

A faint, light gray world map is visible in the background, centered behind the text.

Monte Carlo Method in Image Segmentation

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Introduction

[1] Angelova, D. , & Mihaylova, L. . (2011). *Contour segmentation in 2D ultrasound medical images with particle filtering*. Springer-Verlag New York, Inc.

[2] Erdil, E. , Yıldırım, Sinan, Çetin, Müjdat, & Taşdizen, Tolga. (2016). Mcmc shape sampling for image segmentation with nonparametric shape priors.

- Why I choose these two papers?
- Why is it interesting and important?

Partition the image into meaningful (homogeneous) regions.

How these two papers are related:

They both need prior information about object shape.

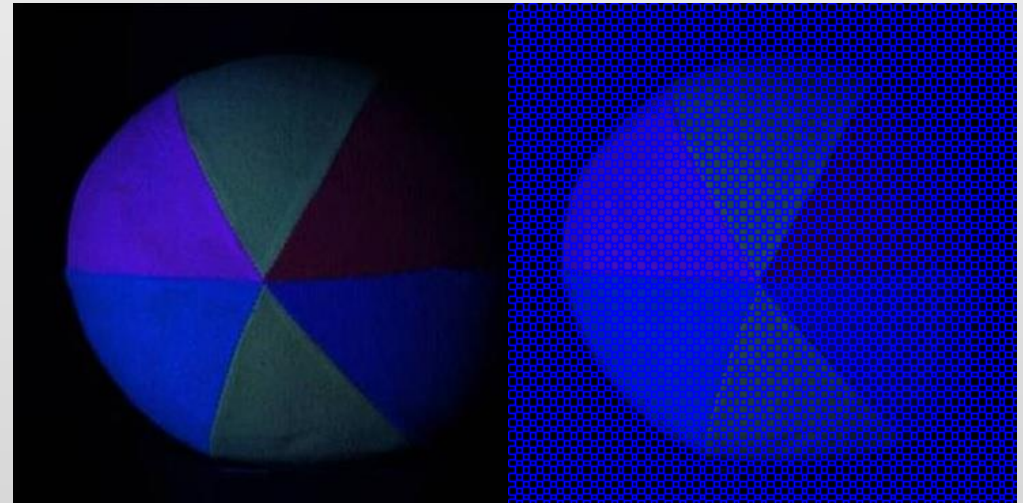
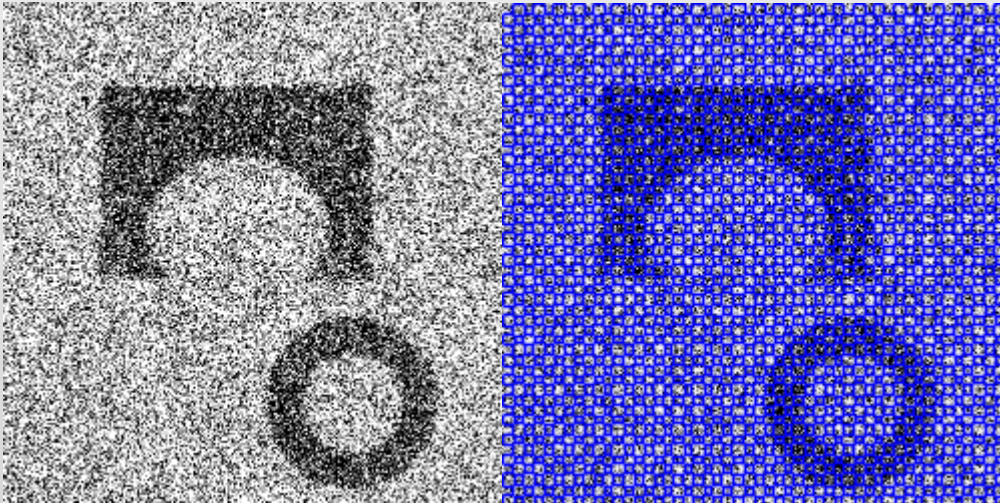
They both based on Monte Carlo Algorithm.

They both want to combine shape information and data in a Bayesian framework.

They both based on active contours.

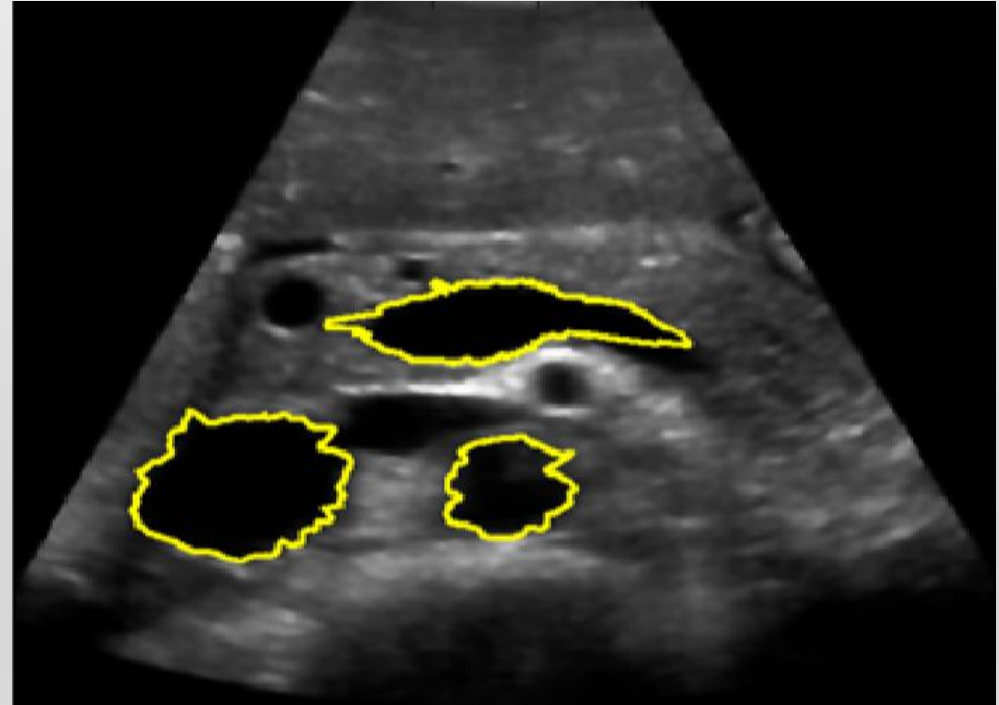
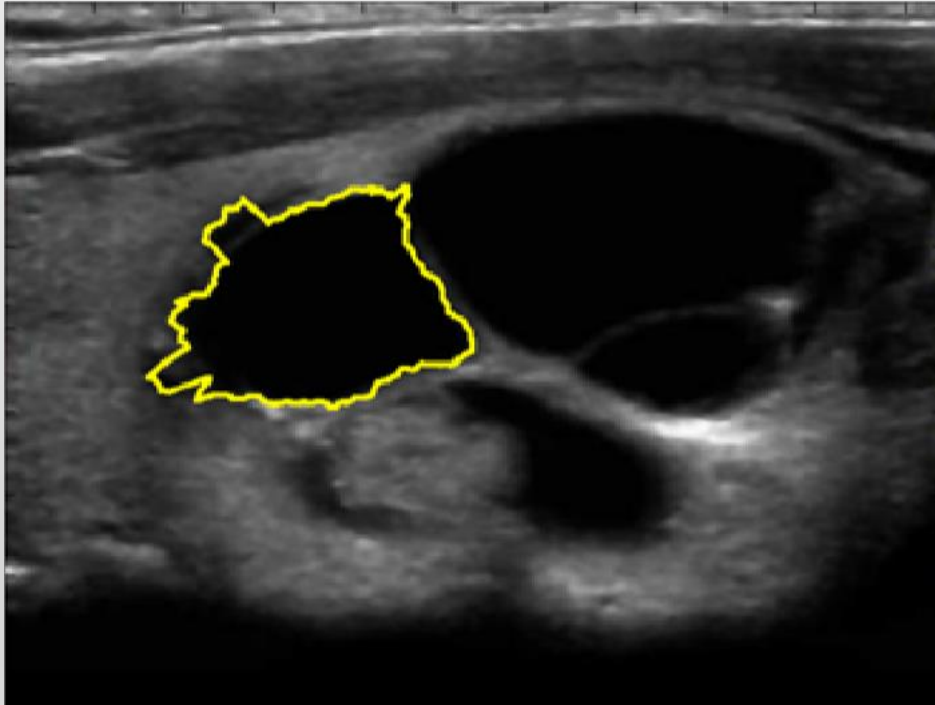
They both aim to do segmentation in complicated images.

