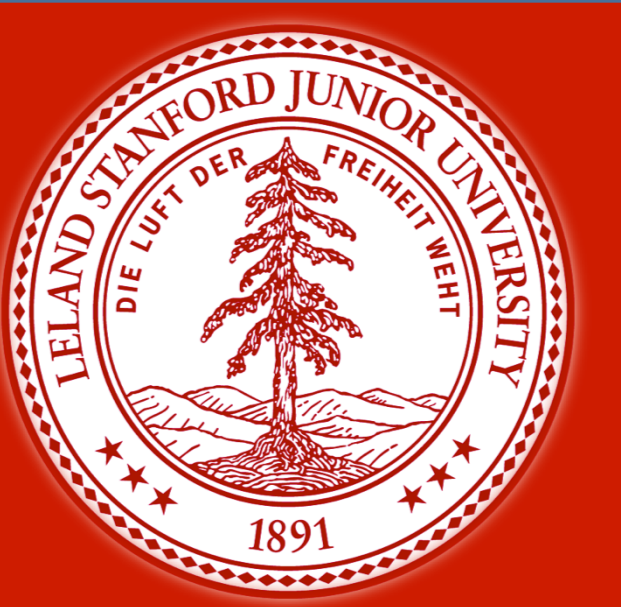


# Constellation Detection

Xiaoge Liu<sup>1</sup>, Suyao Ji<sup>2</sup>, Jinzhi Wang<sup>3</sup>

1.Department of Applied Physics, 2.Department of Electrical Engineering, 3.Department of Civil and Environmental Engineering  
Stanford University



## Motivation

It is of great interest for sky gazers and amateur photographers to take pictures of the sky, and recognize constellations in them. For this project, we seek to use the techniques outlined in class to develop a constellation detection.



