Search for Exoplanets

with convolutional neural network

PMF-MO
Strojno Učenje

Petra Brčić
Sandro Lovnički

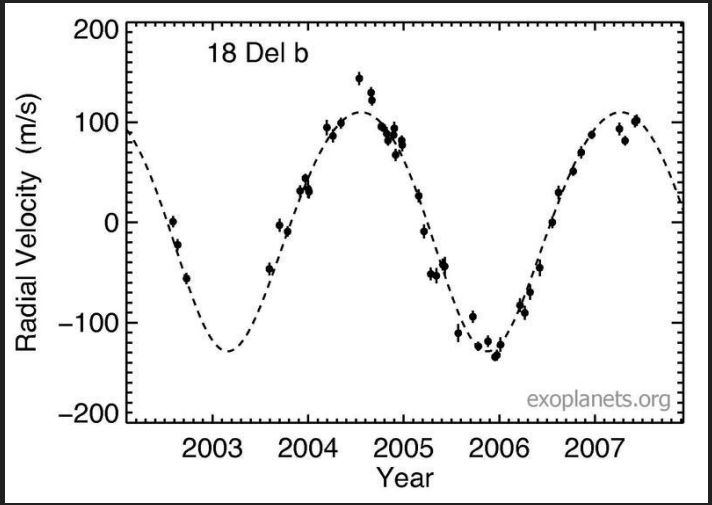
Current State

Transiting Exoplanet Survey Satellite (launched in April, 2018)

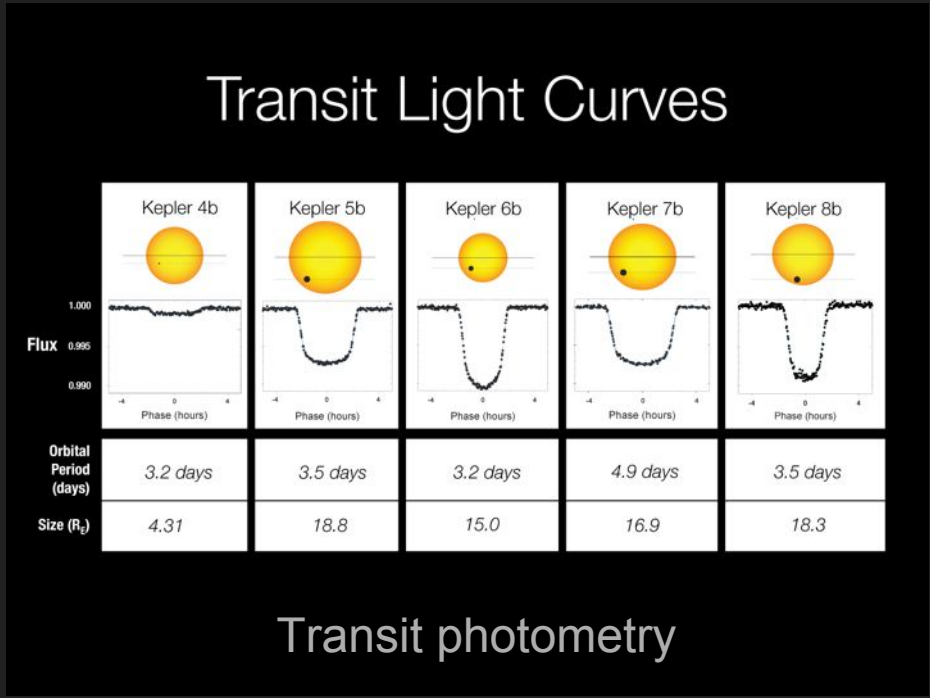
Kepler space observatory (launched in 2009)

- 3,758 confirmed exoplanets in 2,808 systems, with 627 systems having more than one planet.
- expecting 20,000 new exoplanets in the next 2 years

