Fields Multi-Modality Imaging and Modeling

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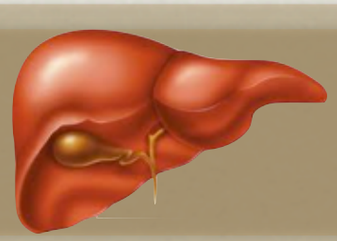
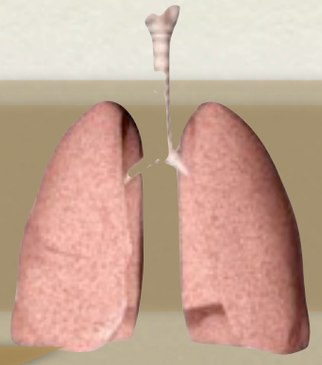
problem by Shuo Li (GE)

Fields Multi-Modality Imaging and Modeling

body part



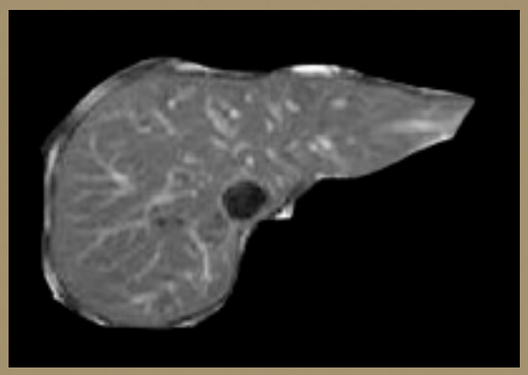


"model"

geometry

material properties

physiological properties



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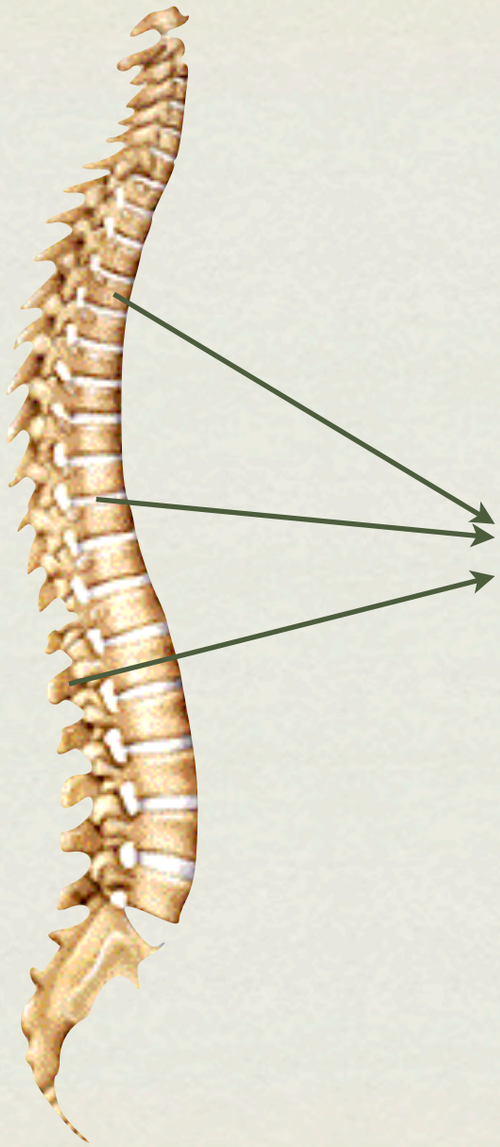
organ



different tissue properties

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scans

multiple modalities (ct, mri, pet, …)

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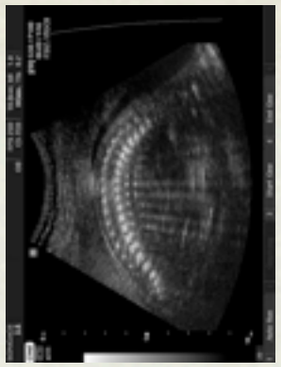

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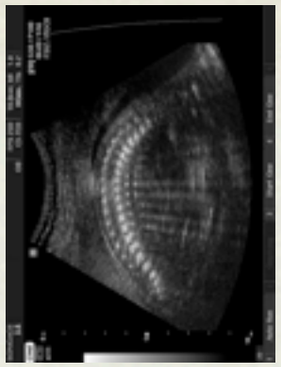
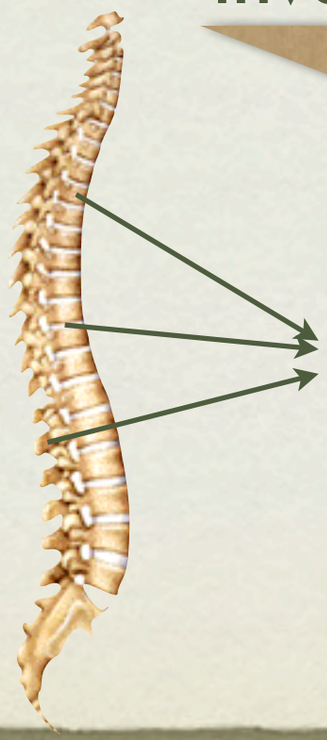


inverse problem



different tissue properties

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application

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application

baby girl is born

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application

baby girl is born

create a model for the baby

population statistics for girls

amniocentesis

blood sample

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4 weeks-old

How healthy is her spine?

