

# DISTRIBUTED PANORAMA CONSTRUCTION OF UAV DRONE IMAGES USING PUBLIC COMPUTE NODES

**Satish Palaniappan & Somasundaram Mahesh**

# THE SMART INDIA HACKATHON 2018

## WHAT? WHERE? HOW?

WYSIWYG

# WHAT EXACTLY IS THE PROBLEM STATEMENT?

## Panorama Stitching



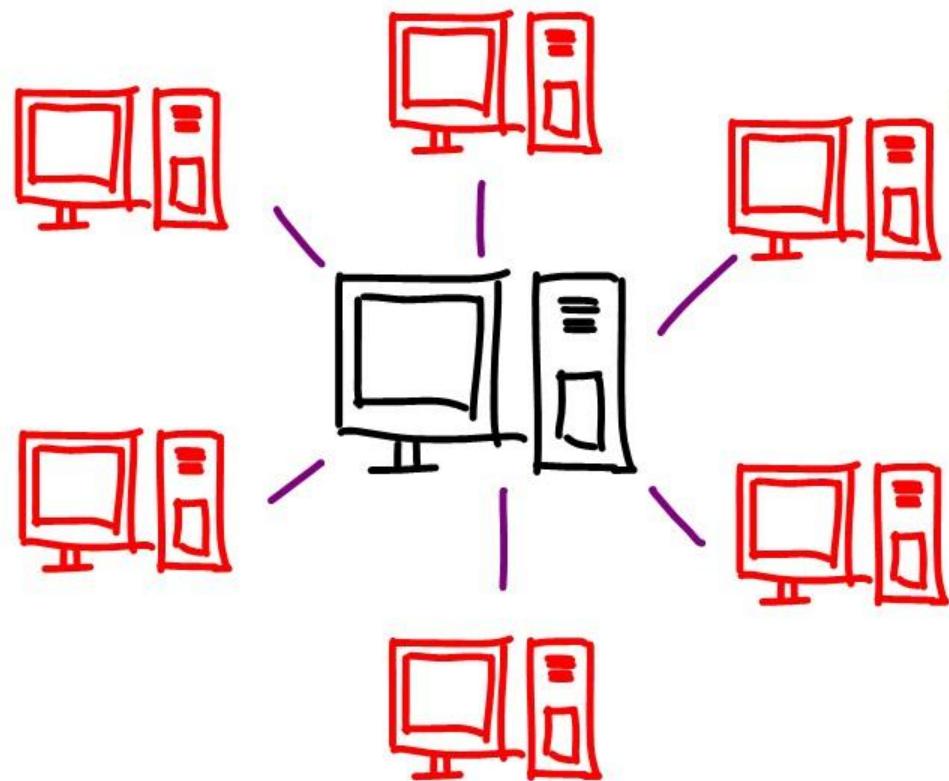
## UAV Drone Images



## Sample Output



# Distributed Computing



## Public Compute Nodes



# HOW DO WE STITCH?

1. Image Processing Solution:

- a. SIFT
- b. FLANN
- c. RANSAC

2. Deep Learning Solution:

- a. DeepHomographyNet

IMAGE PROCESSING SOLUTION

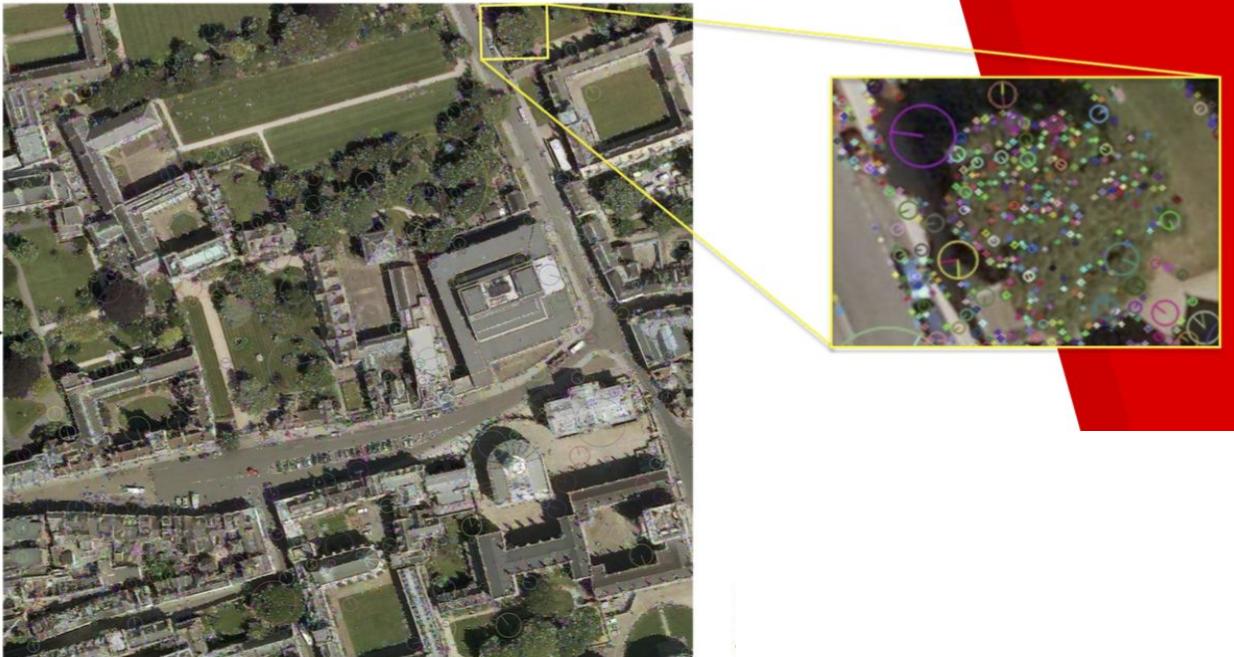
# SAMPLE INPUT IMAGE



# SIFT (SCALE-INVARIANT FEATURE TRANSFORM)



# SIFT (SCALE-INVARIANT FEATURE TRANSFORM)

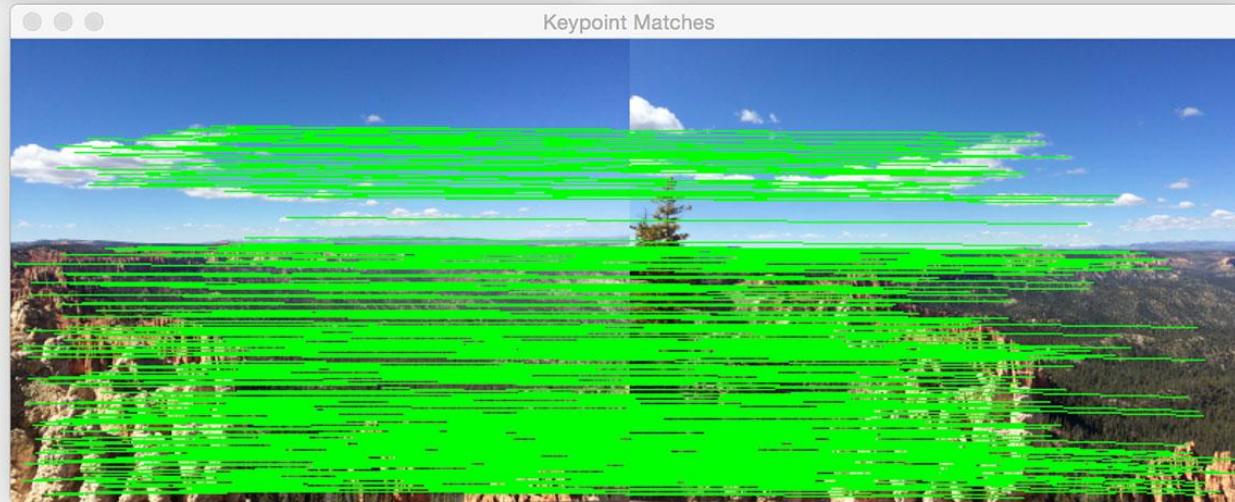
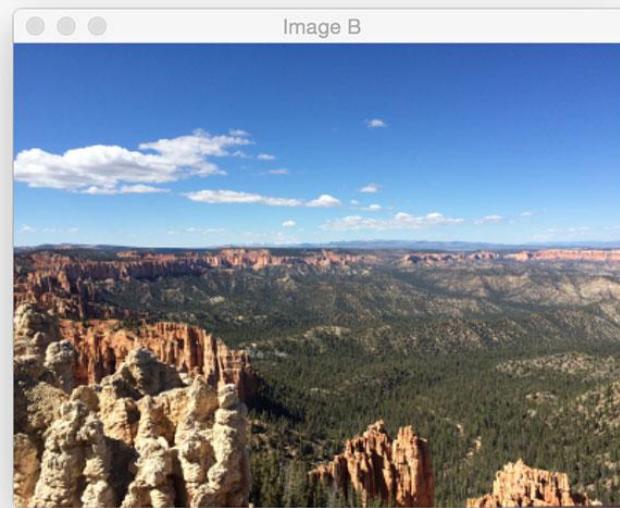
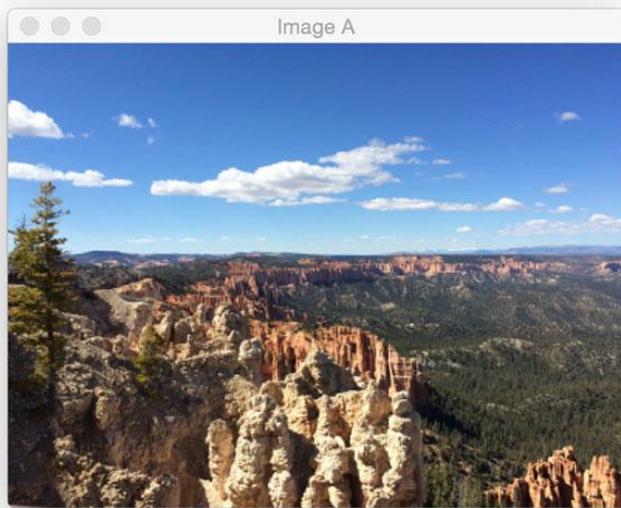