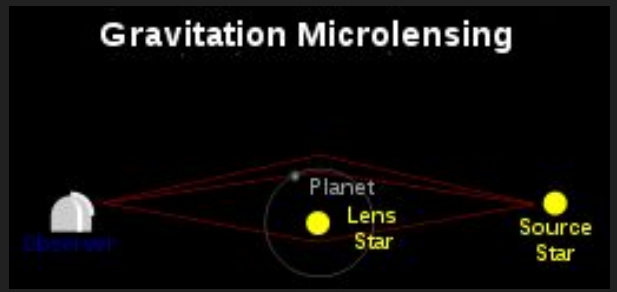
Methods



Radial velocity

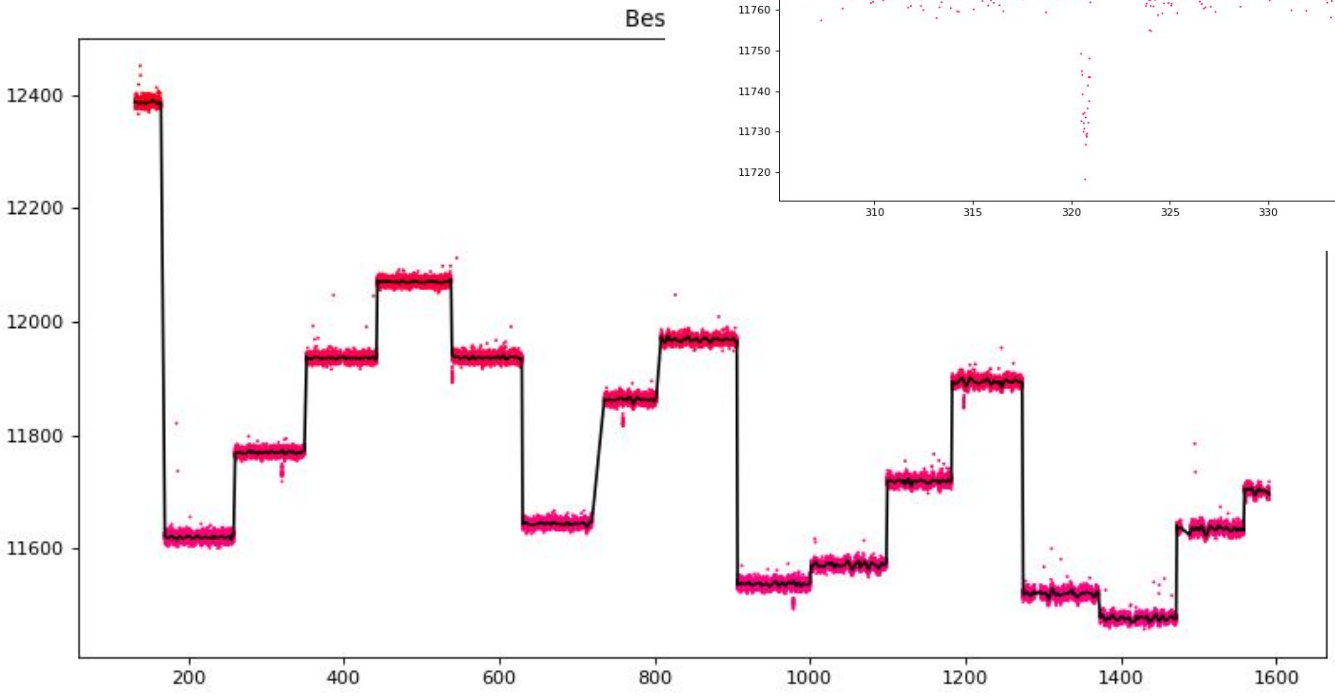


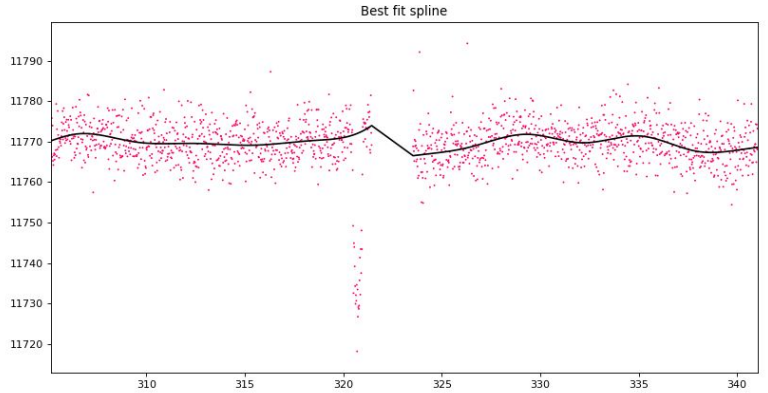
Transit photometry



