UI-Net: Interactive Artificial Neural Networks for Iterative Image Segmentation Based on a User Model

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Segmentation Group
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Outline

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"Why an interactive segmentation?"

Outline

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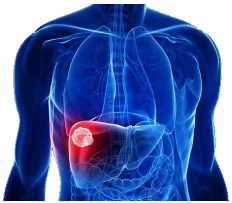
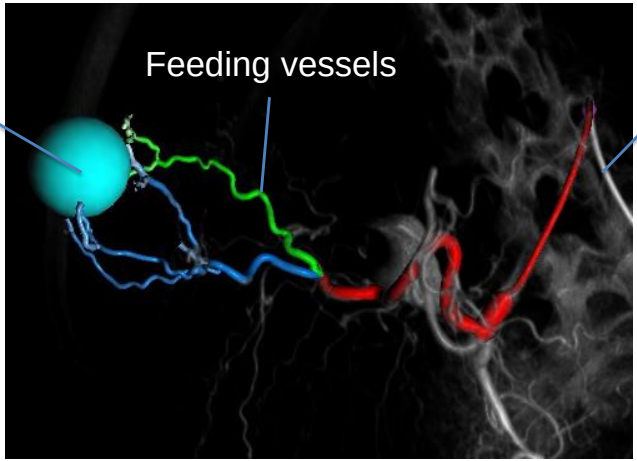
"How to make CNNs interactive?"

Outline

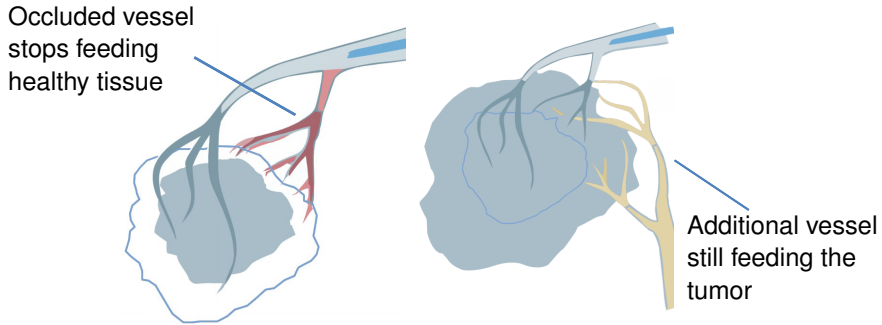
Transcatheter Arterial Chemoembolization (TACE)





Roughly segmented tumor and subsequently generated vessel tree

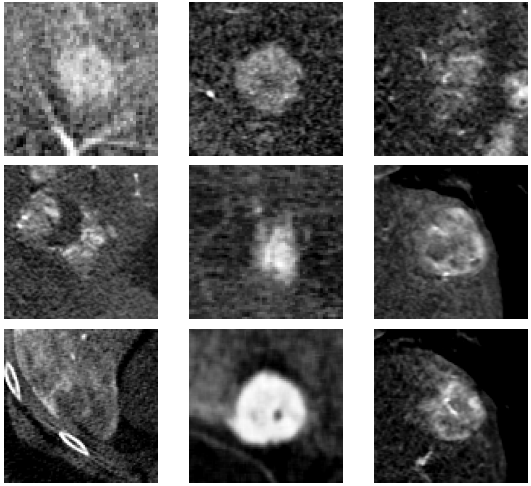
Tumor Therapy – Impact of Segmentation Quality



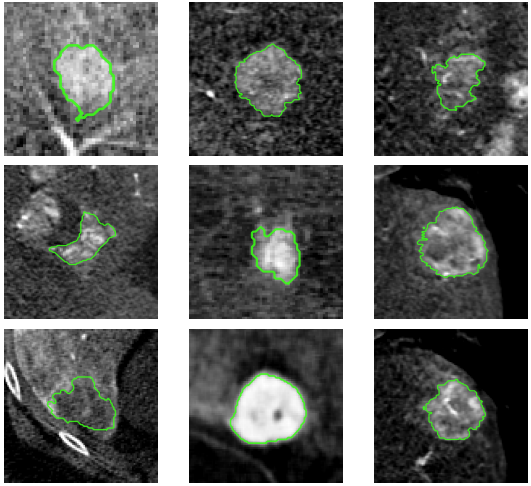
Why an exact segmentation?

