ExoScanner

The Developing and Testing of a Software to Help the Search for Exoplanets

Introduction

Exoplanets are planets orbiting stars other than our sun. The first such exoplanet was discovered in 1992. Up until today, only around 5000 exoplanets have been discovered.

For amateurs it has been possible to detect already known exoplanets. However, it was not really possible to discover new exoplanets, simply because there was no software which could search a huge dataset for exoplanets. I wanted to change that. The goal was to write a software:

ExoScanner
Enable amateur astrophotographers to discover new exoplanets.

Methods

The Transit Method

is a method to detect an exoplanet. The idea is that an exoplanet will, during its orbit, transit inbetween us and its host star. This will cause the host star to appear slightly darker. Even though this change in brightness is barely one percent, it is possible to detect it using an amateur telescope and camera.

Smaller Subproblems

were the key to success. The problem of «finding potential exoplanets» was split into these subproblems:

1. Data Calibration

is used to subtract faults in the camera sensor from the image data.

2. Star Detection

is the problem of finding stars in an image.

3. Alignment

identifies the same stars throughout multiple images.

4. Brightness Calculation

measures the brightness of a star in an image. It needs to be very precise.

5. Data Cleansing

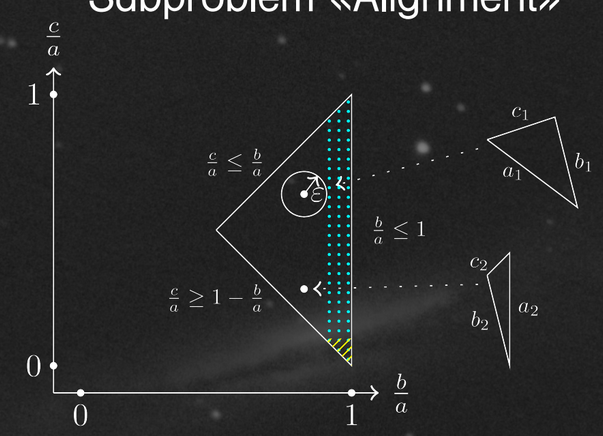
is necessary to remove bad data, for example caused by clouds.

6. Data Analysis

mathematically examines the extracted data and determines which stars might host an exoplanet.

Some of the used algorithms were described in research papers, others were developed from scratch. One notable example is the subproblem «Alignment». The very interesting theoretical algorithm in the paper «FOCAS Automatic Catalog Matching Algorithms» formed the basis for solving it.

Subproblem «Alignment»



Main Idea: Using the mathematical «triangle space» to match similar triangles from the brightest 20 stars throughout each image. The two dimensional «triangle space» is based on the idea to map any triangle with sorted side-lengths (a,b,c) to the coordinates $x = a/c$ and $y = b/c$. The beauty of this space is that similar triangles get mapped to similar coordinates.

Results

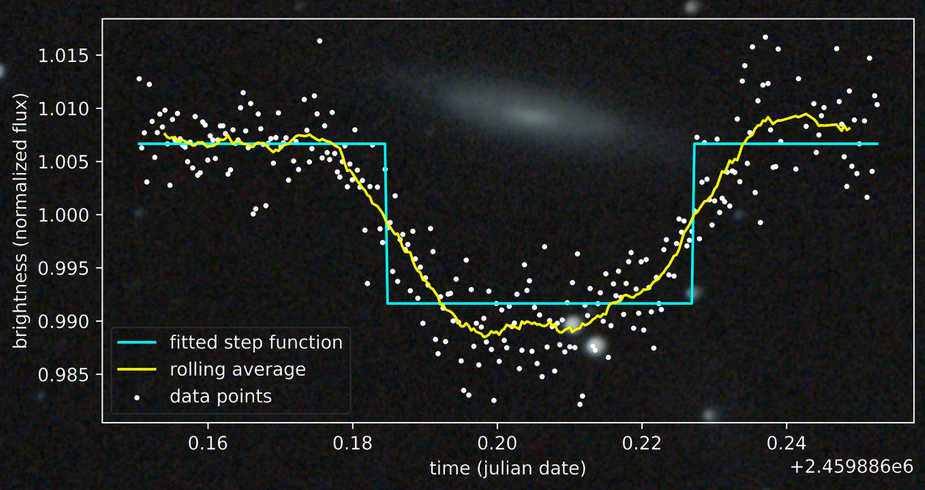
ExoScanner was tested on multiple different datasets of verified exoplanet transits. ExoScanner could successfully identify the recorded exoplanets.

ExoScanner is actually being used. There are multiple amateurs around the globe who have installed and used ExoScanner.

Furthermore, there is a student at University Cardiff in Wales who tries to discover a new exoplanet using ExoScanner and the telescope at his university.

So maybe ExoScanner will actually be responsible for the discovery of a new exoplanet. I am excited what the future will bring.

Exoplanet WASP-140 b as identified by ExoScanner



This output from ExoScanner shows the brightness of the star over time and demonstrates the brightness dip caused by a transit. The blue line was fitted by ExoScanner during the data analysis step.

To install ExoScanner yourself or view the source code, scan the QR code or visit: *github.com/josia-john/ExoScanner*

Kantonsschule Im Lee

Josia John
Supervised by Thomas Graf

Images, Diagrams and Graphs by Josia John