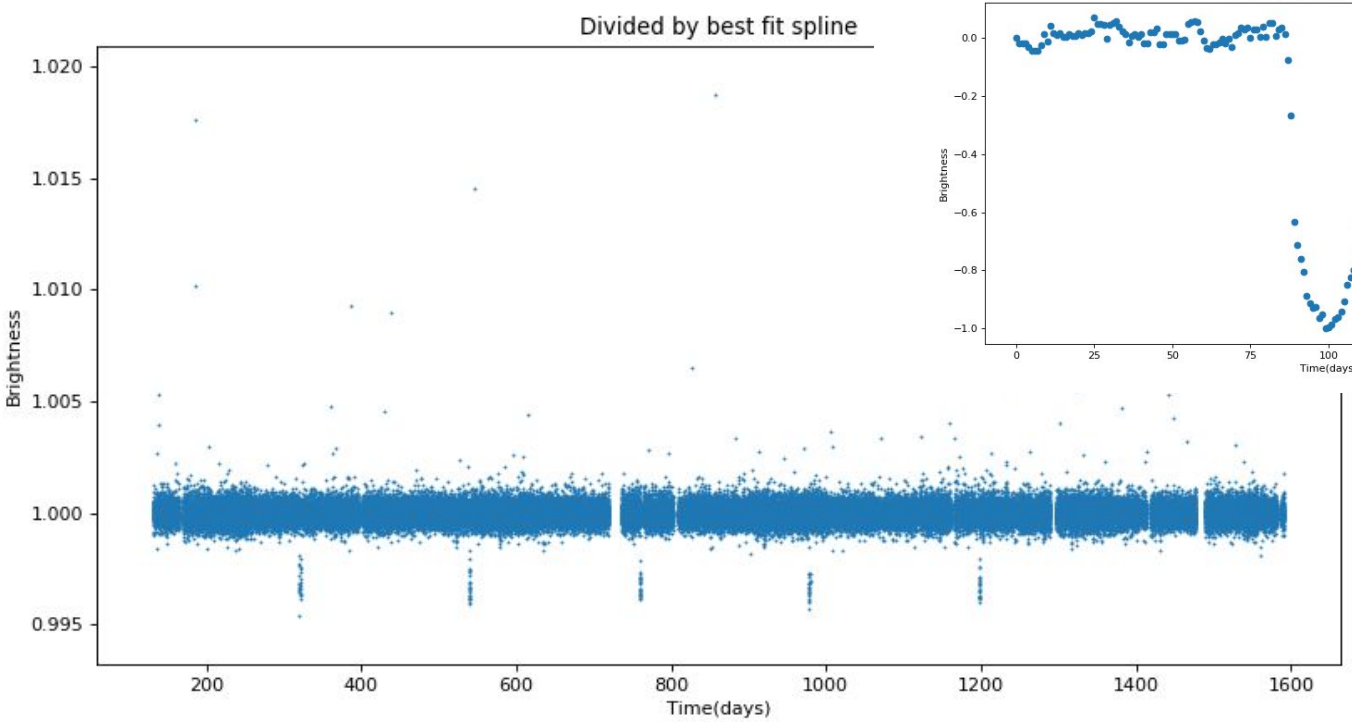
Gravitational microlensing

Data: raw + spline





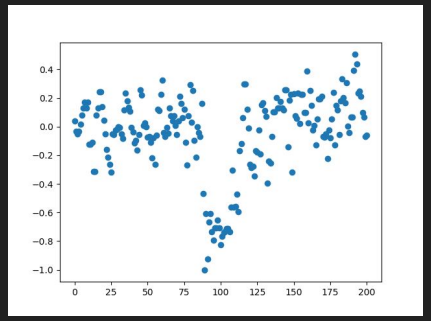
Data: divided by spline / folded drops over period