- segmented volume too big $\rightarrow$ healthy tissue gets occluded (toxicity increases)
- segmented volume too small $\rightarrow$ tumor growth unimpeded (efficacy decreases)

Hepatic Lesion Segmentation – C-Arm CT Volumetric Input Data



Hepatic Lesion Segmentation – Outcome



Interventional Segmentation Environment

Exam Room

Control Room

Interventional Segmentation Environment

Exam Room

Control Room

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Exam Room

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Interactive Segmentation Interface Prototypes

- Fully manual segmentation takes a lot of time; accurate outcome
- Fully automatic segmentation can take a lot of time to compute; quality correlated with size of ground truth database
- Interactive segmentation introduces a feedback loop for the user via seed points and scribbles

⇒ Idea: increase efficiency during segmentation via assisted interaction

Interactive Segmentation Interface Prototypes

Manual Segmentation

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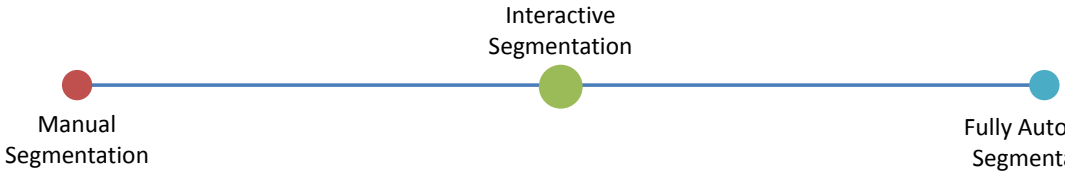

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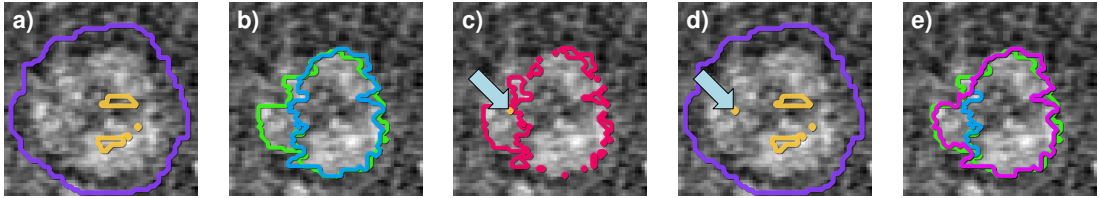
Interactive FCN – Seed Update



a) Current seed mask with background and foreground seeds

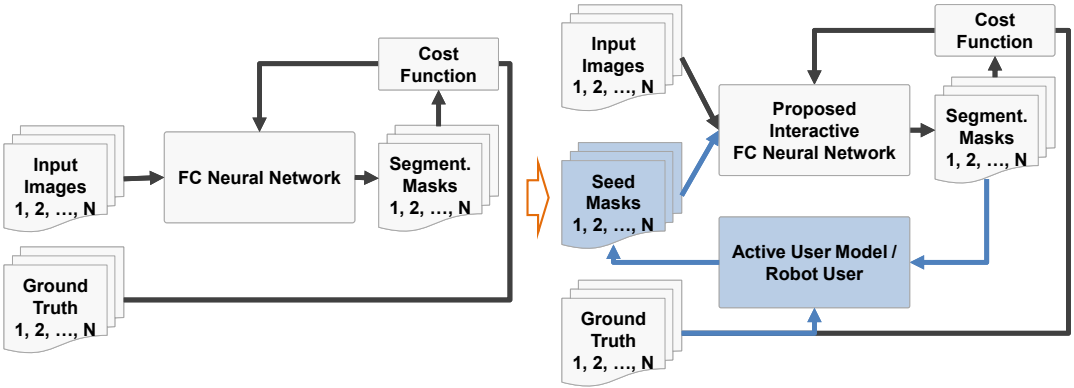
b) Compute segmentation mask based on a), compare to ground truth

