

Let's reinvent
the research university model
for the digital world

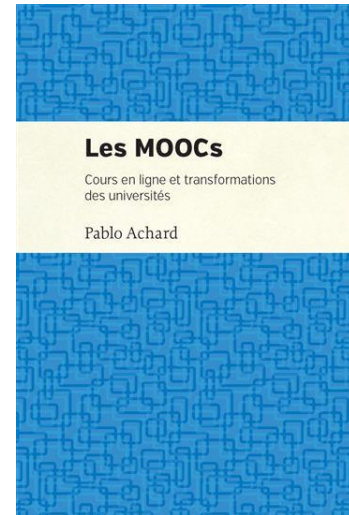
Pablo Achard
University of Geneva & Ayaru

MOOCs

- Reach large and diverse audiences
- A showcase of on-campus learning
- An engine for pedagogical innovations

But

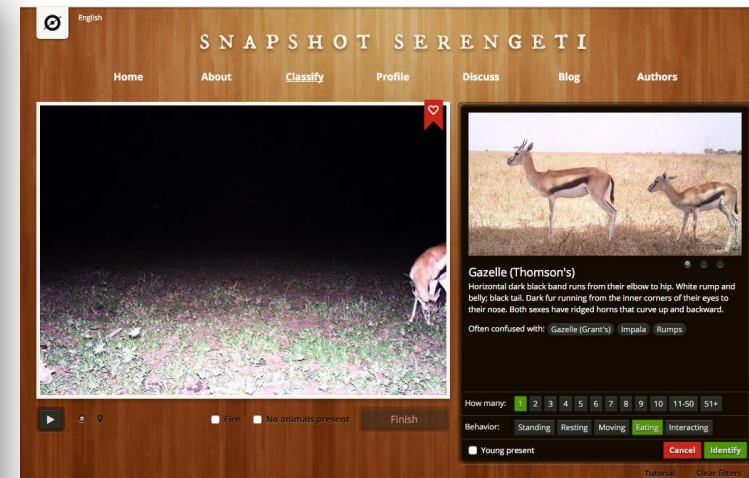
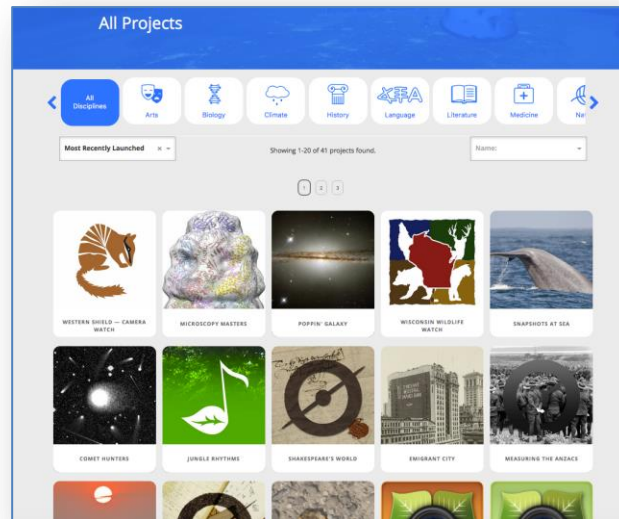
- Exercises often limited to quizzes
- Almost no teaching to/through research
- “Everyone does MOOCs”



Citizen sciences: what

- Invite amateurs to participate in the scientific endeavor
- Collect, annotate, analyze, classify, tag,... large data sets.
- By redundancy, amateur's performances are as good as expert's ones. (A. Swanson et al., *Conserv. biol.*, 2016)

2007 Oxford Galaxy Zoo
2014 1M participants,
70+ articles



Citizen sciences: benefits

For scientific researchers

- Reporting measurements taken over a wide area or very short timescale
- Quick, accurate analysis of very large datasets.
- Finding the needle in the haystack
- Exploration of parameter spaces in simulations
- Serendipity

For volunteers

- Enjoyment
- Social community
- Ability to participate in real science

For STEM educators

- Opportunity for direct communication with scientists
- Increased content knowledge
- An experience of the process of science
- Opportunity for changes in attitude toward science