Features extracted in Original  
Image

# FLANN (FAST LIBRARY FOR APPROXIMATE NEAREST NEIGHBORS)



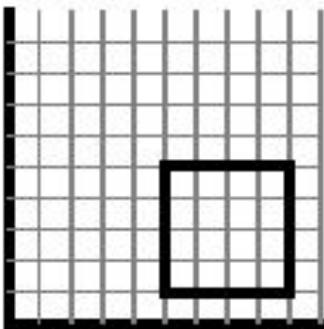
# FLANN



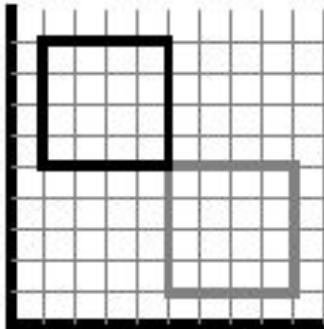
# THE HOMOGRAPHY MATRIX

# 2D TRANSFORMATIONS

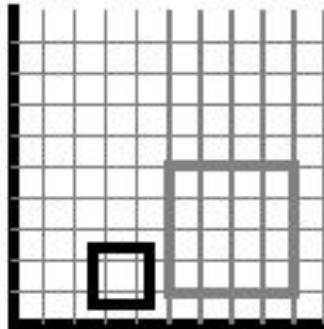
original



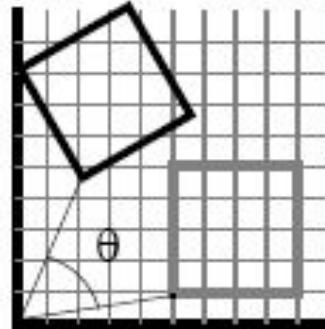
translation



scaling



rotation



$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} d_x \\ d_y \end{bmatrix} + \begin{bmatrix} x \\ y \end{bmatrix}$$

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} s_x & 0 \\ 0 & s_y \end{bmatrix} \cdot \begin{bmatrix} x \\ y \end{bmatrix}$$

$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix} \cdot \begin{bmatrix} x \\ y \end{bmatrix}$$



tpsatish95 commented on Jan 28, 2016

Contributor + X

...  
No  
No  
Yo  
be  
3 f  
  
□



some sample images of random\_shear,  
before:



