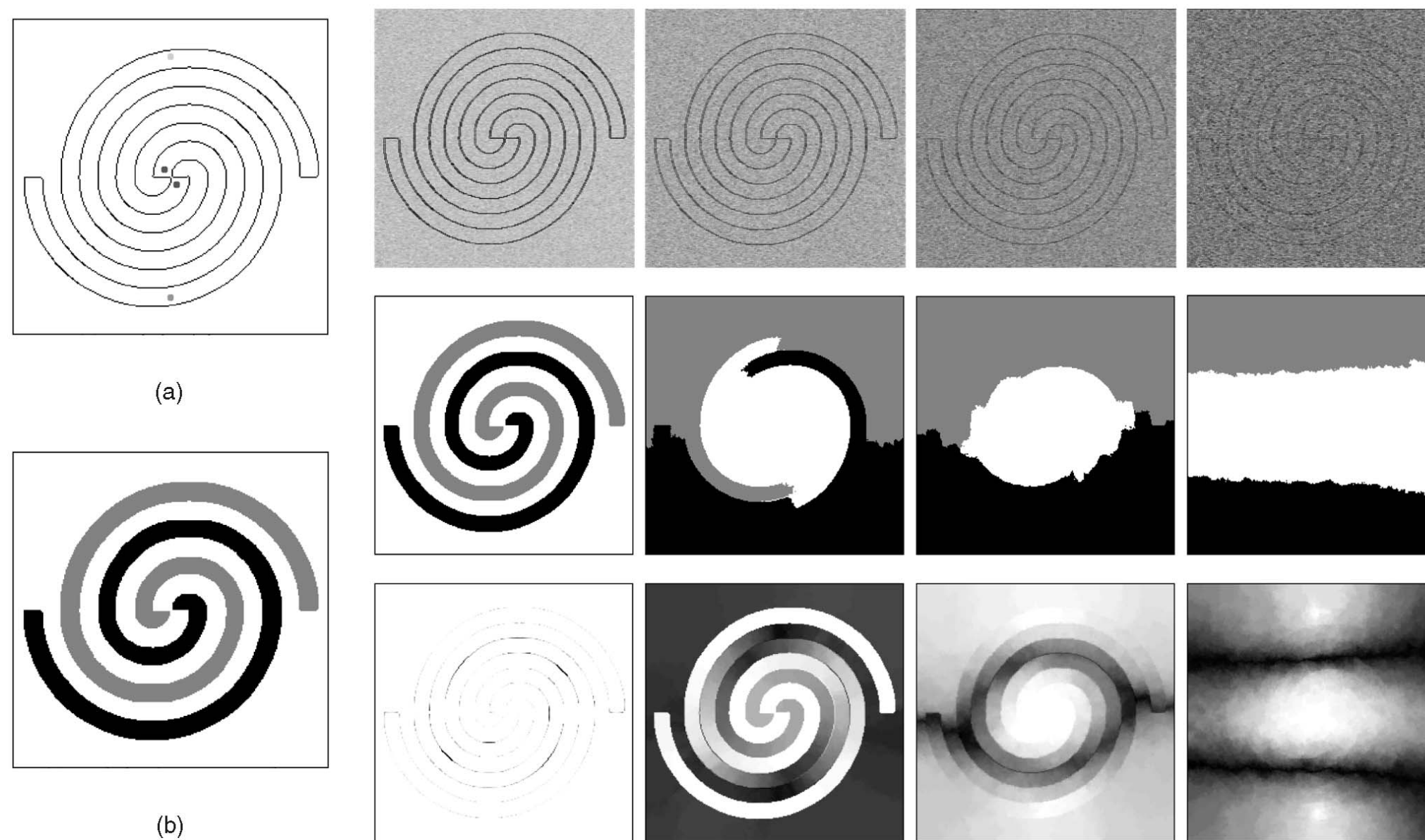Figure 13: Probabilities for reaching seed 1