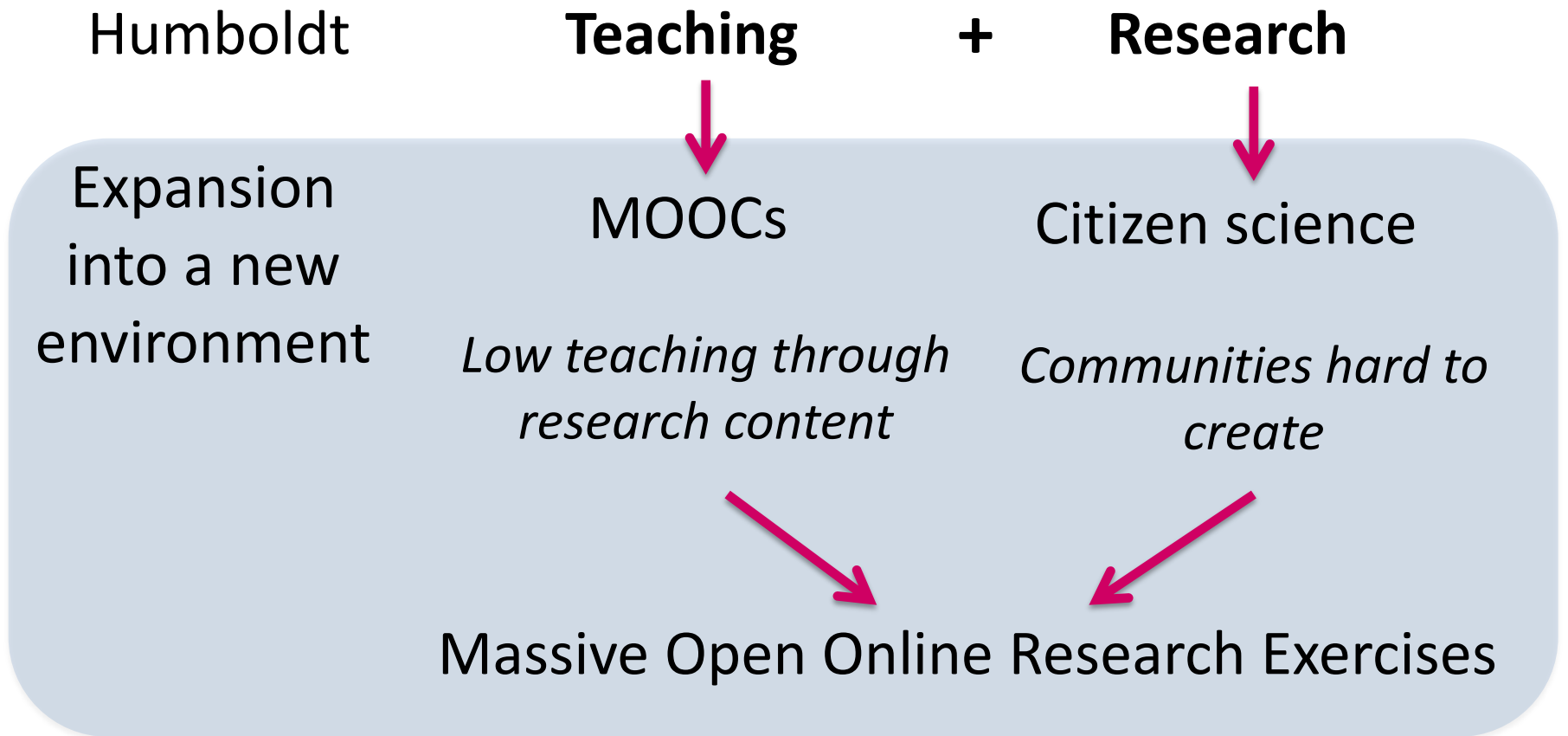
For society at large

- Closer connection between scientists and the public
- Increase in scientific understanding and habits of mind by the public as a whole

Citizen sciences: limits

- Reaching a critical mass of participants isn't easy
- Often limited to simple tasks
 - AI is catching fast
 - Scientific success can obscure a failure in STEM education (Gottschalk, Druschke & Seltzer, 2013)

Humboldt in the 21st century



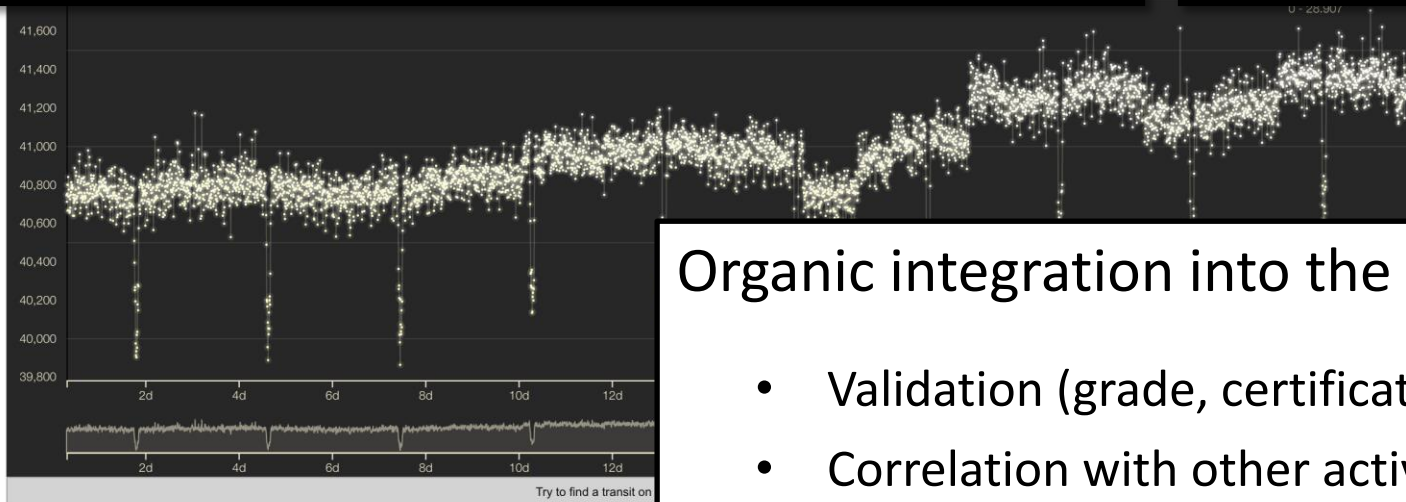
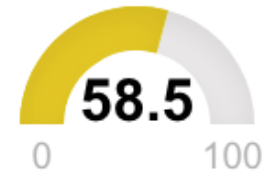
MOORE: exoplanet detection



