Evaluace modelů scintigrafických obrazových sekvencí

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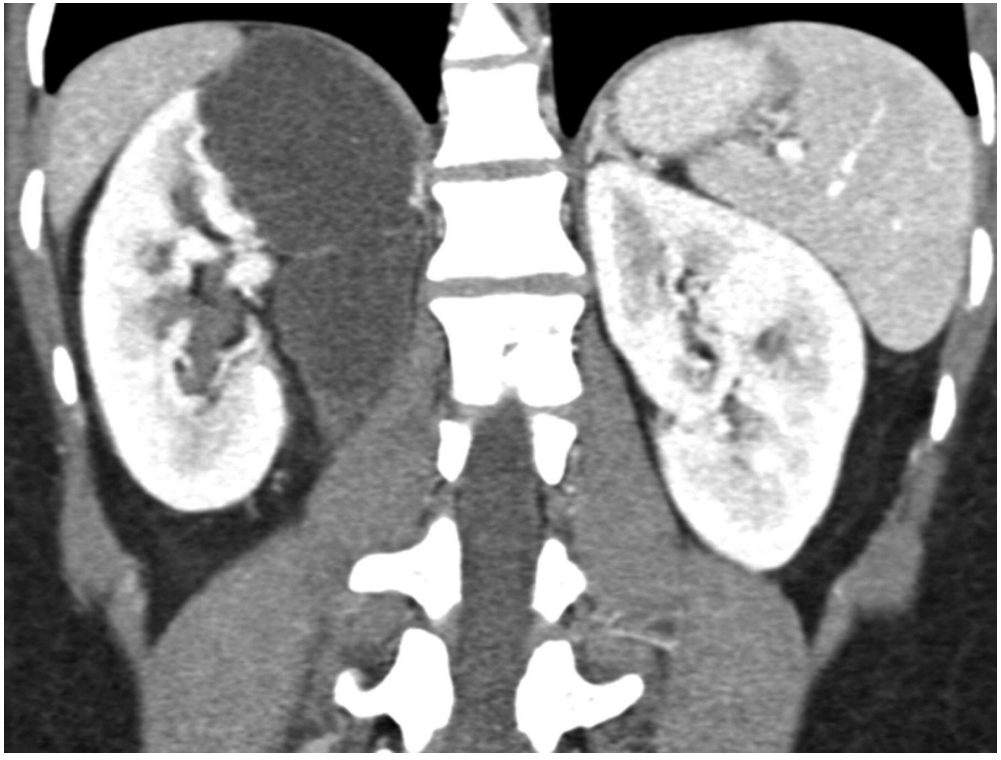
seminář AS, UTIA

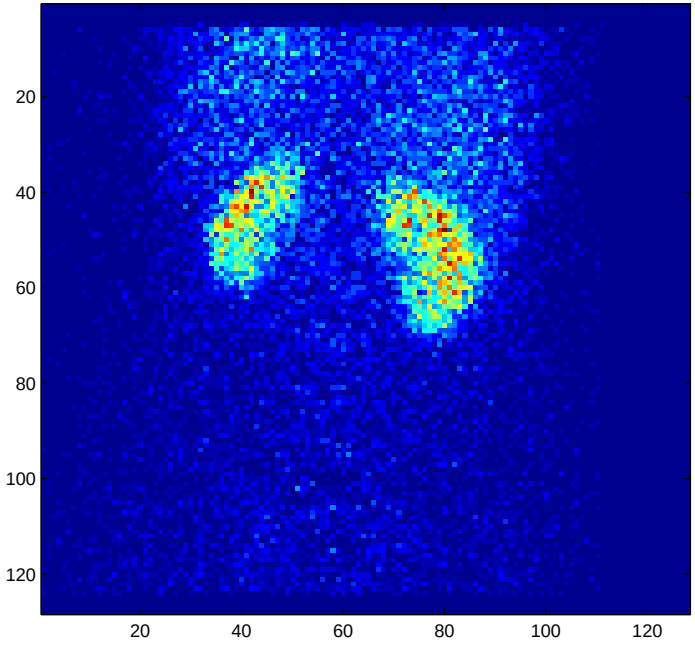
Task Specification

Structure of Function?