c) User selects misclassified image element position(s) from difference mask

d) User updates seed mask

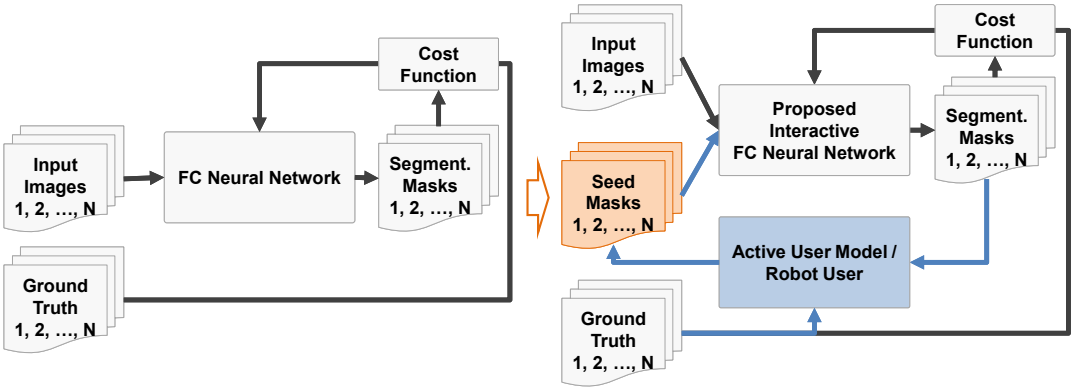
e) Compute improved segmentation mask w. r. t. old segmentation mask

Interactive FCN – Proposed Topology Changes



Traditional FCN training procedure (left) and proposed training method by user simulation (right).

Interactive FCN – Proposed Topology Changes



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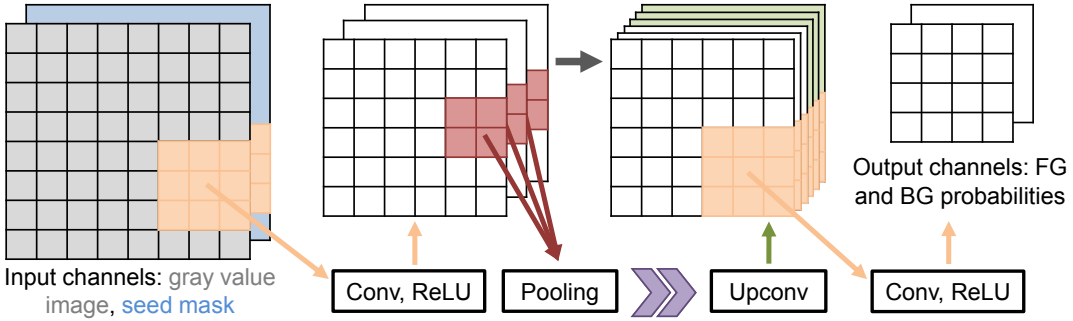
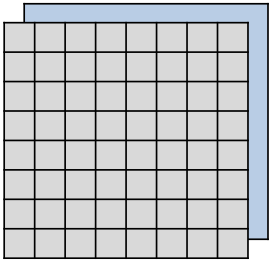
Interactive FCN – User Seed Mask Integration



Schematic FCN computation including user information as additional input.

Purple arrows represent further computational layers based on the U-net topology.

