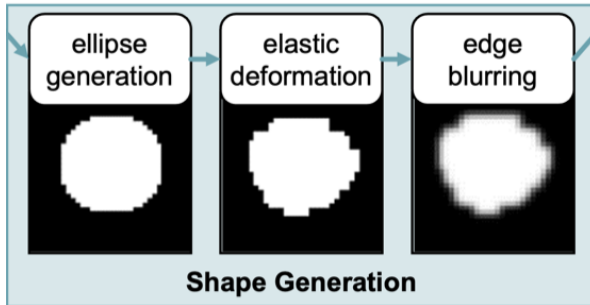


From Pixel to Cancer: Cellular Automata in Computed Tomography

Author: Yuxiang Lai, Xiaoxi Chen, Angtian
Wang, Alan Yuille, Zongwei Zhou*

Background: Tumor Synthesis

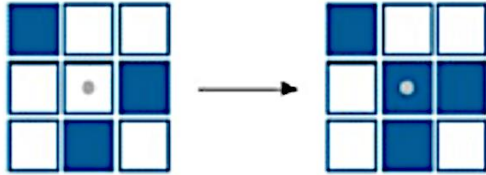
- Limitations of previous synthetic tumors [Hu et al., CVPR 2023]



- Hand-craft shapes
- Blurry boundary
- Unrealistic big tumors
- Lack of the interaction between organs and tumors

