

A Crash Course in Using Diffeomorphic Models in CellOrganizer

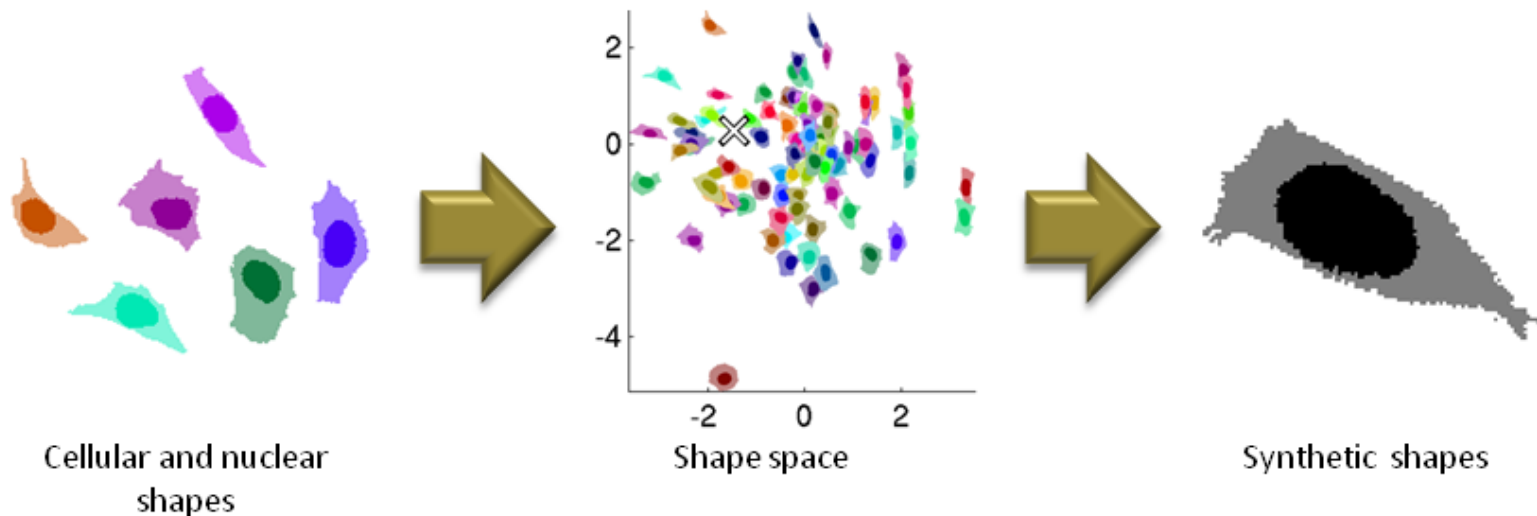
Gregory R. Johnson

Purpose:

Provide a basic background on how to train, synthesize from and manipulate the CellOrganizer diffeomorphic model.

Diffeomorphic Models

- Uses Large deformation diffeomorphic metric mapping (LDDMM)
- Morph one shape to another
- Builds “shape space”
- Allows for walks through shape space that could be used to describe cellular dynamics



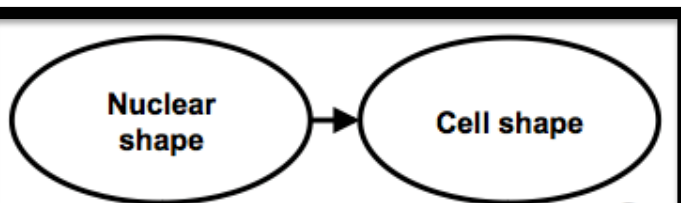
Cell Images

Model Parameters

Synthetic Images

Training

Synthesis



Object pos. probability

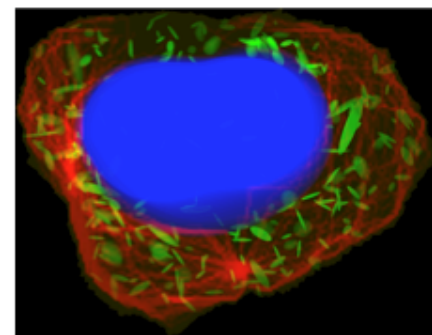
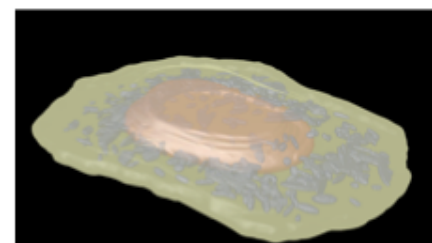
Microtubule distribution

Object appearance

Object positions

Object number

Object distribution



Training a Diffeomorphic Model

- Relevant Demos: Demo3D20

There are several ways to train a (diffeomorphic) model in CellOrganizer

```
>> Train(dnopath, cellpath, protpath, croppath, resolution, filename,  
dimensionality, isdiffeomorphic)
```

(saves file to specified path)

```
>> img2slml( dimensionality, dnopath, cellpath, protpath, param )
```

(saves file to specified path)

```
>> model = img2model( dimensionality, dnopath, cellpath, protpath,  
param )
```

Training a Diffeomorphic Model

- Only parameter necessary is to specify the diffeomorphic training.

```
... setup parameter structure ...
```

```
>> param.nucleus.type = 'diffeomorphic';  
>> param.cell.type = 'diffeomorphic';  
>> img2slml( dimensionality, dnapath, cellpath, protpath,  
param );
```

Accessing The Model

Identical copies of the model are contained in the nuclear shape and cell shape fields

```
>> model.nuclearShapeModel
```

```
>> model.cellShapeModel
```