Interactive FCN – User Seed Mask Integration



Input channels: gray value image, seed mask

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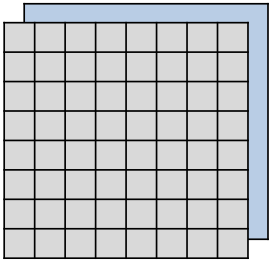

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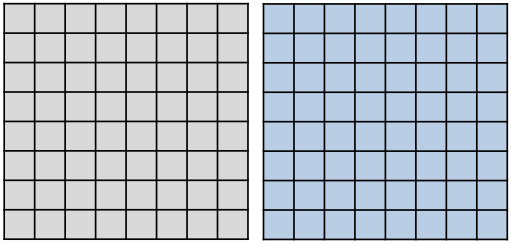

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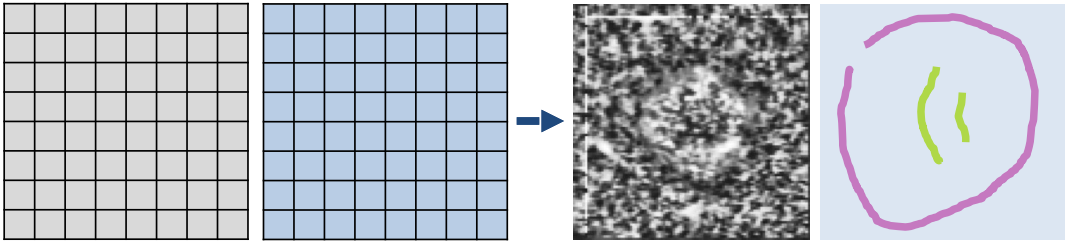

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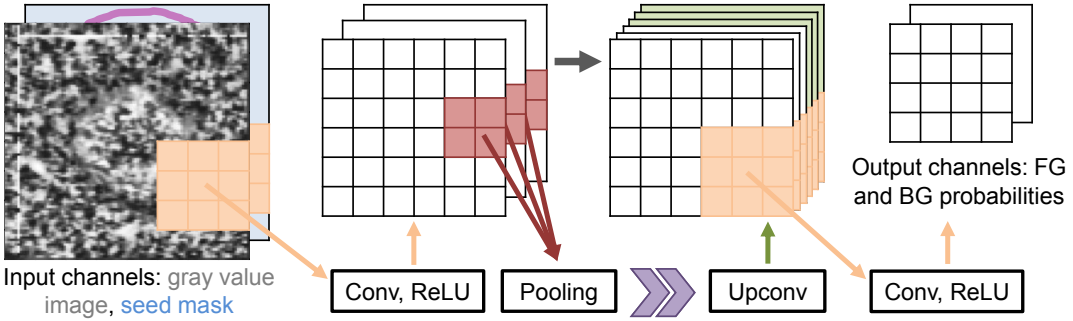

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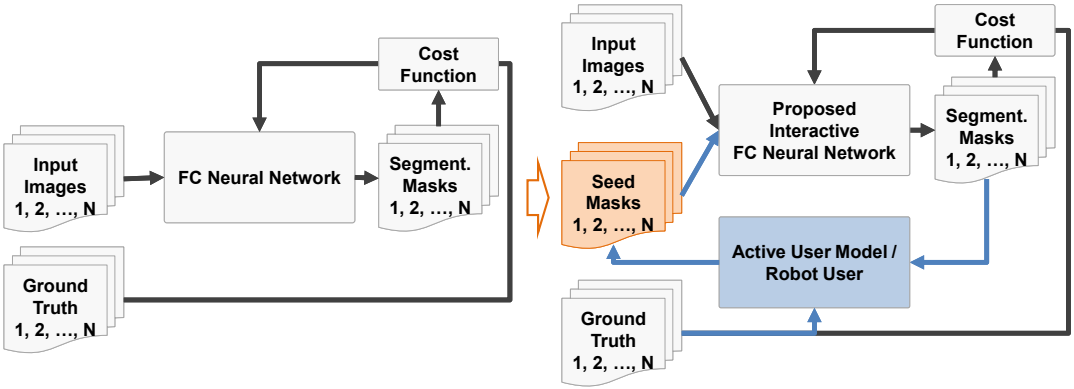