## Image Pretreatment

Original Image



Clear Image with stars labeled

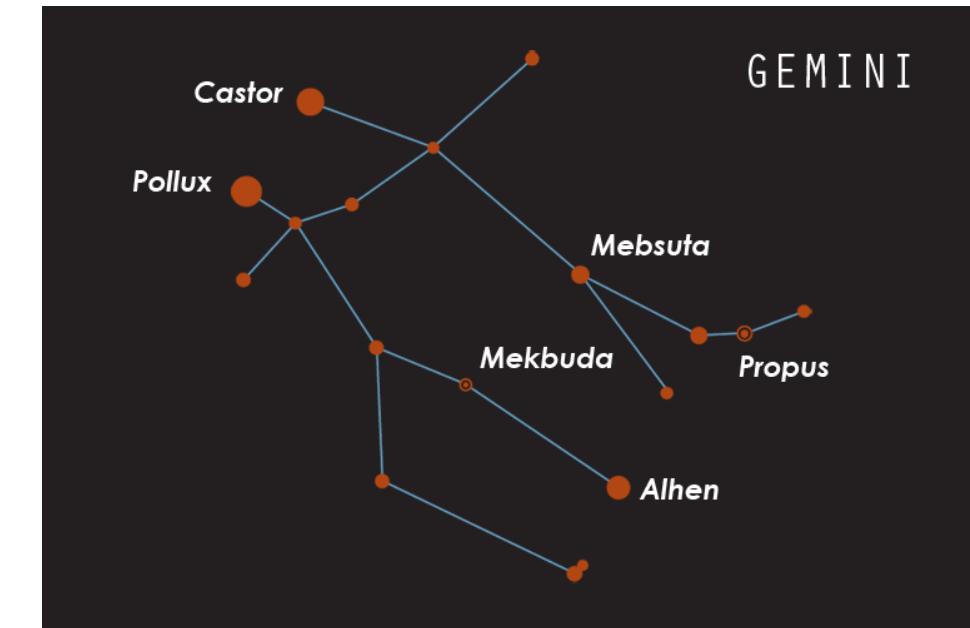


### Challenges

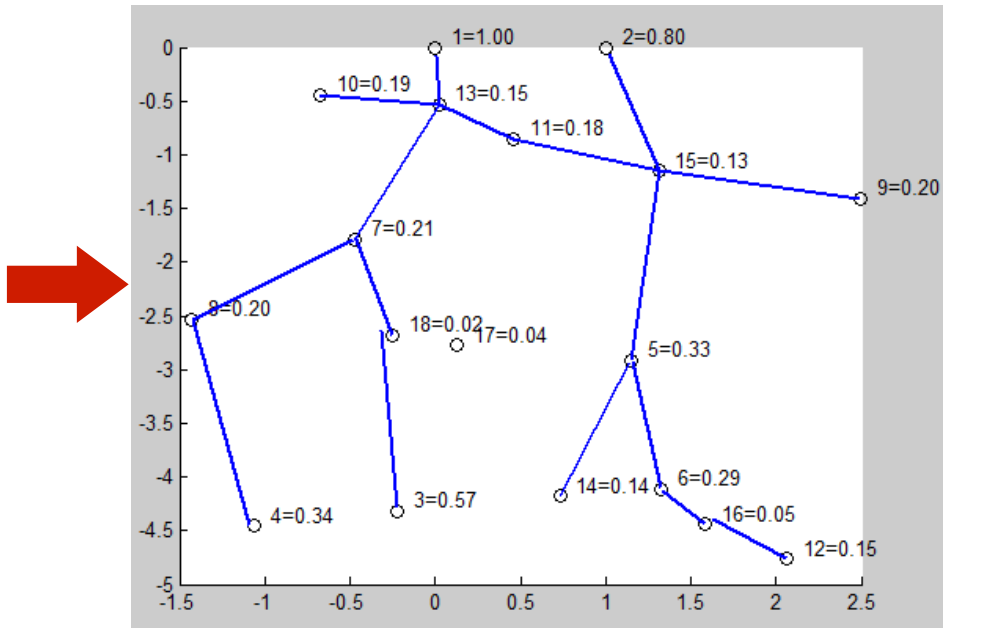
- Correctly conserve bright stars
- Filter out weak stars and noise
- Express star brightness by areas
- Trim out ground objects like trees, etc.