Cellular Automata

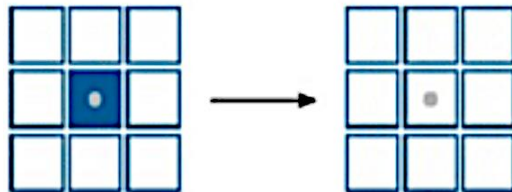
■ = 3



■ = 2 || 3

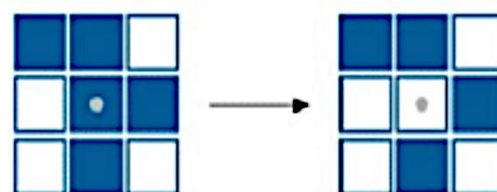


■ < 2



Growth

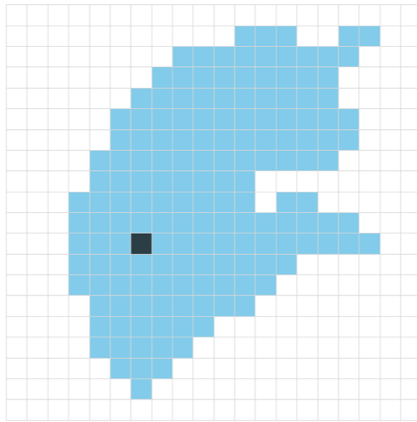
■ > 3



Death

Solution

From Pixel



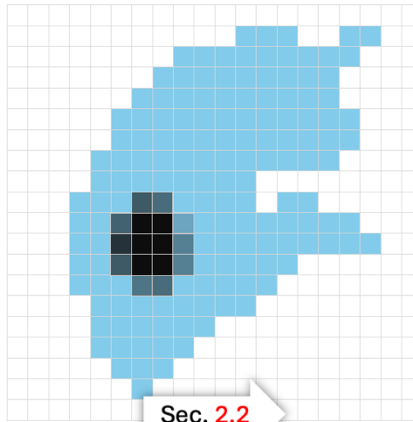
quantified organ

- level 4
- level 3
- level 2
- level 1
- level 0

Sec. 2.1

applying three generic rules

Tumor Development



Sec. 2.2

tumor & organ interaction

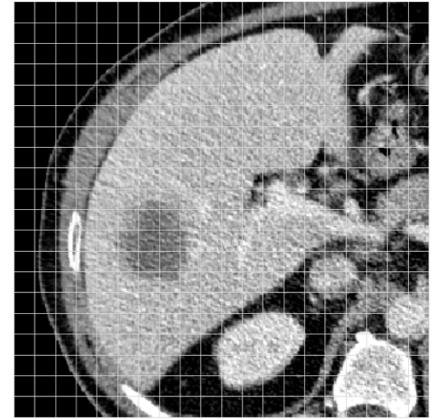
tumor population map



Sec. 2.3

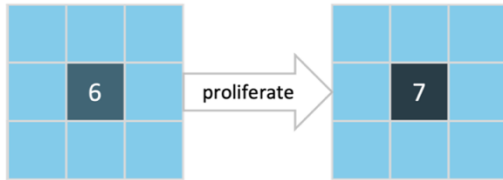
tumor generation in CT images

To Cancer

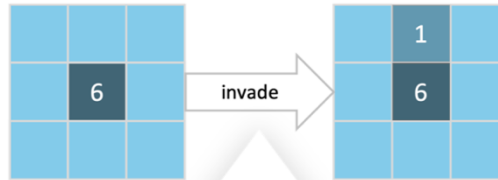


Rules

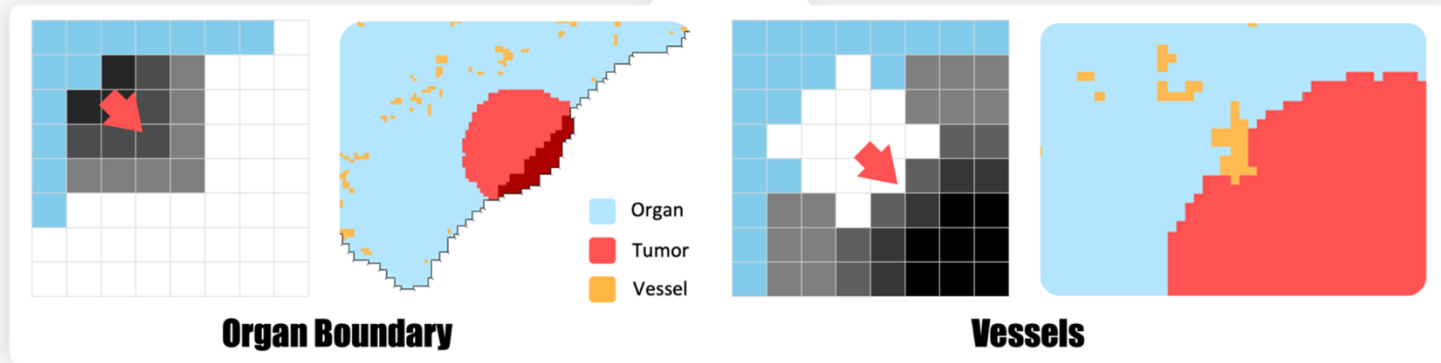
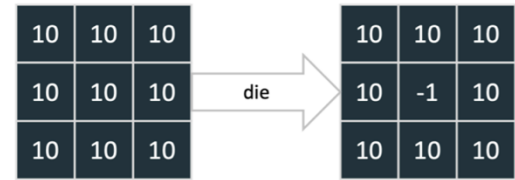
R1. Growth