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4 weeks-old

How healthy is her spine?

population statistics + particular information

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4 weeks-old

How healthy is her spine?

population statistics + particular information

likelihood that the

spine is healthy

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take a ct scan

update the tissue properties in the model

compare tissue properties of spine → particular girl

compare tissue properties of spine → healthy average girl

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take a ct scan

update the tissue properties in the model

new information

population statistics

simulate mri scan

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keep updating model

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keep updating model

new scans of the girl

new modalities

each addition to the girl's model

adds to the population statistics

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toy problem

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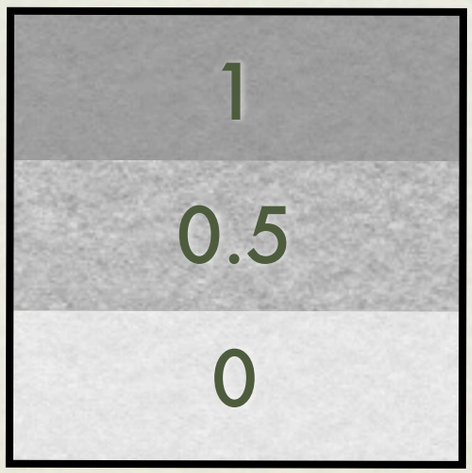
toy problem

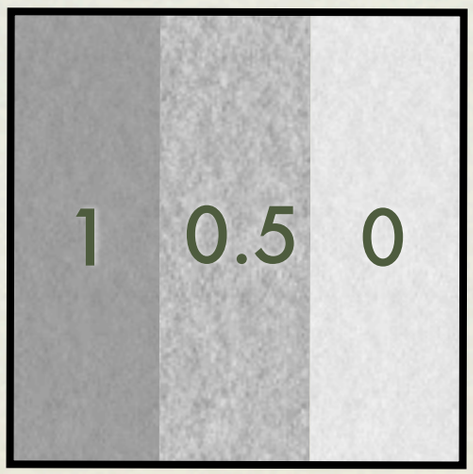
1 organ

tissue properties

cuteness (C)



fluffiness (F)



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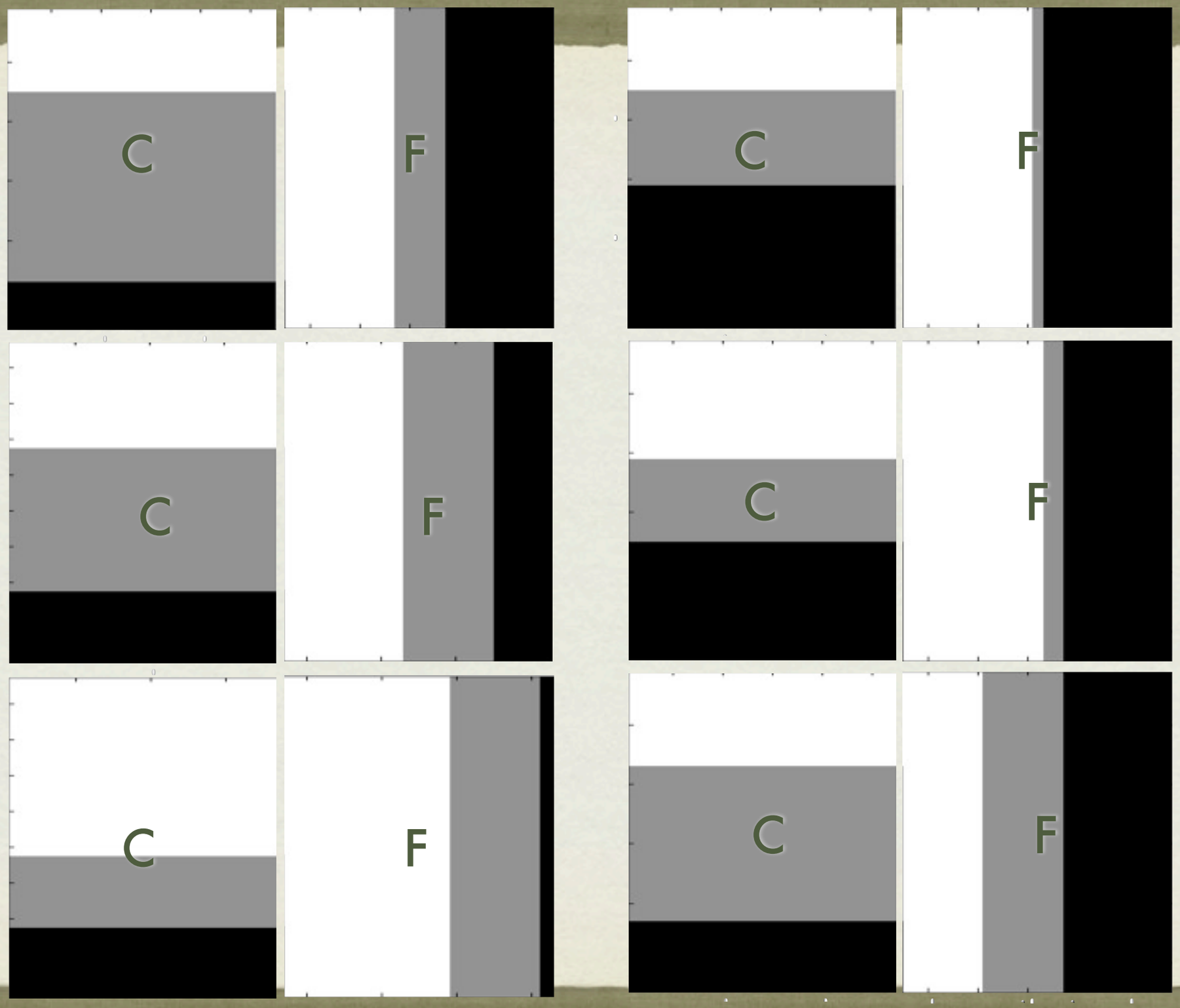
toy problem