Background: Active Contours, Snakes

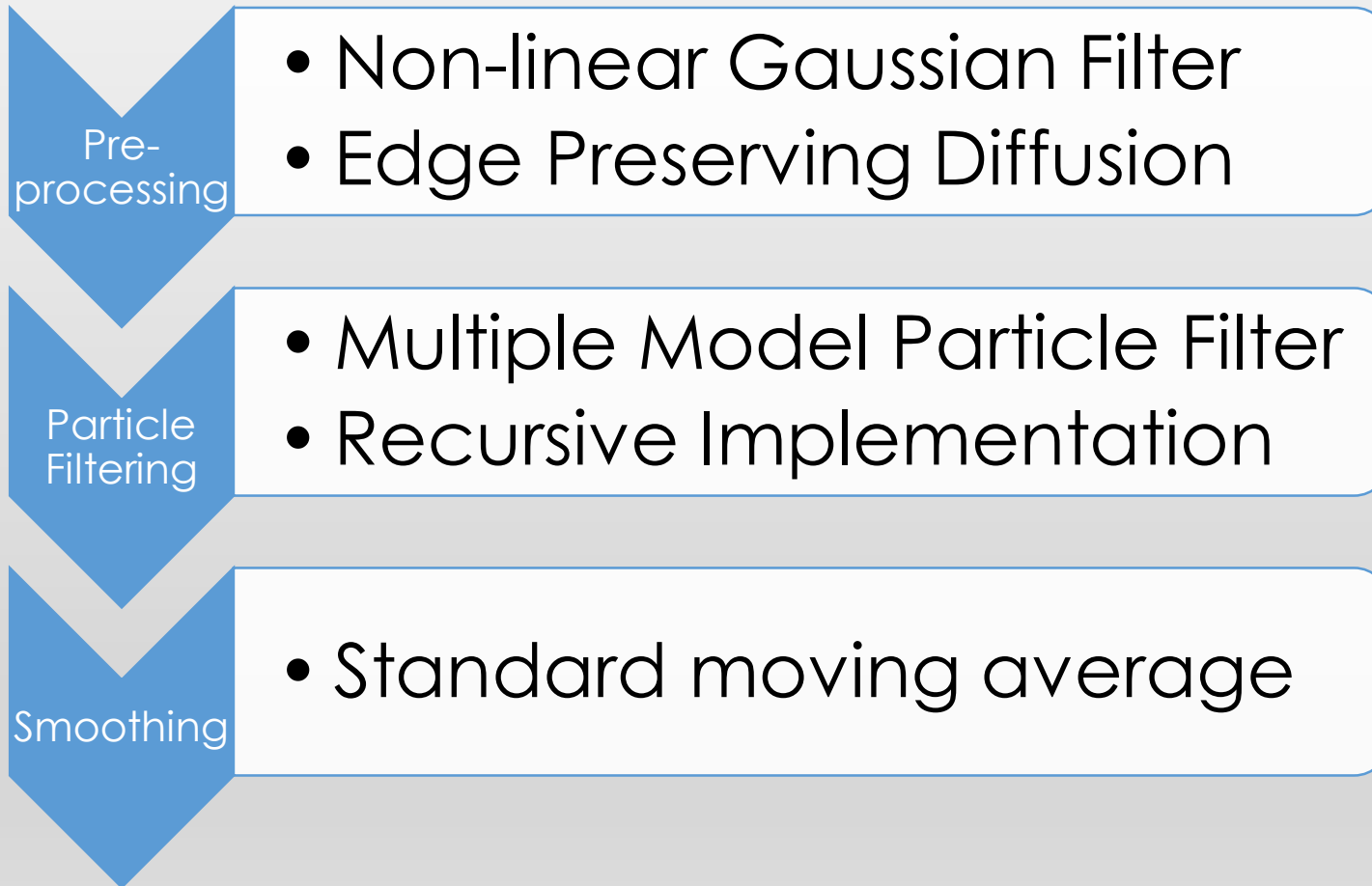


Contour segmentation in 2D ultrasound medical images with particle filtering

- Goal: Extracting lesion contours in ultrasound medical images.