Noise Robustness

Figure 14: Edge mask (a) and ground truth segmentation (b) for a 3-class spiral segmentation task and segmentation results: edge masks with increasing noise level (right part, top row), random walker segmentation (right part, middle row), difference to ground truth (right part, bottom row)
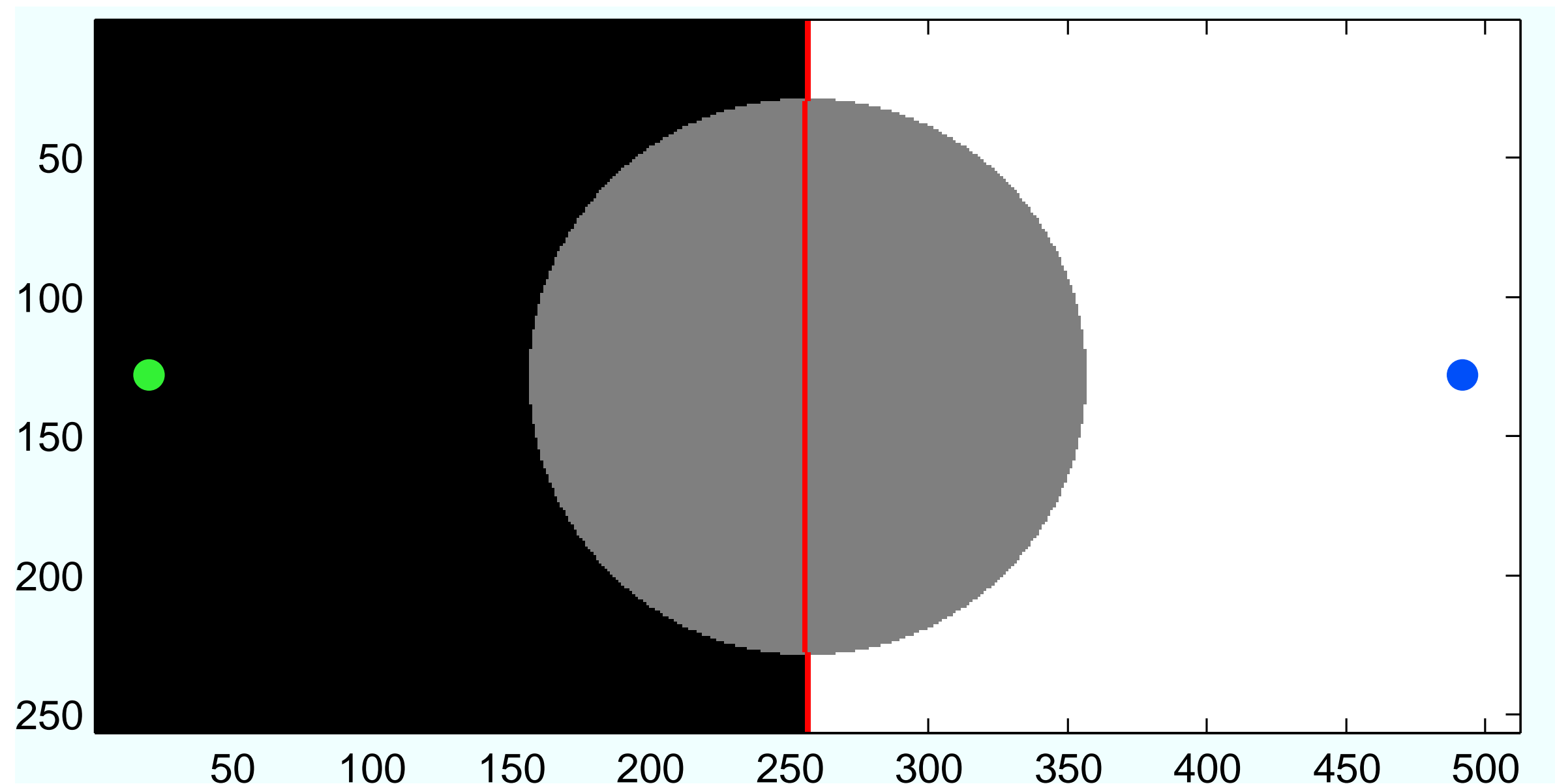
Ambiguous Unseeded Regions