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toy problem

simulate scans

2 modalities

scan A

$$\alpha(C, F) = \omega_A C + (1 - \omega_A) F$$

scan B

$$\beta(C, F) = \omega_B C + (1 - \omega_B) F$$

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toy problem

acquire material properties from scans

method 1

minimize $\mathcal{J}(C,F) = \|\alpha(C,F) - I_A\|_2^2 + \|\beta(C,F) - I_B\|_2^2$

least squares with constraints

obtain tissue characteristics for each weeble

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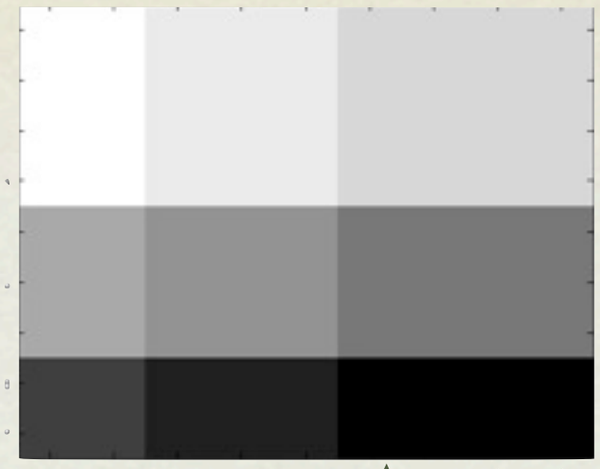
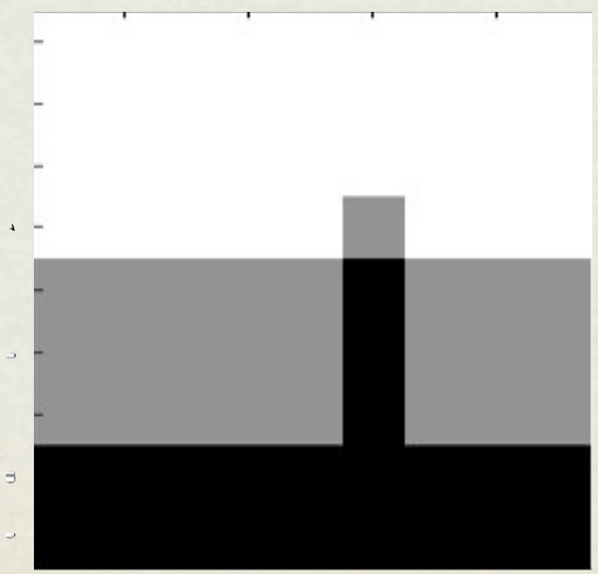
toy problem

