RSNA 2023 Abdominal Trauma Detection

Detect and classify traumatic abdominal injuries

Задача

- Оценить степень повреждения почек, селезёнки и печени по 3 степеням (healthy, low, high). Определить наличие или отсутствие кровотечения и повреждения кишечника.

Team

Апарин
Георгий

Bachelor at
NUST MISIS

MLE at Uvenco

Competitions
Expert

Current Rank	Highest Rank
1827	1759
of 218,990	

0	1	1

AMP®-Parkinson's Disea...
· 7 months ago
Top 2%
24th
of 1805

RSNA 2023 Abdominal Tr...
· 2 months ago
Top 6%
64th
of 1125

Predict Student Performa...
6 months ago
Top 14%
272nd
of 2051

Ионов
Тимур

Master at ITMO,
AI talent hub

Intern researcher at
MIPT, DeepPavlov

MLE at Norsi-trans

Competitions
Expert

Current Rank	Highest Rank
1860	1769
of 218,990	

0	0	3

HuBMAP - Hacking the H...
· 5 months ago
Top 6%
54th
of 1021

RSNA 2023 Abdominal Tr...
· 2 months ago
Top 6%
64th
of 1125

ICR - Identifying Age-Rel...
· 4 months ago
Top 6%
361st
of 6430
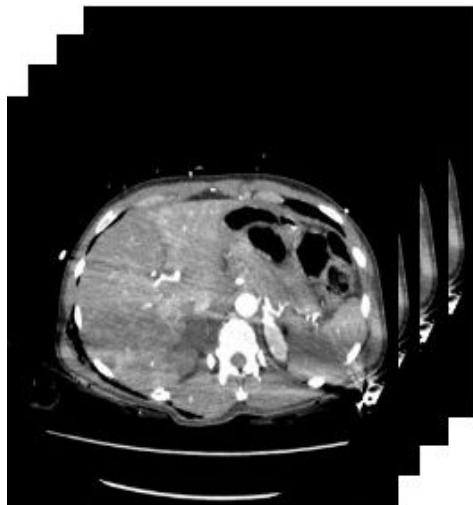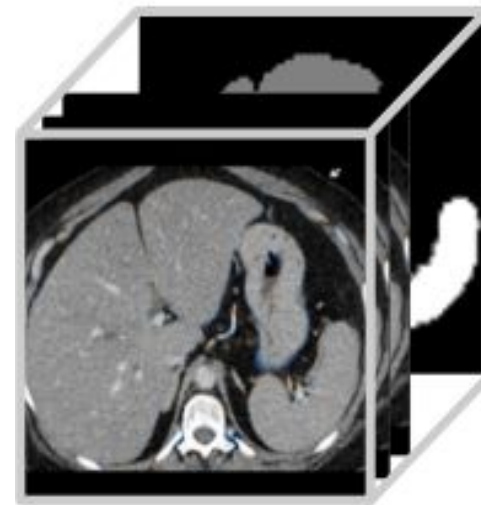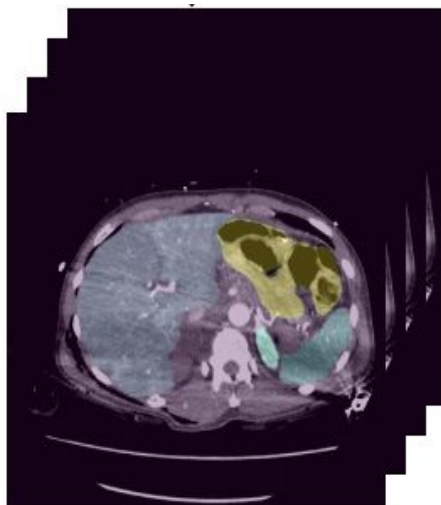
Data

