Search for Exoplanets

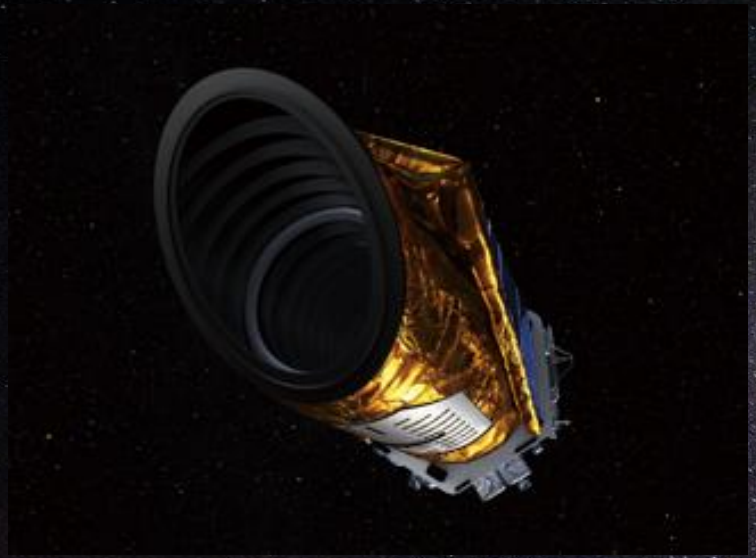
with convolutional neural network

PMF-MO
Strojno Učenje

Petra Brčić
Sandro Lovnički

Current State

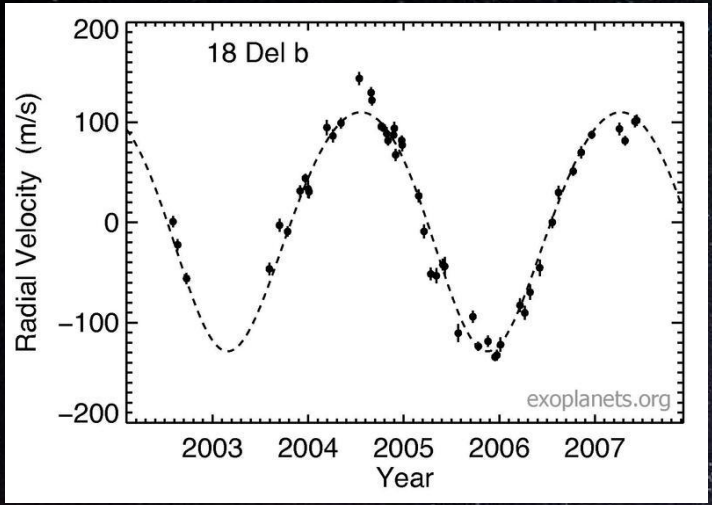
Transiting Exoplanet Survey Satellite (launched in April, 2018)



Kepler space observatory (launched in 2009)

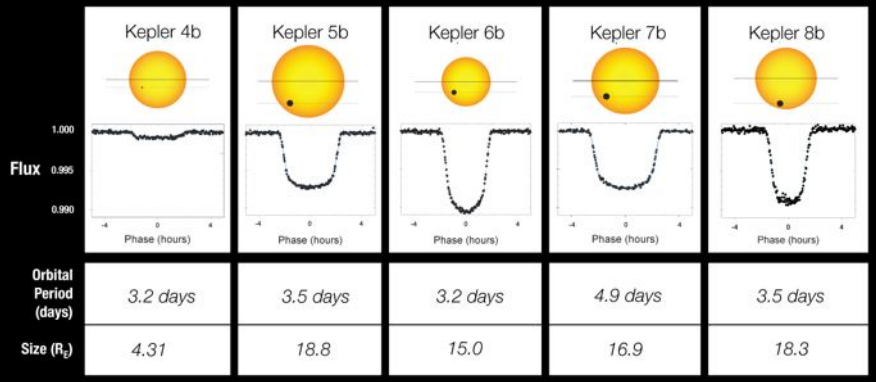
- 3,758 confirmed exoplanets in 2,808 systems, with 627 systems having more than one planet.
- expecting 20,000 new exoplanets in the next 2 years