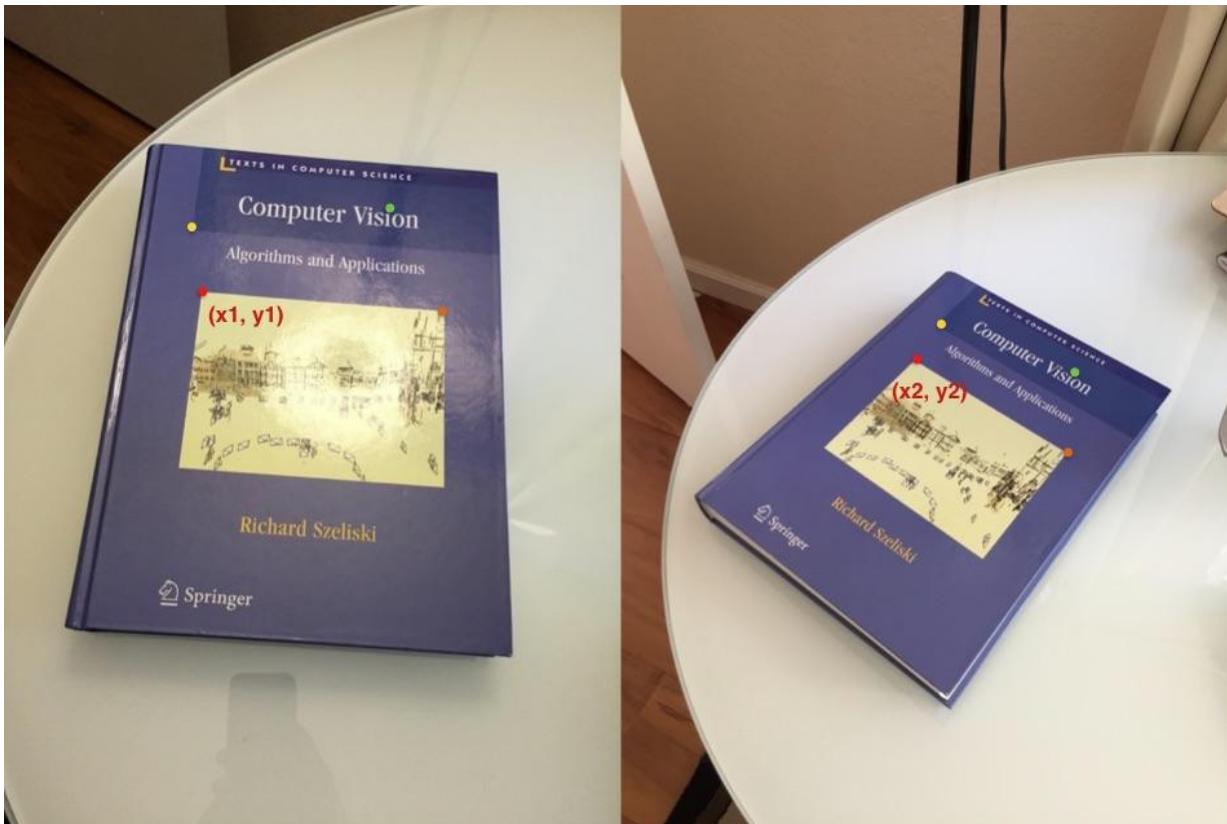
random\_shear(imread("test\_image.png"), -0.2)



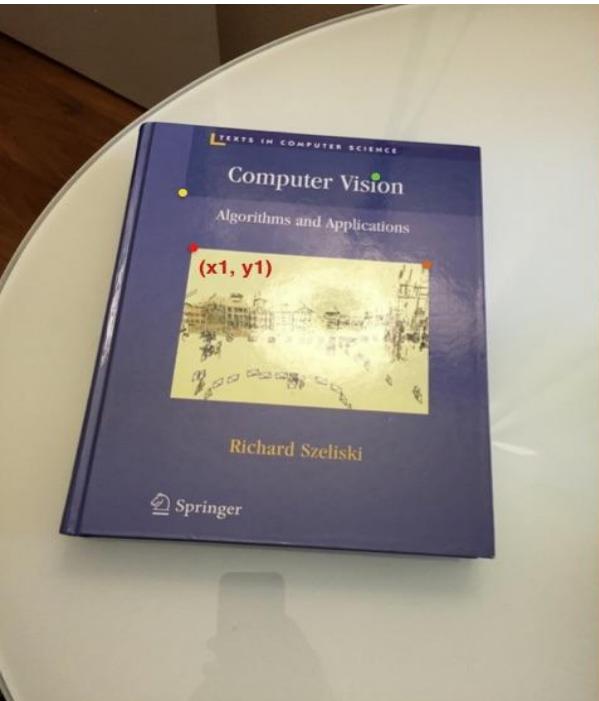
# HOMOGRAPHY MATRIX

$$H = \begin{bmatrix} h_{00} & h_{01} & h_{02} \\ h_{10} & h_{11} & h_{12} \\ h_{20} & h_{21} & h_{22} \end{bmatrix}$$