CT:

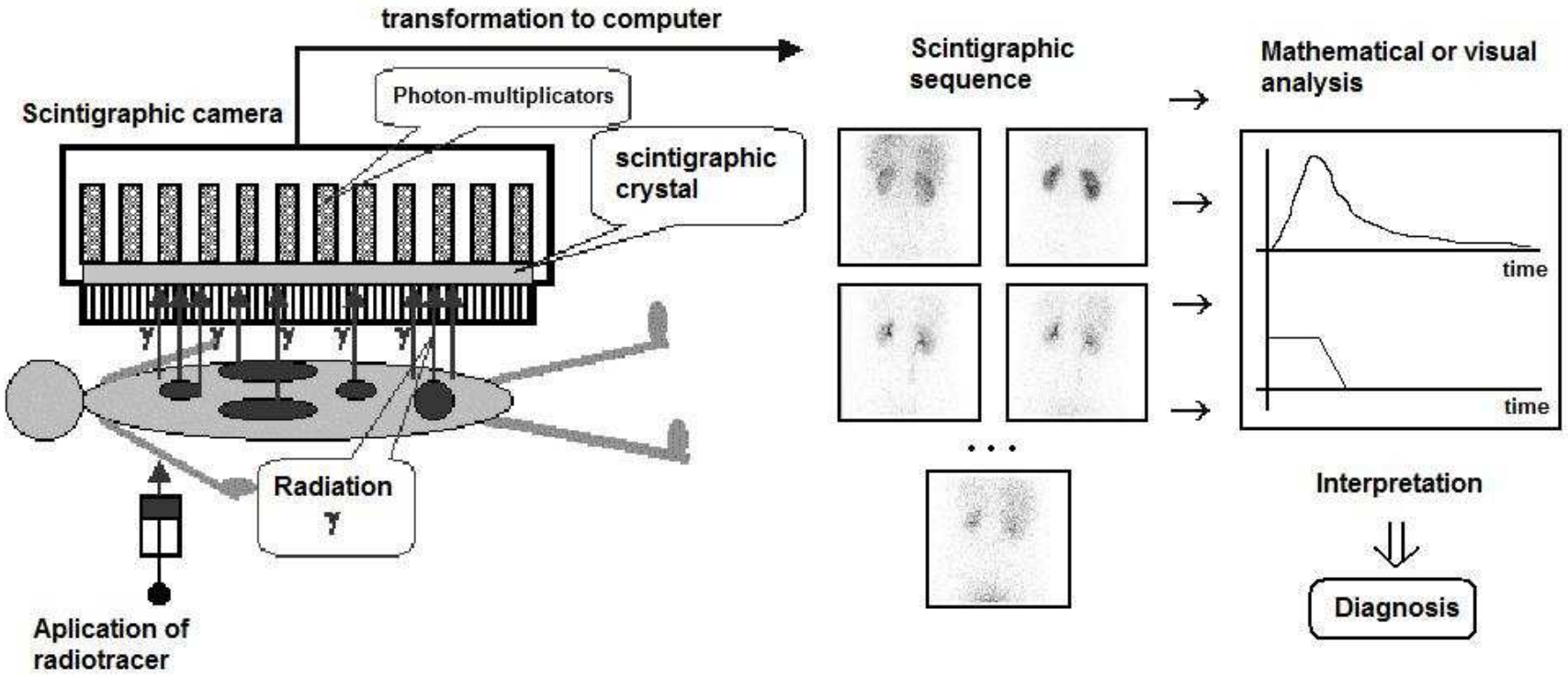


Scintigraphy:



Task Specification

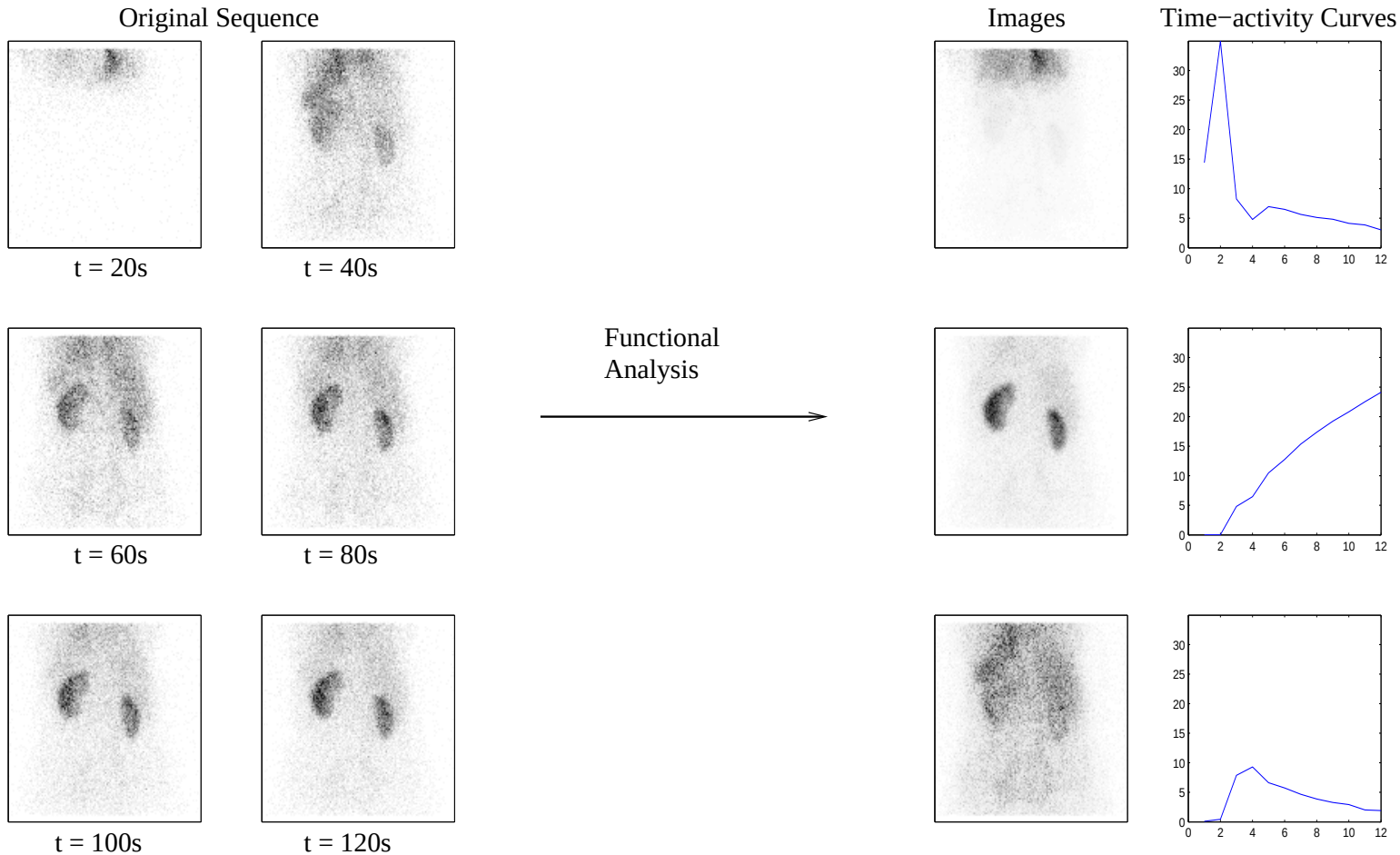
Renal Scintigraphy



Task Specification

Renal Scintigraphy

Samples from the sequence:



Relative Renal Function

How to Compute?

- Directly from well separated data in ROI.

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- Patlak-Rutland plot.

Relative Renal Function

How to Compute?

- Directly from well separated data in ROI.
- Patlak-Rutland plot.
- From decomposed image.

Probabilistic Modeling in Renal Scintigraphy

Variational Factor Analysis (FA)

General model of factor analysis is given by equation:

$$\mathbf{d}_t = \sum_{k=1}^{r} \mathbf{a}_k x_{t,k} + \mathbf{e}_t \tag{1}$$

Probabilistic Modeling in Renal Scintigraphy

Variational Factor Analysis (FA)

General model of factor analysis is given by equation:

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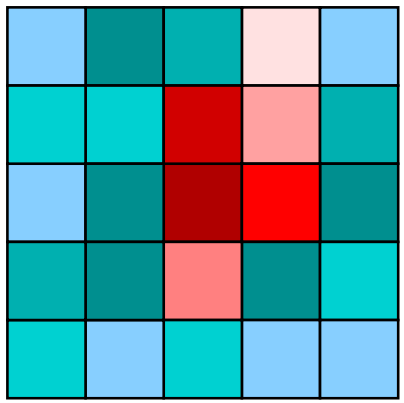
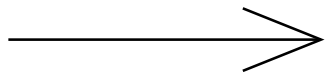
Assumptions and issues are:

1. Poisson observation noise
2. Positivity of factor images and factor curves
3. Unknown number of factors

Probabilistic Modeling in Renal Scintigraphy

FA + Regions of Interest (FAROI)

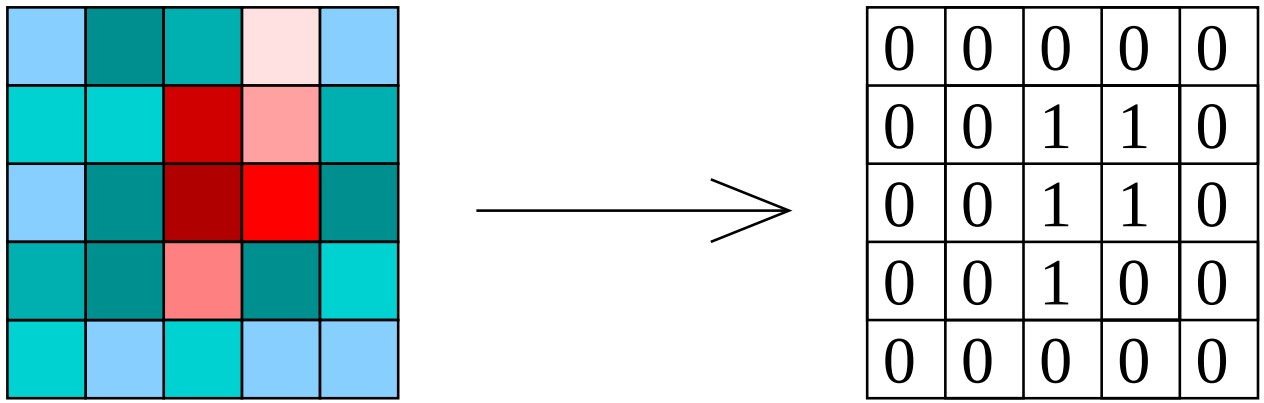




0	0	0	0	0
0	0	1	1	0
0	0	1	1	0
0	0	1	0	0
0	0	0	0	0

Probabilistic Modeling in Renal Scintigraphy

FA + Regions of Interest (FAROI)



0	0	0	0	0
0	0	1	1	0
0	0	1	1	0
0	0	1	0	0
0	0	0	0	0

Each pixel $\mathbf{a}_{i,j}$ in the factor image $\mathbf{a}_j$ has an indicator variable $\mathbf{i}_{i,j}$ such that

$$\mathbf{i}_{i,j} = \begin{cases} 1 & \text{i-th pixel has non-zero activity in the j-th factor,} \\ 0 & \text{i-th pixel has zero activity in the j-th factor.} \end{cases} \quad (2)$$

Probabilistic Modeling in Renal Scintigraphy

FA with Convolution (CFA)

Motivation:

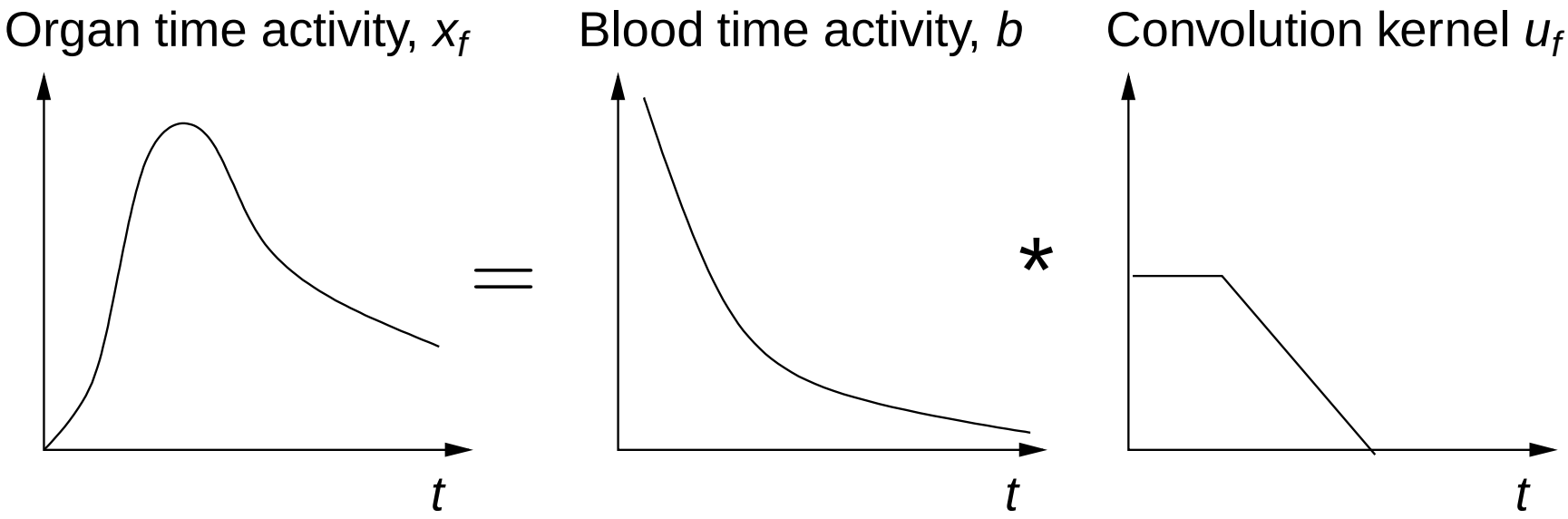
- The time-activity curves of organs are convolution of the input activity (the blood) and organ-specific kernels

Probabilistic Modeling in Renal Scintigraphy

FA with Convolution (CFA)

Motivation:

- The time-activity curves of organs are convolution of the input activity (the blood) and organ-specific kernels
- The shape of the kernels is expected to be formed by a constant plateau followed by monotonic decrease to zero



Clinical Validation

Data

- 107 data sets are available on http://www.dynamicrenalstudy.org/ since March 2012.
- Data are well described.

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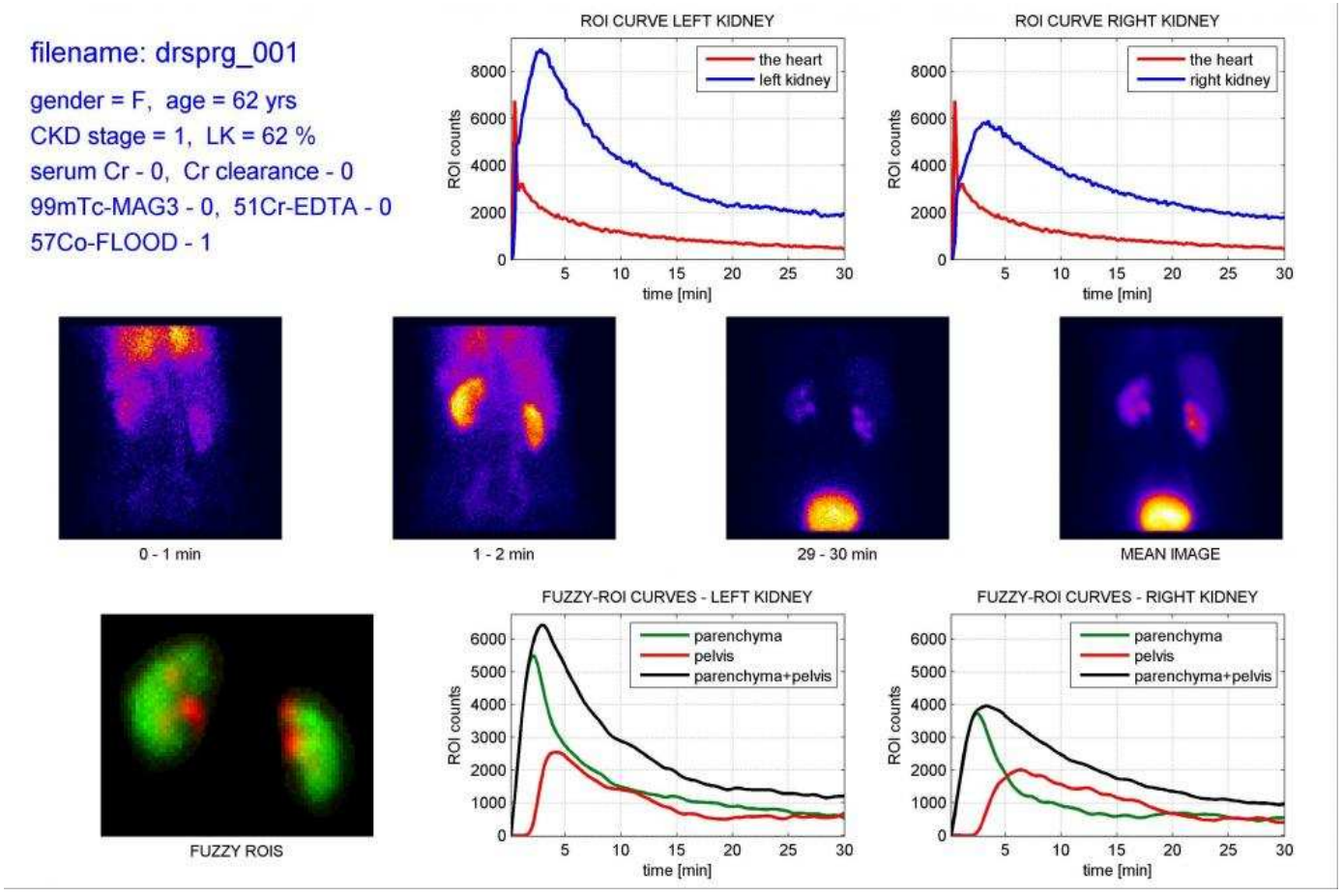