THE DIVERSITY OF EXOPLANETS

EXOPLANET LAB AS PABLO ACHARD

Accuracy score



Do you see any transit?

yes

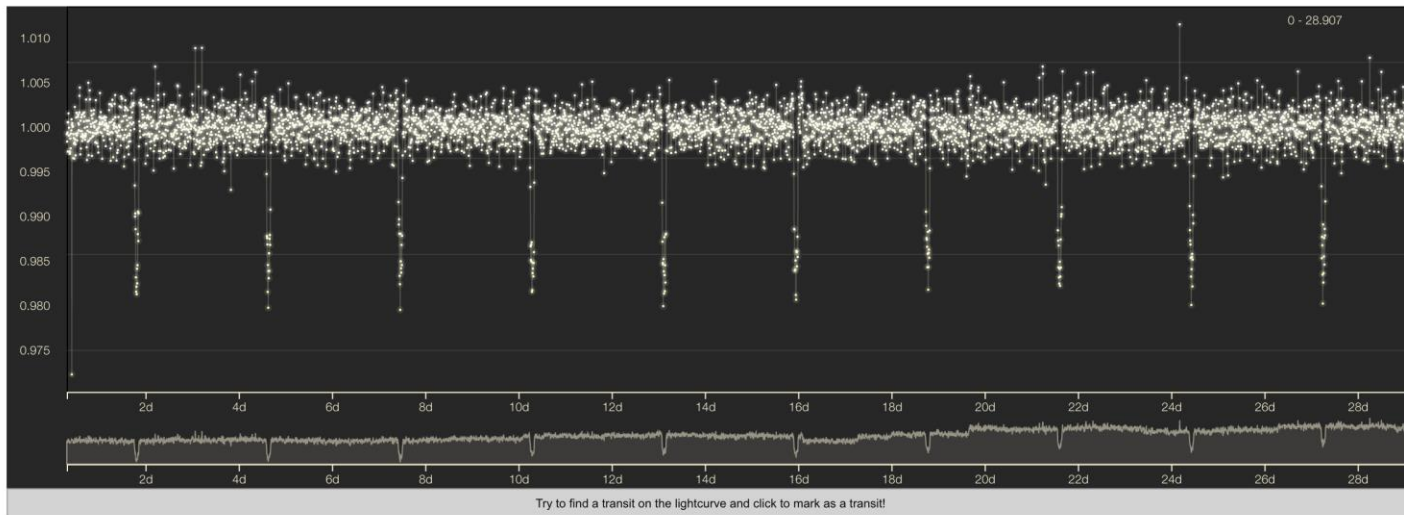
Detrending (1h 5h 10h)

off

Organic integration into the MOOC

- Validation (grade, certificate,...)
- Correlation with other activities (pedagogy research)
- Availability of existing tools (forums, A/B testing,...)

MOORE: exoplanet detection



Do you see any transit?