## Template Machine Learning

Constellation Template



Visualized Constellation Database

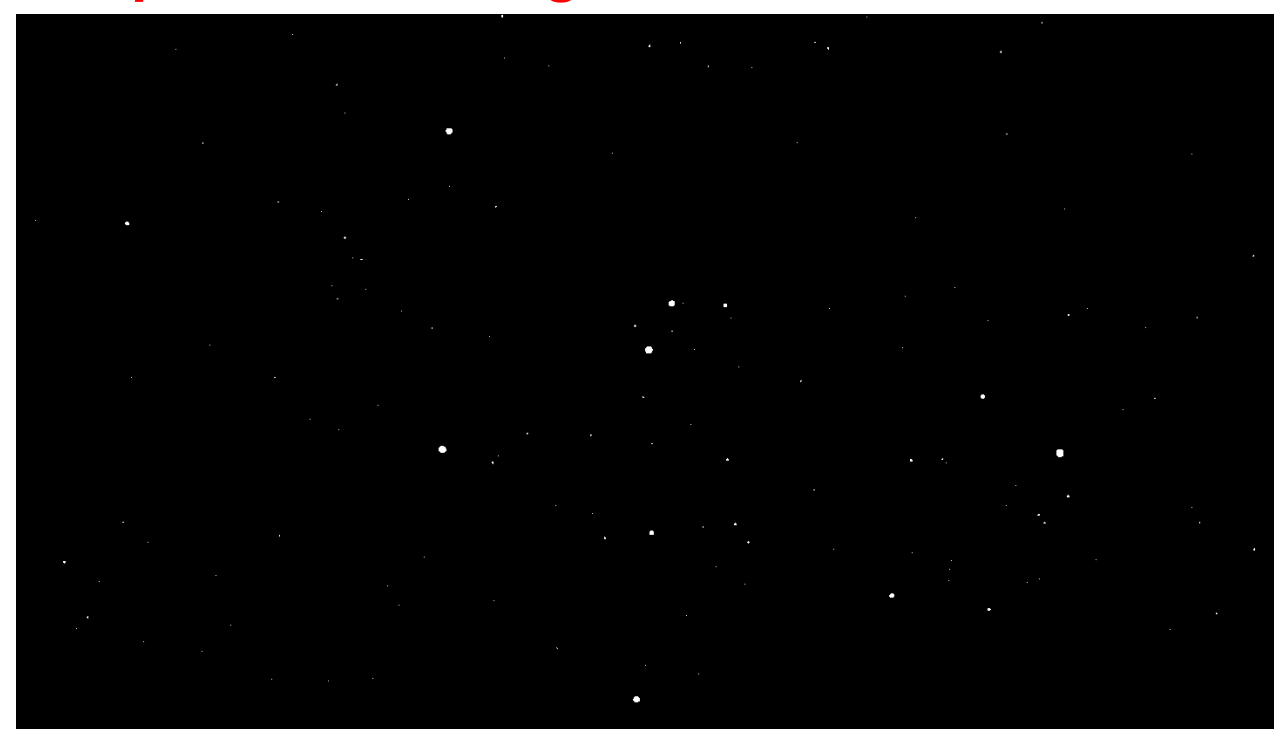


### Tasks: Feature descriptor for