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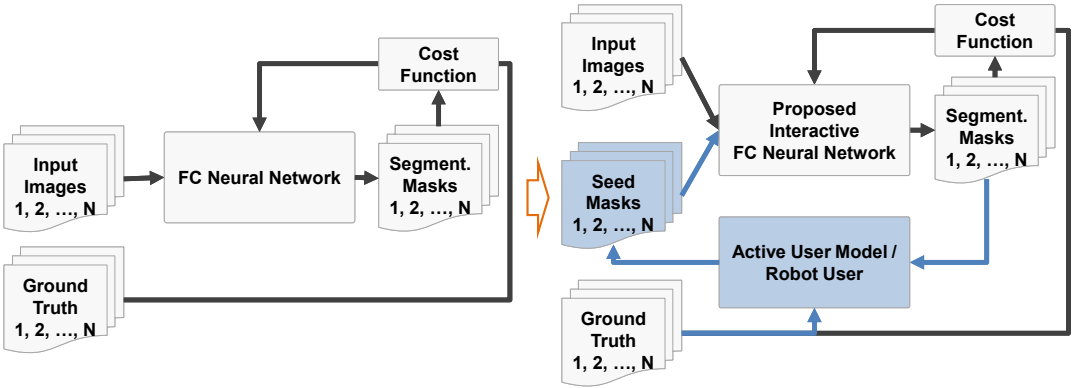

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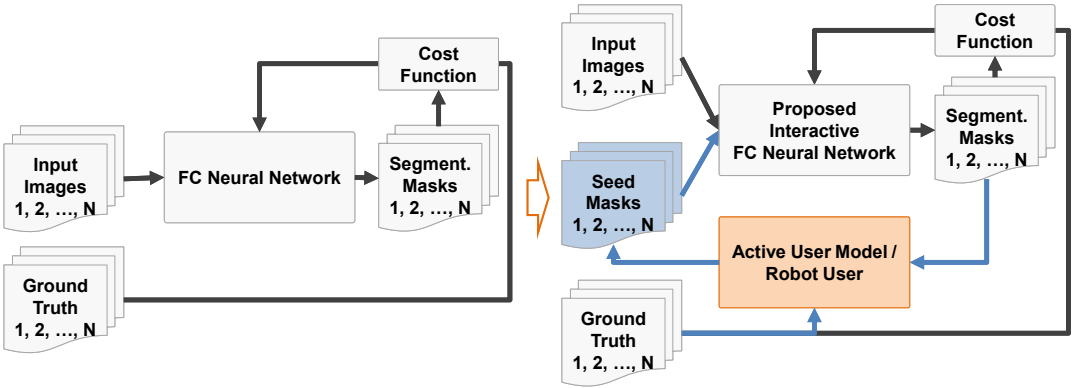

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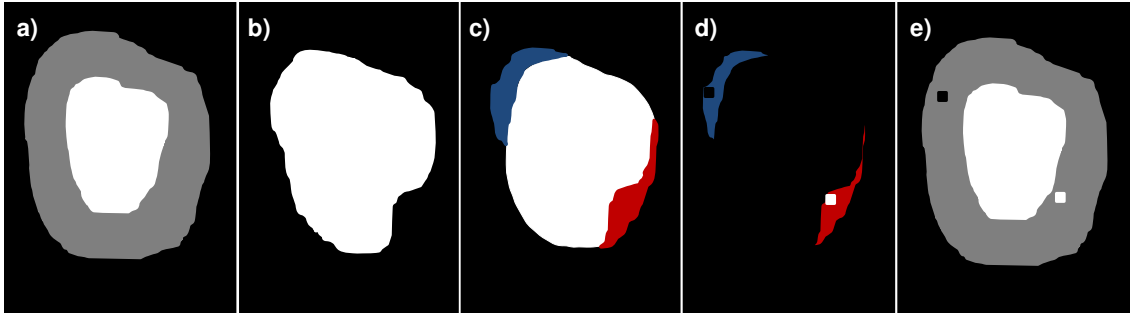
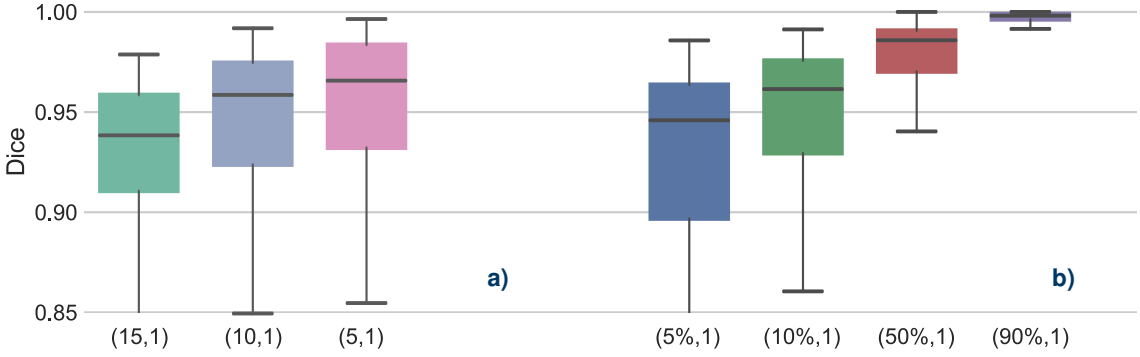
Interactive FCN – Rule-Based Simulated User Input