R2. Invasion

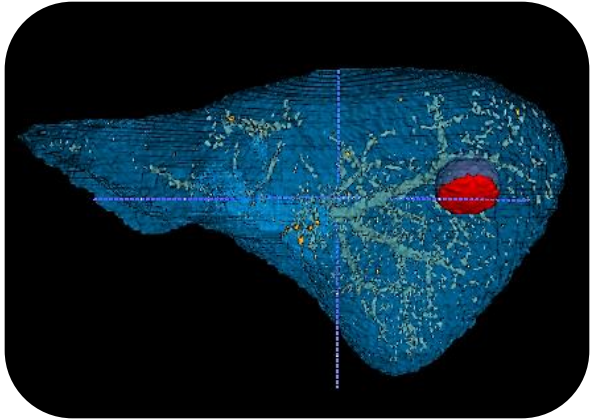


R3. Death

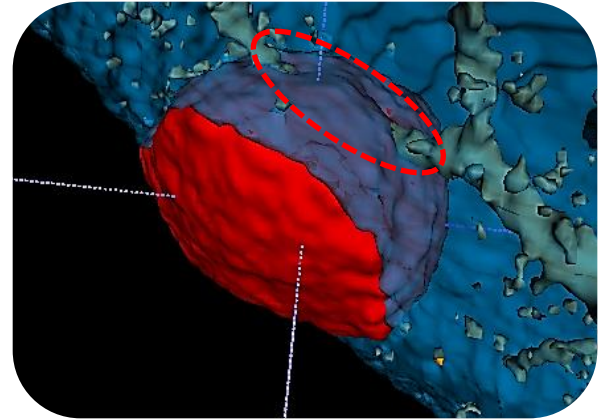


Interaction

- Organ Boundary



- Vessel

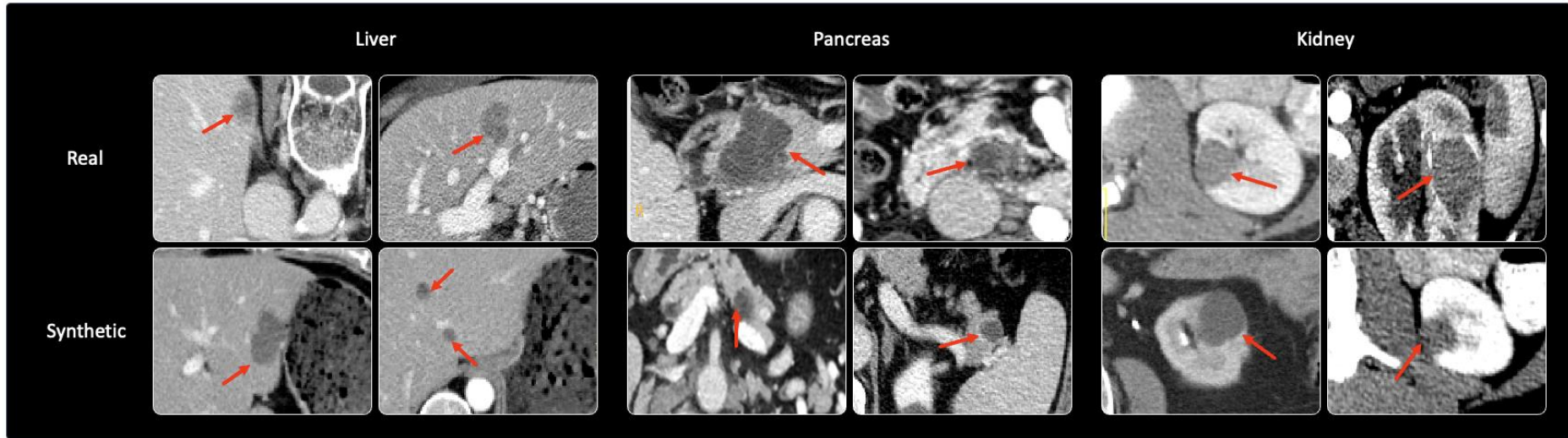


Reader Study

	metric	liver	pancreas	kidneys
R1 <i>3-year experience</i>	sensitivity (%)	100	95.0	95.5
	specificity (%)	27.3	22.7	26.7
	accuracy (%)	60.9	57.1	67.6
R2 <i>7-year experience</i>	sensitivity (%)	94.7	87.5	90.0
	specificity (%)	47.8	47.4	56.3
	accuracy (%)	69.1	65.7	75.0
R3 <i>10-year experience</i>	sensitivity (%)	100	100	100
	specificity (%)	45.4	55.6	57.9
	accuracy (%)	68.4	72.4	75.8

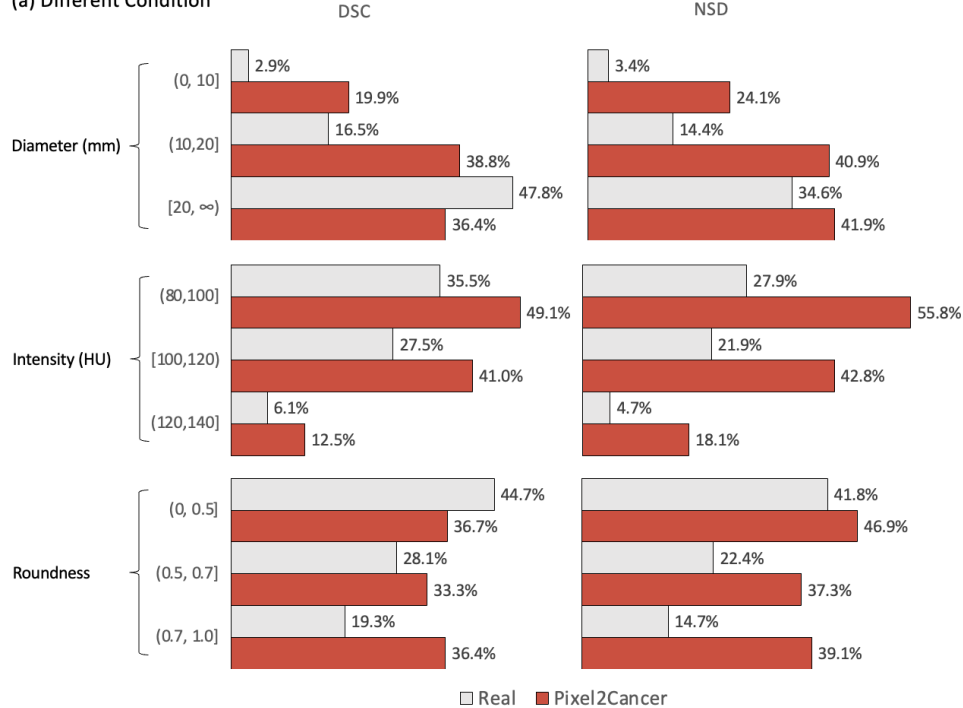
positives: real tumors ($N = 25$); negatives: synthetic tumors ($N = 25$).

Examples

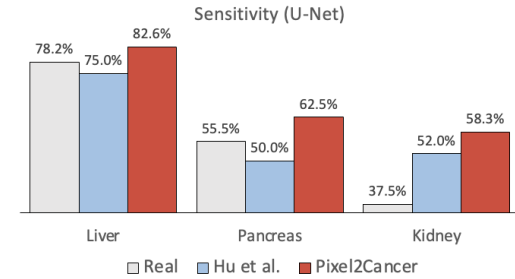


Results

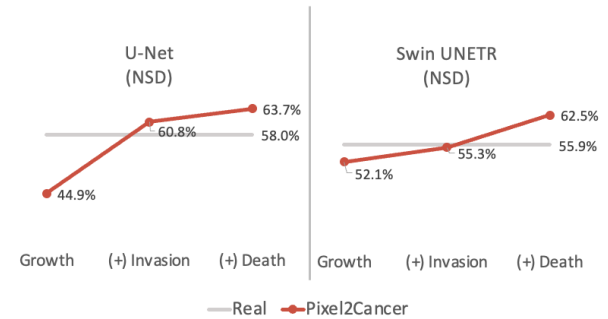
(a) Different Condition



(b) Early Tumor Detection



(c) Effectiveness of Rules Design





JOHNS HOPKINS

WHITING SCHOOL
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