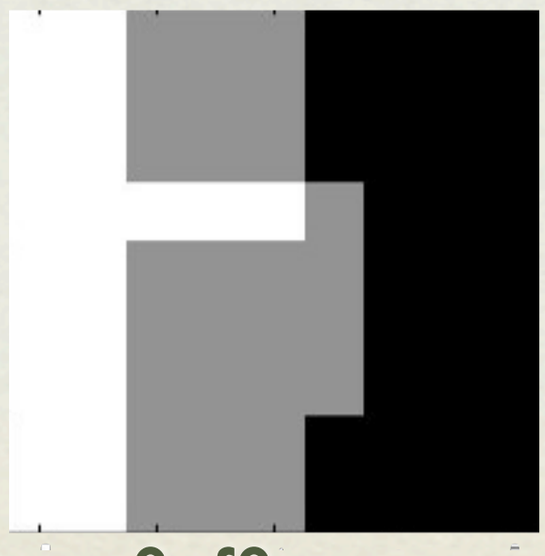


scan A

scan B



cuteness



fluffiness

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toy problem

acquire material properties from scans

method 2

learning algorithm

no assumption on forward functions

$$\alpha(C, F) \qquad \beta(C, F)$$

obtain tissue characteristics for each weeble

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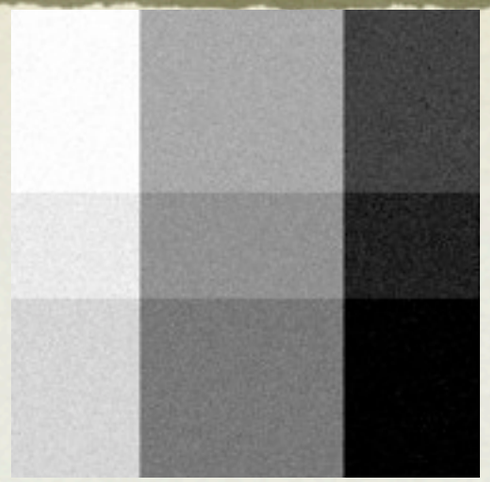
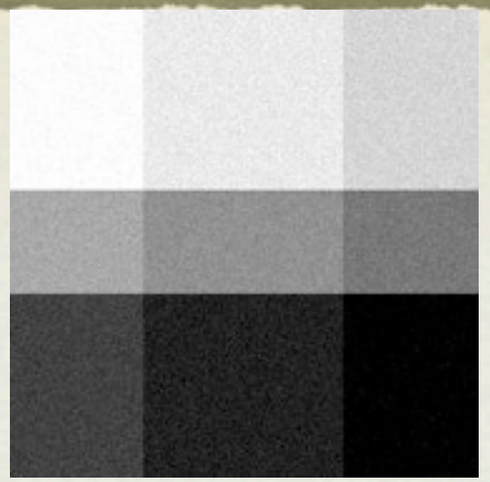
toy problem



scan A



scan B

cuteness

fluffiness

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toy problem

training data

forward functions

$\alpha(C, F)$ $\beta(C, F)$

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toy problem

scan A

C	F
1	1
1	0.5
1	0
0.5	1
0.5	0.5
0.5	0
0	1
0	0.5
0	0

$\alpha(C, F)$

$\alpha(C, F)$
1
0.9
0.8
0.6
0.5
0.4
0.2
0.1
0

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toy problem

scan A

scan B

C	F	$\alpha(C,F)$
1	1	1
1	0.5	0.9
1	0	0.8
0.5	1	0.6
0.5	0.5	0.5
0.5	0	0.4
0	1	0.2
0	0.5	0.1
0	0	0

C	F	$\beta(C,F)$
1	1	1
1	0.5	0.6
1	0	0.2
0.5	1	0.9
0.5	0.5	0.5
0.5	0	0.1
0	1	0.8
0	0.5	0.4
0	0	0