yes

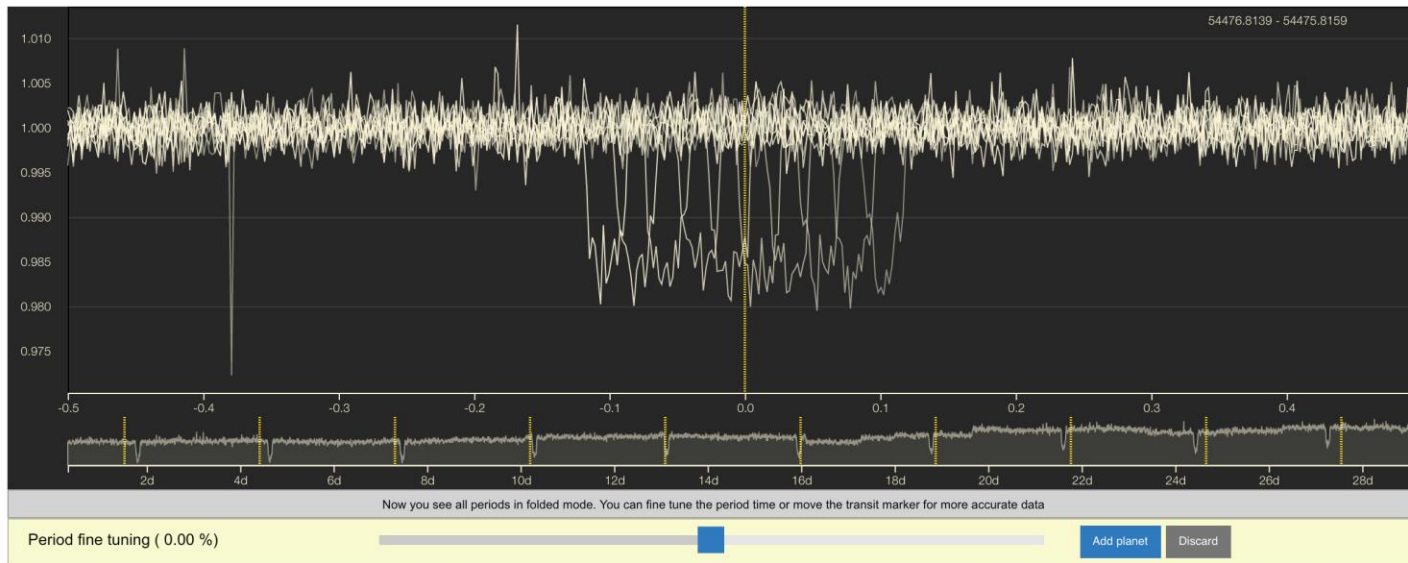
Detrending ([1h](#) [5h](#) [10h](#) [24h](#))

on

Mark stellar activity

Submit analysis

MOORE: exoplanet detection



Do you see any transit?

yes

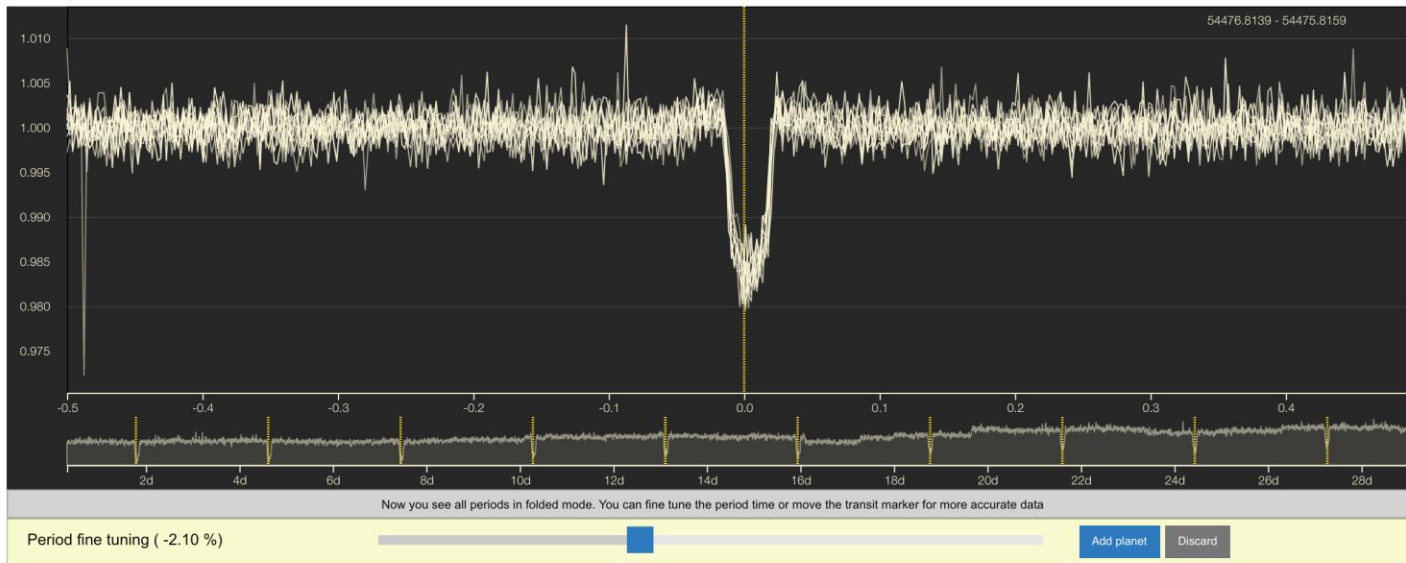
Detrending ([1h](#) [5h](#) [10h](#) [24h](#))