Methods

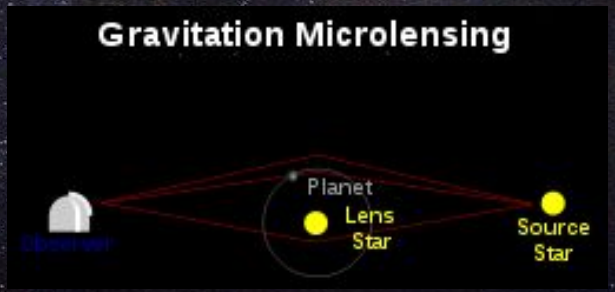


Radial velocity

Transit Light Curves

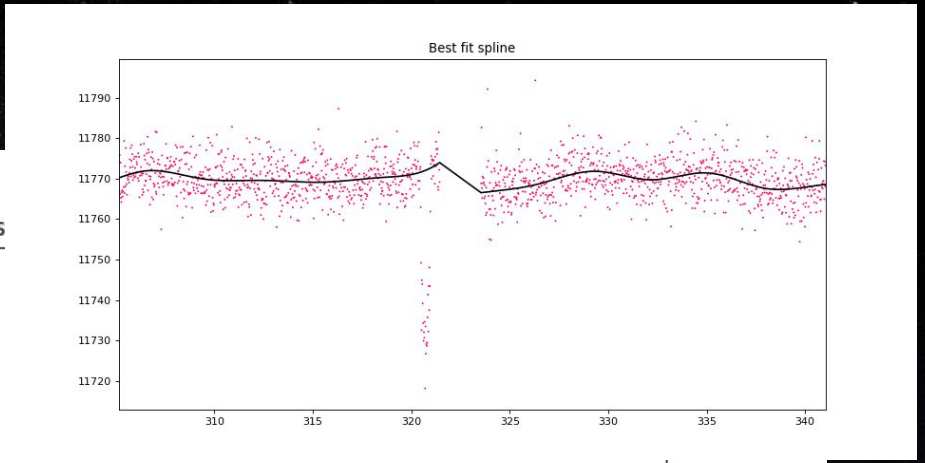


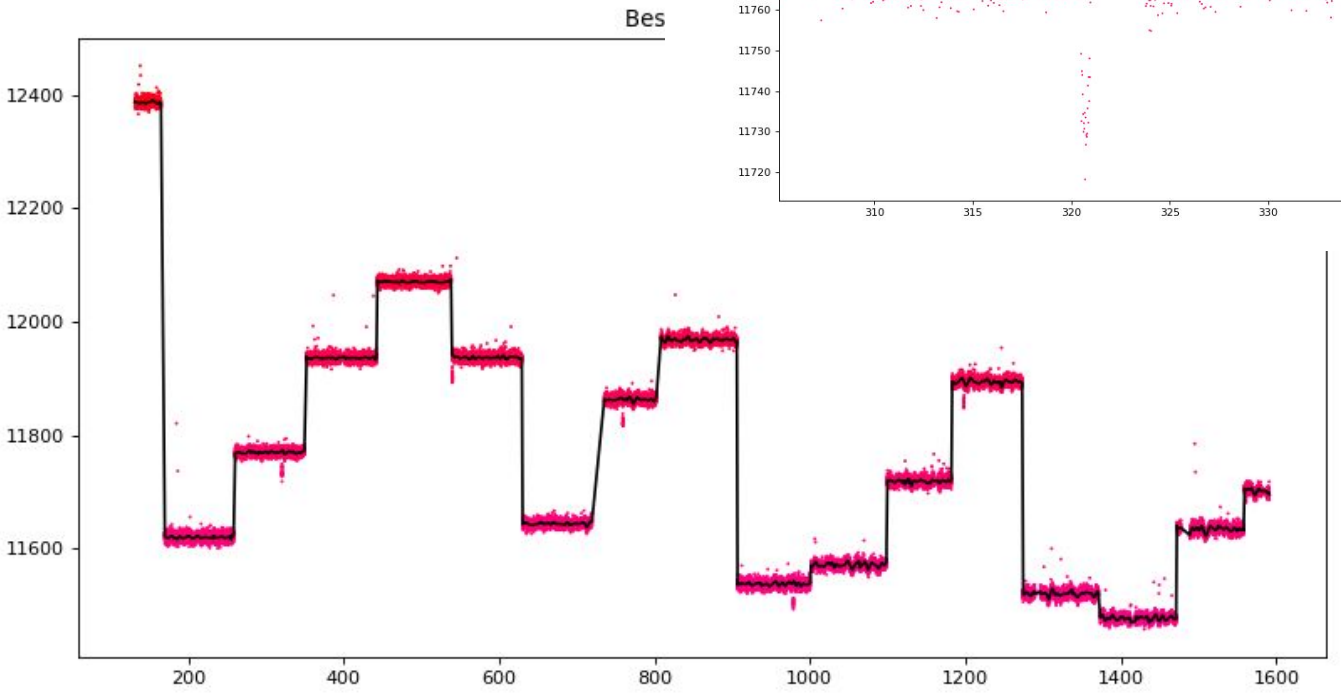
Transit photometry