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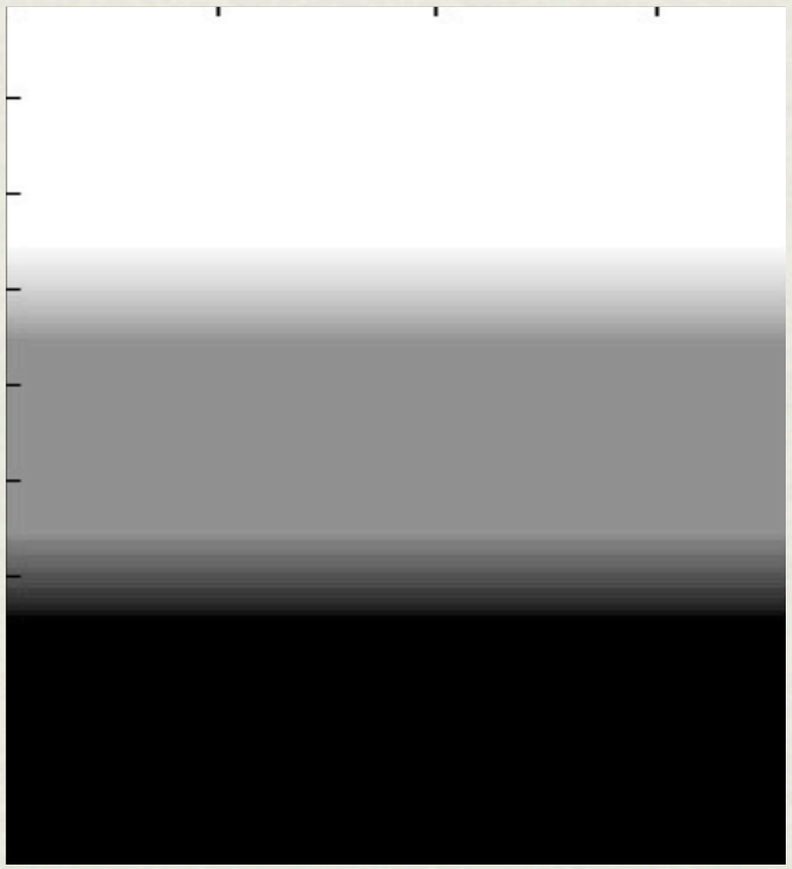
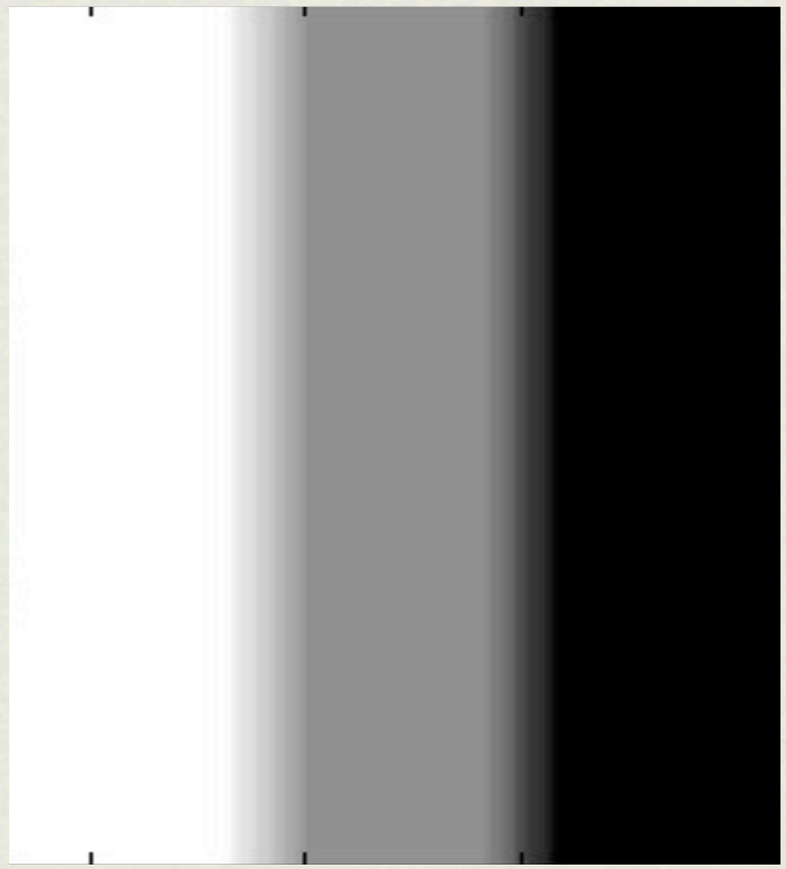
toy problem

average healthy weeble



cuteness



fluffiness

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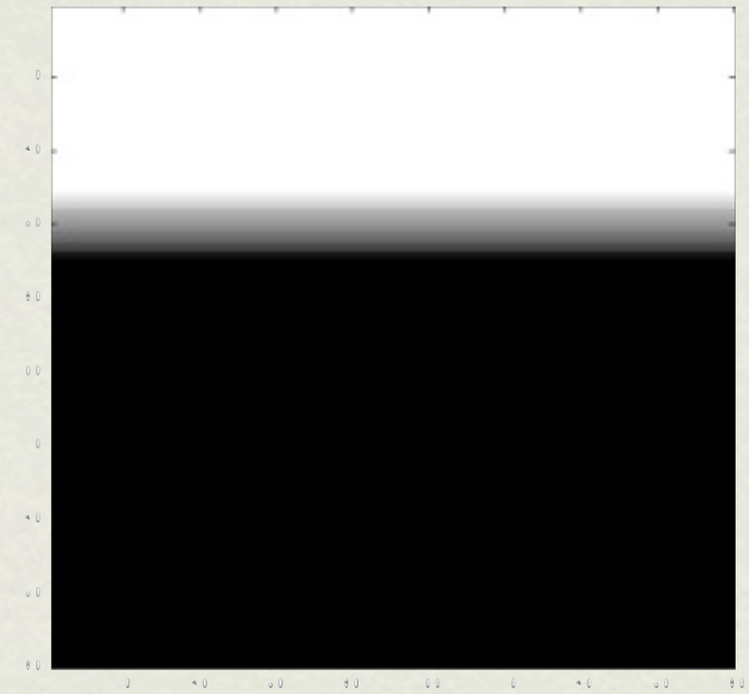
toy problem