Figure 15: **Centered precisely** with respect to surface area and intensity

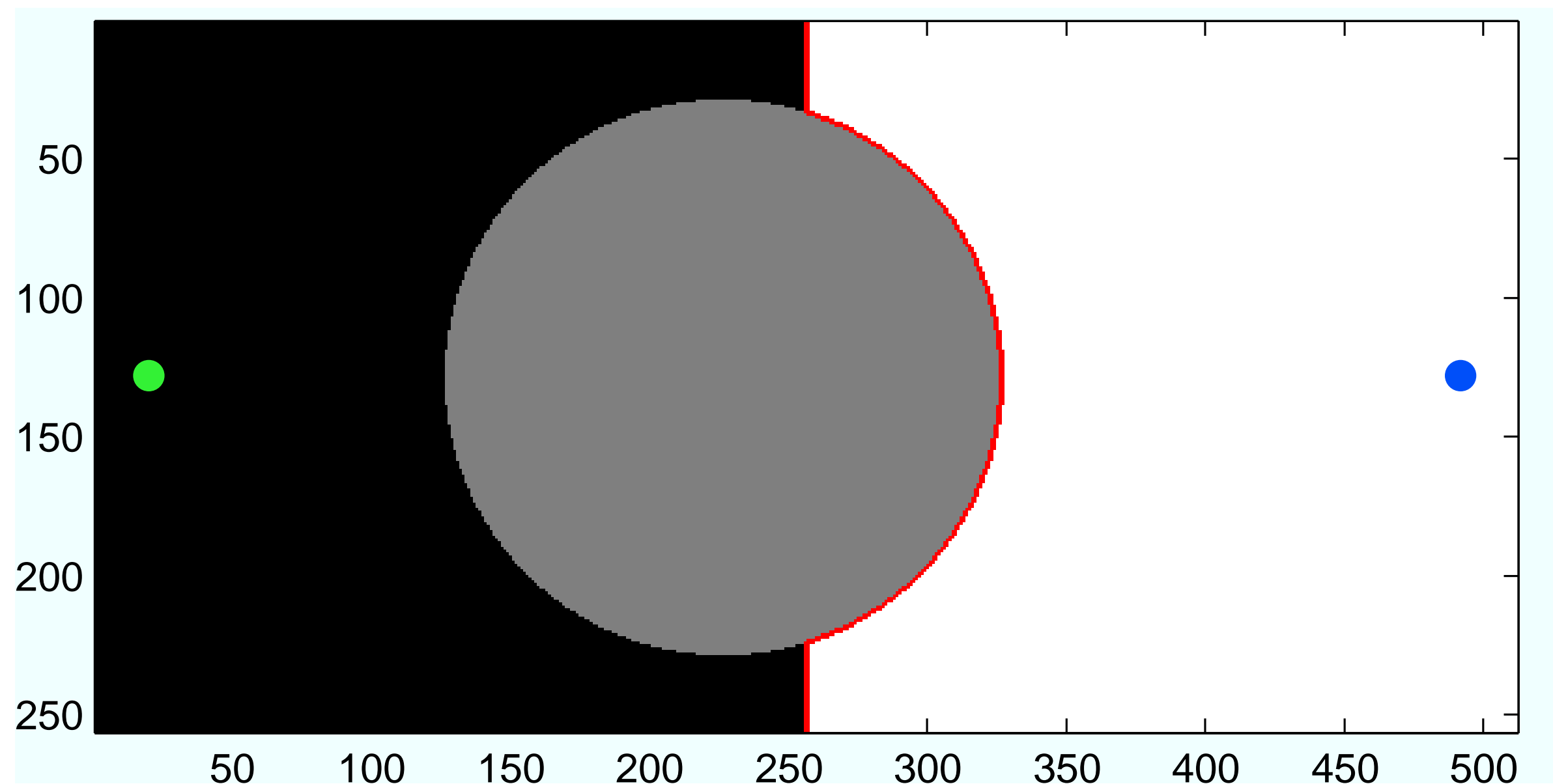# Ambiguous Unseeded Regions