every constellation

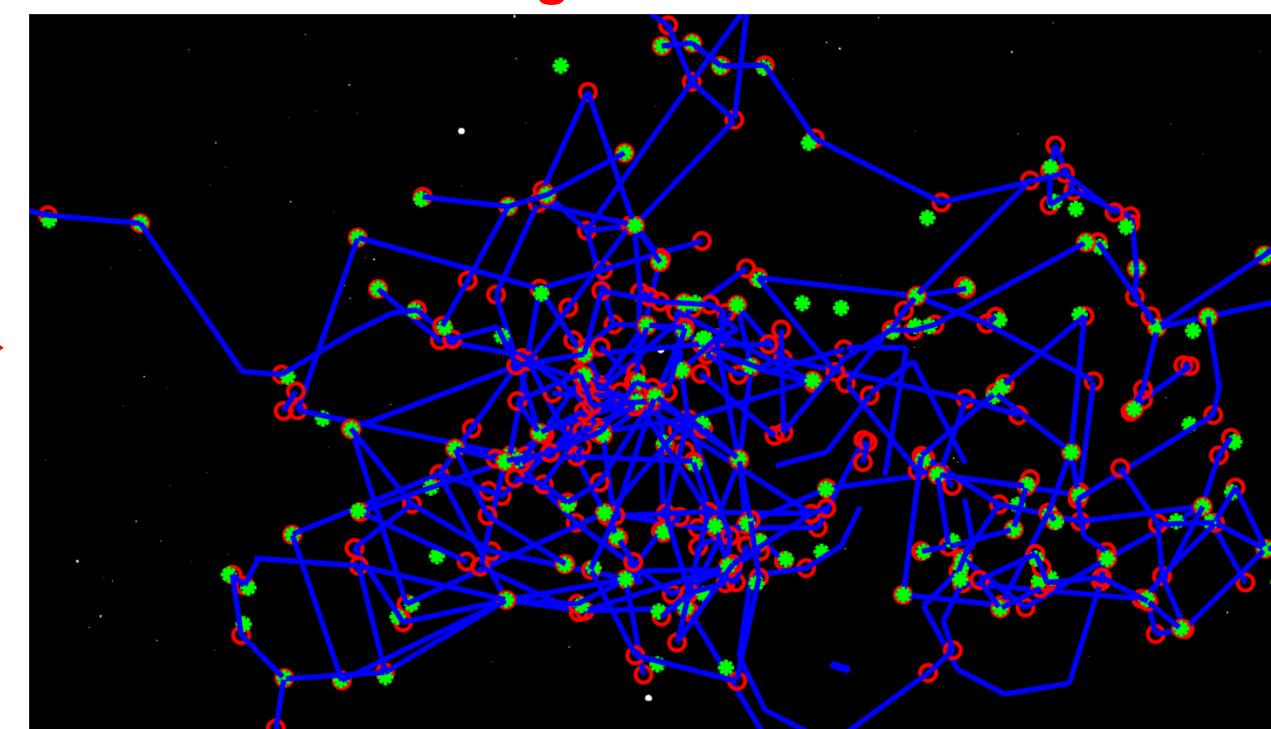
- Relative positions and areas of every star
- Constellation absolute size
- Neighbour constellations