User Model: Probabilistic seed placement using difference mask from GT and current segmentation

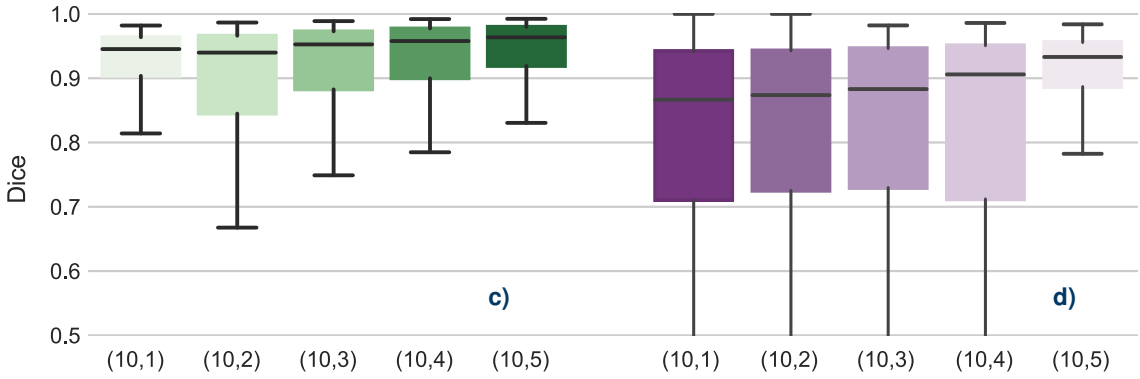
Outline

Interactive FCN Results – Without a User Model



UI-nets trained with a) varying contour width and b) randomized seed masks for initial seeding.

Interactive FCN Results – With a User Model



Segmentation quality after one to five iterations: c) interactive UI-net and d) GrowCut.

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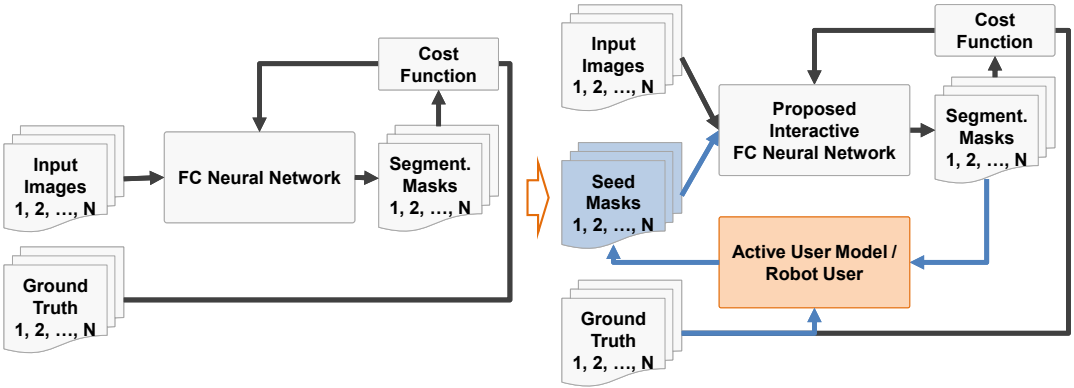