3D CT сканы   3D маски органов

Data processing

PyDicom (чтение .dcm)
Slice thickness
Dicom windowing
Aortic HU

Non-contrast

Arterial Phase

Metric

$$L_{i,j} = -w_j(y_{i,j}\log(p_{i,j}) + (1 - y_{i,j})\log(1 - p_{i,j})))$$

$$w_j = \begin{cases} 1, & \textit{for all healthy labels.} \\ 2, & \textit{for low grade solid organ injuries (liver, spleen, kidney).} \\ 4, & \textit{for high grade solid organ injuries.} \\ 2, & \textit{for bowel injuries.} \\ 6, & \textit{for extravasation.} \\ 6, & \textit{for the auto} - \textit{generated any}_i\textit{njury label.} \end{cases}$$
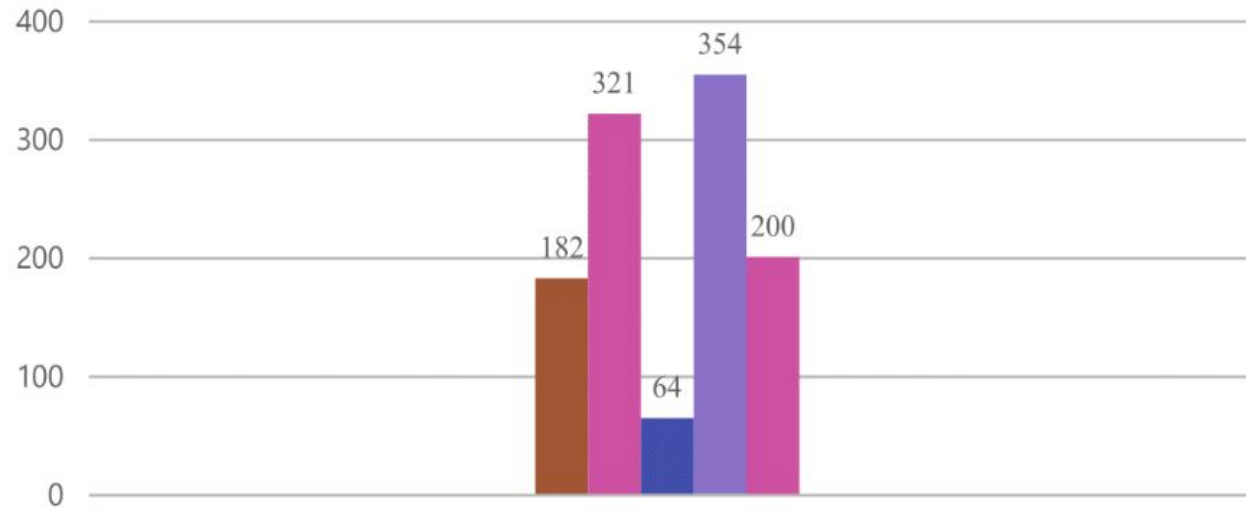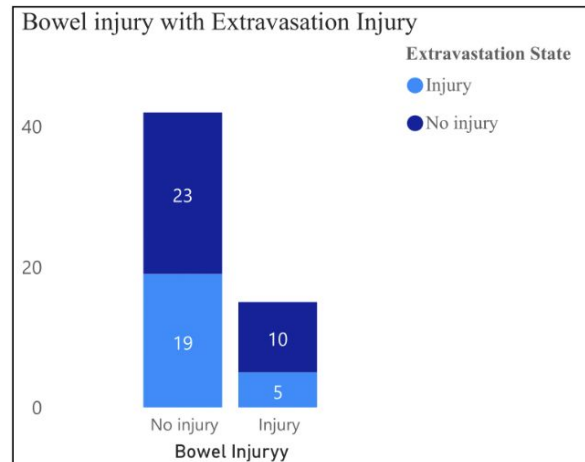
Distribution of patients with and without injuries
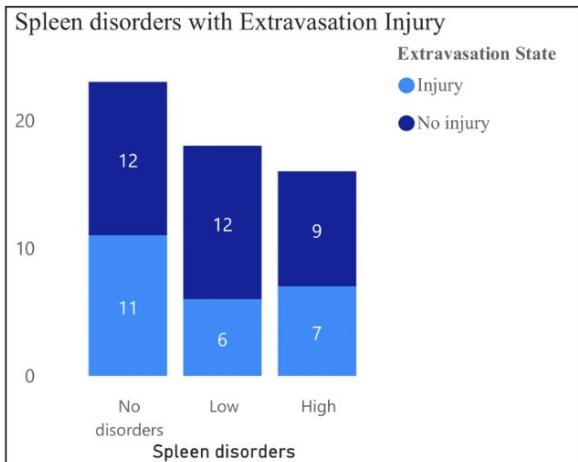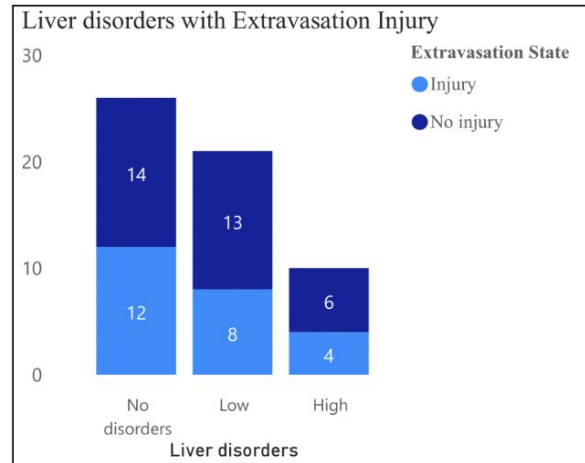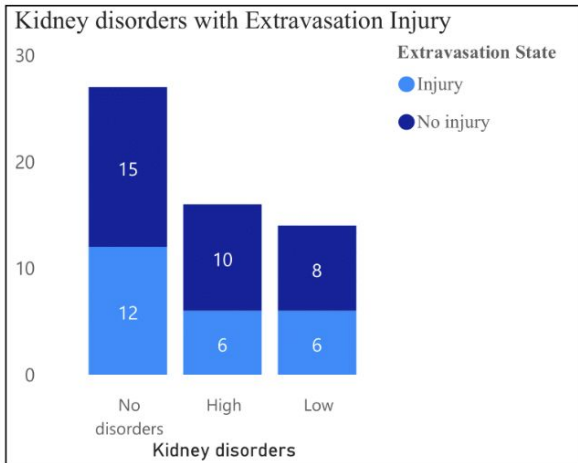
27,17%

855

2292

72,83%
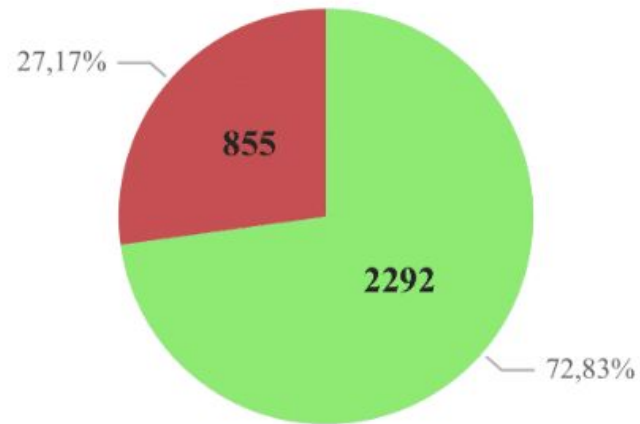
Health Status ● Healthy ● Injured

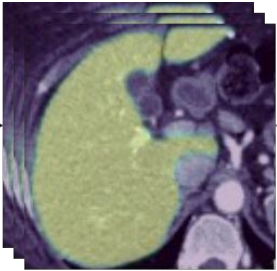# Types of disorders

● Unhealthy Kidney ● Unhealthy Liver ● Injured Bowel ● Unhealthy Spleen ● Extravasation Injury
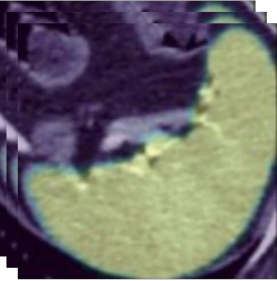
Kidney disorders with Extravasation Injury

Extravasation State
- Injury
- No injury

Kidney disorders	Injury	No injury
No disorders	12	15
High	6	10
Low	6	8

Liver disorders with Extravasation Injury

Extravasation State
- Injury
- No injury

Liver disorders	Injury	No injury
No disorders	12	14
Low	8	13
High	4	6

Spleen disorders with Extravasation Injury

Extravasation State
- Injury
- No injury

Spleen disorders	Injury	No injury
No disorders	11	12
Low	6	12
High	7	9

Bowel injury with Extravasation Injury

Extravastation State
- Injury
- No injury

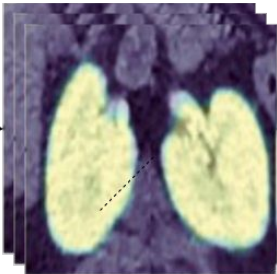| Bowel Injuryy	Injury	No injury
No injury	19	23
Injury	5	10