Figure 16: **Sharing more** surface area with **black region**
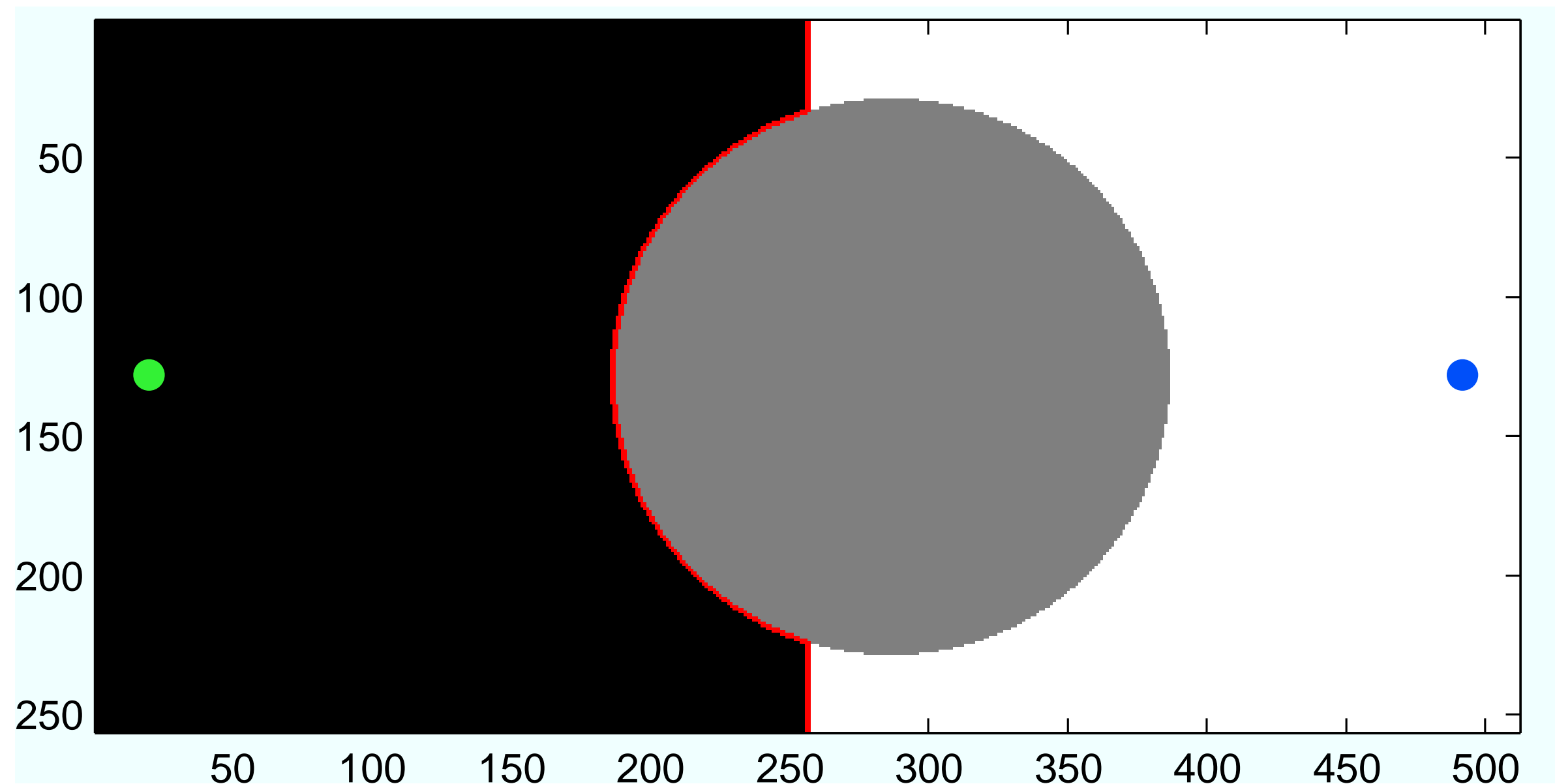
Ambiguous Unseeded Regions