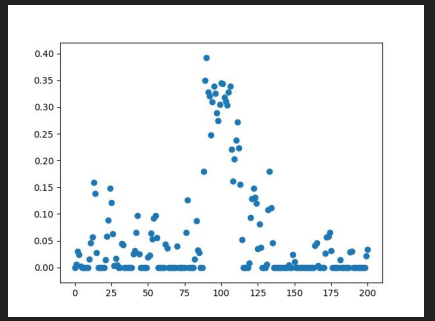


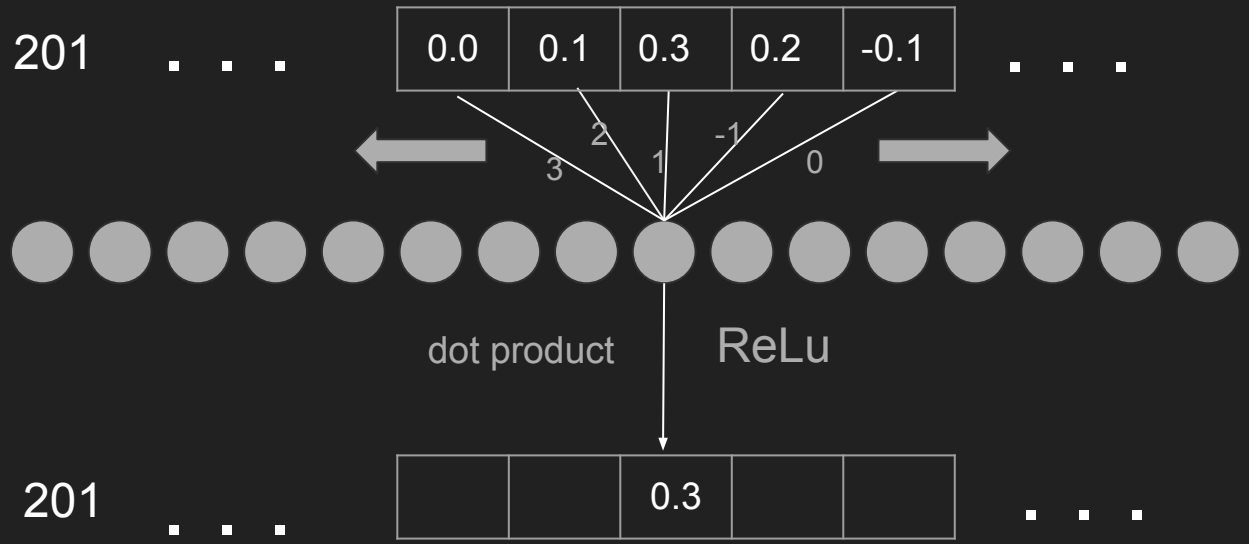
CNN: Overall shape

- ➔ input data shape : (201,)
- ➔ conv1b1 output shape: (?,201, 16)
- ➔ conv1b2 output shape: (?,201, 16)
- ➔ pool1 output shape : (?,98, 16)
- ➔ conv2b1 output shape: (?,98, 32)
- ➔ conv2b2 output shape: (?,98, 32)
- ➔ pool2 output shape : (?,46, 32)
- ➔ flatened output shape : (?,1472)
- ➔ fc1 output shape : (?,1024)
- ➔ fc2 output shape : (?,1)

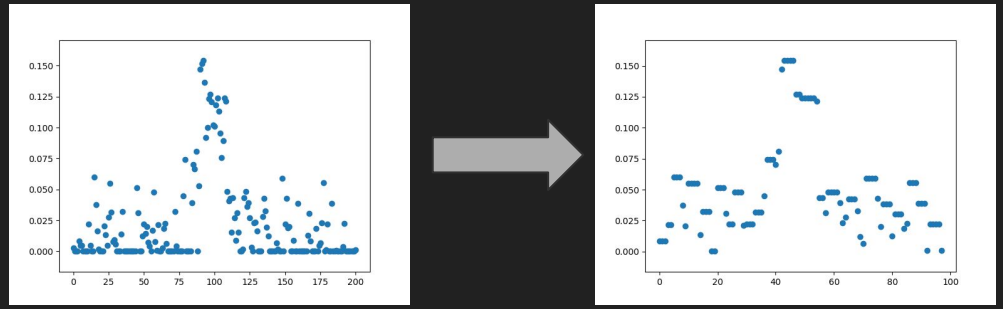
CNN:
1D Convolution



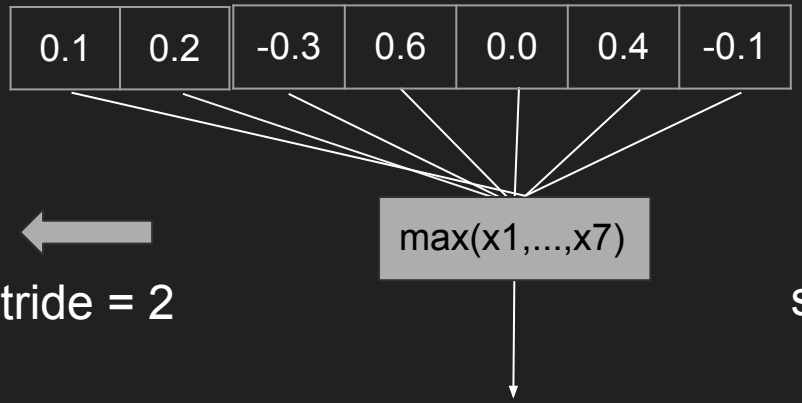




CNN:
Max Pooling



201 . . .