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Data

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- Each dataset: 180 images taken after each 10 seconds as a matrix of 128×128 pixels.

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Data

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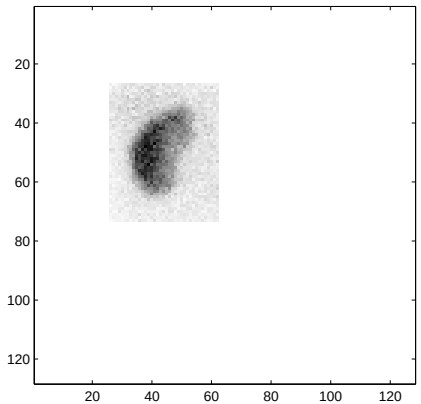
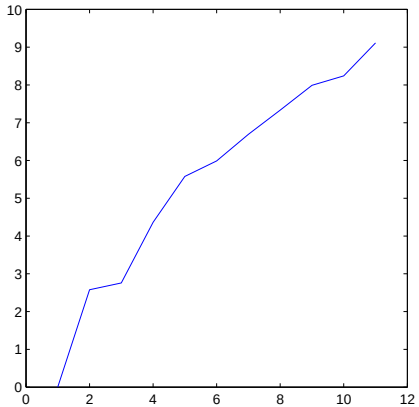
- Each dataset: 180 images taken after each 10 seconds as a matrix of 128×128 pixels.

Our objection:

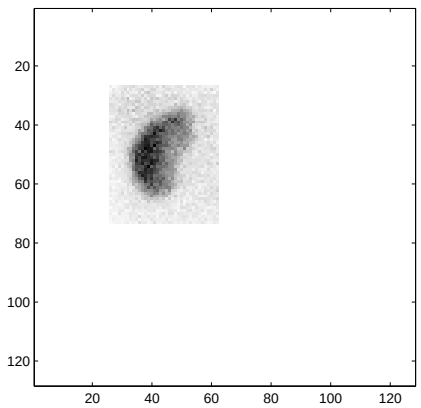
- Assesment of relative renal function using: FA, FAORI, CFA, manualy...

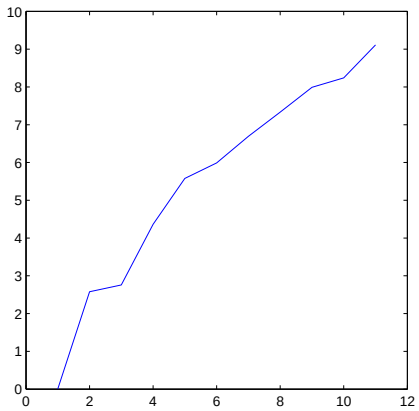
Clinical Validation

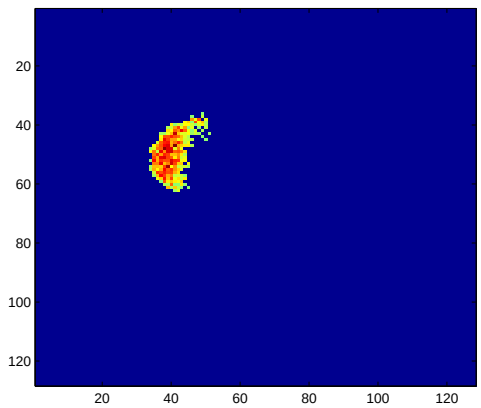




Clinical Validation







- threshold = 0.5

Clinical Validation

Results

- Expert values (from database) are taken as a ground truth.