Figure 17: **Sharing more** surface area with **white region**

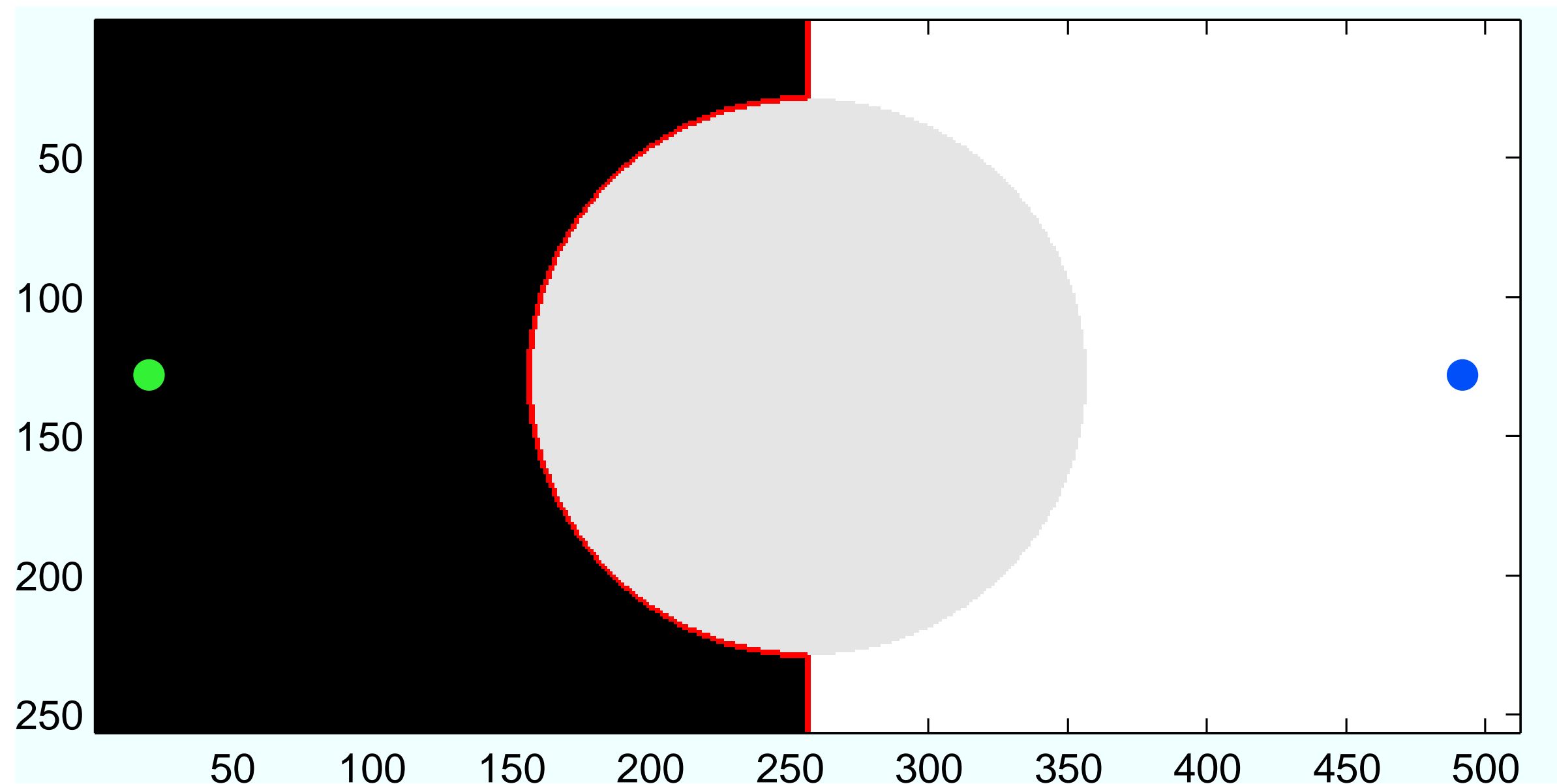# Ambiguous Unseeded Regions

Figure 18: **Closer in intensity** to the **white** region (gray value **0.9**)