. . .

padding = True

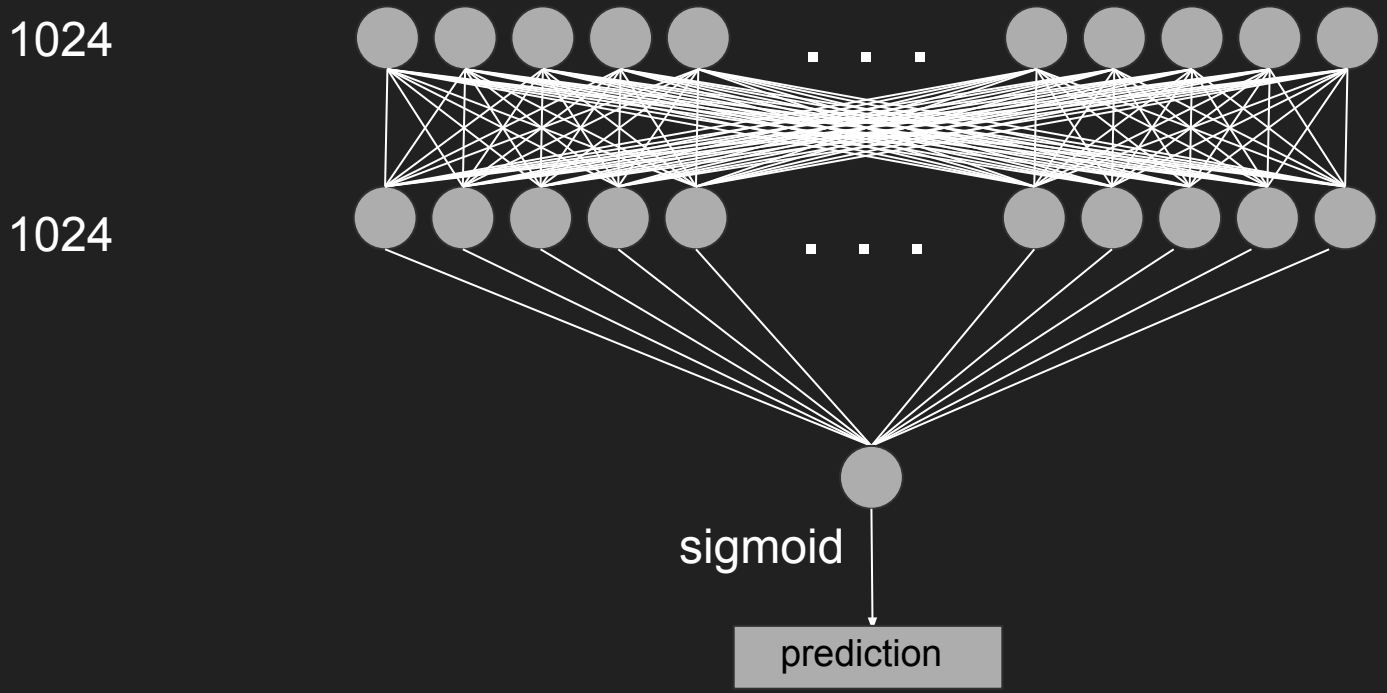
stride = 2

stride = 2

98 . . .

. . .

CNN: Fully Connected



CNN: Training

- ➔ training set: 1810 examples
- ➔ validation set: 226 examples
- ➔ test set: 227 examples

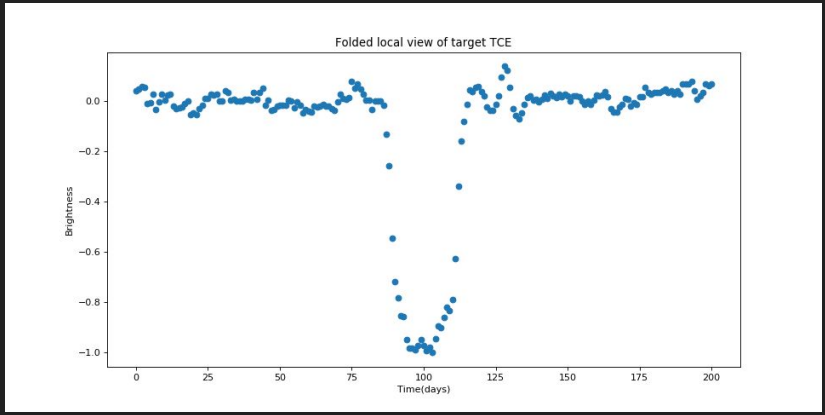
		true values: P	true values: N
predict	P	105	4
	N	2	115