Clinical Validation

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Algorithm	<3%	<5%	<10%	>10%
manual	18.7%	36.4%	70.8%	29.2%

Clinical Validation

Results

- Expert values (from database) are taken as a ground truth.

Algorithm	<3%	<5%	<10%	>10%
manual	18.7%	36.4%	70.8%	29.2%
FA	23.9%	39.5%	81.2%	18.8%

Clinical Validation

Results

- Expert values (from database) are taken as a ground truth.

Algorithm	<3%	<5%	<10%	>10%
manual	18.7%	36.4%	70.8%	29.2%
FA	23.9%	39.5%	81.2%	18.8%
FAROI	34.3%	54.1%	84.4%	15.6%

Clinical Validation

Results

- Expert values (from database) are taken as a ground truth.

Algorithm	<3%	<5%	<10%	>10%
manual	18.7%	36.4%	70.8%	29.2%
FA	23.9%	39.5%	81.2%	18.8%
FAROI	34.3%	54.1%	84.4%	15.6%
CFA	42.7%	63.5%	89.6%	10.4%

Clinical Validation

Results

- Here, healthy kidneys are taken (RRF $45\% - -55\%$).

Clinical Validation

Results

- Here, healthy kidneys are taken (RRF $45\% - -55\%$).

Algorithm	<3%	<5%	<10%	>10%
manual	27%	59.4%	89.2%	10.8%

Clinical Validation

Results

- Here, healthy kidneys are taken (RRF $45\% - -55\%$).

Algorithm	<3%	<5%	<10%	>10%
manual	27%	59.4%	89.2%	10.8%
FA	27%	40.5%	91.9%	8.1%

Clinical Validation

Results

- Here, healthy kidneys are taken (RRF $45\% - -55\%$).

Algorithm	<3%	<5%	<10%	>10%
manual	27%	59.4%	89.2%	10.8%
FA	27%	40.5%	91.9%	8.1%
FAROI	43.2%	62.1%	94.6%	5.4%

Clinical Validation

Results

- Here, healthy kidneys are taken (RRF $45\% - -55\%$).

Algorithm	<3%	<5%	<10%	>10%
manual	27%	59.4%	89.2%	10.8%
FA	27%	40.5%	91.9%	8.1%
FAROI	43.2%	62.1%	94.6%	5.4%
CFA	43.2%	67.5%	100%	0%

Clinical Validation

Results

- Here, harmed kidneys are taken (RRF $56\% - -99\%$).

Clinical Validation

Results

- Here, harmed kidneys are taken (RRF $56\% - -99\%$).

Algorithm	<3%	<5%	<10%	>10%
manual	10.8%	17.3%	47.8%	52.2%

Clinical Validation

Results

- Here, harmed kidneys are taken (RRF $56\% - -99\%$).

Algorithm	<3%	<5%	<10%	>10%
manual	10.8%	17.3%	47.8%	52.2%
FA	19.5%	39.1%	69.6%	30.4%

Clinical Validation

Results

- Here, harmed kidneys are taken (RRF $56\% - -99\%$).

Algorithm	<3%	<5%	<10%	>10%
manual	10.8%	17.3%	47.8%	52.2%
FA	19.5%	39.1%	69.6%	30.4%
FAROI	26%	43.4%	71.7%	28.3%

Clinical Validation

Results

- Here, harmed kidneys are taken (RRF $56\% - -99\%$).

Algorithm	<3%	<5%	<10%	>10%
manual	10.8%	17.3%	47.8%	52.2%
FA	19.5%	39.1%	69.6%	30.4%
FAROI	26%	43.4%	71.7%	28.3%
CFA	41.3%	58.6%	80.4%	19.6%

Future

- Add information from heart ROI.
- Suppression of background.
- Compare the methods for RRF assesment.

Thank you for your attention.