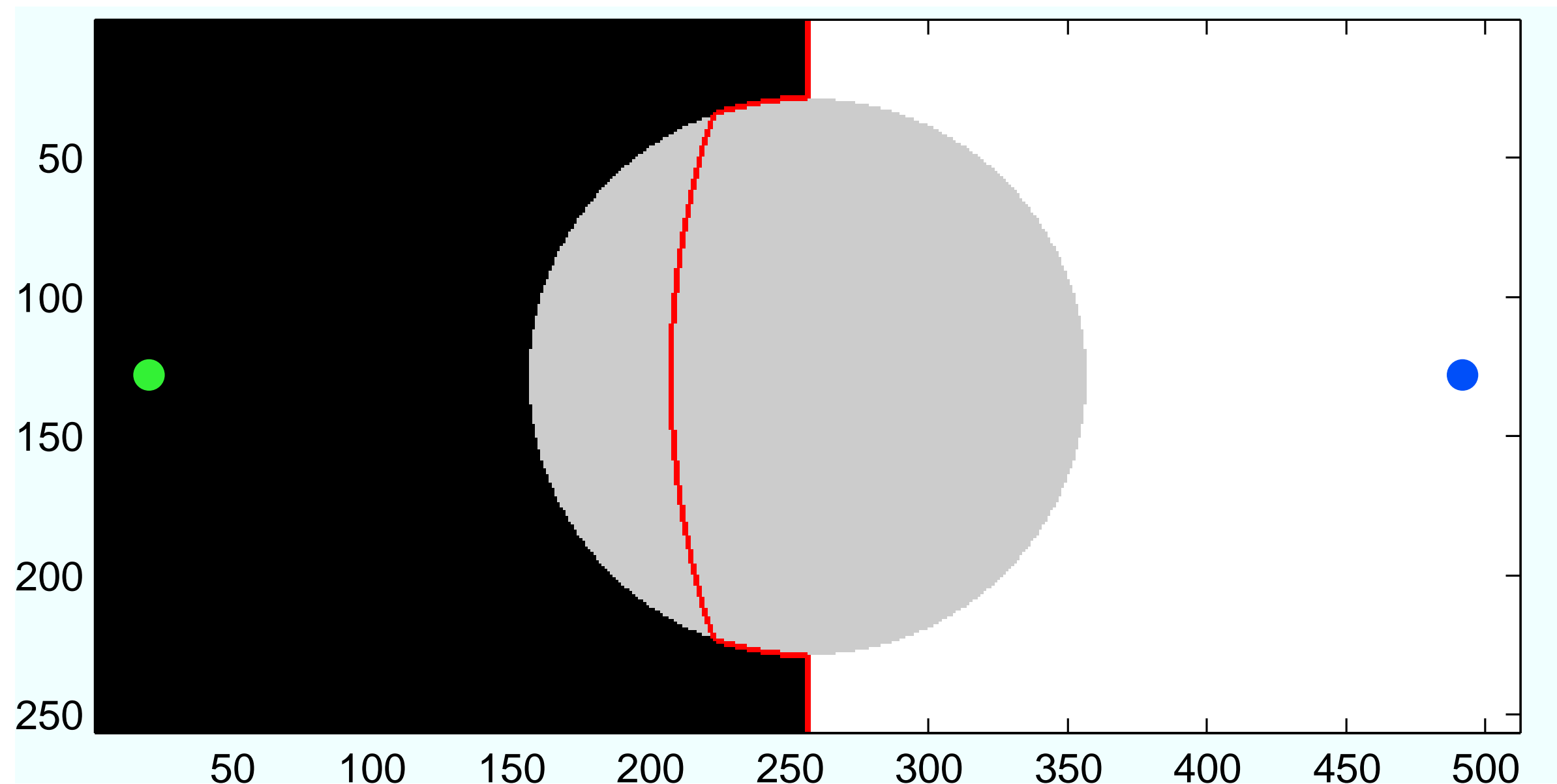# Ambiguous Unseeded Regions

Figure 19: **Closer in intensity** to