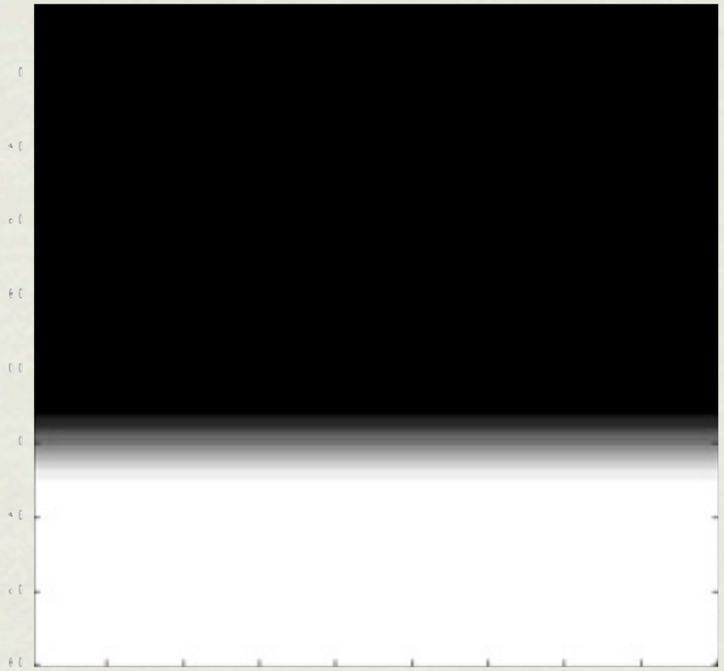
average healthy weeble

$P(C = 1)$



$P(C = \frac{1}{2})$

$P(C = 0)$



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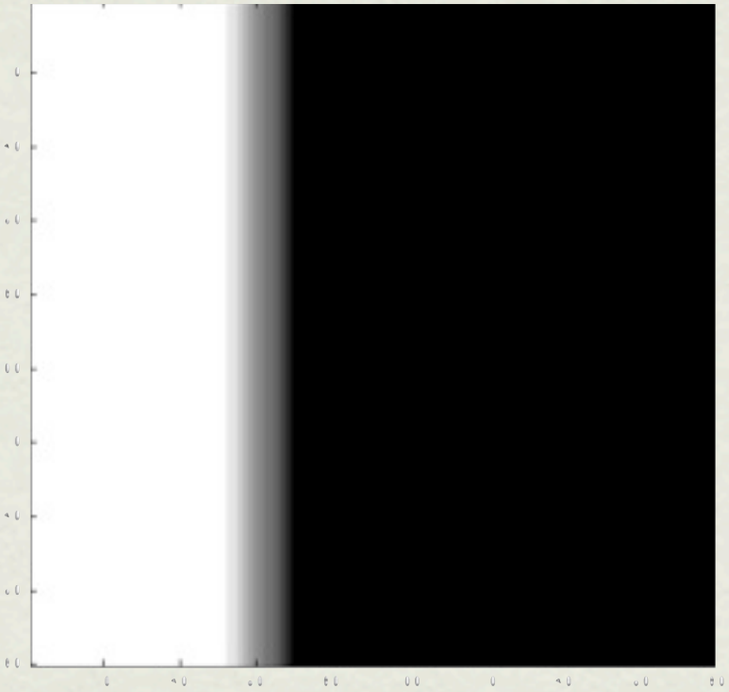
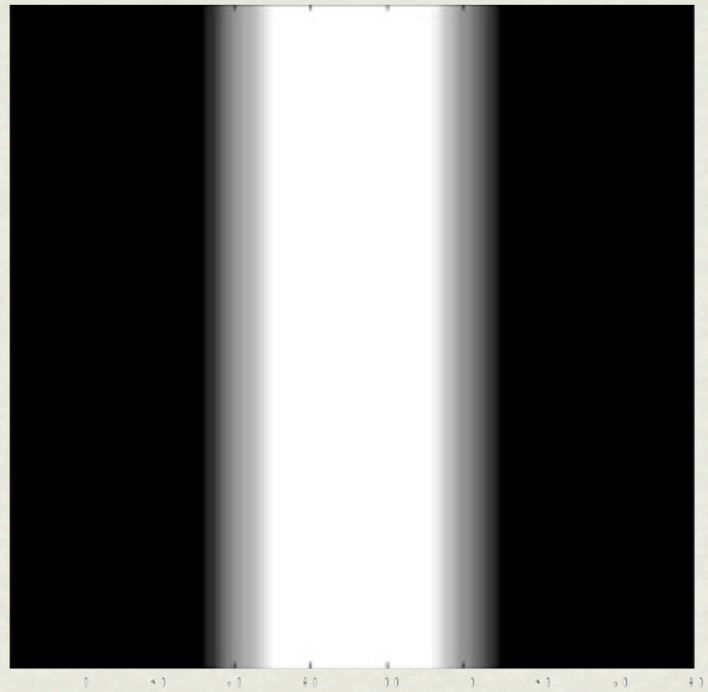
toy problem