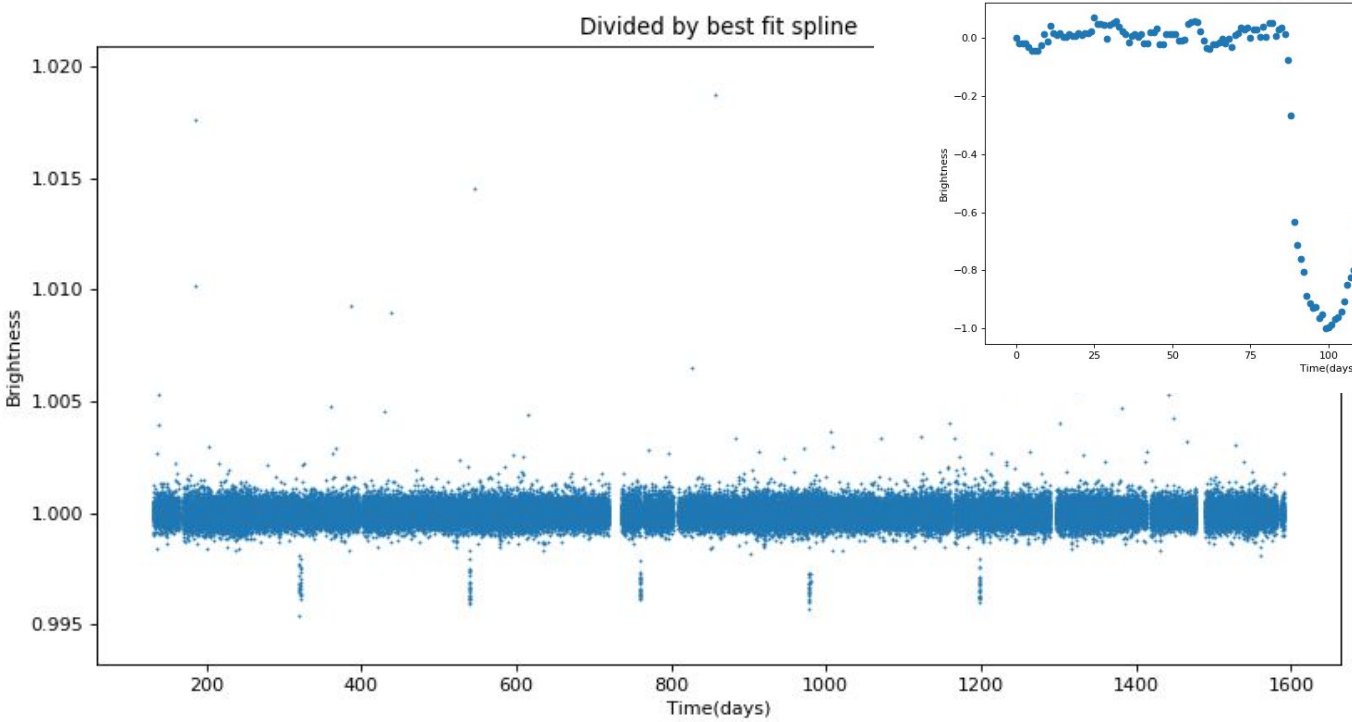
Gravitational microlensing

Data: raw + spline





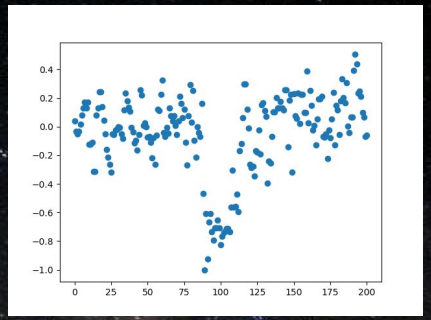
Data: divided by spline / folded drops over period