# HOMOGRAPHY MATRIX



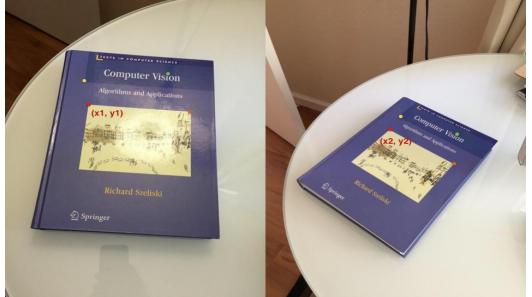
# HOMOGRAPHY MATRIX

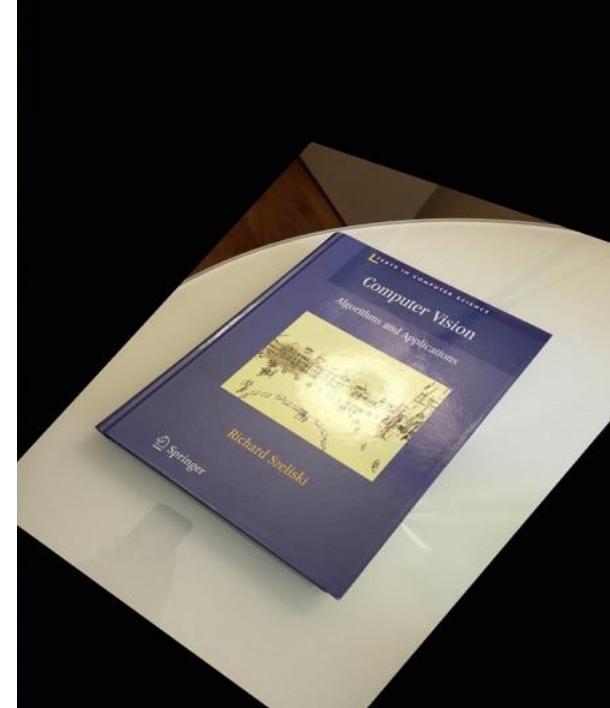


$$H = \begin{bmatrix} h_{00} & h_{01} & h_{02} \\ h_{10} & h_{11} & h_{12} \\ h_{20} & h_{21} & h_{22} \end{bmatrix}$$

X

For the below pair of images





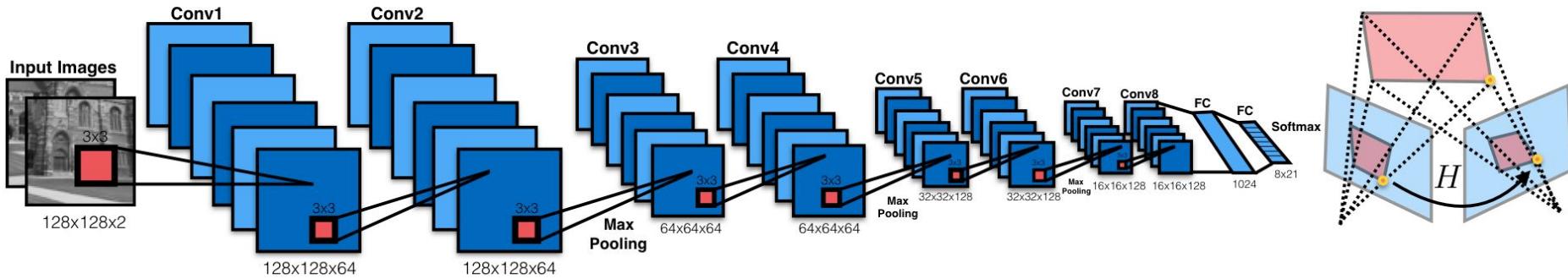
# RANSAC (RANDOM SAMPLE CONSENSUS ALGORITHM)

RANSAC loop:

- 
1. Select four feature pairs (at random)
  2. Compute homography  $H$  (exact)
  3. Compute *inliers* where  $SSD(p_i', H p_i) < \varepsilon$
  4. Keep largest set of inliers
  5. Re-compute least-squares  $H$  estimate on all of the inliers

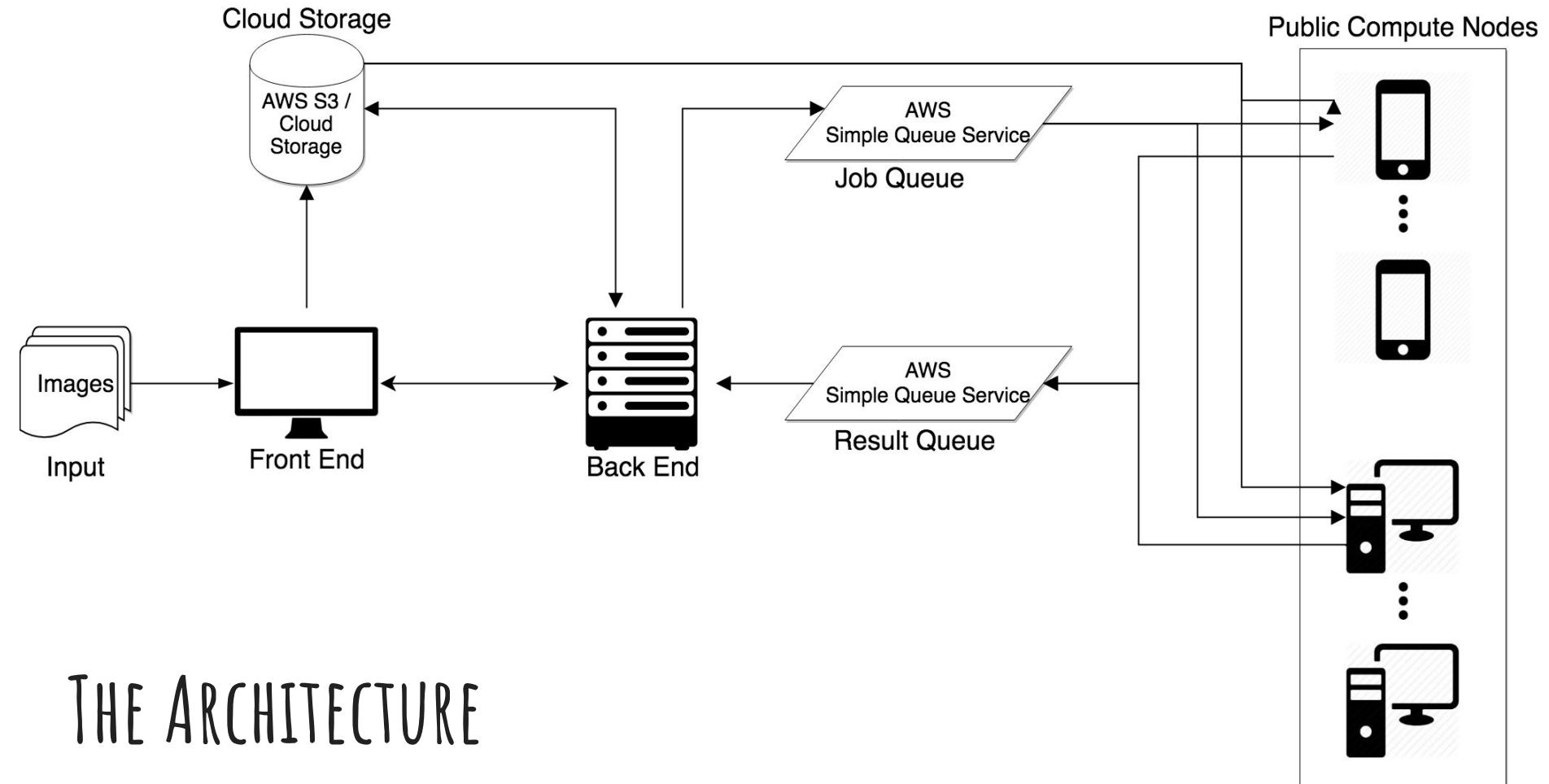
# DEEP LEARNING SOLUTION

## DeepHomographyNet



WHY WE PREFERRED THE TRADITIONAL APPROACH  
OVER THE DEEP LEARNING APPROACH?