(здоров, поврежден, сильно поврежден)
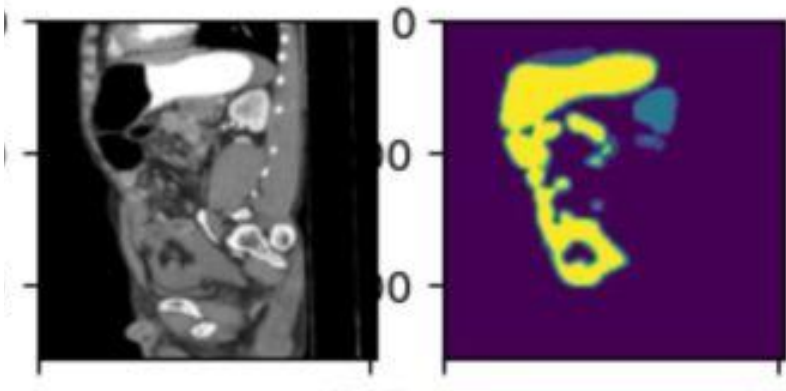
Печень → 3 класса

Селезёнка → 3 класса

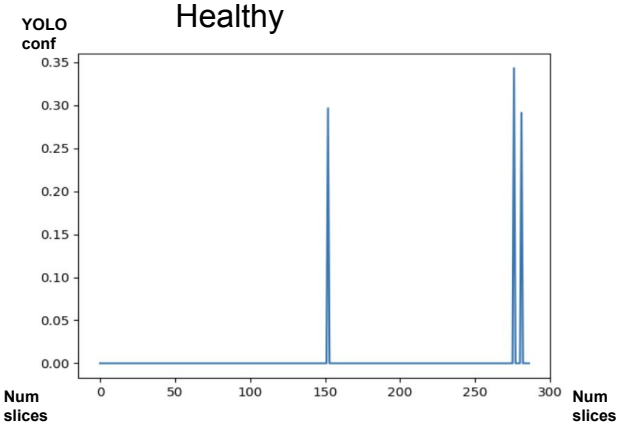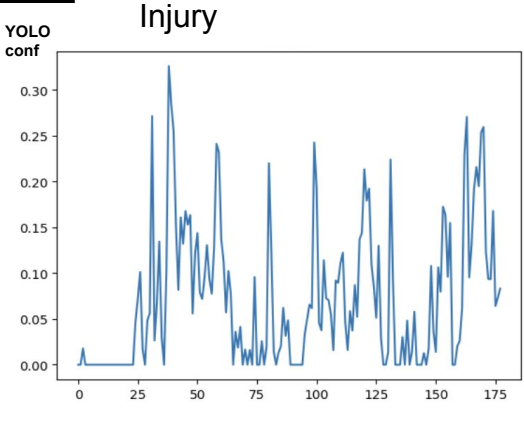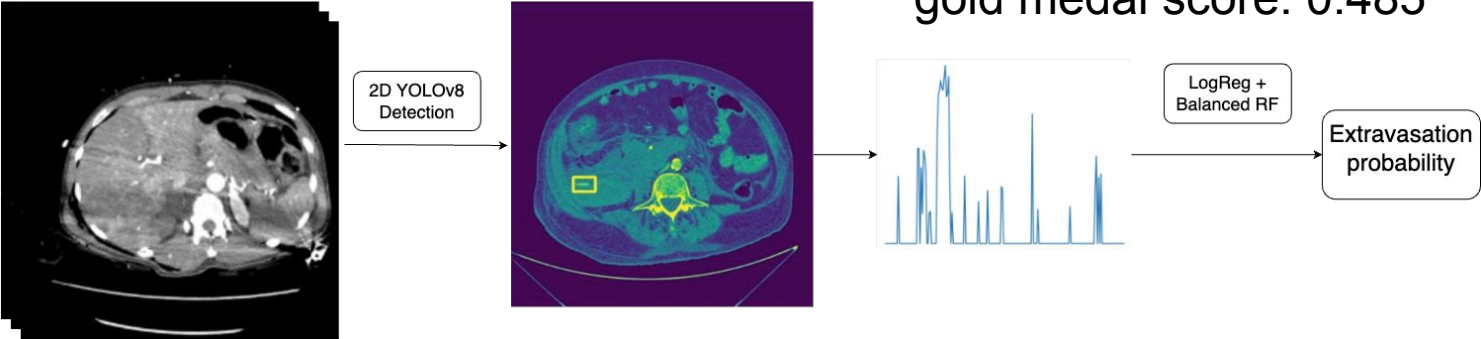Почки → 3 класса

Кровотечение → 2 класса (есть / нет)

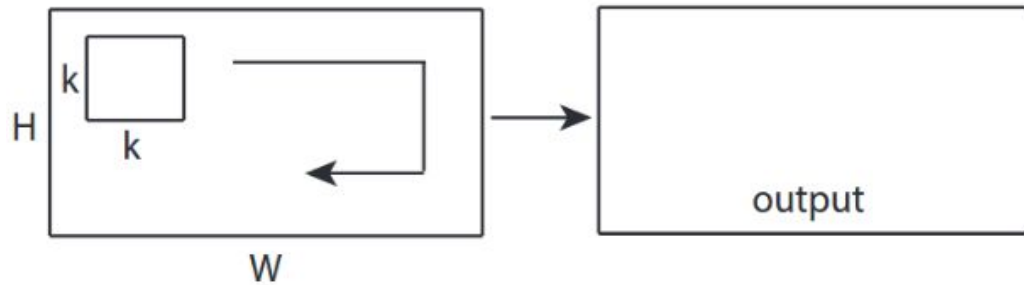Кишечник → 2 класса (здоров / повреждён)

Extravasation classification

score on cv: 0.507 +- 0.046 logloss
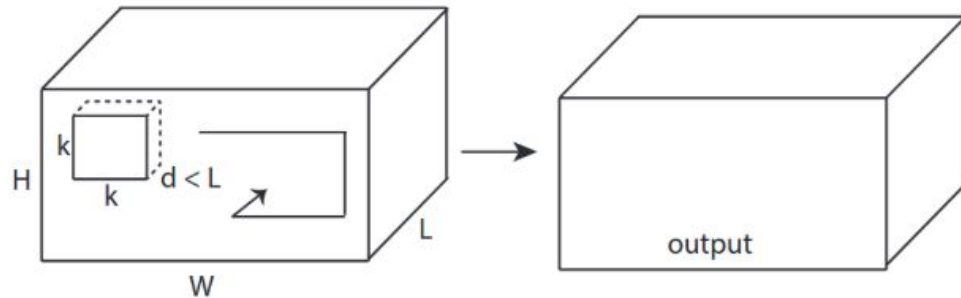const score: 0.631
gold medal score: 0.485