average healthy weeble

$P(F = 1)$



$P(F = \frac{1}{2})$



$P(F = 0)$

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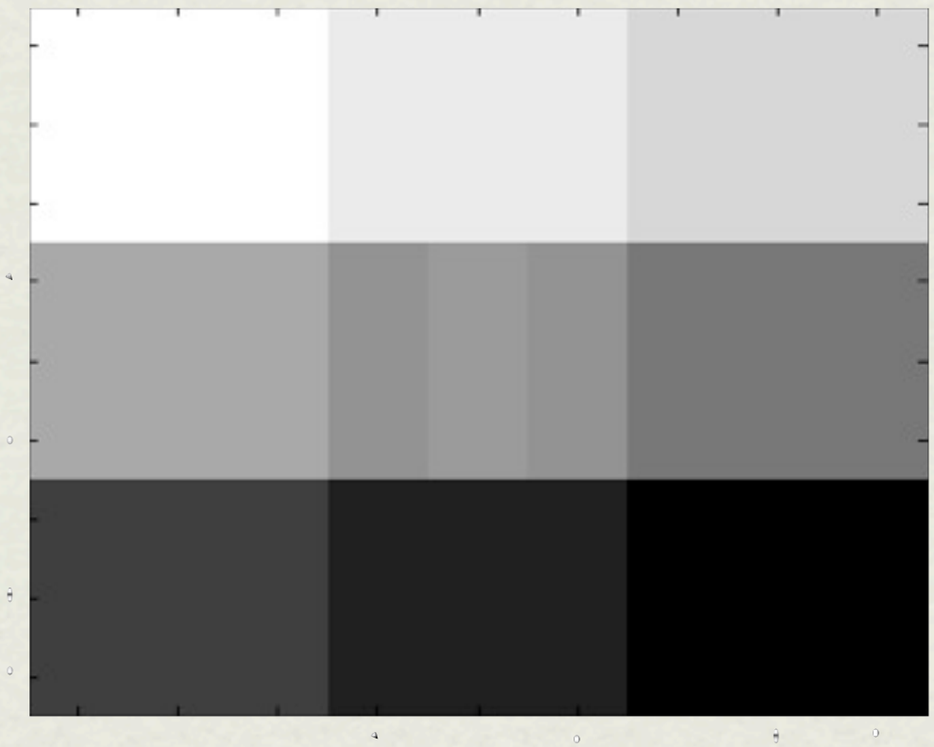
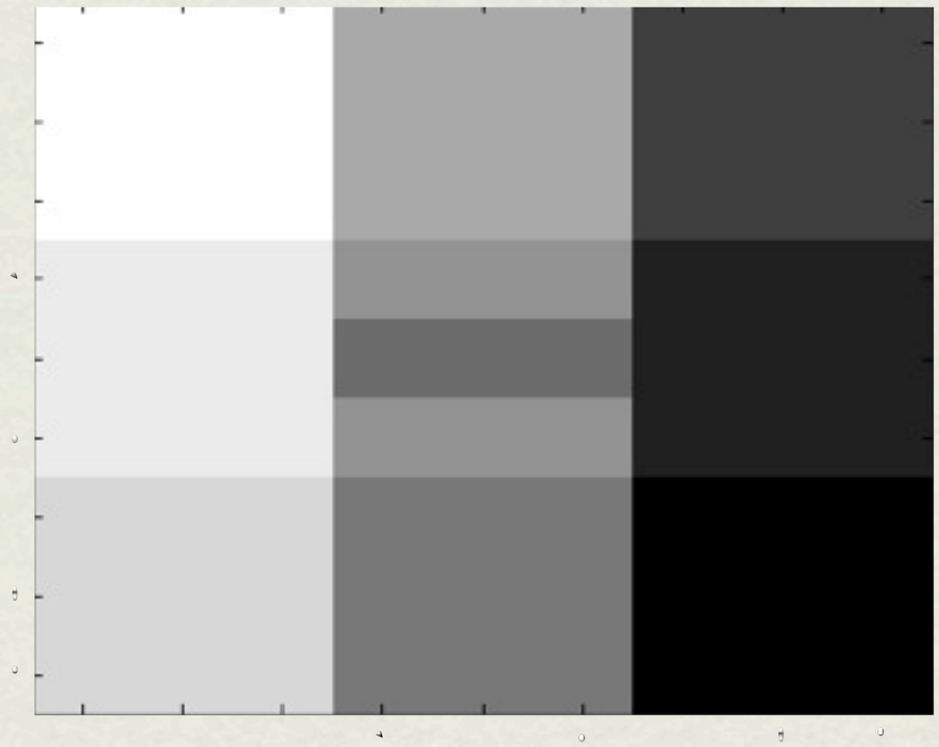
toy problem