## Main Detection

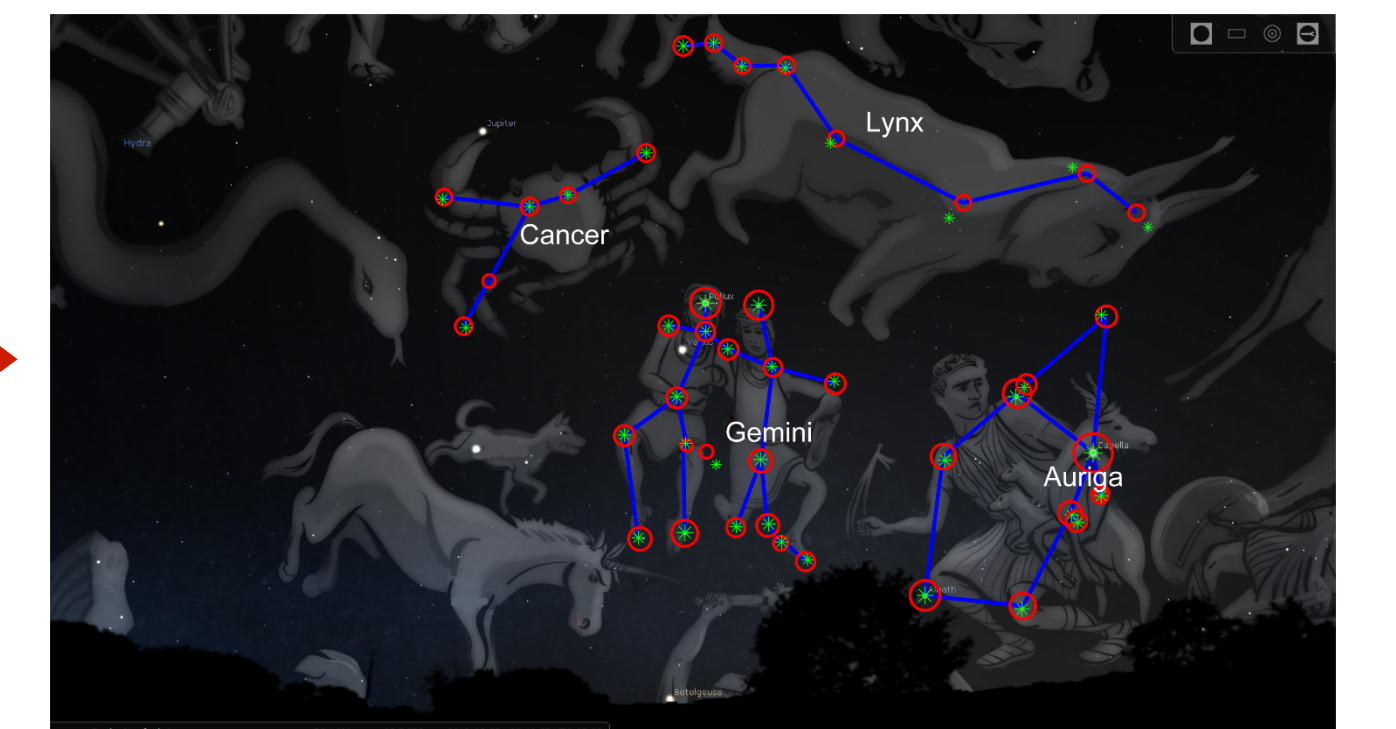
Preprocessed Image



Detected Matching



Final Detection Result



### 1. Match template with tolerance

- star location
- star ranks

### 2. Remove wrong constellation.

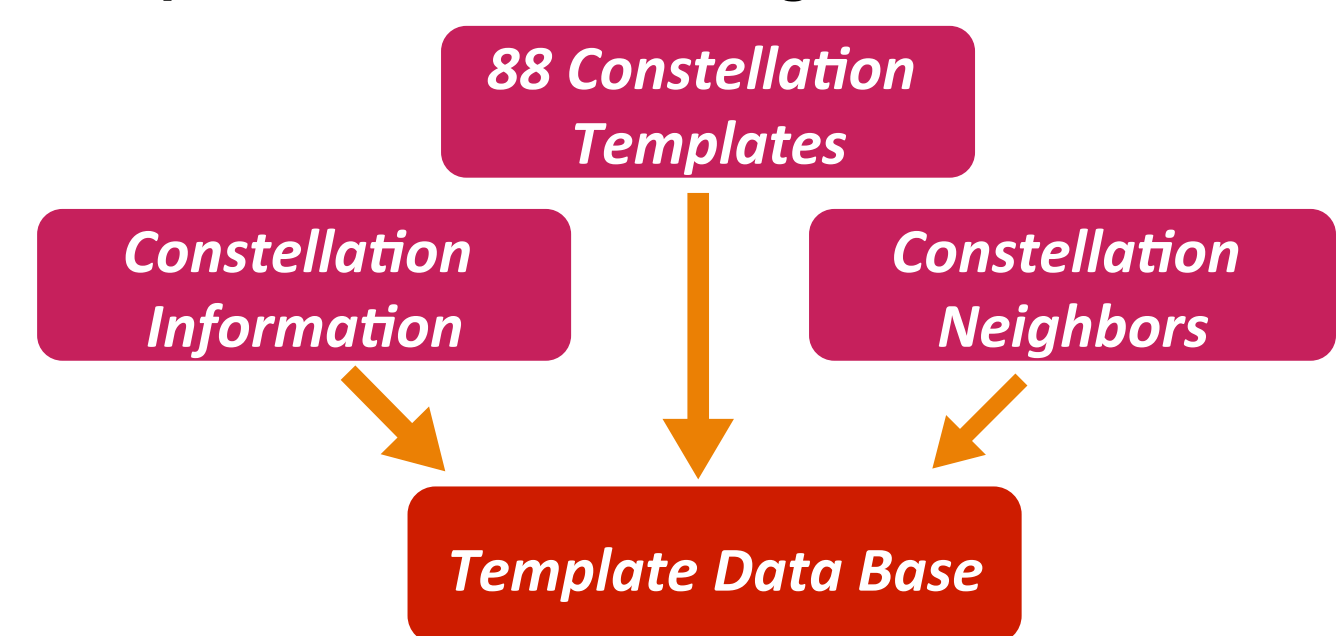
- constellation scale
- neighbor constellation
- star overlap