Architecture
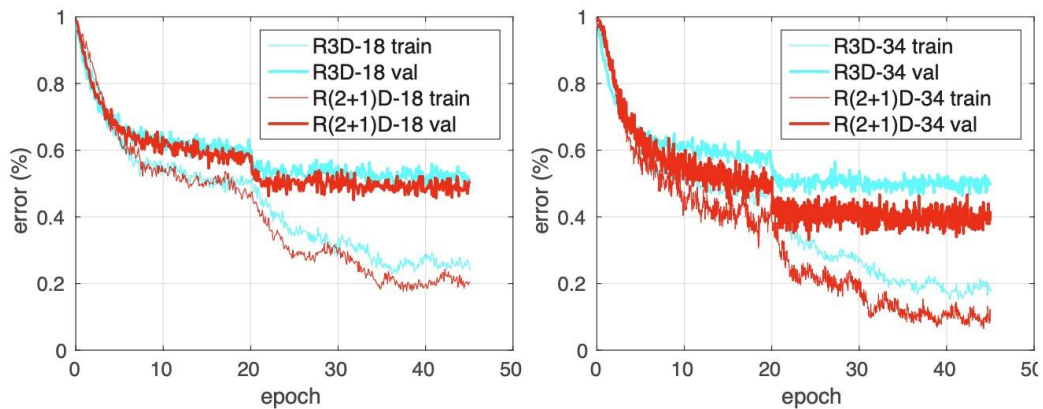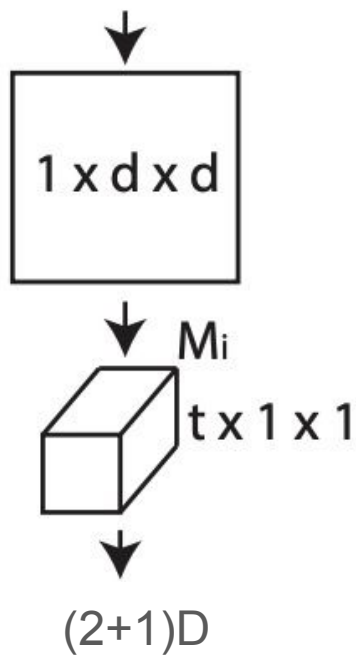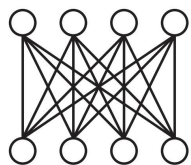
2D Conv

3D Conv

(2+1)D

$$1 \times d \times d$$
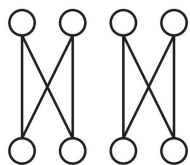
M_i

$$t \times 1 \times 1$$
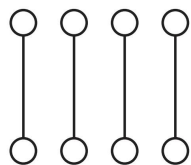
(2+1)D

Figure 3. **Training and testing errors for R(2+1)D and R3D**.

Depthwise separable 3D

a) conv   b) group conv   c) depthwise conv

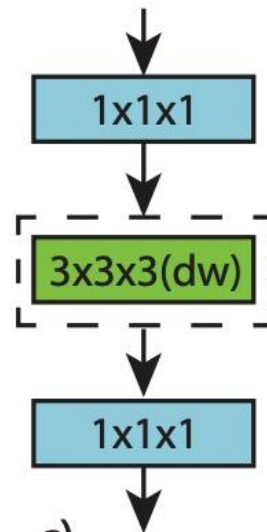| model	depth	video@1 (%)	FLOPs ×10⁹	params ×10⁶	interactions ×10⁹
ResNet3D	26	**65.3**	14.3	20.4	0.42
ir-CSN	26	62.4	4.0	1.7	0.27
ip-CSN	26	64.6	5.0	2.4	0.42
ResNet3D	50	69.4	29.5	46.9	5.68
ir-CSN	50	70.3	10.6	13.1	5.42
ip-CSN	50	**70.8**	11.9	14.3	5.68
ResNet3D	101	70.6	44.7	85.9	8.67
ir-CSN	101	71.3	14.1	22.1	8.27
ip-CSN	101	**71.8**	15.9	24.5	8.67
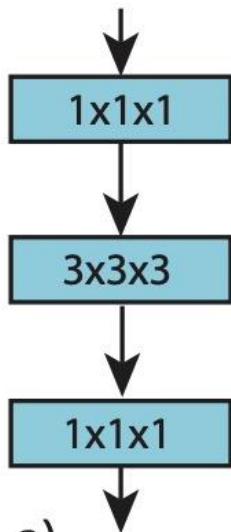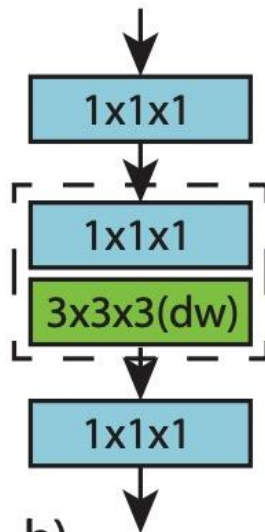
a)   b) Interaction-preserved   c) Interaction-reduced

Models

Segmentation (3D Unet):

- encoder: ip-csn resnet50
- decoder: (2+1)D resnet50
- Mean/std normalization
- Jaccard + Focal loss
- 256x256x112
- batch size: 5
- total samples: 150

Classification:

- encoder: ip/ir-csn resnet152
- Mean/std normalization
- CrossEntropy
- Weighted sampler
- batch size: 6 or 9
- 5 folds

Augmentations

3D:

1) Flips
2) Gaussian noise
3) Random padded shift

tips:

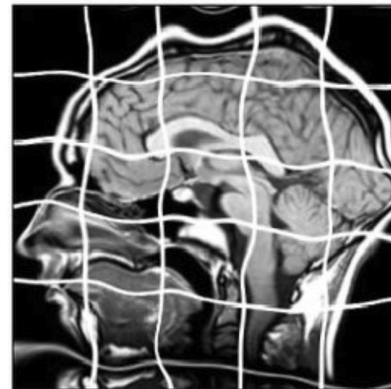1) True 3D augs are too slow (1.5s+), make it own hands
2) 3D segmentation quite easy task

2D (replay):