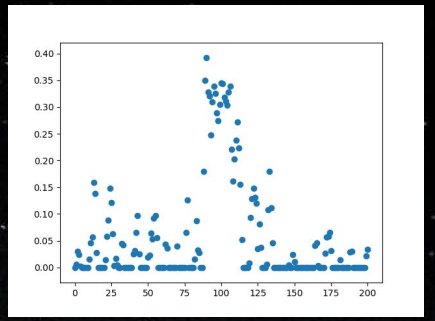


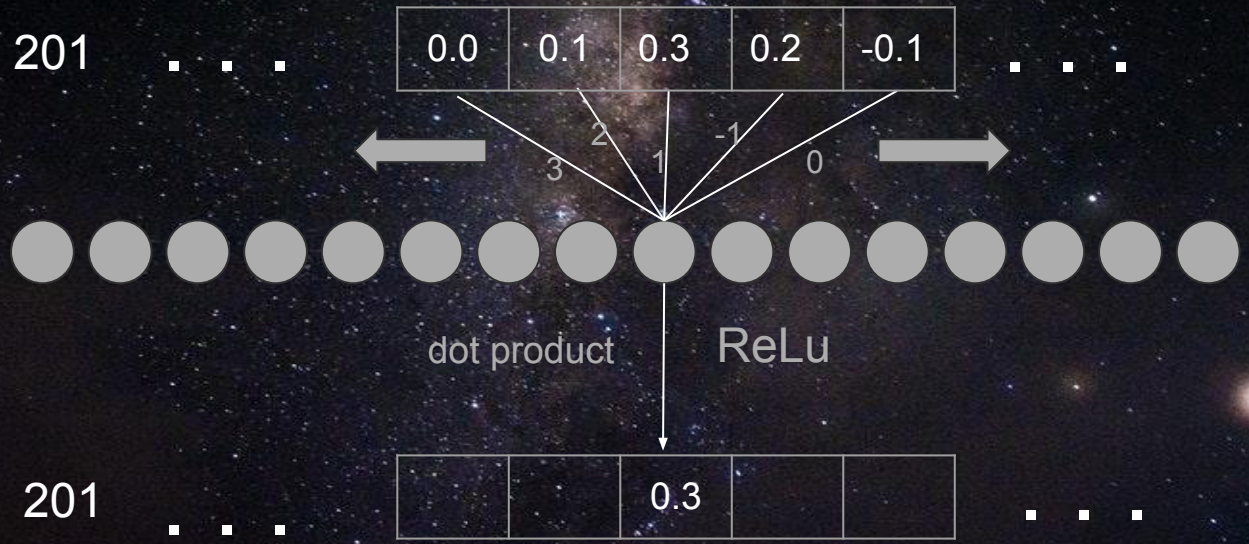
CNN: Overall shape

- 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,)

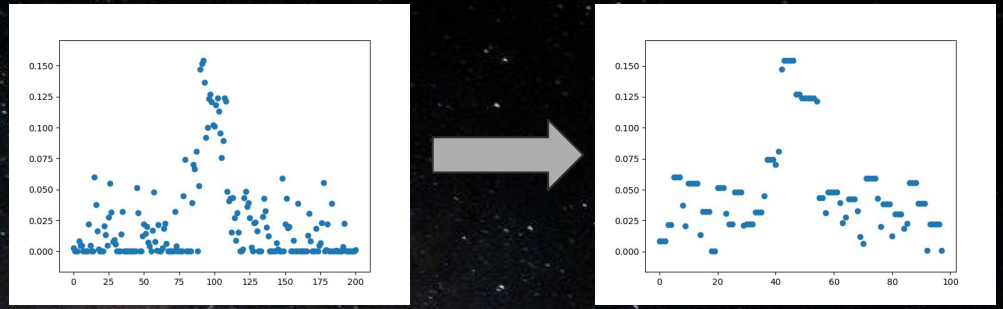
CNN:
1D Convolution







CNN:
Max Pooling



201 . . .