on

Mark stellar activity

Submit analysis

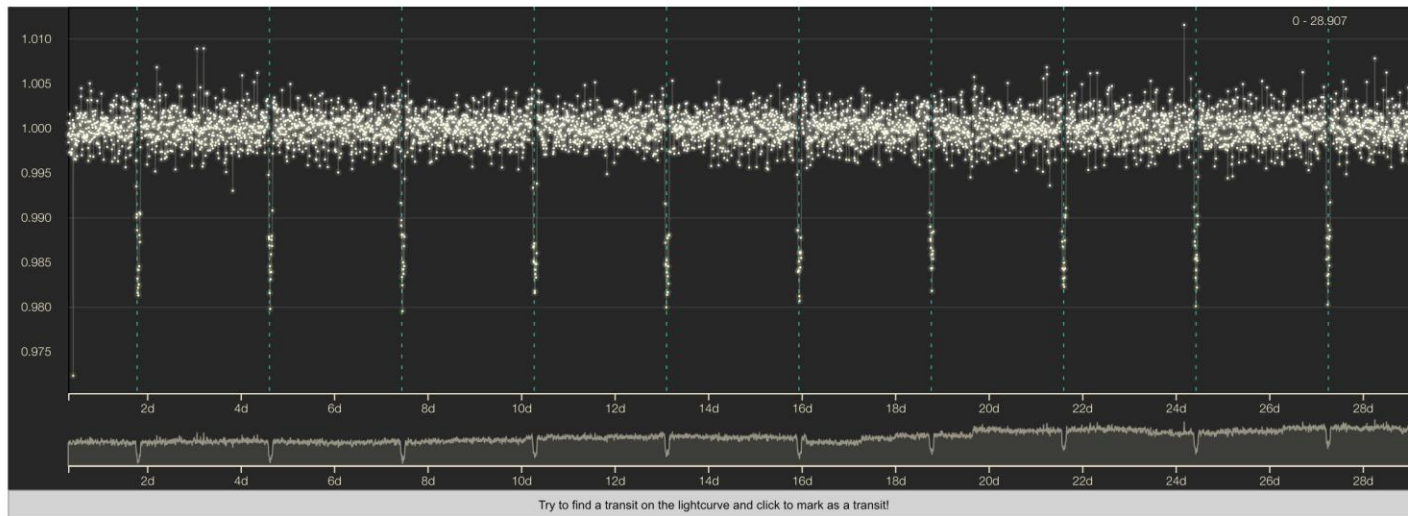
MOORE: exoplanet detection



Do you see any transit?
 yes

Detrending ([1h](#) [5h](#) [10h](#) [24h](#))
 on

MOORE: exoplanet detection



Do you see any transit?

yes

Detrending (1h 5h 10h 24h)

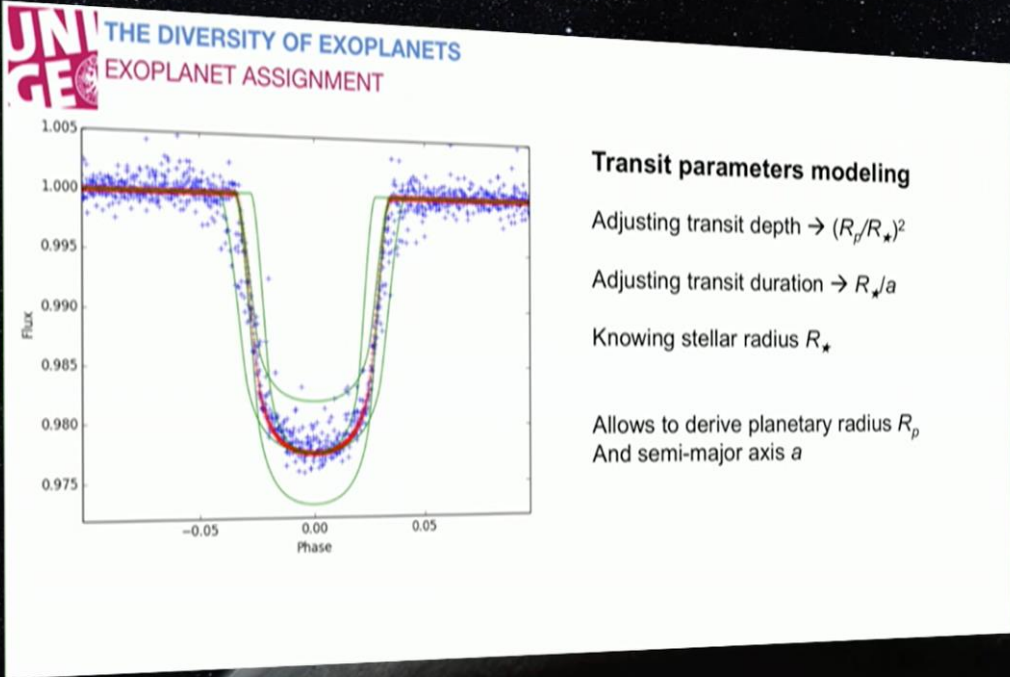
on

Mark stellar activity

Planet	Epoch	Period	
Planet no.1	12.8 day	2.83 days	

Submit analysis

MOORE: exoplanet measurement



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EXOPLANET ASSIGNMENT

Flux

Phase

Transit parameters modeling

- Adjusting transit depth $\rightarrow (R_p/R_\star)^2$
- Adjusting transit duration $\rightarrow R_\star/a$
- Knowing stellar radius R_\star