Diffeomorphic Models in CellOrganizer

```
cellorganizer/models/3t3_model.mat  
cellorganizer/models/hela_model.mat
```

```
>> load('hela_model.mat')  
>> model.cellShapeModel
```

```
ans =
```

```
           positions: [506x6 double]  
           convex_hull: [4241x6 double]  
           tessellation: [32515x7 double]  
 explained_variances: [132x1 double]  
           distances: [506x506 double]  
 distances_incomplete: [506x506 double]  
 shape_space_options: [1x1 struct]  
           imfunc:  
@(x)diffeo_img_function(x,imgs,image_output_size,imsizes,imcrops)  
           numimgs: 506  
           imsize: [49 49 4]  
           name: ''  
           type: 'diffeomorphic'  
 matCompletionFunctionString: []  
           version: 1  
           resolution: [0.3920 0.3920 0.4000]  
           id: ''
```


Visualizing the Diffeomorphic Model

```
>> [img, proj_orig, eig] = showShapeSpace(model, labels,  
skipmissing, proj_orig, cm, traces)
```

model - diffeomorphic CellOrganizer model

labels - n x 1 vector of labels (1 to n) (image classes, total fluorescence, etc)

Skipmissing - boolean (false) - uses only computed distances (true) or use approximated complete distance matrix

proj_orig - n x 2 matrix - alternate embedding

cm - n x 3 matrix - mapping from each image to an RGB color

traces - n x 2 matrix - pairs of images to draw lines between

Visualizing the Diffeomorphic Model

```
>> [img, proj_orig, eig] = showShapeSpace(model);
```

```
>> figure, imshow(img)
```

```
>> size(proj_orig)
```

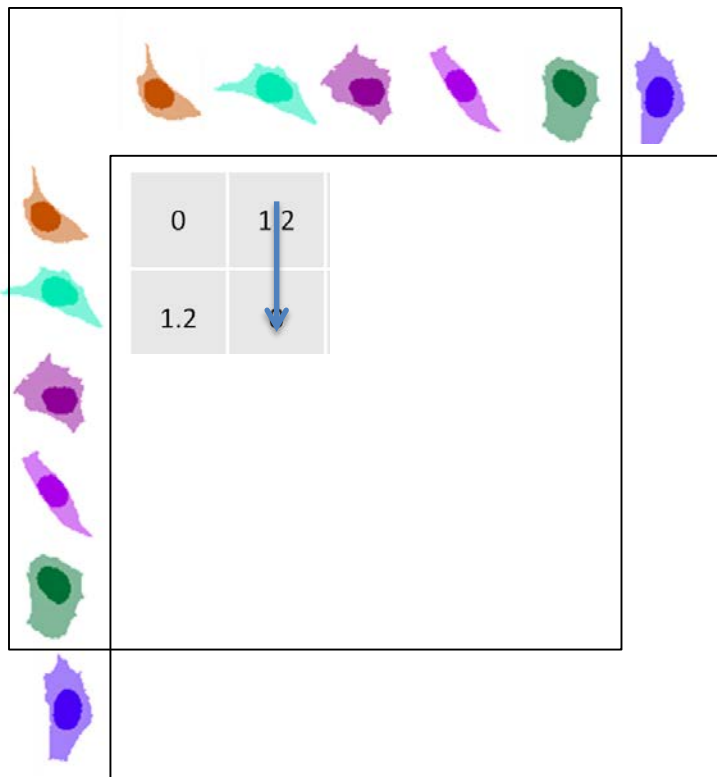
```
>> figure, plot(eig)
```

```
>> eig(eig<0) = 0;
```

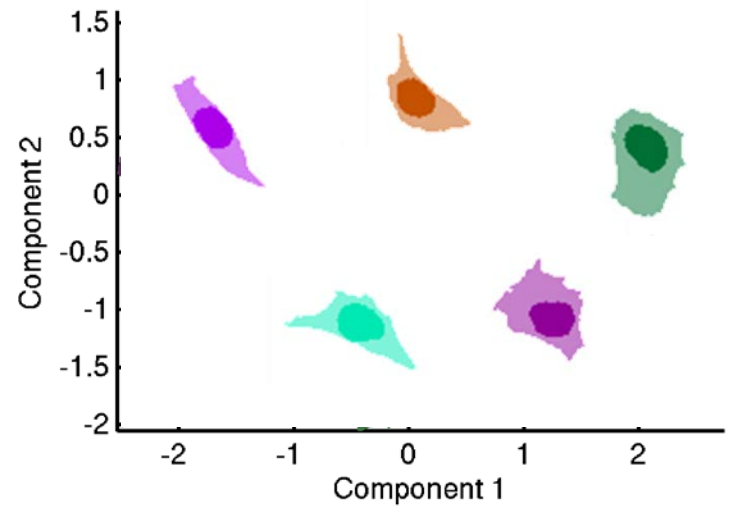
```
>> figure, plot(cumsum(eig)/sum(eig))
```

Partial Distance Matrix Learning

- Most complete shape space



MDS



Training a Diffeomorphic Model

- Relevant Demos: Demo3D20

```
>> img2slml( dimensionality, dnapath, cellpath, protpath,  
param )
```

```
>> model = img2model( dimensionality, dnapath, cellpath,  
protpath, param )
```

```
>> param.model.diffeomorphic.useCurrentResults = true
```

Synthesizing from a Diffeomorphic Model

```
>>model2img( {model} )
```

Sampling From Models

[cellorganizer/demos/3D/demo3DDiffeoSynth](#)