

A Crash Course in Using Diffeomorphic Models in CellOrganizer

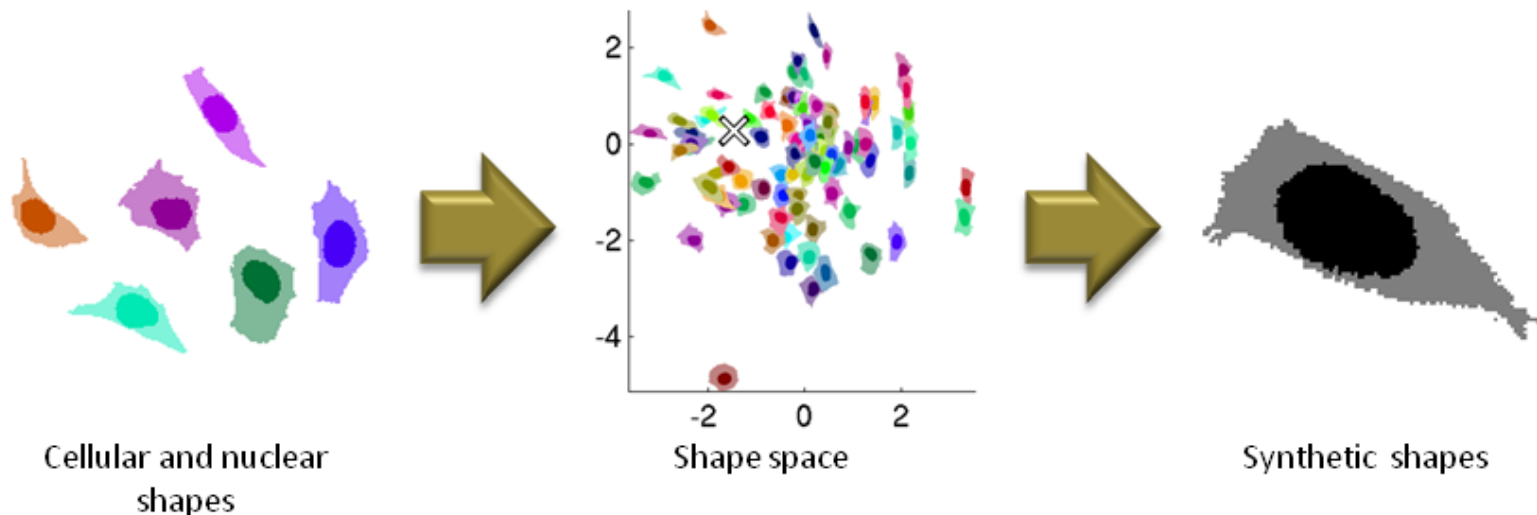
Gregory R. Johnson

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



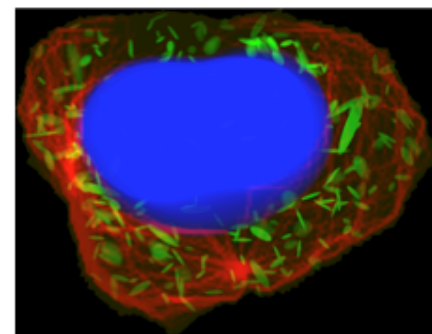
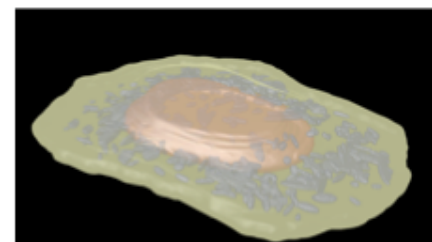
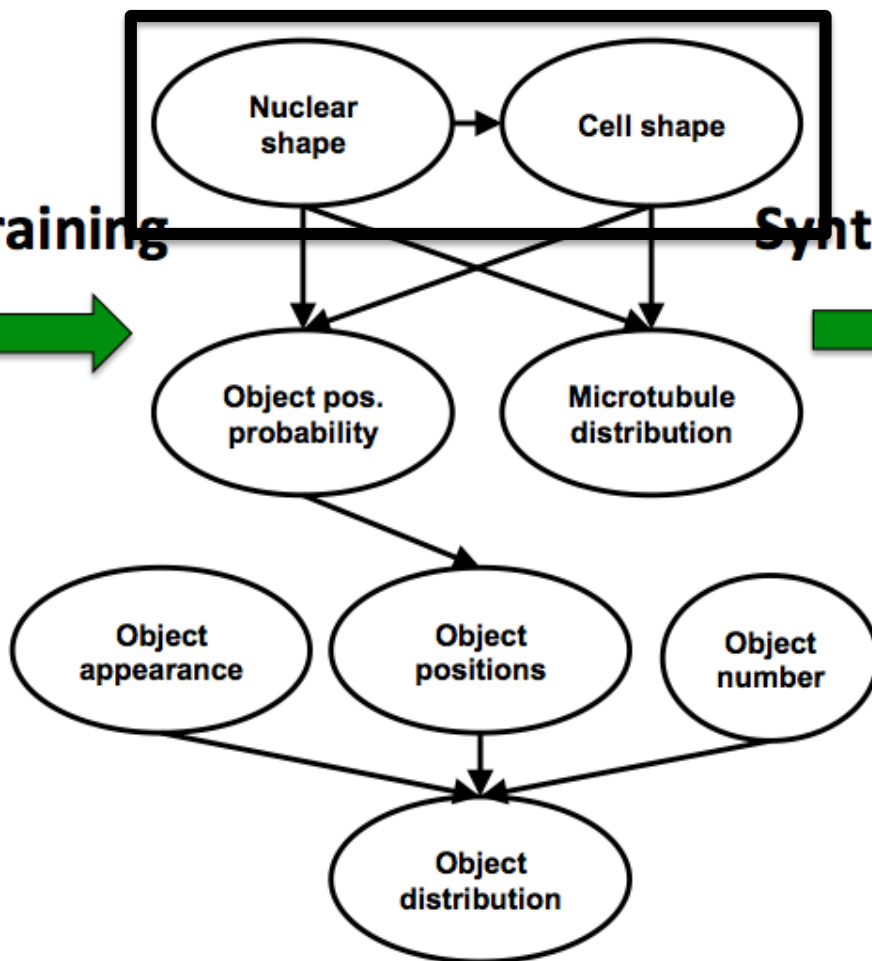
**Cell
Images**