abnormal weeble



scan A



scan B

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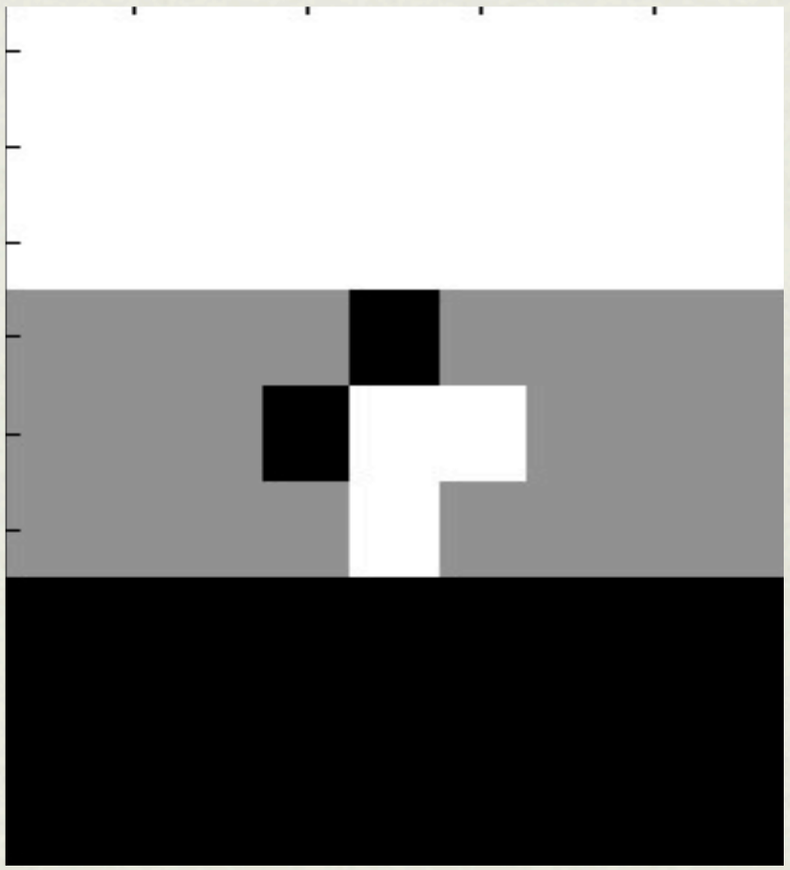
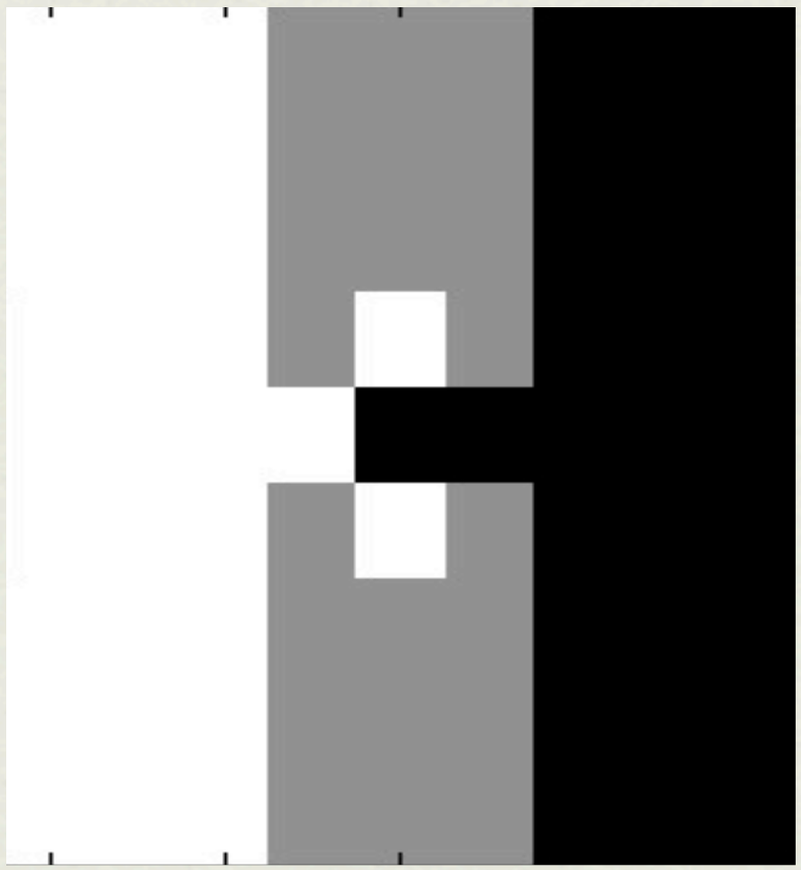
toy problem

abnormal weeble



cuteness



fluffiness

Fields Multi-Modality Imaging and Modeling

future work – real setting

Fields Multi-Modality Imaging and Modeling

future work – real setting

how to derive tissue properties from scans (ct, mri, …)

Fields Multi-Modality Imaging and Modeling

future work – real setting

how to derive tissue properties from scans (ct, mri, …)

how to simulate scans (ct, mri, …)

Fields Multi-Modality Imaging and Modeling

future work – real setting

how to derive tissue properties from scans (ct, mri, …)

how to simulate scans (ct, mri, …)

large data set of medical images and real tissue properties (atlas)

Fields Multi-Modality Imaging and Modeling

future work – real setting

how to derive tissue properties from scans (ct, mri, …)

how to simulate scans (ct, mri, …)

large data set of medical images and real tissue properties (atlas)

good algorithm to compare tissue properties to detect abnormalities