0.1	0.2	-0.3	0.6	0.0	0.4	-0.1

. . .

padding = ‘same’

stride = 2

max(x1,...,x7)

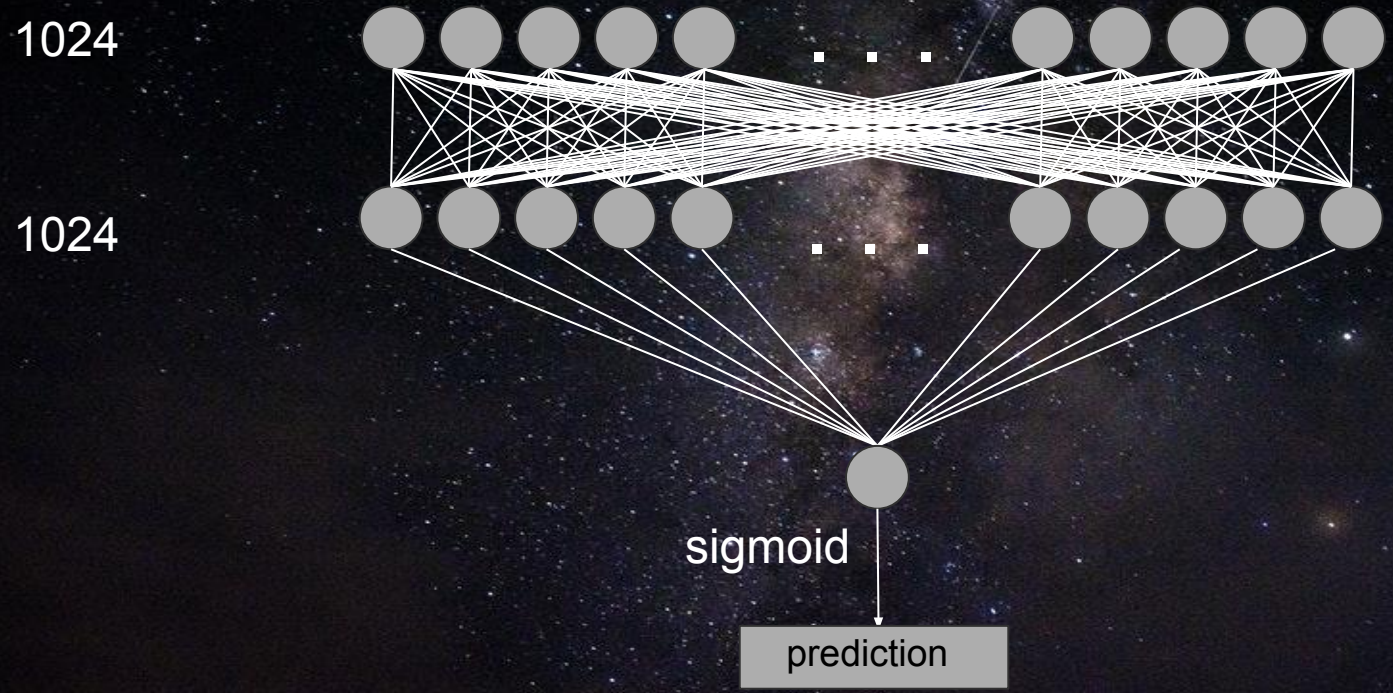
stride = 2

98 . . .

				0.6		

. . .

CNN: Fully Connected



CNN: Training

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

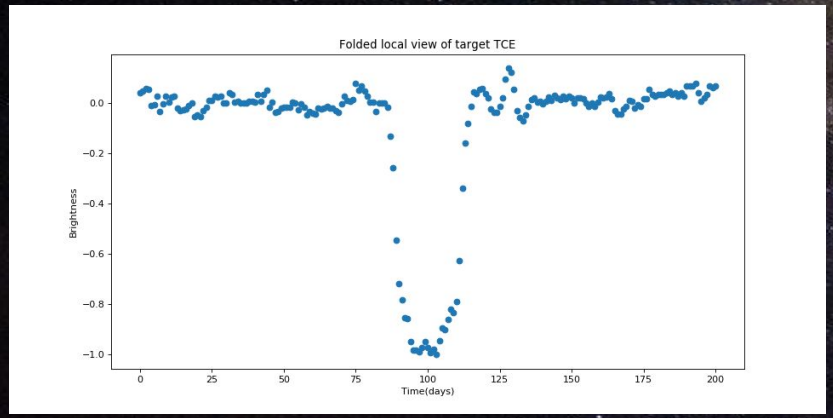
		true values: P	true values: N
predict	P	105	4
predict	N	2	115