1) Grid distortion
2) Elastic transform
3) Saturation

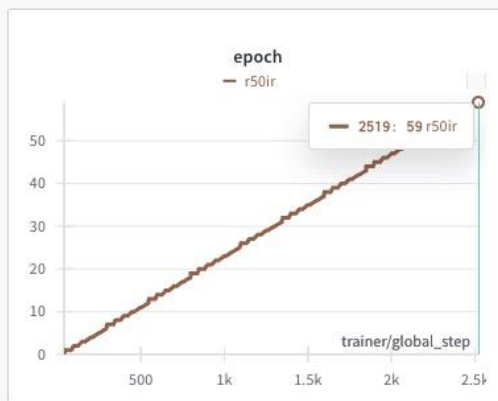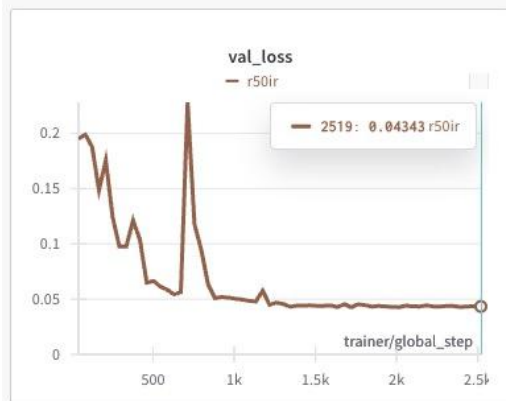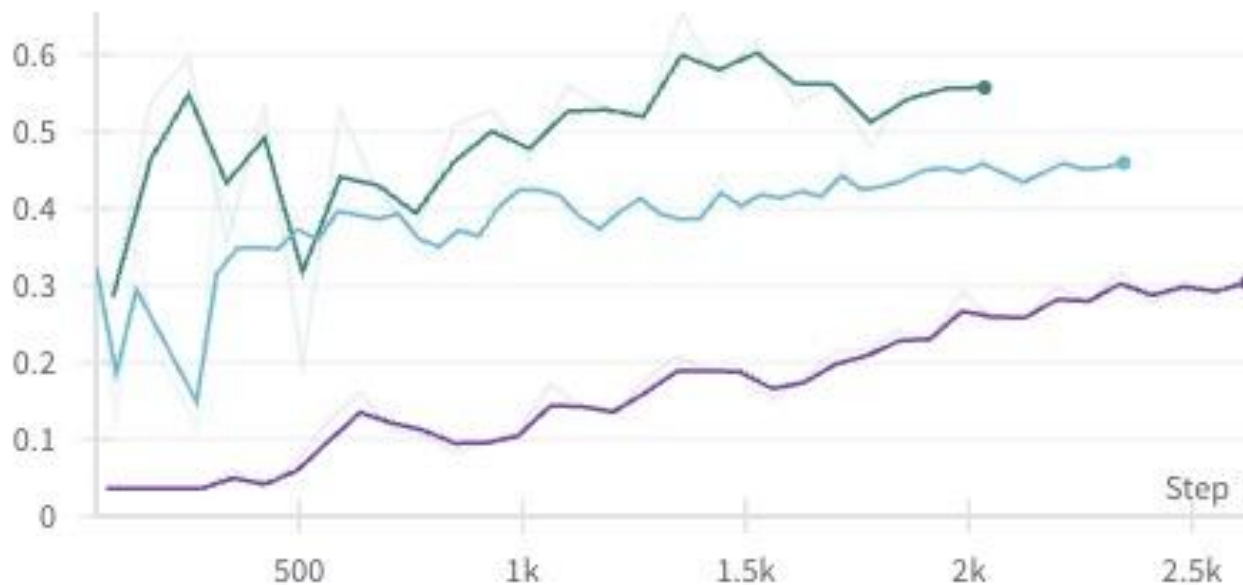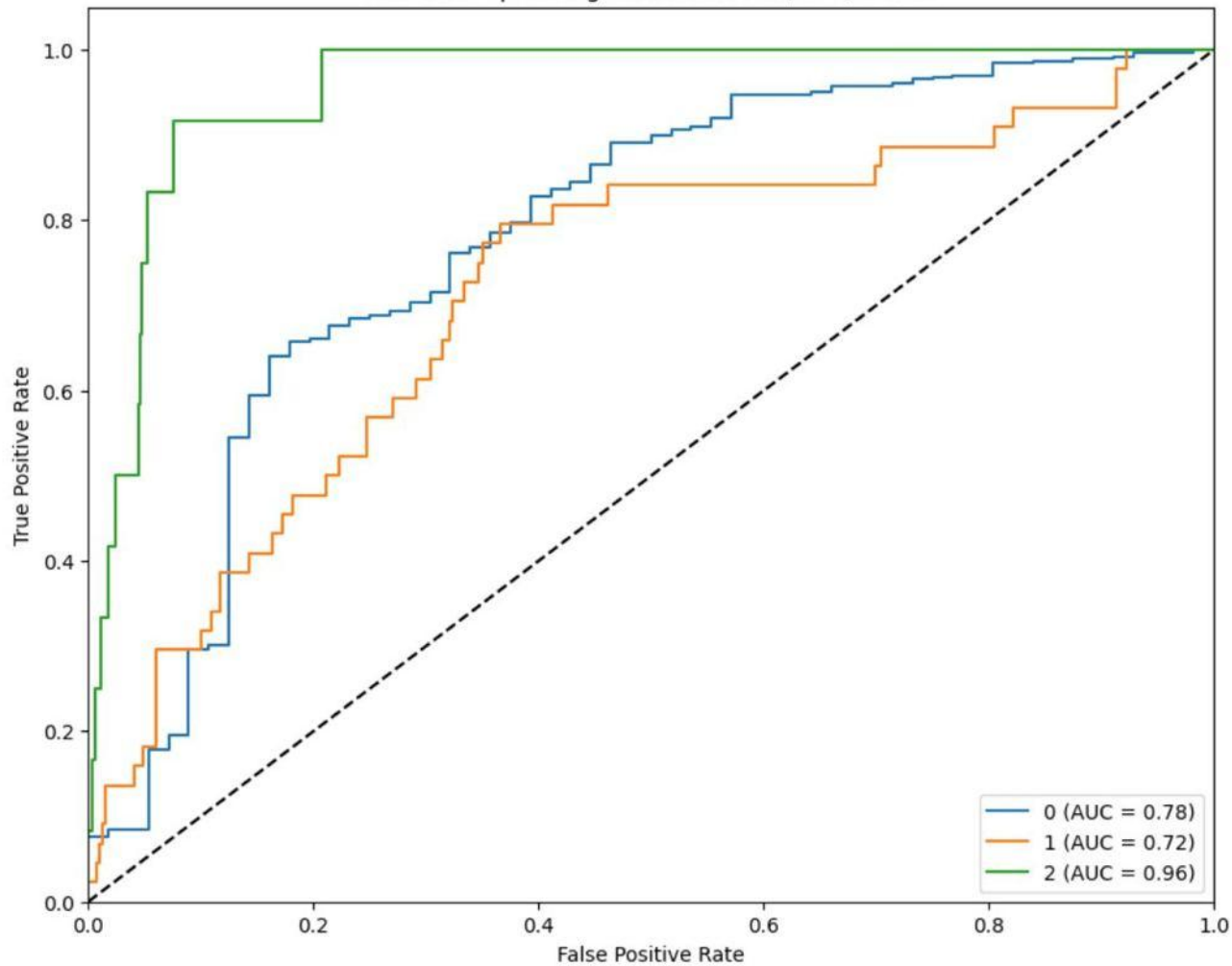# Segmentation
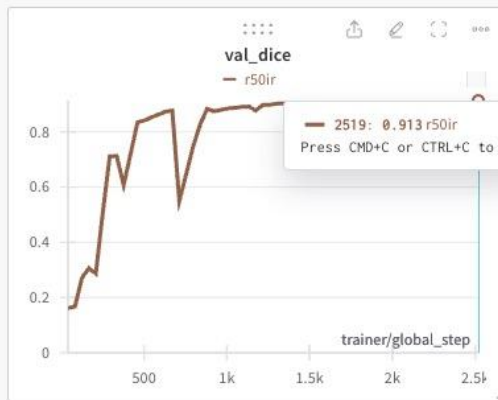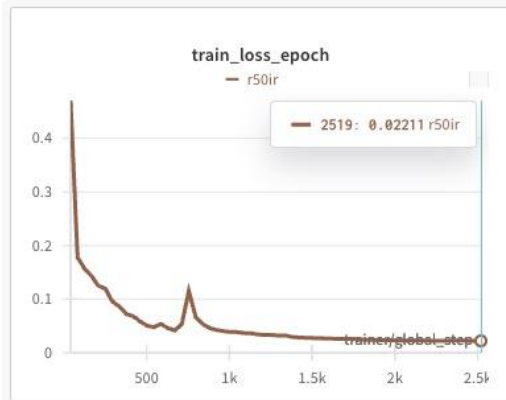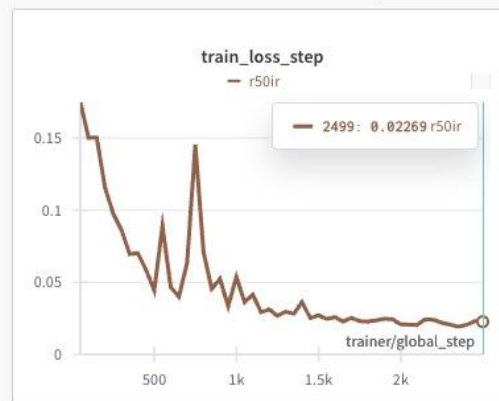
Classification