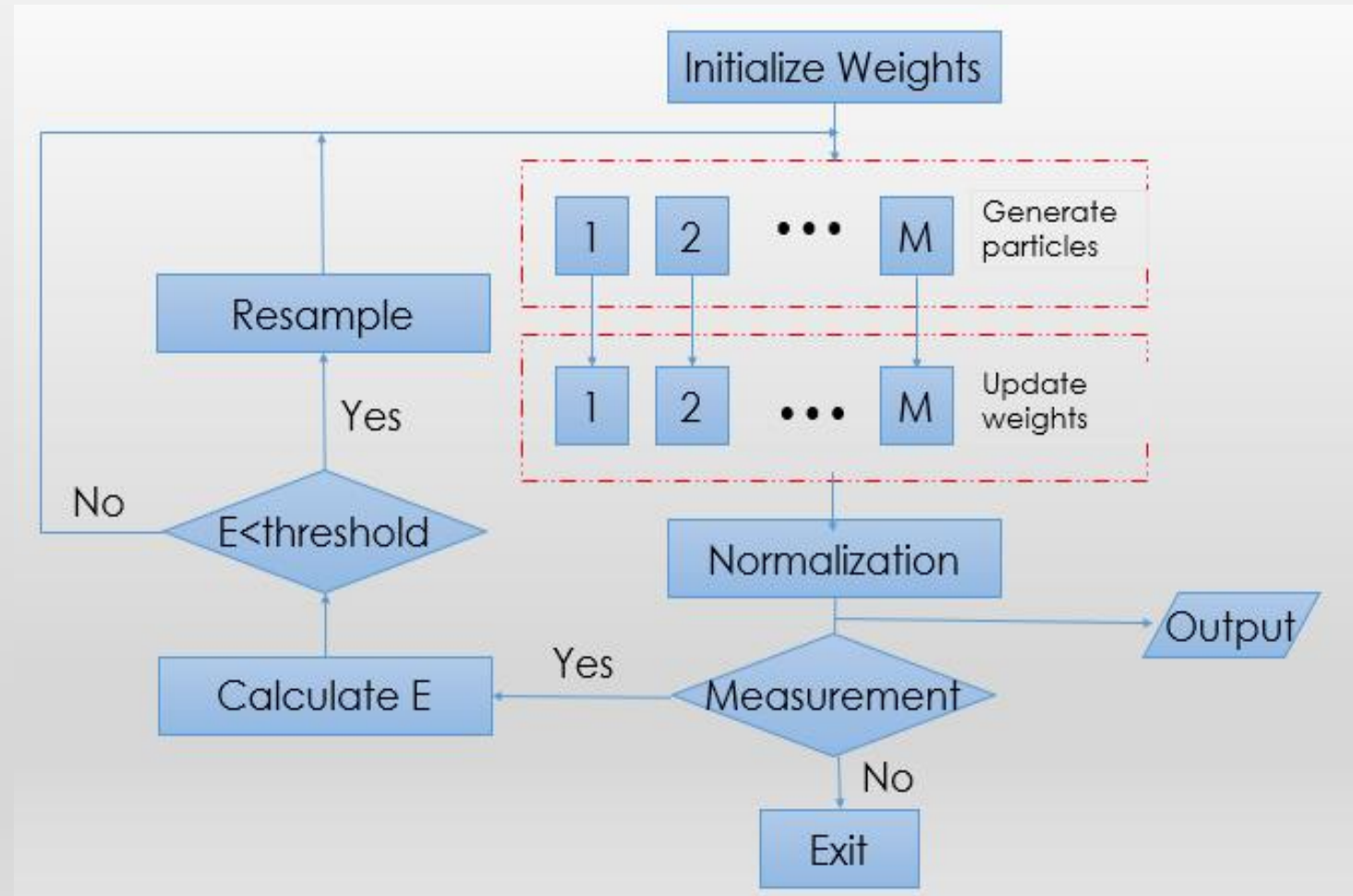
Method including 3 steps



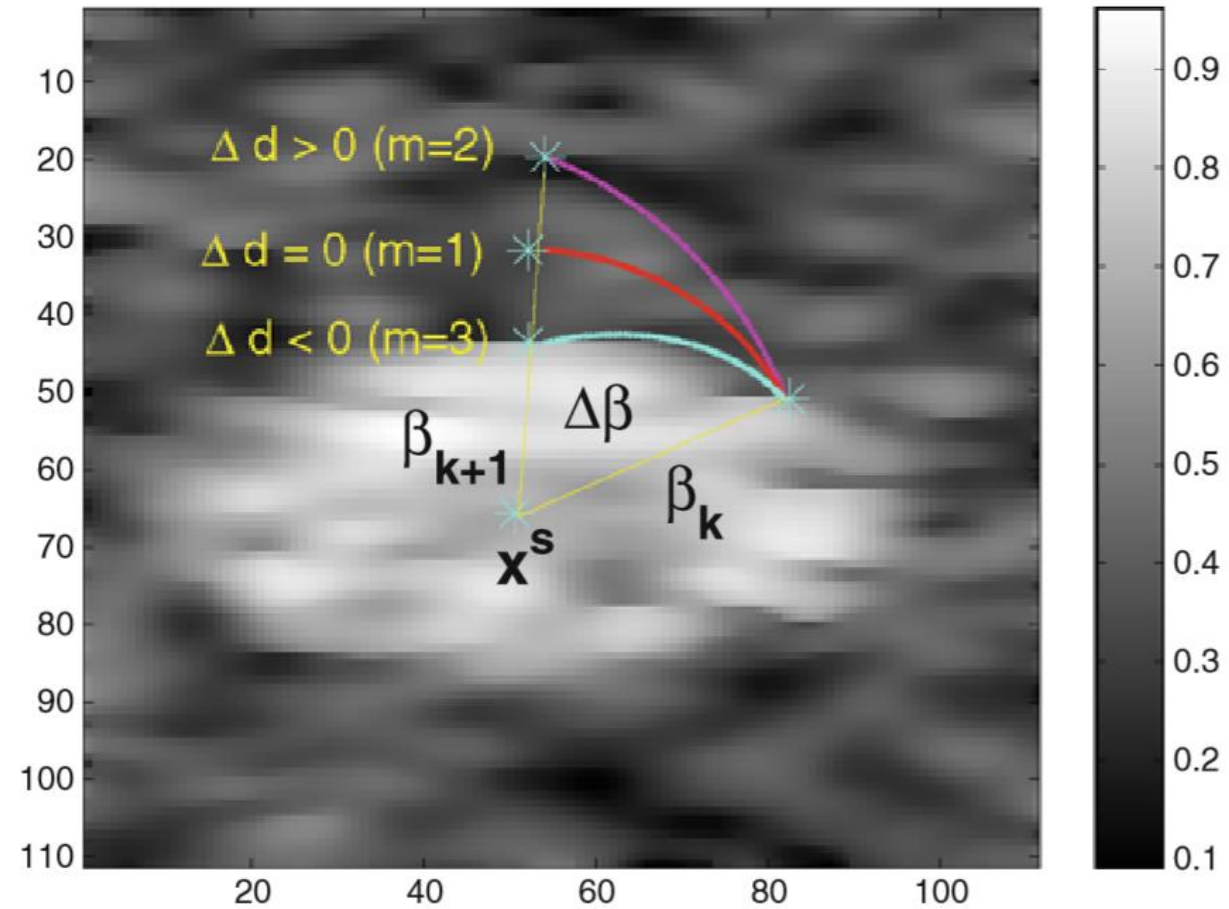
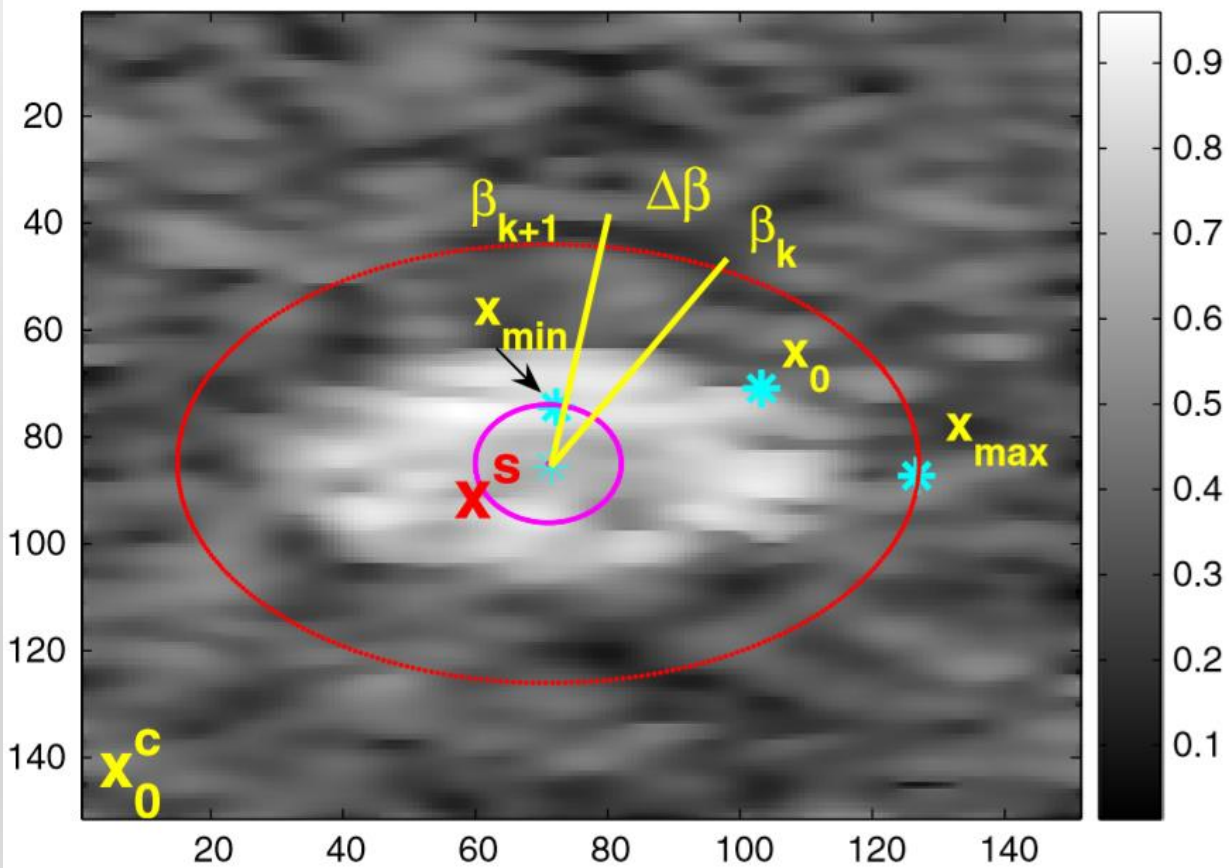