Allows to derive planetary radius R_p
And semi-major axis a

04:21 -02:19

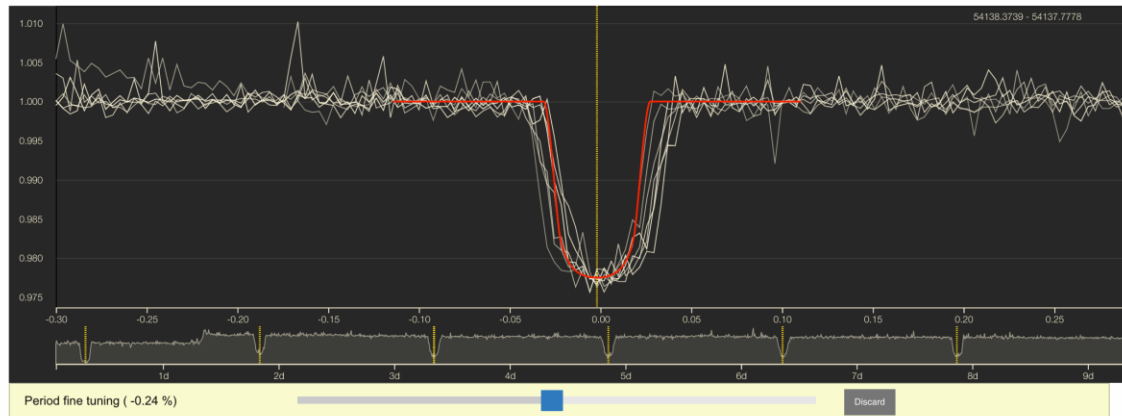
The slide features a plot of Flux vs. Phase. The y-axis ranges from 0.975 to 1.005, and the x-axis ranges from -0.05 to 0.05. Blue dots represent observed data points, and a red line shows a model fit. The plot shows a characteristic U-shaped dip in flux during a transit. To the right of the plot, text describes the modeling process, including adjusting transit depth and duration, and knowing the stellar radius to derive the planetary radius and semi-major axis.



MOORE: exoplanet measurement

Find the transit and fine tune its period (5/1)

You can see a lightcurve with transit. You need to find the transit and fine tune the period. We detrended the lightcurve by default for you to hide noises.



You see a red transit model on the graph, but it's not fit to the transit. Fine tune the a model to get the correct parameters of the star and planet too.

(rp/Rs)² adjusting (y-axis) Rs/a adjusting (x-axis)

Period	(rp/Rs) ²	Rs/a	Stellar radius (Rs)	Velocity semi-amplitude (K)
1.5074 days	0.019266	0.17276	1.11 R _☉	188 m/s

Computed values based on your results:

Planetary radius (rp)	Semi-major axis (a)	Stellar mass (Ms)	Planetary mass (mp)
1.5 R _{Jup}	0.02988 AU	1.6 M _☉	1.433 M _{Jup}

Submit results

MOORE: background detection

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EXOPLANET DUEL

Disentangle Exoplanets from Eclipsing binaries

4 diagnostics

- Depth
- Secondary eclipse
- Ellipsoidal modulation
- Transit U-Shape / V-shape

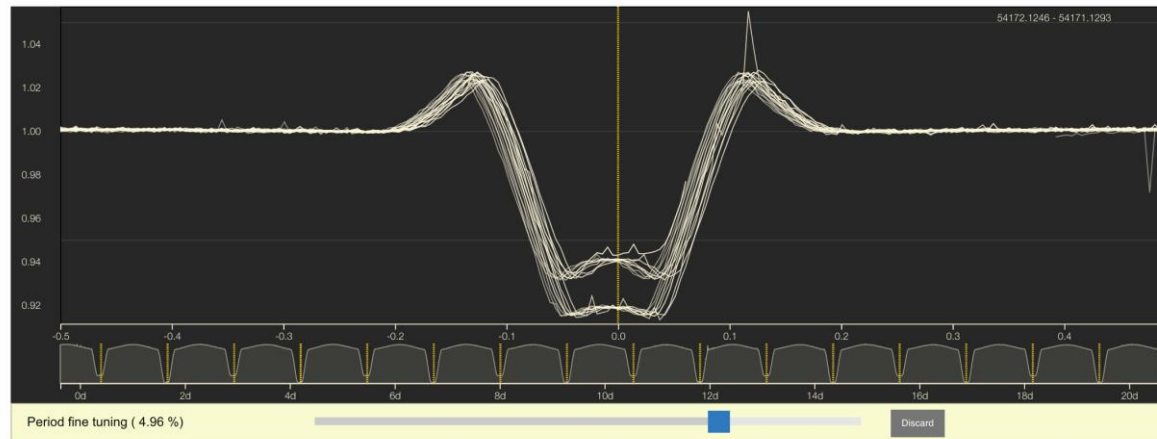
Sideplayer I. Gallagher

04:56 -01:44

MOORE: background detection

Binary vs Transit (10/7)

You see a lightcurve and its detrended and phase folded versions. You have to decide that it contains an eclipsing binary or a planetary transit. We help you with three questions but you need to make the final decision! Let's go.