Macro F1 score

- no aug: 0.29
- 2D + 3D flips aug : 0.46 (+0.17)
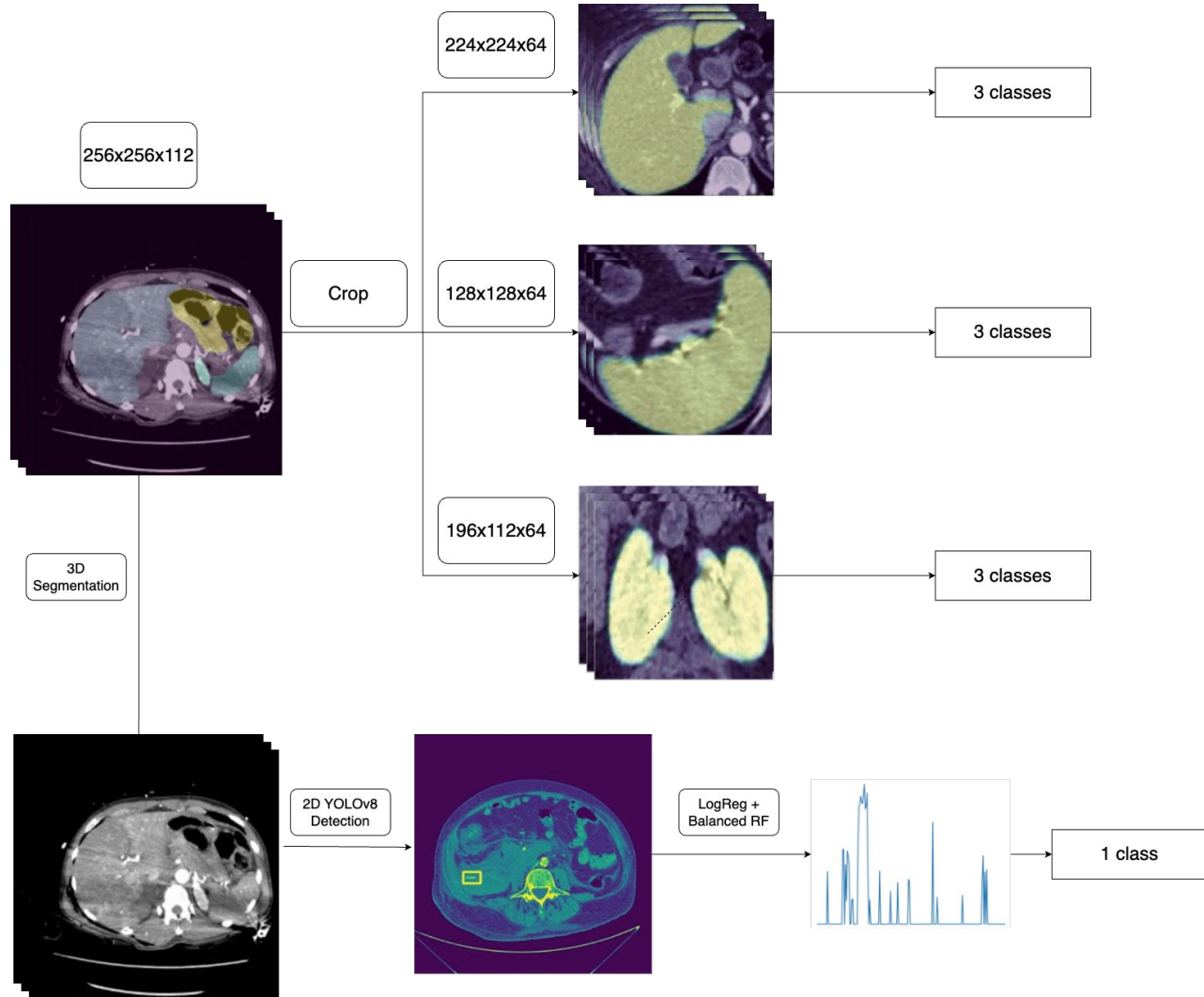- + 3D shift: 0.55 (+0.1)