Key point: MMPF

Particle Filter

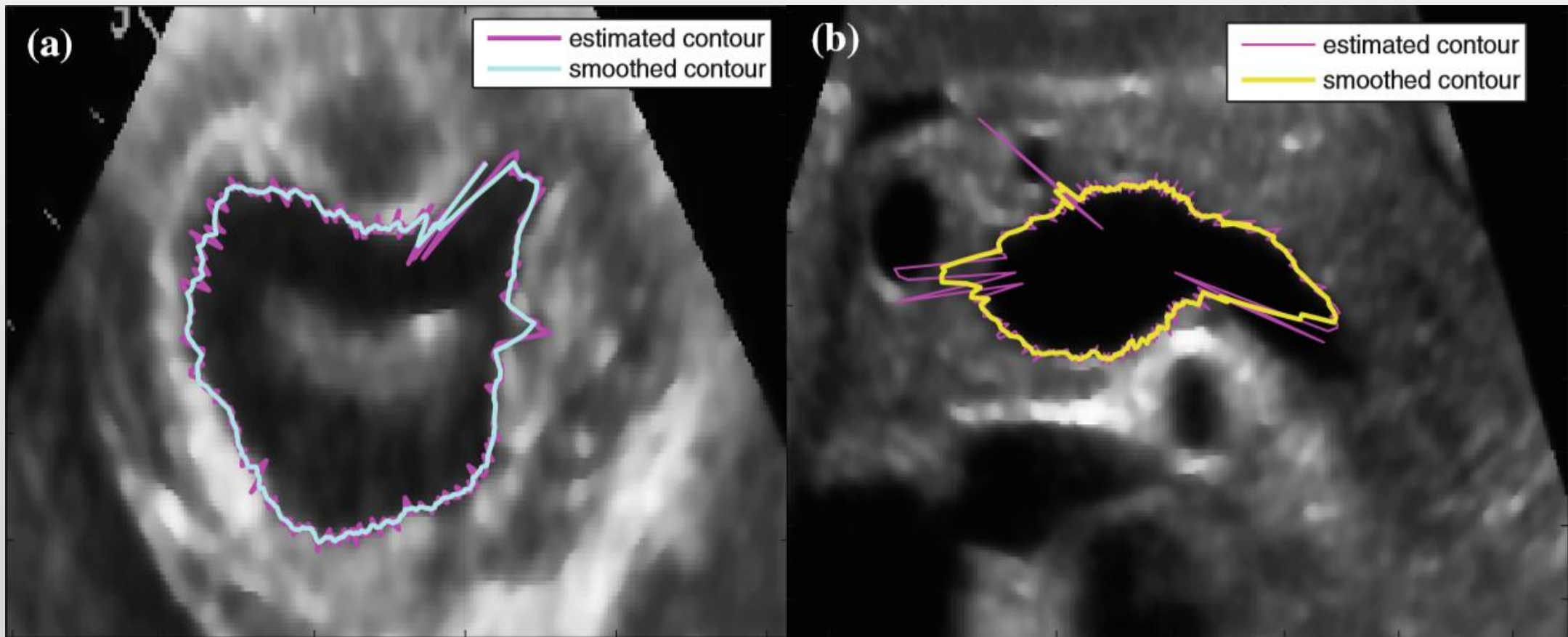
- Particles
- Measurement Space
- State Space