# THE DISTRIBUTED ARCHITECTURE



# THE ARCHITECTURE

THE COMPLEXITY IN DISTRIBUTING THIS TASK



DJI\_0001.JPG



DJI\_0002.JPG



DJI\_0003.JPG



DJI\_0004.JPG



DJI\_0005.JPG



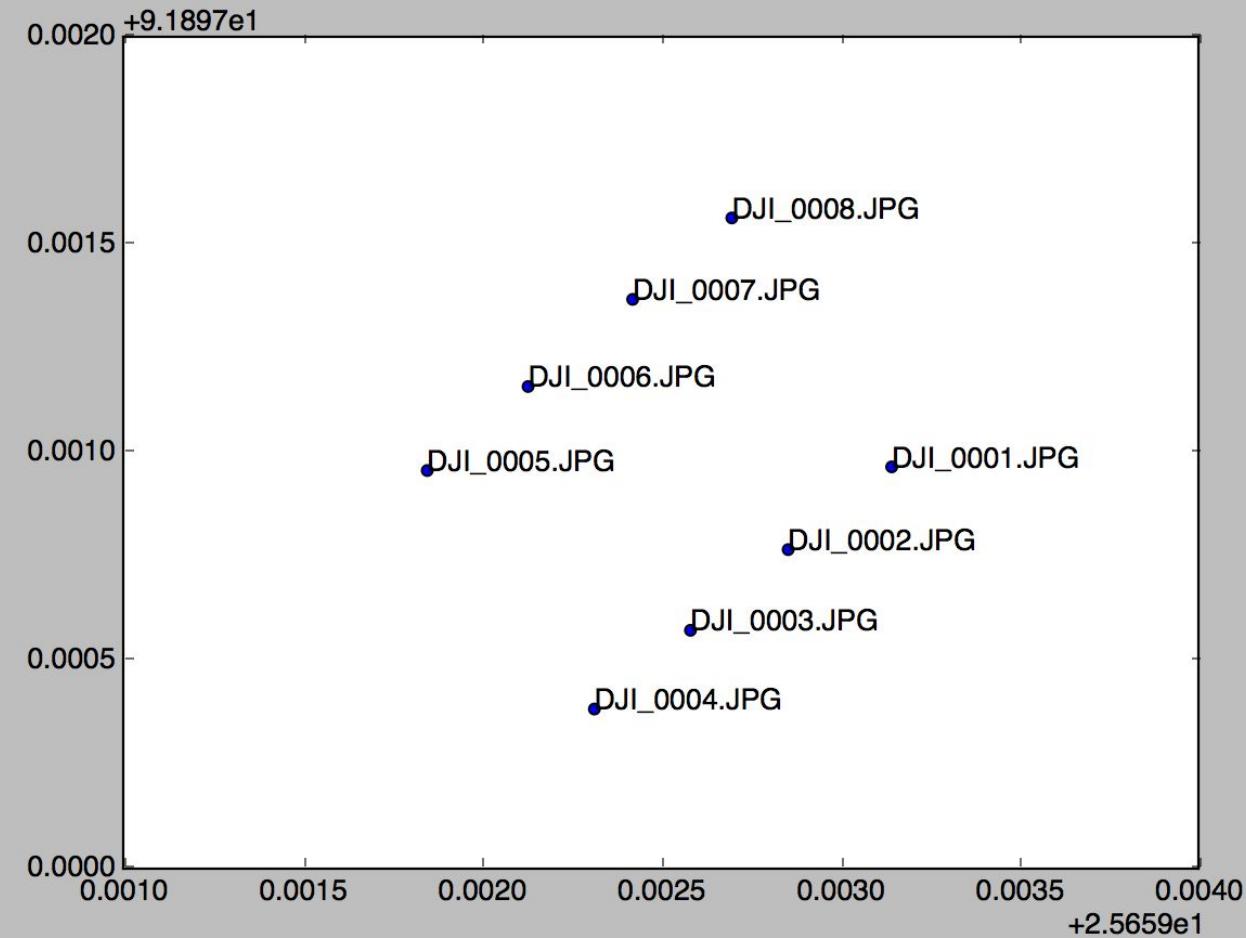
DJI\_0006.JPG



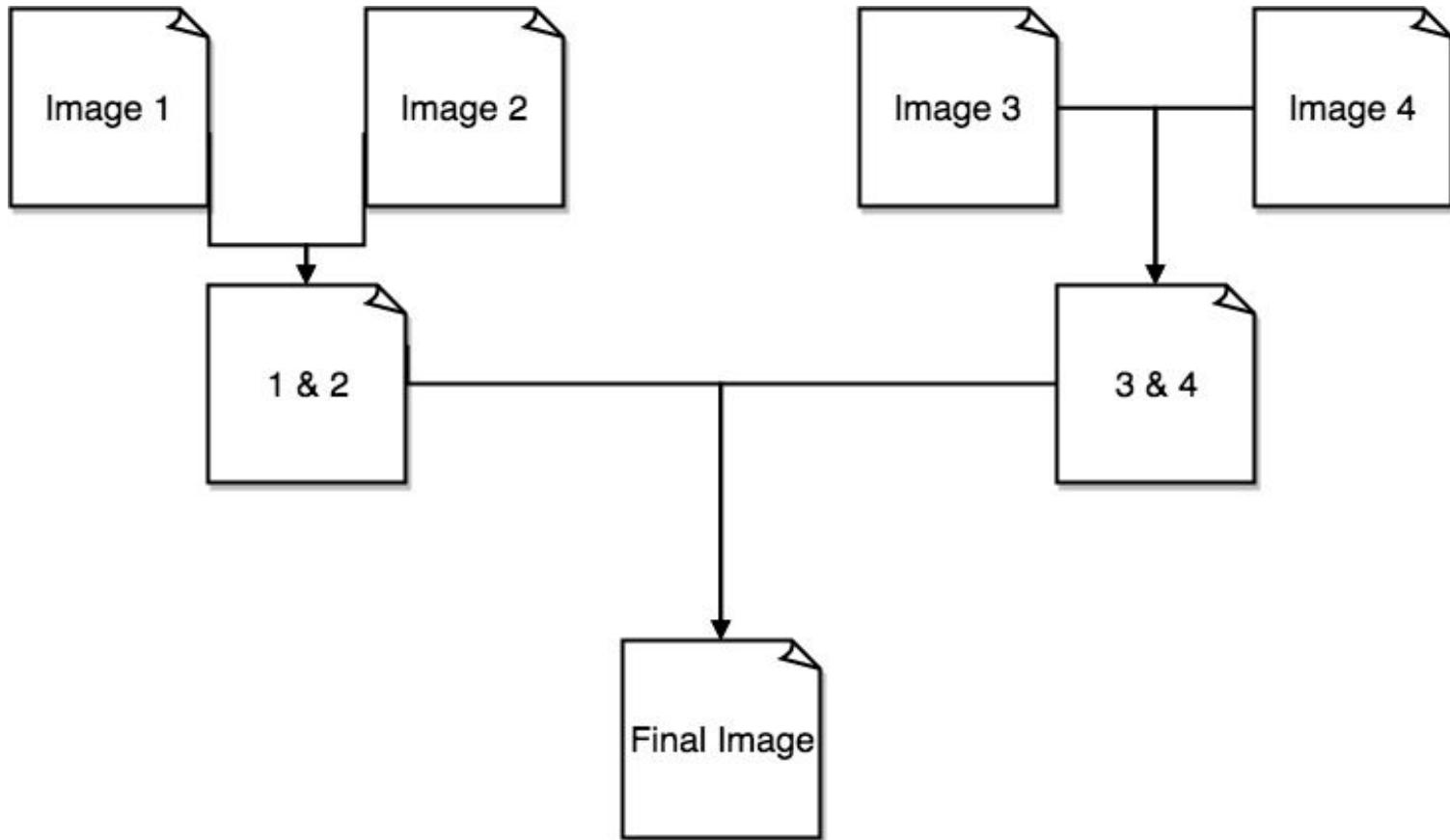
DJI\_0007.JPG



DJI\_0008.JPG



# DIVIDE AND CONQUER



# STAGES

- **Stage 1:**

- "1, 2" = `1\_2` (direction: top\_down)
- "3, 4" = `3\_4` (direction: top\_down)
- "5, 6" = `5\_6` (direction: top\_down)
- "7, 8" = `7\_8` (direction: top\_down)

- **Stage 2:**

- "1\_2, 3\_4" = `1\_2\_3\_4` (direction: top\_down)