the **white** region (gray value **0.8**)
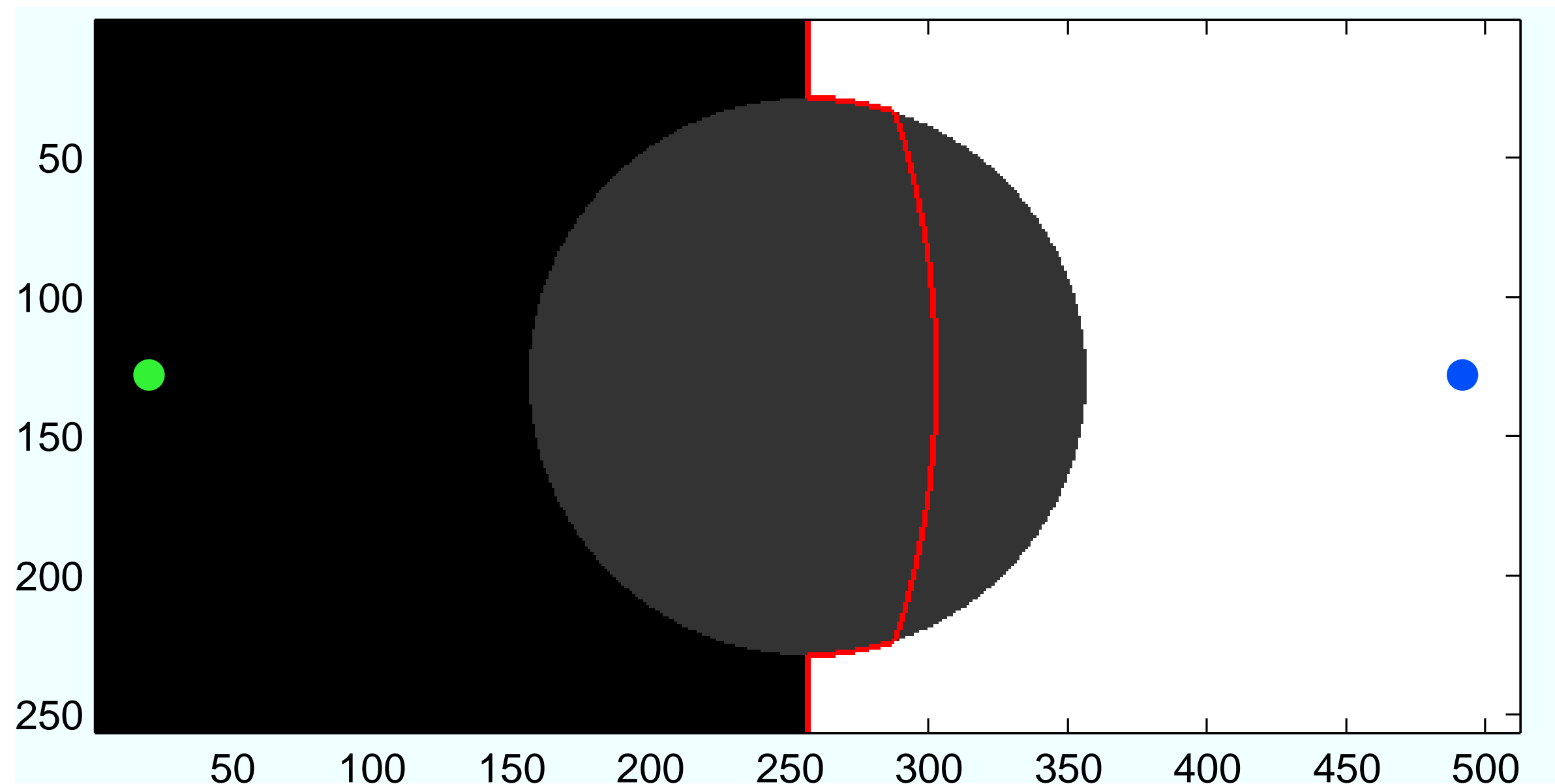
Ambiguous Unseeded Regions