Particle Filter (MMPF)

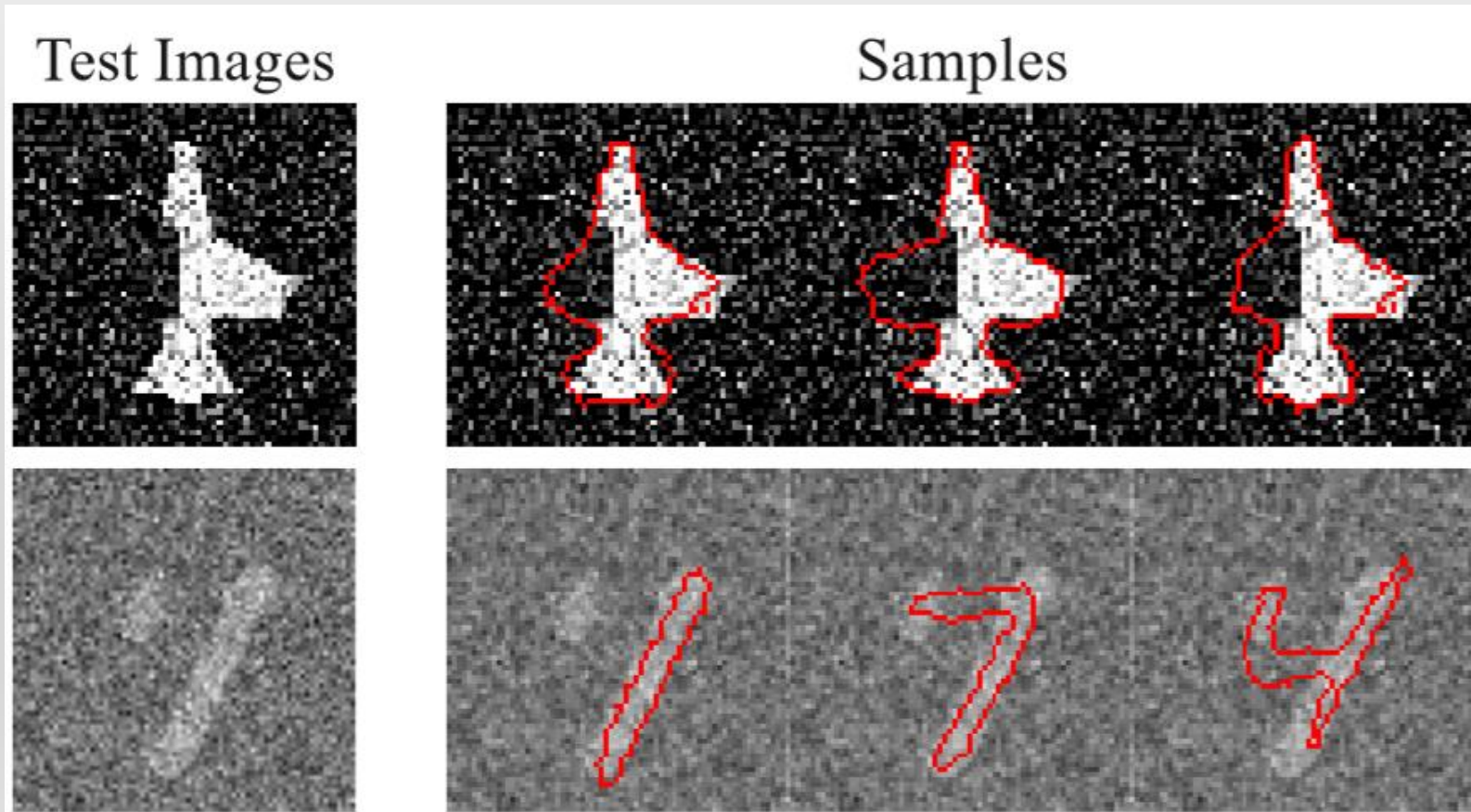


Results

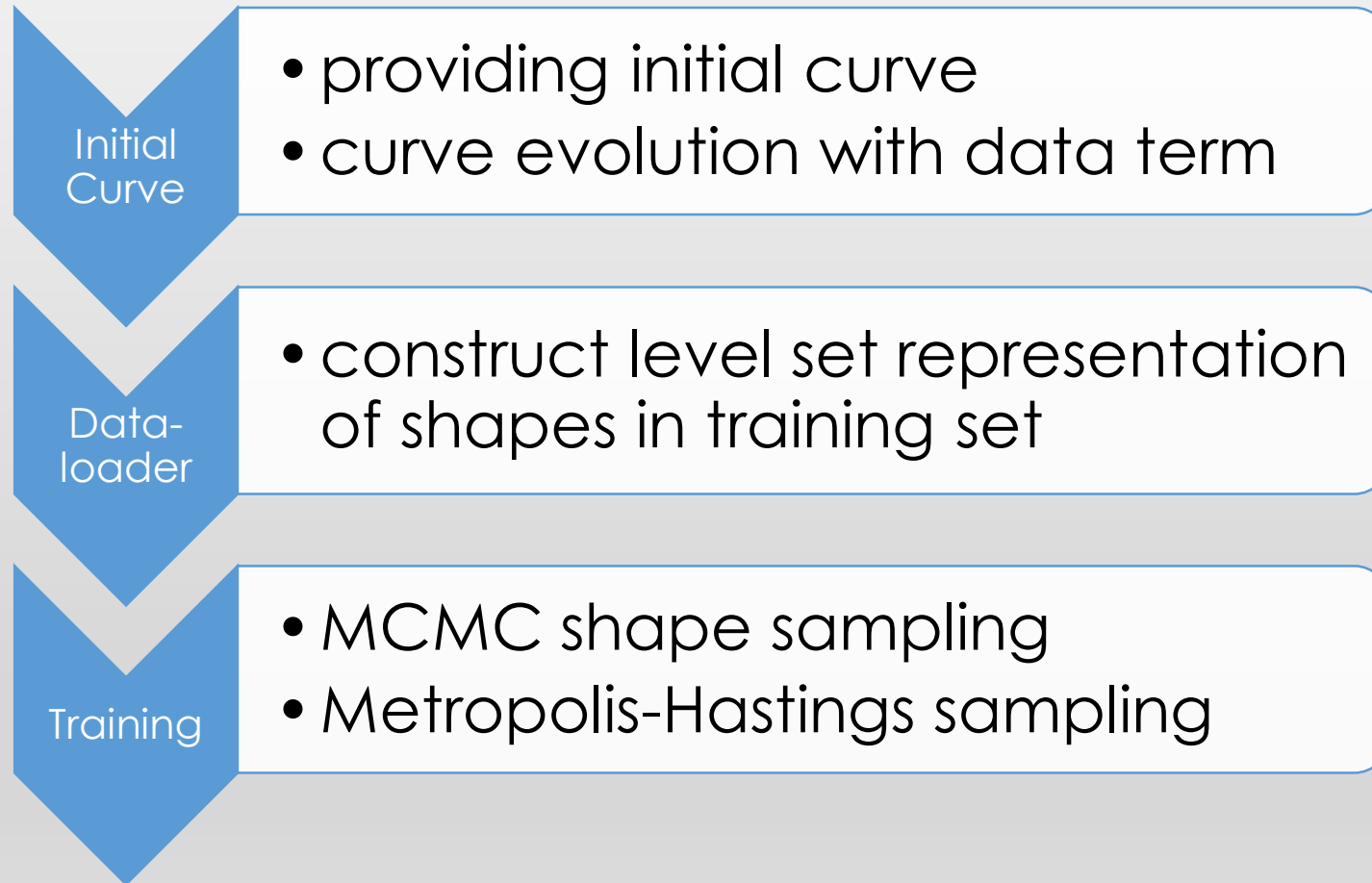


MCMC Shape Sampling for Image Segmentation with Nonparametric Shape Priors

- Goal: segment image with occluded objects or low-quality images.



Method including 3 steps



Key point: MCMC using Metropolis-Hastings sampling

Metropolis–hastings Algorithm

Algorithm 1 MCMC Shape Sampling

```
1: for  $i = 1 \rightarrow M$  do            $\triangleright M$  : # of samples to be generated
2:   Randomly select class of  $C^{(0)}$  as introduced in Section 4.1.
3:   for  $t = 0 \rightarrow (N - 1)$  do    $\triangleright N$  : # of sampling iterations
4:     Generate candidate sample  $\tilde{C}^{(t+1)}$  from curve  $\tilde{C}^{(t)}$  as introduced in Section 4.2.
            $\triangleright$  The steps between 5 - 10 are introduced in Section 4.3
5:     Calculate Metropolis-Hastings ratio,  $Pr$ 
6:      $\eta = \mathcal{U}_{[0,1]}$ 
7:     if  $(t + 1) = 1$  OR  $\eta < Pr$  then
8:        $\tilde{C}^{(t+1)} = \tilde{C}^{(t+1)}$             $\triangleright$  Accept the candidate
9:     else
10:       $\tilde{C}^{(t+1)} = \tilde{C}^{(t)}$             $\triangleright$  Reject the candidate
11:    end if
12:  end for
13: end for
```

$$Pr[C^{(t+1)} = \mathcal{C}^{(t+1)} | C^{(t)}] = \min \left[\underbrace{\frac{\pi(\mathcal{C}^{(t+1)})}{\pi(C^{(t)})} \cdot \frac{q(C^{(t)} | \mathcal{C}^{(t+1)})}{q(\mathcal{C}^{(t+1)} | C^{(t)})}}_{\text{Metropolis-Hastings ratio}}, 1 \right]$$

Implementation (Code)

- 1. Load the data (train & test).
- 2. Providing initial curve.
- 3. Construct level set representation of shapes in training set.