Receiver Operating Characteristic (ROC) Curve

0 - healthy
1 - low
2 - hard

- 0 (AUC = 0.78)
- 1 (AUC = 0.72)
- 2 (AUC = 0.96)

Models

256x256x112

224x224x64 → 3 classes

Crop

128x128x64 → 3 classes

196x112x64 → 3 classes

3D Segmentation

2D YOLOv8 Detection

LogReg + Balanced RF → 1 class

const predict - 0.65

```
# Set output to mean of training data
submission[Target_cols] = train[Target_cols].mean()

# Scale each category by desired scale factor
submission[scale_by_2] *=sf_2
submission[scale_by_4] *=sf_4
submission[scale_by_6] *=sf_6
submission[scale_healthy] *=scale_h
```

Selim
2022:
4 place
2023:
21 place 0.44

| #	△	Team	Members		Score	Entries	Last	Solution
1	▲ 1	Team Oxygen		🥇	0.35301	88	2mo	📄
2	▼ 1	On Strike		🥇	0.35667	15	2mo	📄
3	▲ 3	[Aillis.jp] Yuji Ariyasu		🥇	0.38848	91	2mo	📄
4	▼ 1	sheep		🥇	0.39234	60	2mo	📄
5	▼ 1	Magic City		🥇	0.39947	25	2mo	
6	▲ 2	Sushi Master		🥇	0.40531	37	2mo	📄
51	▲ 3	MaxChen303		⚪	0.53854	43	2mo	📄
52	▼ 14	tatsutaka		⚪	0.53855	21	2mo	
53	▼ 14	Aleksandr Lavrikov		⚪	0.53945	89	2mo	
54	▲ 4	devchopin		⚪	0.54015	47	2mo	
55	▼ 7	NorthM344		⚪	0.54768	122	3mo	
56	▼ 1	MI2RL&CILAB		⚪	0.54792	61	2mo	
57	▼ 12	Alcor Z		🥉	0.55119	63	2mo	
58	▲ 9	doriskao		🥉	0.55598	48	3mo	
59	▲ 11	YiZ277		🥉	0.55604	80	2mo	📄
60	▲ 1	BuzzTop		🥉	0.55733	27	2mo	
61	▲ 14	Konstantin Sukharev		🥉	0.55941	17	2mo	
62	▼ 12	Akima		🥉	0.55988	32	2mo	
63	—	sho1_24		🥉	0.56061	82	2mo	📄
64	▼ 4	AI Talent Hub × MISIS mlballs		🥉	0.56521	49	2mo	📄
111	▲ 204	Chenyue Song		🥉	0.66701	3	4mo	

1-st place

3D crop ->
96 equidistant ->
reshape to 32

2.5D: i-1, i, i+1
slices as channels

Targets as visibility:
[0.1, 0.4,..., 1, 0.5]