- 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

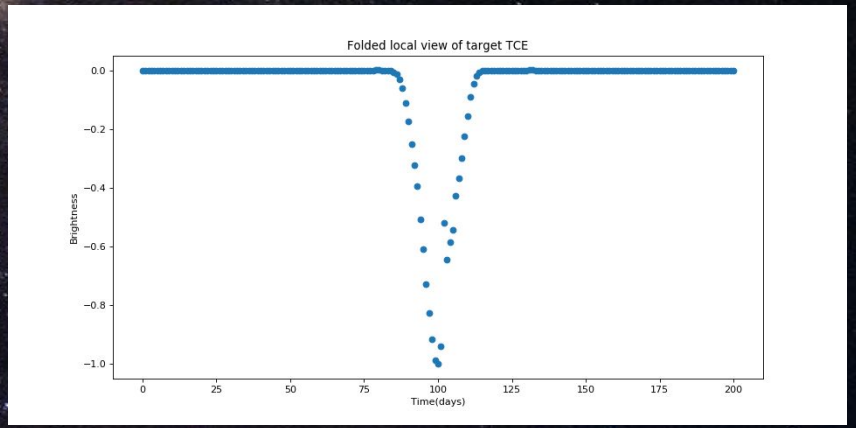
PC

prediction: 0.9563



UNK

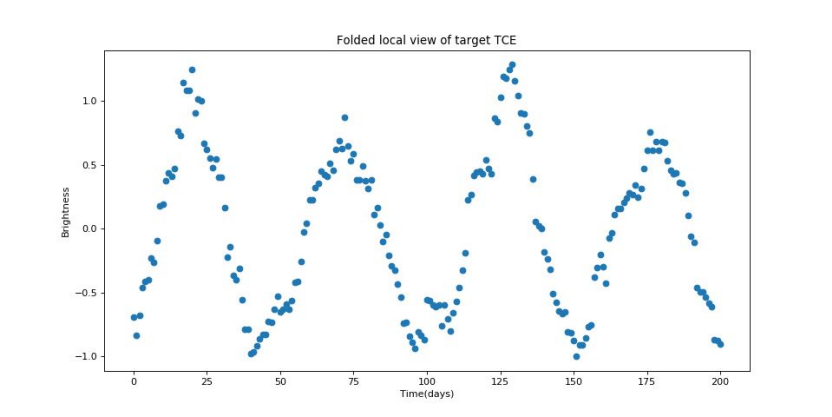
prediction: 0.1898



Results

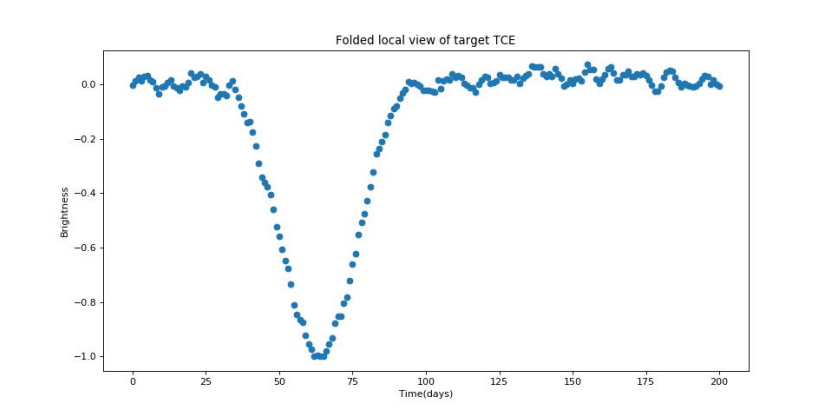
NTP

prediction: 0.0000003



AFP

prediction: 0.007



Questions are places in your mind where answers fit. If you haven't asked the question, the answer has nowhere to go. It hits your mind and bounces right off. You have to ask the question – you have to want to know – in order to open up the space for the answer to fit.

Clayton M. Christensen


THE END