- ➔ training steps: 6000 (α = 0.00001), 1000 (α = 0.000001)
- ➔ optimization: Adam optimizer
- ➔ accuracy: 0.9734513
- ➔ confusion matrix: TP 105, TN 115, FP 4, FN 2
- ➔ test set accuracy: 0.9295154

Results

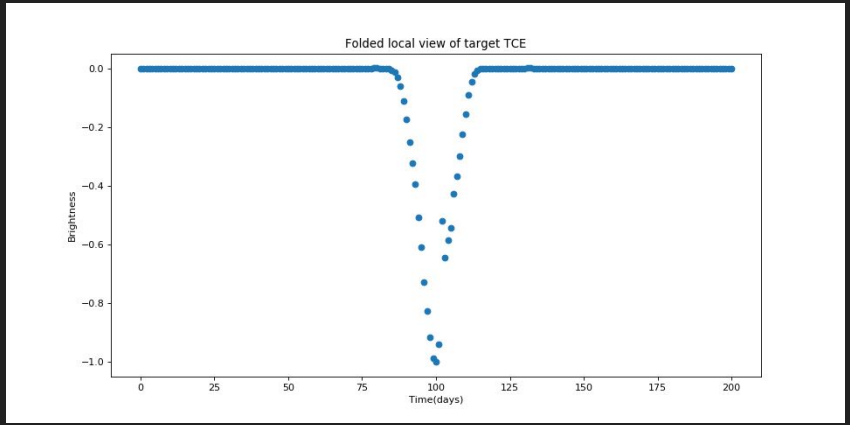
PC

prediction: 0.9563



UNK

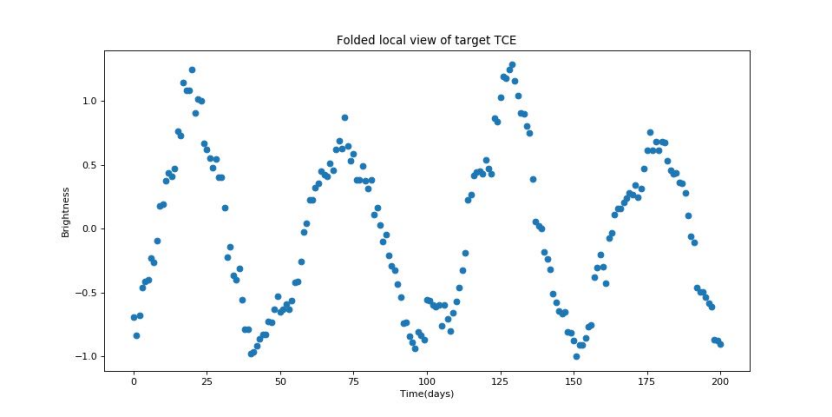
prediction: 0.1898



Results

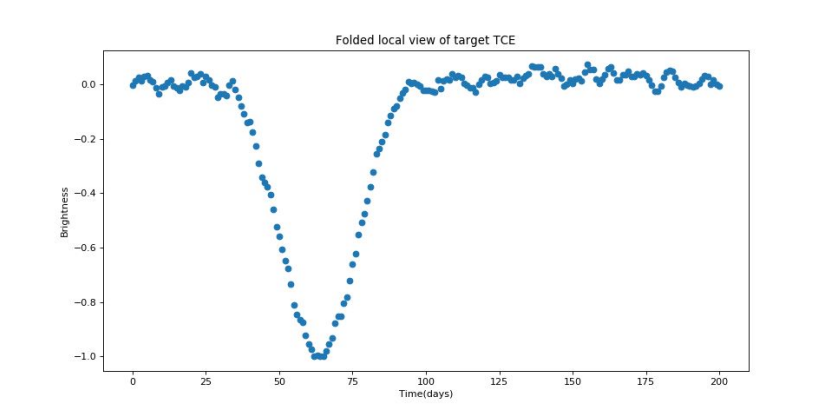
NTP

prediction: 0.0000003



AFP

prediction: 0.007



Questions?