- 4. Curve evolution with data term.
- 5. MCMC shape sampling.

Implementation (MNIST)

GeForce Experience
League of Legends
Steam
Microsoft Edge
Microsoft Teams
微信
PUBG
PLAYERUNKNOWN'S BATTLEGROUNDS
MATLAB R2019b
Counter-Strike: Global Offensive

录制已开始

MATLAB R2019b - academic use

主 页 绘图 APP 编辑器 发布 视图

新建 打开 保存 比较 查找文件 转至 注释 插入 断点 运行 运行并前进 运行并计时

文件 编辑 断点 运行

当前文件夹: D:\MyDoc\cvpr16-master\cvpr16-master

名称

- aircraft
 - Results
 - testImages
 - trainingShapes
- MNIST
 - Results
 - testImages
 - trainingShapes
- compile_mex_files.m
- createNarrowBand.m
- curvature.m
- evaluateEnergyWithDataTerm.m
- evaluateEnergyWithShapePrior.c
- evaluateEnergyWithShapePrior.mexw64
- EvolveWithDataTerm.c
- EvolveWithDataTerm.mexw64
- generateLevelSet.m
- initialLevelSet.m
- LICENSE
- main_mcmc_shape_sampling.asv
- main_mcmc_shape_sampling.m
- mcmcShapeSampling.c
- mcmcShapeSampling.mexw64

编辑器: D:\MyDoc\cvpr16-master\cvpr16-master\main_mcmc_shape_sampling.m

```
1 clear all
2 close all
3 clc
4
5 imageId = '01';
6 datasetName = 'MNIST'; % set 'MNIST' or 'aircraft'
7 load(sprintf('%s/testImages/testImage%s', datasetName, imageId)); % load test image
8
9 if(strcmp(datasetName, 'aircraft') == 1)
10     % training set with the corresponding imageId in the trainingShapes
11     % folder does not include the test image with imageId, i.e., works in
12     % leave-one-out fashion.
13     load(sprintf('%s/trainingShapes/trainingSet%s', datasetName, imageId)); % load training shapes. Contains (sz_i x
14 else
15     load(sprintf('%s/trainingShapes/trainingSet', datasetName)); % load training shapes. Contains (sz_i x sz_j) x #c
16 end
17
```