Figure 20: **Closer in intensity** to the **black** region (gray value **0.2**)
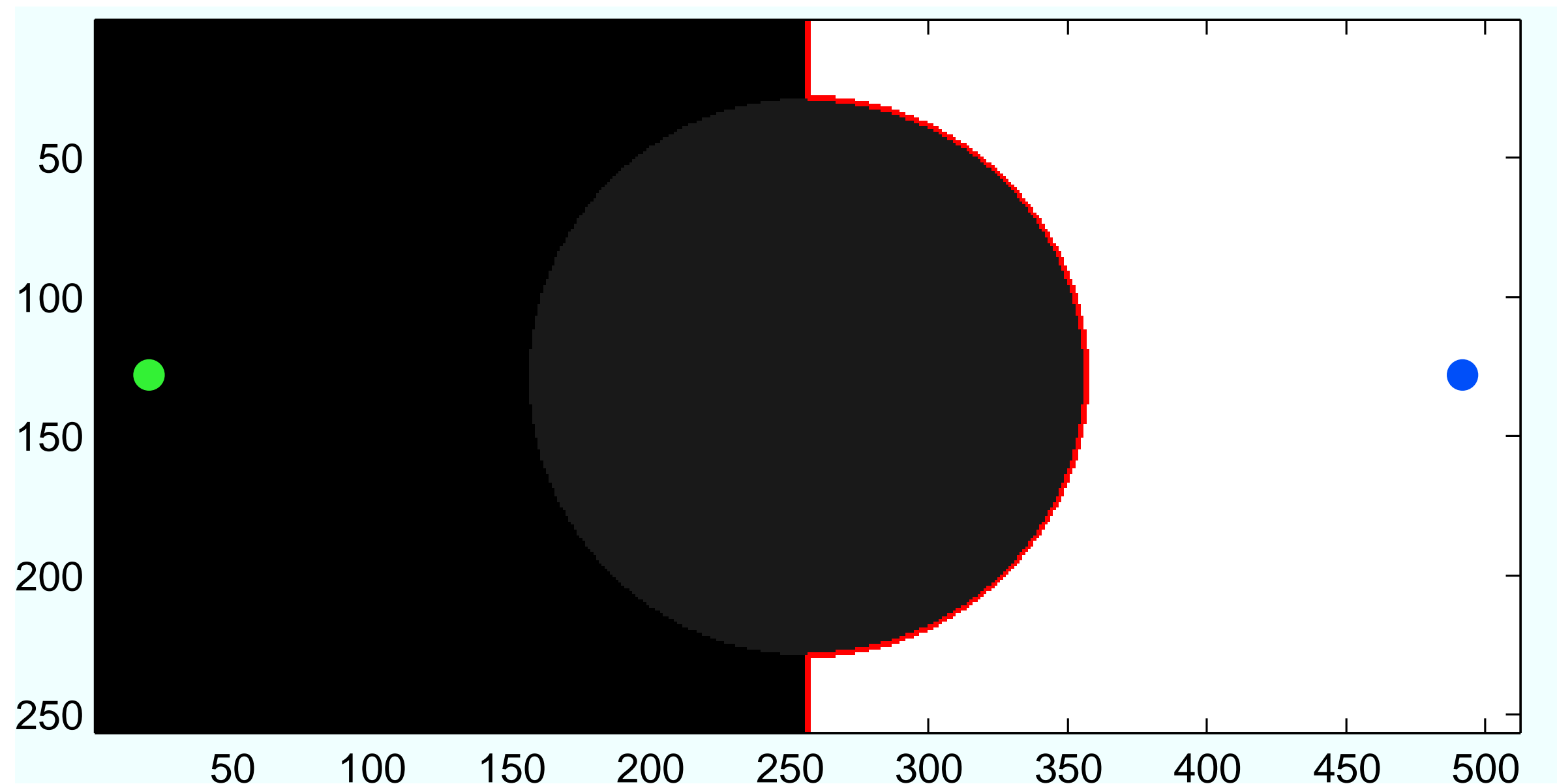
Ambiguous Unseeded Regions

Figure 21: **Closer in intensity** to the **black** region (gray value **0.1**)

Topics

Properties and Effects
Neutral Segmentation
Weak Boundaries
Noise Robustness
Ambiguous Unseeded Regions

Summary
Take Home Messages
Further Readings

Take Home Messages

- The segmentation with random walker works quite well with weak boundaries.
- The algorithm is robust against noise to some degree.
- Unseeded regions are also handled by the algorithm in a useful way.

Further Readings

These slides are based on the following publication:

L. Grady. "Random Walks for Image Segmentation". In: *IEEE Transactions on Pattern Analysis and Machine Intelligence* 28.11 (Nov. 2006), pp. 1768–1783. DOI: 10.1109/TPAMI.2006.233

His implementations in Matlab can be downloaded here:

- Graph Analysis Toolbox
- Random Walker