## Algorithm

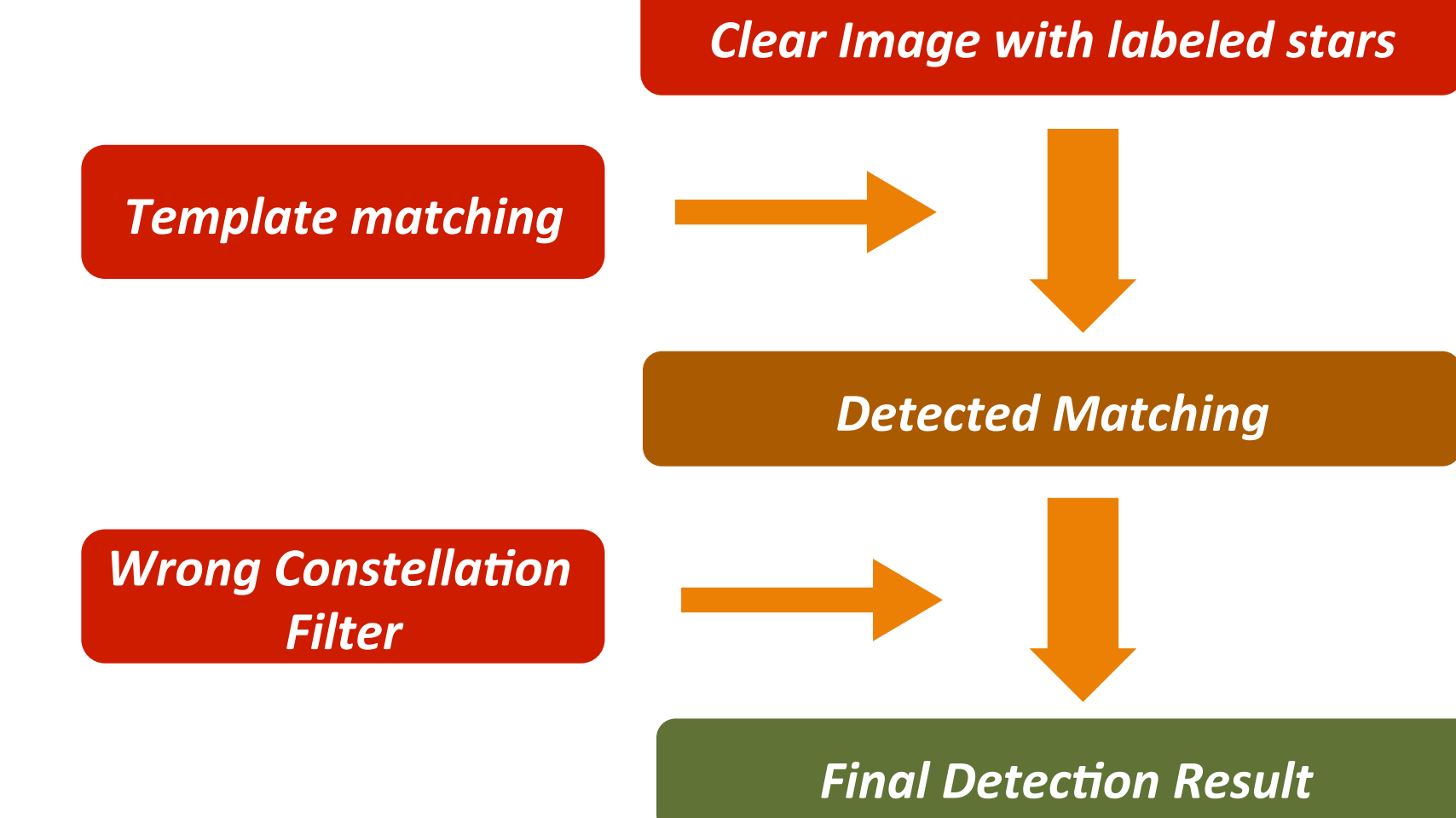
### Image Preprocessing



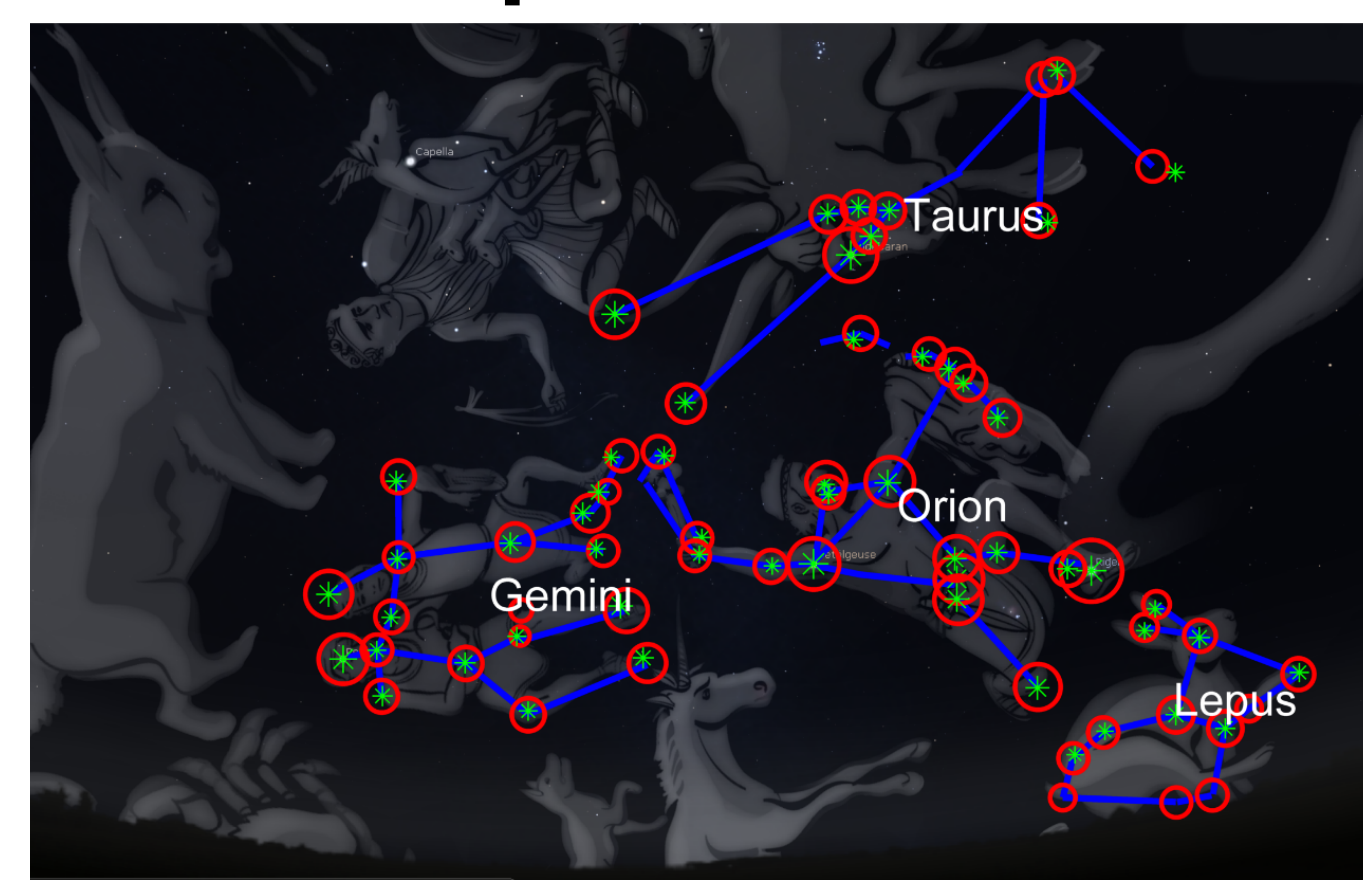
### Template Machine Learning



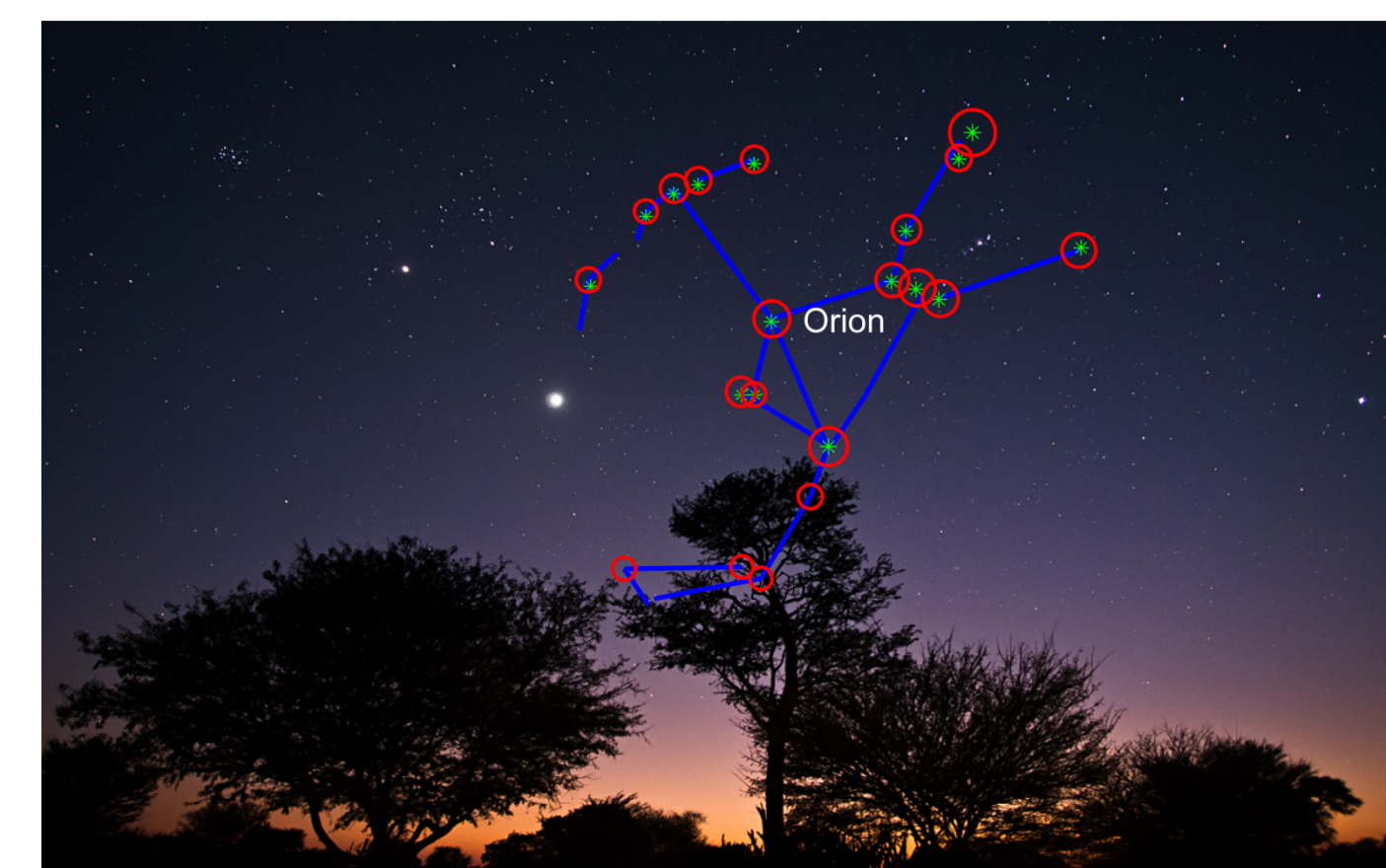
### Main Detection



## Other Experimental Results



Successfully detected *Taurus*, *Gemini*, *Orion* and *Lepus*



Successfully detected *Orion*.  
(Picture took at Kalahari desert)

### Reference

- [1] Liebe, C. "Pattern Recognition of star Constellations for Spacecraft Applications", *IEEE AES Systems Magazine*, Jan 1993
- [2] Jiang, M., etc. "A Novel Star Pattern Recognition Algorithm For Star Sensor" *Proceedings of the Sixth International Conference on Machine Learning and Cybernetics*, 19-22 August 2007
- [3] Rehman, M., etc. "Single Star Identification and Attitude Determination in Tracking Mode" *International Conference on Control, Automation and Systems* 2008
- [4] M. D. Pham, etc. "A Star Pattern Recognition Algorithm for Satellite Attitude Determination" *IEEE Symposium on Industrial Electronics and Applications* September 23-26, 2012,
- [5]. Stellarium, Software, Matthew Gates, Barry Gerdes