工作区

名称	值
acceptedCount	1
AlignedShapeMatrix	4900x100 double
alpha	5
beta	1
currentCurve	70x70 double
currentSelectedClassId	0
currentSelectedShapeId	0
curShape	70x70 double
datasetName	'MNIST'
dir	6x1 struct
display	1
dt	0.2000
dummy	70x70 double
EHistory	30x100 double
energyCandidate	Inf
energyCurrent	Inf
gamma	1
hastingRatio	NaN
i	9
I1	70x70 logical
imageId	'02'
isOccludedRegionKnown	0
j	3
k	10
kappa	70x70 double
mhThreshold	0.2979
minusLogpOfDataCandi...	0
minusLogpOfDataCurrent	0
narrowBand	70x70 double
num	3
numberOfClasses	10
numberOfIterationForSi...	10
numberOfIterations	10
numberOfSamples	100
numberOfSamplingIters...	10

命令行窗口

不熟悉 MATLAB? 请参阅有关快速入门的资源。

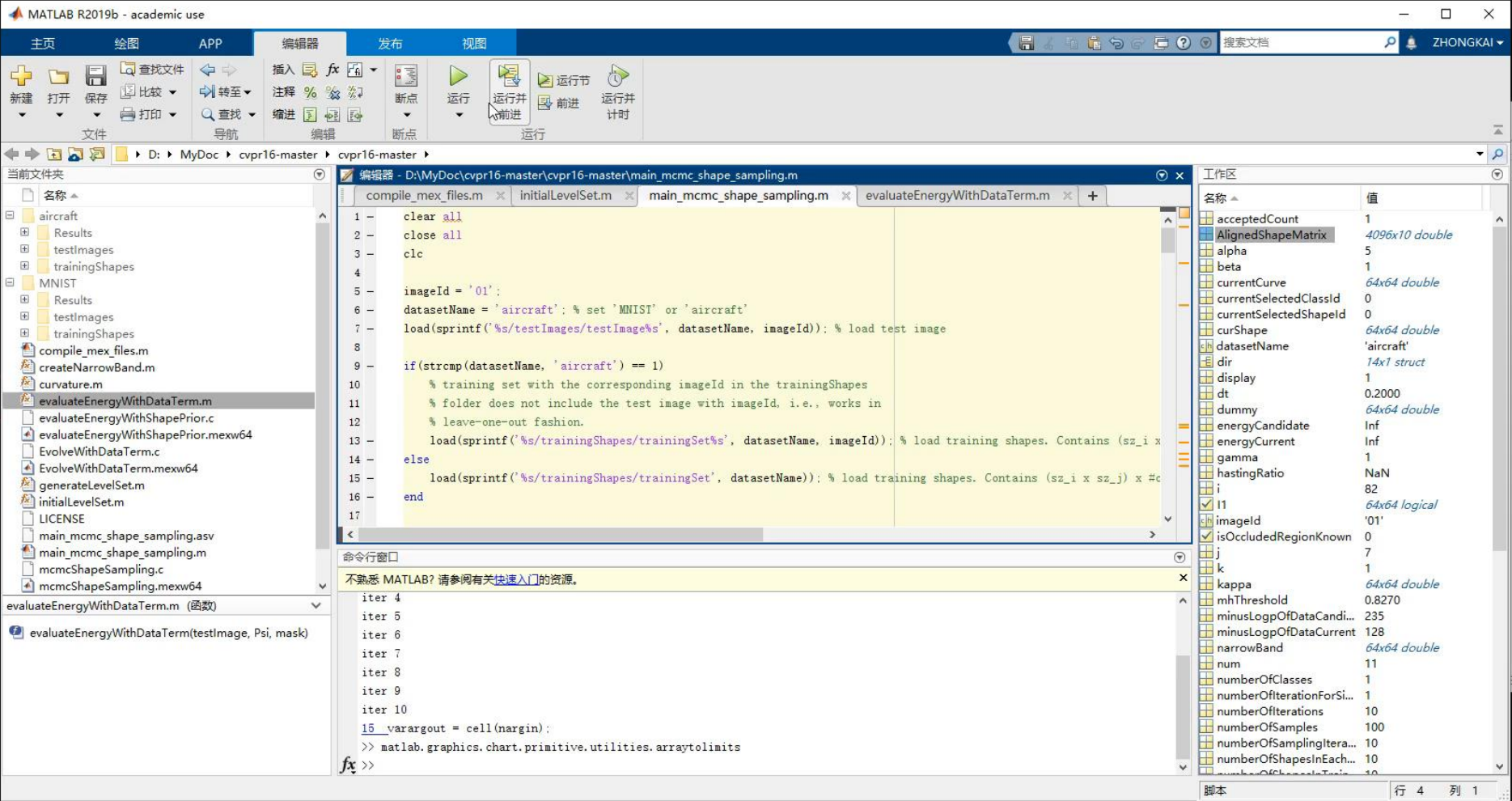
```
iter 4
iter 5
iter 6
iter 7
iter 8
iter 9
iter 10
11 set(obj, pvpairs{:});
>> main_mcmc_shape_sampling
```

正忙

脚本 行 1 列 10

Windows 任务栏: 14:57 2019/12/11

Implementation (Aircraft_1)



The MATLAB R2019b interface is shown, displaying the implementation of the Aircraft_1 dataset. The main window shows the script 'main_mcmc_shape_sampling.m' in the editor. The script includes code for loading training and test images, setting parameters, and running the MCMC sampling process. The command window shows the execution progress, including iterations and a final varargout cell. The workspace window lists various variables and their values.