Detrending ([1h](#) [5h](#) [10h](#) [24h](#))

on

Question 1

What's the depth of the transt? Is the depth of the transit is greater than 4-5%?

Yes, greater

Question 2

Is there a secondary eclipse?

Yes, there is

Question 3

Is there ellipsoidal modulation of the light curve?

Yes, it has

Question 4

Is this lightcurve U-shape or V-shape?

It's V-shape

Final decision

So what do you think, is this an eclipsing binary or a planetary transit?

Eclipsing binary

Go to next duel

Overcoming citizen science limits

- An already existing community of highly motivated participants
- Participants being trained in the topic, advanced tasks can be proposed
 - e.g. text analysis in “World literature” MOOC

Overcoming MOOC limits

- Excitement of scientific discovery making
- An introduction to the scientific endeavor
 - Everything that shines ain't gold (exoplanets / binaries)
 - Parameter measurement through curve fitting
 - From “data manipulation” to “how to separate signal from noise”
- Research universities can demonstrate their added value

Importance of the link between teaching and research

“In research-rich universities students do not just learn about research; they also undertake research and enquiry within and across disciplines. Their **active engagement with cutting-edge enquiry leads to a wide range of learning outcomes needed for professional life**, including critical thinking, the ability to solve complex problems and ethical awareness.”

D. Fung, J. Besters-Dilger & R. van der Vaart,
“*Excellent education in research-rich universities*”
LERU position paper (Feb. 2017)

One more thing...

Integration into a video game

EVE Online “a space-based, persistent world massively multiplayer online role-playing game (MMORPG)” launched in 2003