- "5\_6, 7\_8" = `5\_6\_7\_8` (direction: top\_down)

- **Stage 3:**

- "1\_2\_3\_4, 5\_6\_7\_8" = `1\_2\_3\_4\_5\_6\_7\_8` (direction: left\_right)

# THE PLANNER

# JOBs (INPUT1, INPUT2, OUTPUT, DIRECTION)

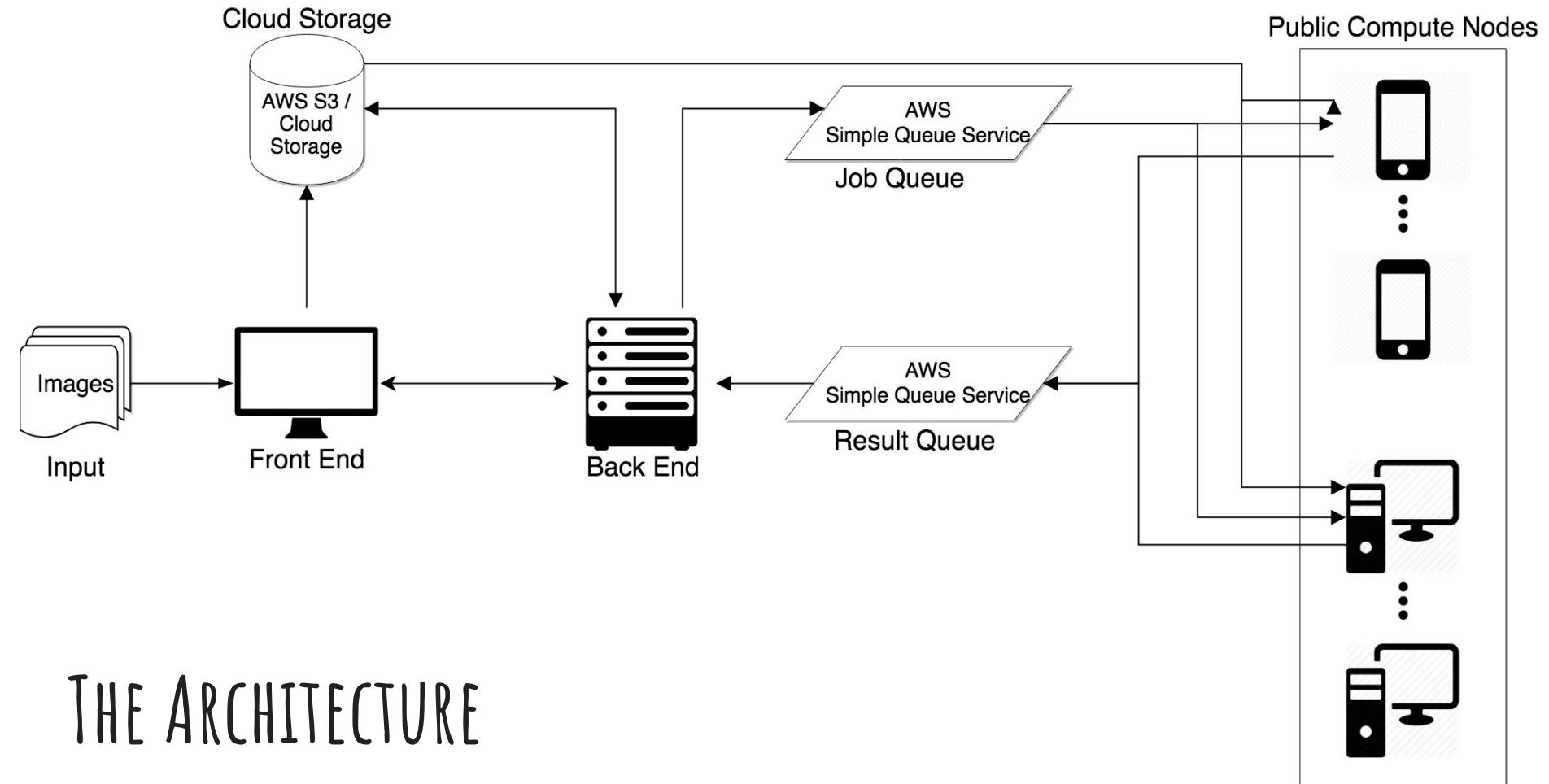
- Job1("1", "2", "1\_2", "top-to-bottom")
- Job2("3", "4", "3\_4", "top-to-bottom")
- Job3("5", "6", "5\_6", "top-to-bottom")
- Job4("7", "8", "7\_8", "top-to-bottom")
- Job5("1\_2", "3\_4", "1\_2\_3\_4", "top-to-bottom")
- Job6("5\_6", "7\_8", "5\_6\_7\_8", "top-to-bottom")
- Job7("1\_2\_3\_4", "5\_6\_7\_8", "1\_2\_3\_4\_5\_6\_7\_8", "left-to-right")