Model Parameters

**Synthetic
Images**

Training

Synthesis



Training a Diffeomorphic Model

- Relevant Demos: Demo3D20

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

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

(saves file to specified path)

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

(saves file to specified path)

```
>> model = img2model( dimensionality, dnapath, 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)
```

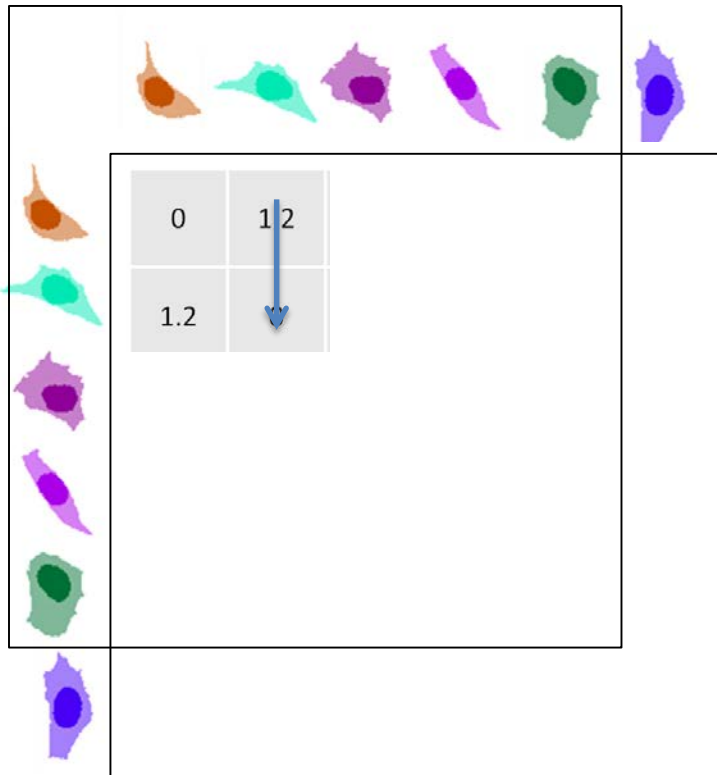
```
>> figure, plot(eig)
```

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

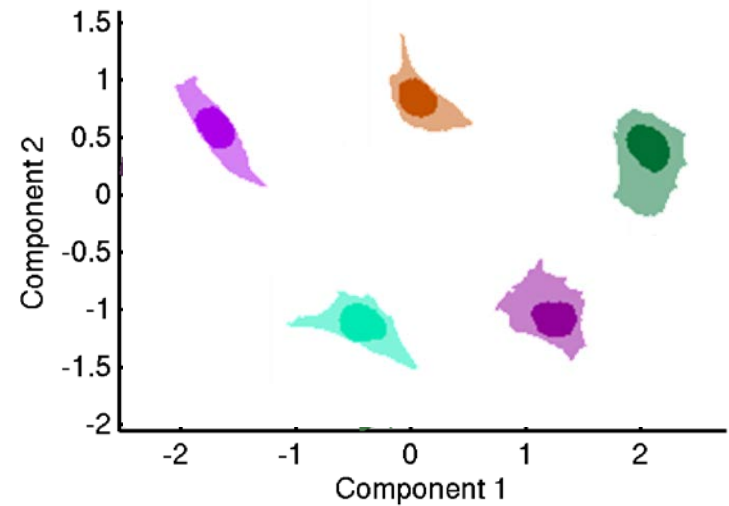
```
>> figure, plot(cumsum(eig)/sum(eig))
```

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`