Script Content (main_mcmc_shape_sampling.m):

```
1 clear all
2 close all
3 clc
4
5 imageId = '01';
6 datasetName = 'aircraft'; % set 'MNIST' or 'aircraft'
7 load(sprintf('%s/testImages/testImage%s', datasetName, imageId)); % load test image
8
9 if(strcmp(datasetName, 'aircraft') == 1)
10     % training set with the corresponding imageId in the trainingShapes
11     % folder does not include the test image with imageId, i.e., works in
12     % leave-one-out fashion.
13     load(sprintf('%s/trainingShapes/trainingSet%s', datasetName, imageId)); % load training shapes. Contains (sz_i x
14 else
15     load(sprintf('%s/trainingShapes/trainingSet', datasetName)); % load training shapes. Contains (sz_i x sz_j) x #c
16 end
17
```

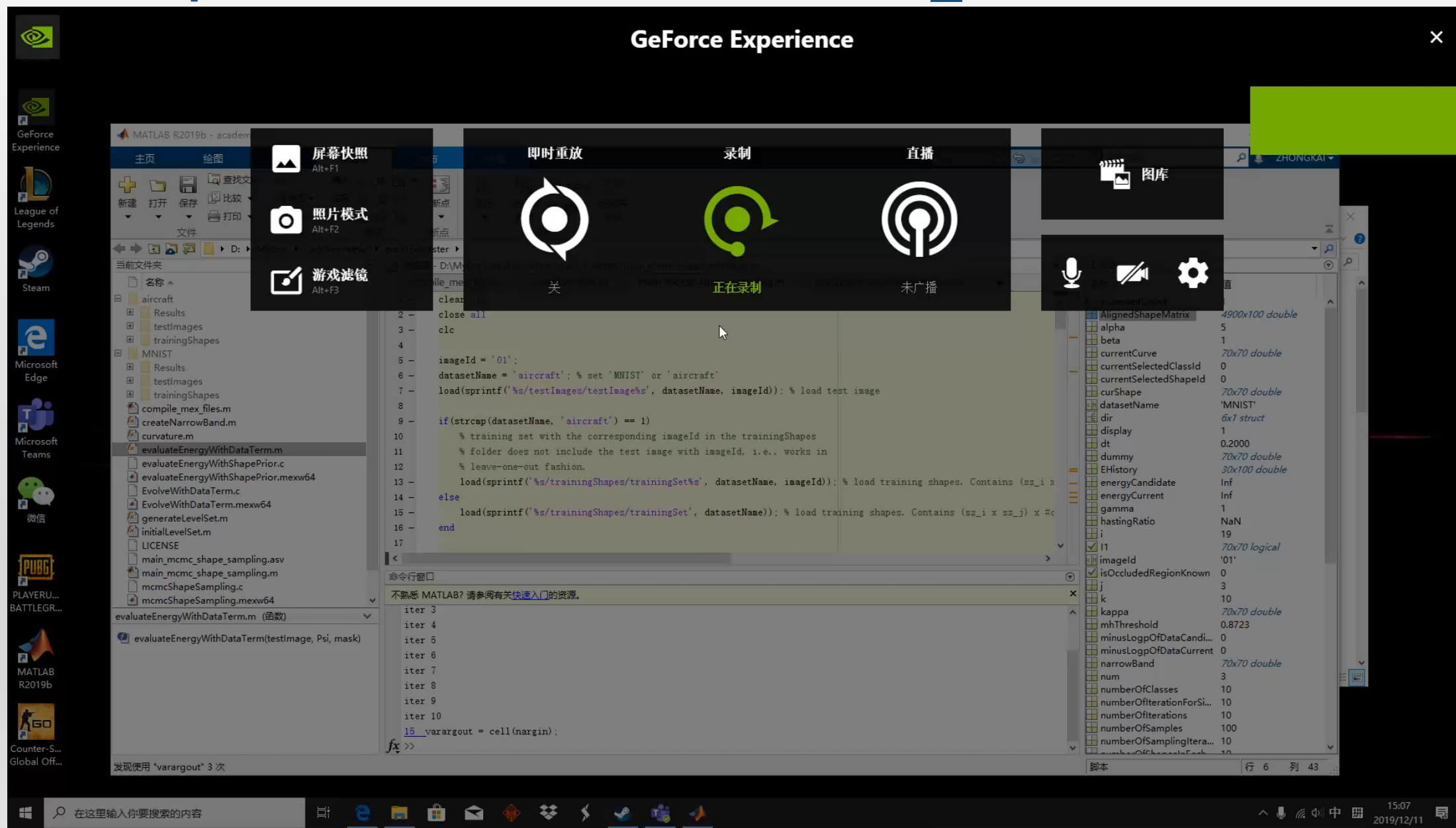
Command Window Output:

```
iter 4
iter 5
iter 6
iter 7
iter 8
iter 9
iter 10
15_varargout = cell(nargin):
>> matlab.graphics.chart.primitive.utilities.arraytolimits
fx >>
```

Workspace Variables:

名称	值
acceptedCount	1
AlignedShapeMatrix	4096x10 double
alpha	5
beta	1
currentCurve	64x64 double
currentSelectedClassId	0
currentSelectedShapeId	0
curShape	64x64 double
datasetName	'aircraft'
dir	14x1 struct
display	1
dt	0.2000
dummy	64x64 double
energyCandidate	Inf
energyCurrent	Inf
gamma	1
hastingRatio	NaN
i	82
i1	64x64 logical
imageId	'01'
isOccludedRegionKnown	0
j	7
k	1
kappa	64x64 double
mhThreshold	0.8270
minusLogpOfDataCandi...	235
minusLogpOfDataCurrent	128
narrowBand	64x64 double
num	11
numberOfClasses	1
numberOfIterationForSi...	1
numberOfIterations	10
numberOfSamples	100
numberOfSamplingIters...	10
numberOfShapesInEach...	10
numberOfShapesInTrain...	10

Implementation (Aircraft_2)



Implementation



15 epochs with right
prior information



100 epochs with wrong
prior information

Comparison

- **Commons:**

- 1. Based on MC method.
- 2. Using active contours
- 3. Need prior information about object shape.
- **Limitation:**
 - 1. Heavily rely on the prior shape information.
 - 2. Hard to balance time and accuracy.

- **Difference:**

Paper One	Paper Two
Initialized with 4 points.	Generate a curve based on a given seed point.
Direct sample.	Metropolis-Hastings sample.
Segment with one class.	Segment for multi-classes(MNIST).

Comments & Contributions

- First Paper:
 - 1. Proposed a Multiple Model Particle Filter structure.
 - 2. Incorporation of constraints accounting for the contour convexity, which is an improvement from another method JetStream.
- Second Paper:
 - 1. Better characterization of the statistical structure of the problem.
 - 2. Have the potential to address issues with getting stuck at local optima.
 - 3. Being able to find multiple probable solutions from different modes of the shape density.
 - 4. Can deal with the missing data.

Expectations in the future.

- 1. Improve the update strategy, make the MC process converge faster or less computational.
- 2. Combine MC method with DNN.
- 3. Go to reinforcement learning.
- 4. Apply to bigger images with multiple types.

 Questions?

Thank you!