# THE JOB JSON

```
{  
  "direction": "LR",  
  "inputData": [  
    {  
      "highResPath": "https://s3.amazonaws.com/results-bucket/bd749d3e-2374-4980-9799-8b1b721ac17d.jpg",  
      "imageId": "bd749d3e-2374-4980-9799-8b1b721ac17d",  
      "isRotate": true,  
      "lowResPath": "",  
      "localPath": "",  
      "scalingFactor": 1  
    },  
    {  
      "highResPath": "https://s3.amazonaws.com/results-bucket/985e68cd-1325-4f48-b933-badc52463553.jpg",  
      "imageId": "985e68cd-1325-4f48-b933-badc52463553",  
      "isRotate": false,  
      "lowResPath": "",  
      "localPath": "",  
      "scalingFactor": 1  
    }  
  ],  
  "isFinal": true,  
  "isMobile": false,  
  "jobId": "c5595a59-27ff-46b4-b129-0c3d97f7efb6",  
  "outputData": {  
    "expectedImageId": "98171b37-a8b7-444d-93e8-067f7f236cf3",  
    "expectedPath": "https://s3.amazonaws.com/results-bucket/98171b37-a8b7-444d-93e8-067f7f236cf3.jpg"  
  }  
}
```

# THE RESULT JSON

```
{  
    "direction": "LR",  
    "isSuccess": <true or false>,  
    "isUploaded": <true or false> (Mobile Nodes: False, Computer Nodes: True)  
    "inputData": [  
        {  
            "highResPath": "https://s3.amazonaws.com/results-bucket/bd749d3e-2374-4980-9799-8b1b721ac17d.jpg",  
            "imageId": "bd749d3e-2374-4980-9799-8b1b721ac17d",  
            "isRotate": true,  
            "lowResPath": "",  
            "localPath": "",  
            "scalingFactor": 1  
        },  
        {  
            "highResPath": "https://s3.amazonaws.com/results-bucket/985e68cd-1325-4f48-b933-badc52463553.jpg",  
            "imageId": "985e68cd-1325-4f48-b933-badc52463553",  
            "isRotate": false,  
            "lowResPath": "",  
            "localPath": "",  
            "scalingFactor": 1  
        }  
    ],  
    "isFinal": true,  
    "isMobile": false,  
    "jobId": "c5595a59-27ff-46b4-b129-0c3d97f7efb6",  
    "outputData": {  
        "expectedImageId": "98171b37-a8b7-444d-93e8-067f7f236cf3",  
        "expectedPath": "https://s3.amazonaws.com/results-bucket/98171b37-a8b7-444d-93e8-067f7f236cf3.jpg"  
        "homographyMatrix": []  
    }  
}
```



# THE ARCHITECTURE



## Indian Space Research Organisation

Distributed Panorama Construction of High Resolution UAV Imagery Using Public Compute Nodes