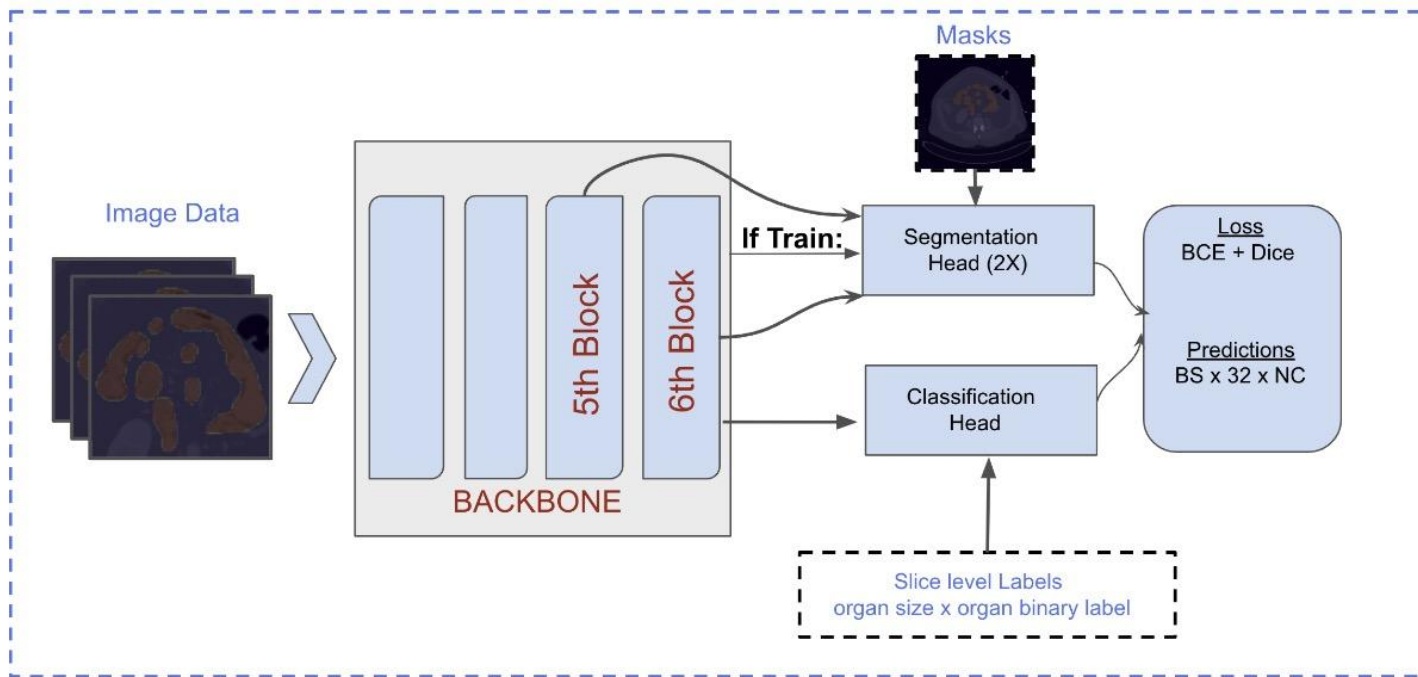Sigmoid

inference: maxpool
by slices
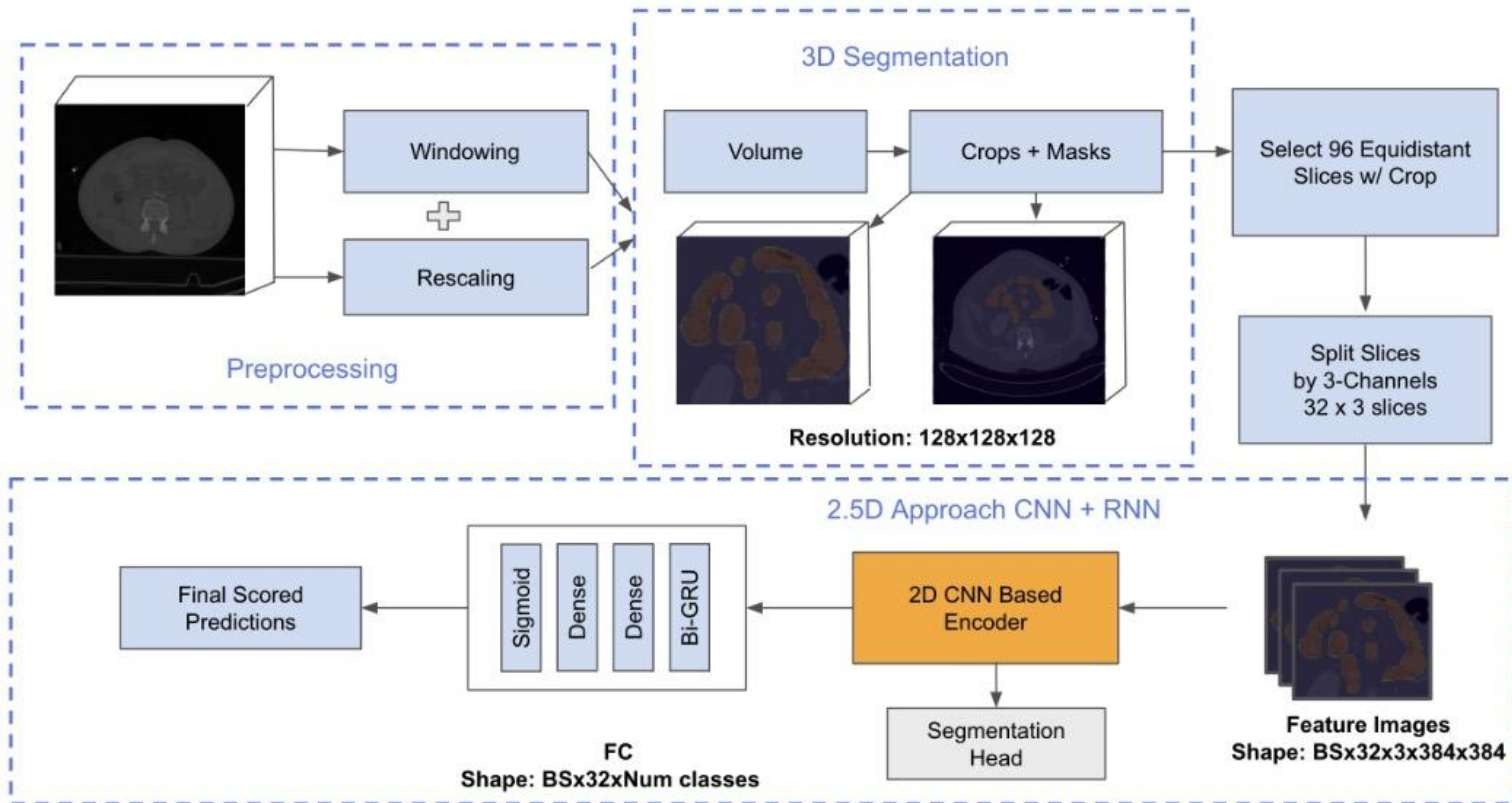
1-st place

Ensemble:

- Coat Lite Medium w/ GRU
- Coat Lite Small w/ GRU
- Efficientnet v2s w/ GRU

Augmentations:

- Perspective
- H/V Flip
- Rotate +-25

2.5D Approach: CNN+RNN w/ Aux Loss

1-st place

Overall: 0.325

bowel: 0.1
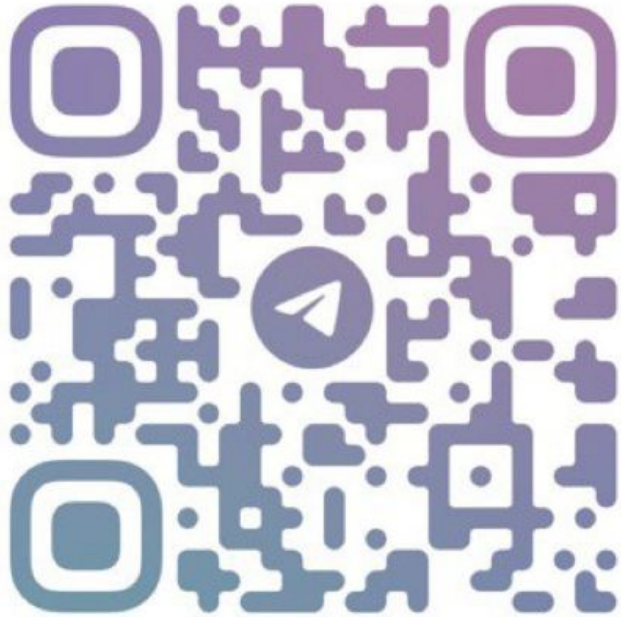extravasation: 0.45
kidney: 0.24
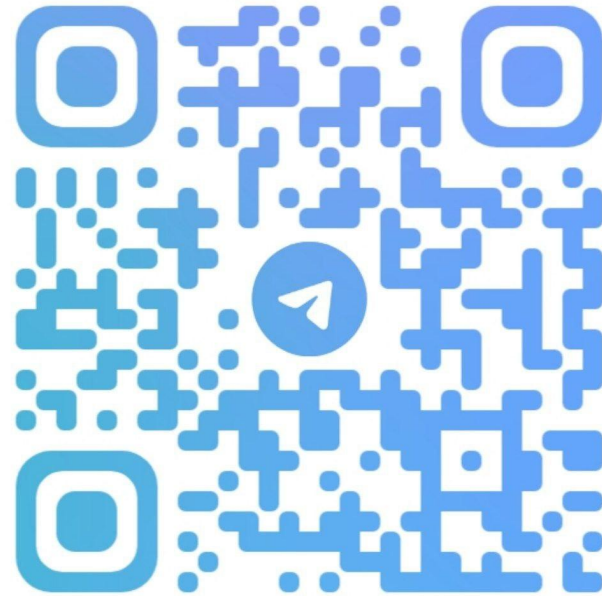liver: 0.39
spleen: 0.38
any: 0.38

Summary

- check previous top solutions

- check all additional data

- wait until the domain expert provides the EDA.

- check discussions daily

- use augmentations in any CV tasks

Our social media

@AI_MINDS

@APARINAI