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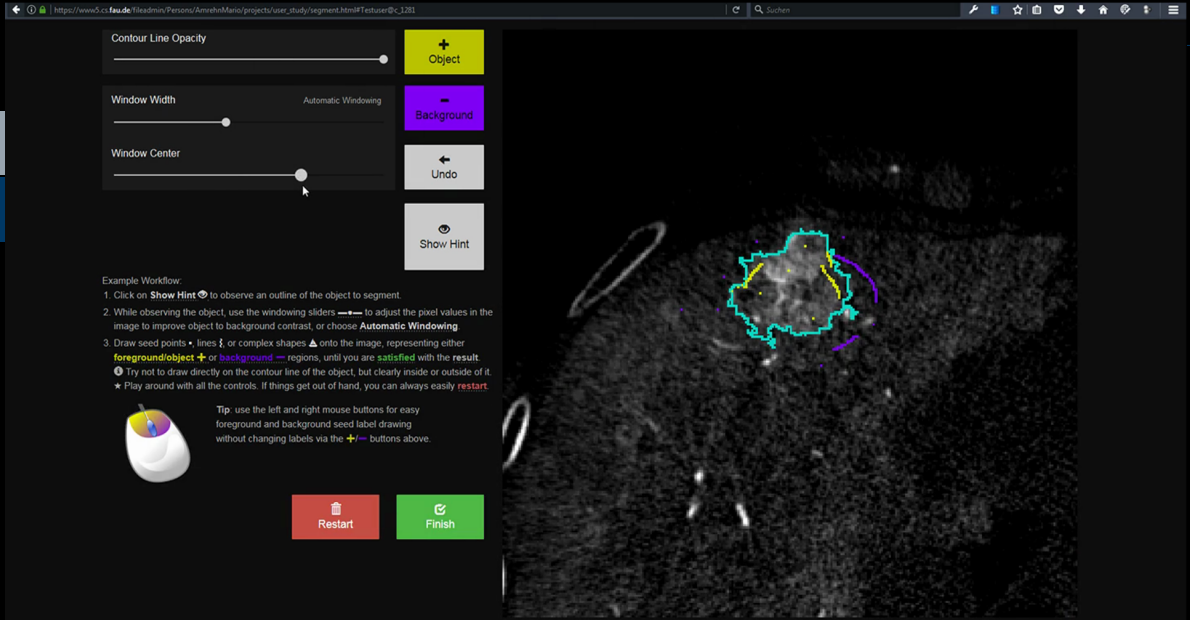
https://www5.cs.fau.de/fileadmin/Persons/AmrehnMario/projects/user_study/segment.html#Testuser@c_1281
Suchen
Contour Line Opacity
Object
Window Width
Automatic Windowing
Background
Window Center
Undo
Show Hint
Example Workflow:
1. Click on Show Hint to observe an outline of the object to segment.
2. While observing the object, use the windowing sliders to adjust the pixel values in the image to improve object to background contrast, or choose Automatic Windowing.
3. Draw seed points, lines, or complex shapes onto the image, representing either foreground/object + or background − regions, until you are satisfied with the result.
Try not to draw directly on the contour line of the object, but clearly inside or outside of it.
Play around with all the controls. If things get out of hand, you can always easily restart.
Tip: use the left and right mouse buttons for easy foreground and background seed label drawing without changing labels via the +/− buttons above.
Restart
Finish

Thank you for your attention!

Are there any questions?

Participation: **www.bit.ly/vcbmseg**

User Study

In order to participate in the user study, please fill in the password provided in your invitation.
If you did not receive an invitation, but like to participate in the study,
please just send me a short request per email.

Thank you!