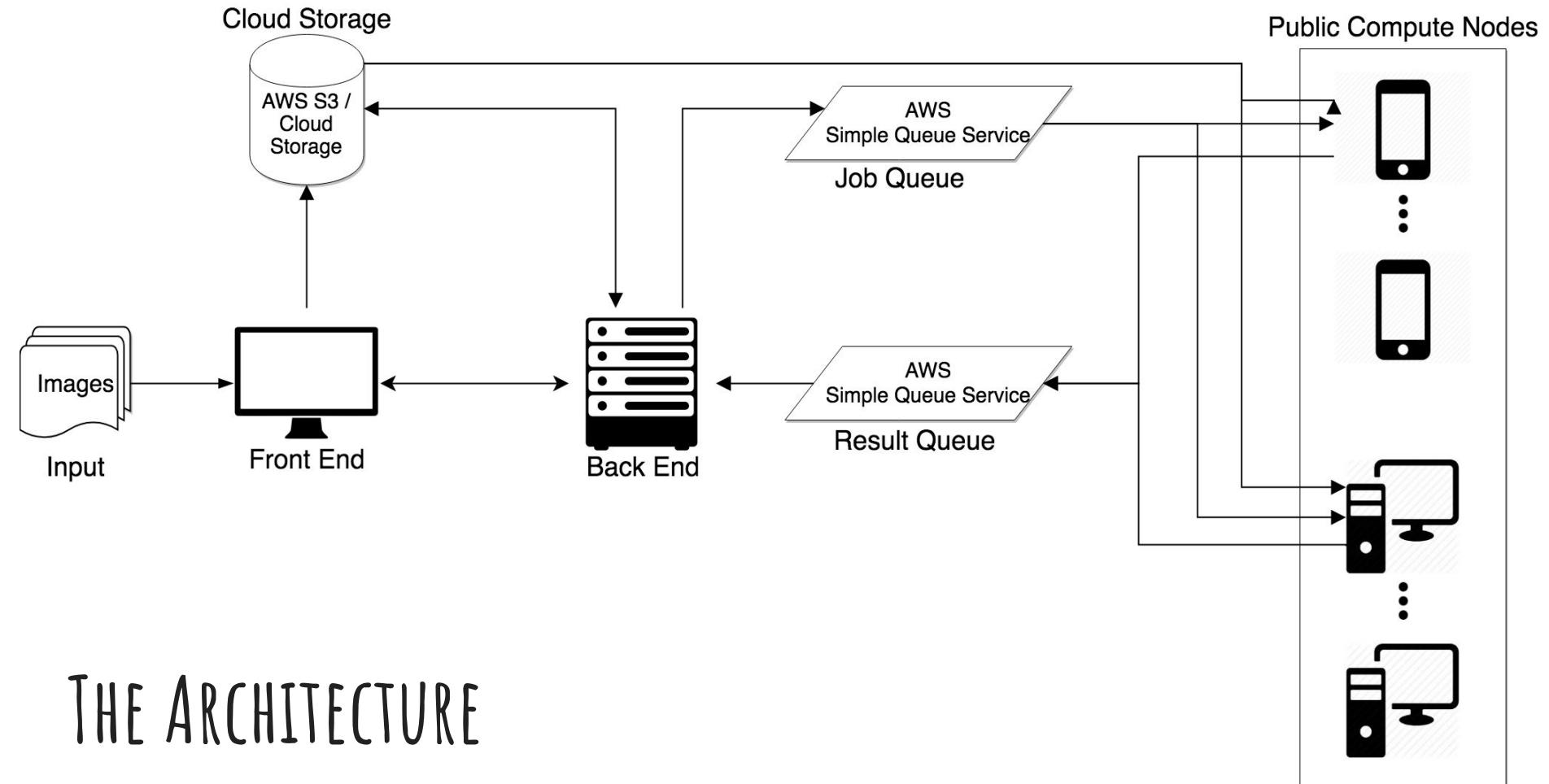
Distributed Image Panorama Stitching

① Upload multiple files with the file dialog or by dragging and dropping images onto the dashed region

Batch Name\*:

Upload files to Stitch

—



# THE ARCHITECTURE

# THE MOBILE NODES AND COMPUTER NODES

# GENERIC ARCHITECTURE

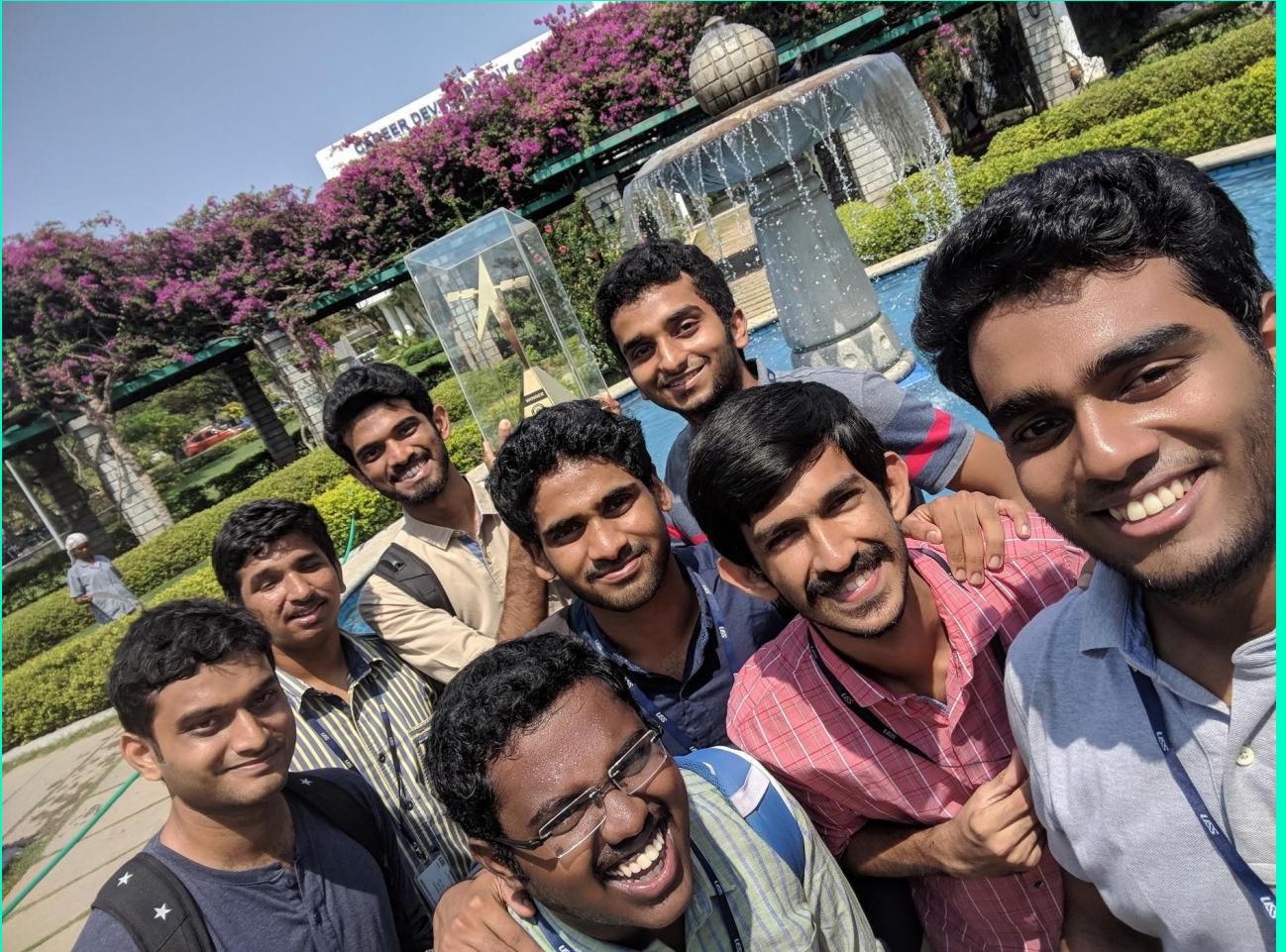
FUN :P

PROJECT CODE NAME ???

# TAILORSIFT (TAYLOR SWIFT) !!!



# THE TEAM!



THANK YOU!