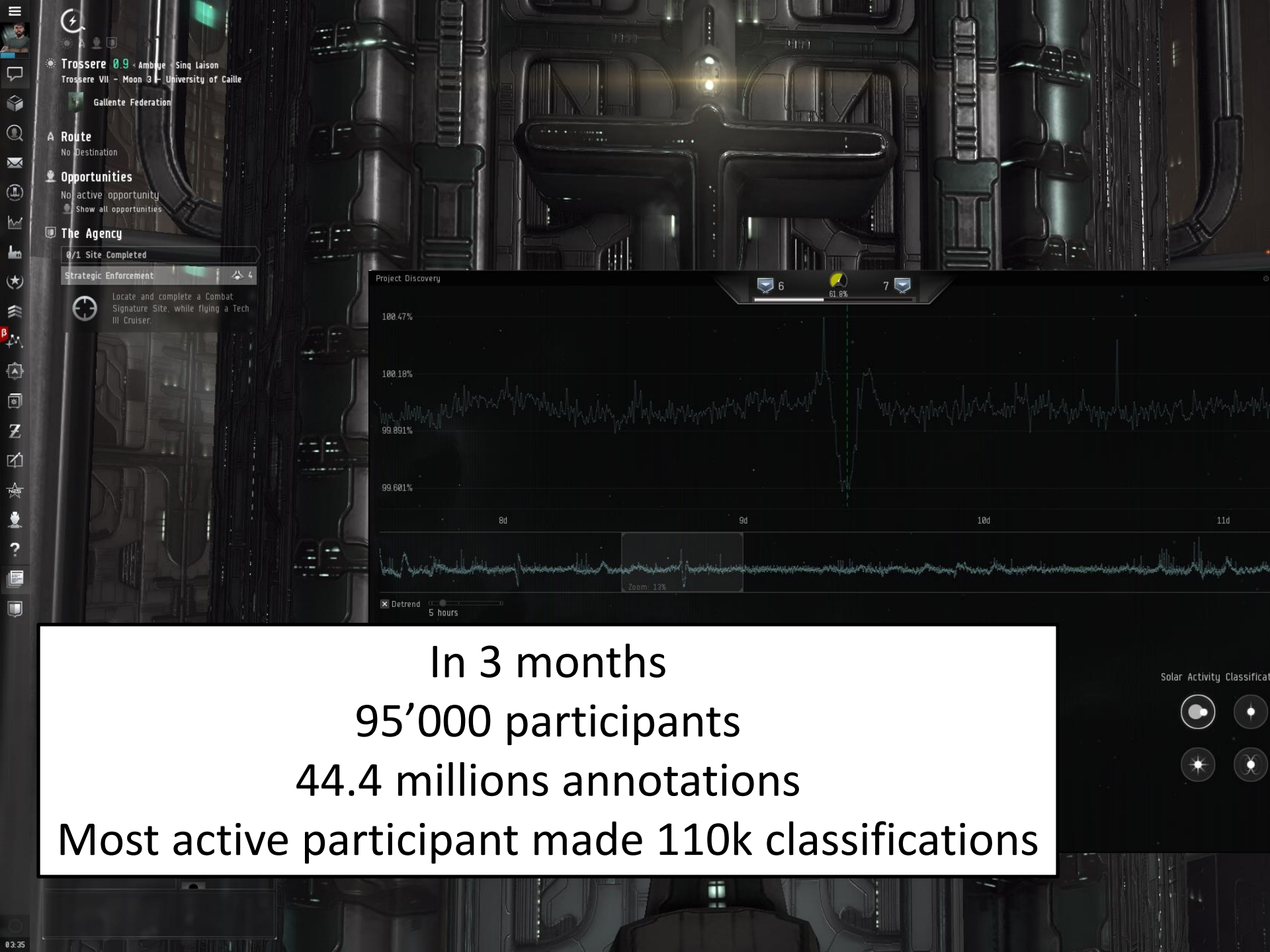


Project discovery

Launched the 11th of July 2017



MMOS
Massively Multiplayer Online Science

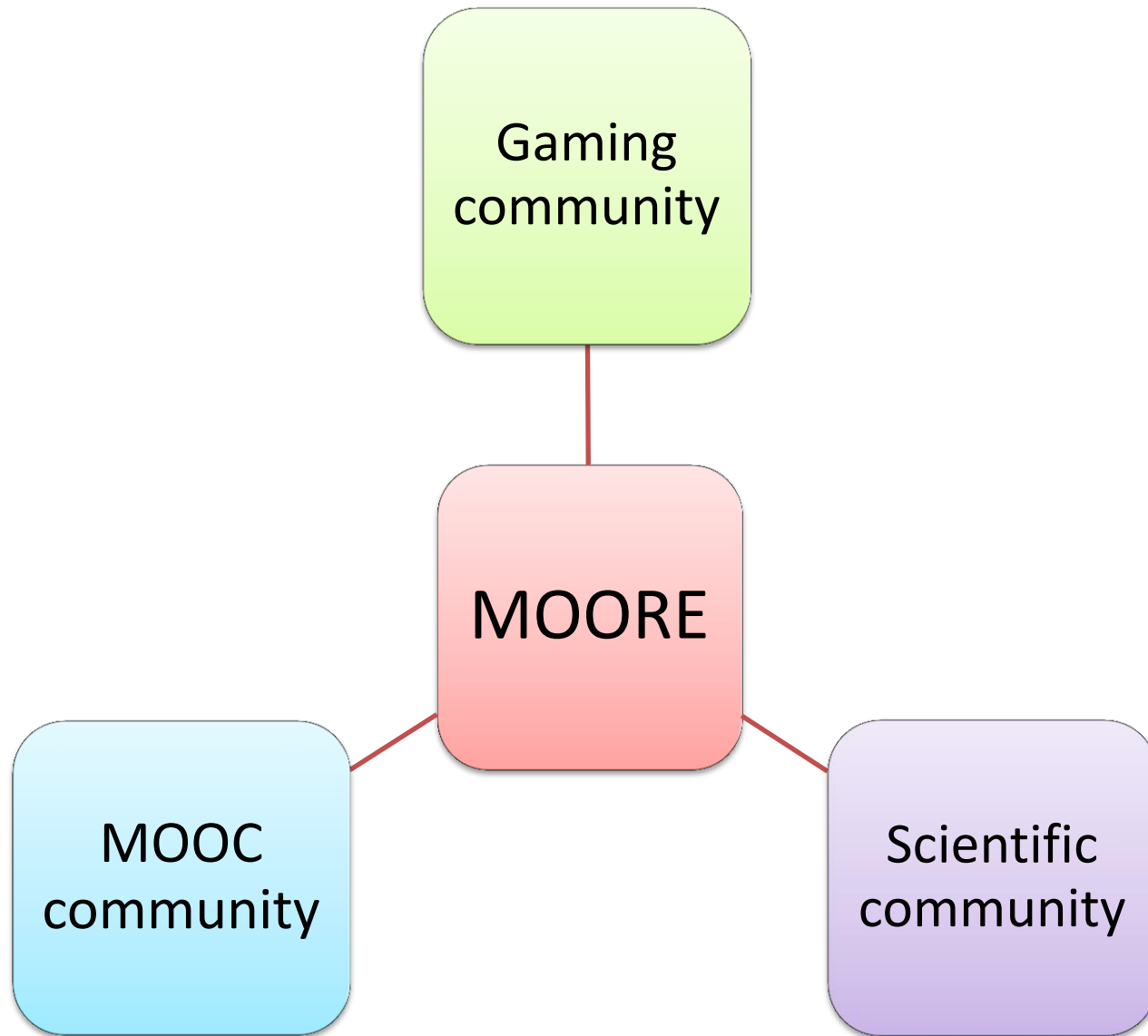


In 3 months

95'000 participants

44.4 millions annotations

Most active participant made 110k classifications



Thank you for your attention

www.ayaru.ch

Coursera > The diversity of exoplanets (dec.17)

Eve online > Project discovery