I trained a classifier and now I don’t know what to do with it

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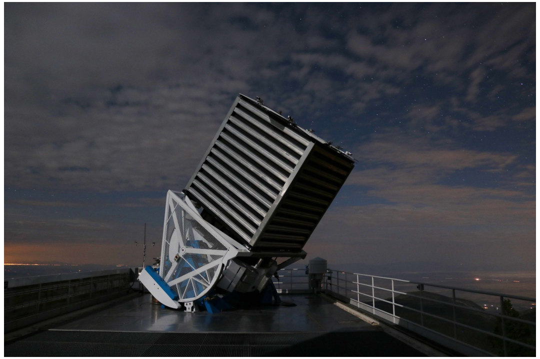
Slides: http://www.mso.anu.edu.au/~alger/mso217

We have too much data

- Surveys like SDSS and FIRST generate more data than we can look at
- Surveys like EMU generate more data than we can *store*
- How do we look through it all?

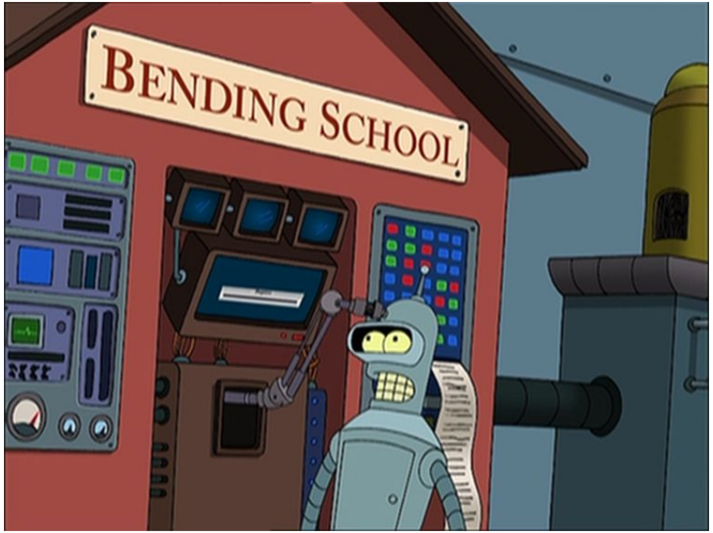
Australian SKA Pathfinder.
Image: CSIRO



The SDSS Telescope.
Image: Patrick Galume

Let’s use a classifier

- A **classifier** is a function $f: \mathbb{R}^d \rightarrow [0, 1]$
- Plenty of applications:
    - Galaxy morphology classification
    - Transient detection
    - Artefact removal



Machine learning.

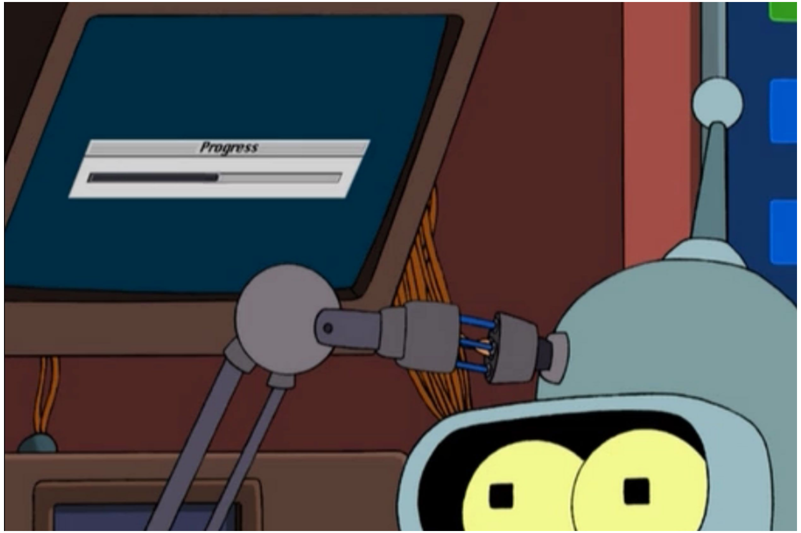
Image: Groening et al./Twentieth Century Fox

Training a classifier

- Standard approach: parametrise f and find good parameters
- e.g.

$$f(\boldsymbol{x}; \boldsymbol{w}) = (1 + \exp(\boldsymbol{w} \cdot \boldsymbol{x}))^{-1}$$

$$\boldsymbol{w}^{(t+1)} = \boldsymbol{w}^{(t)} - \varepsilon \nabla L_{\boldsymbol{w}}$$

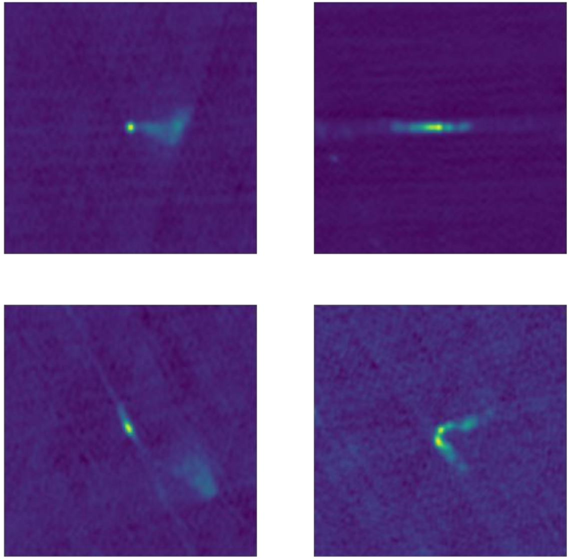


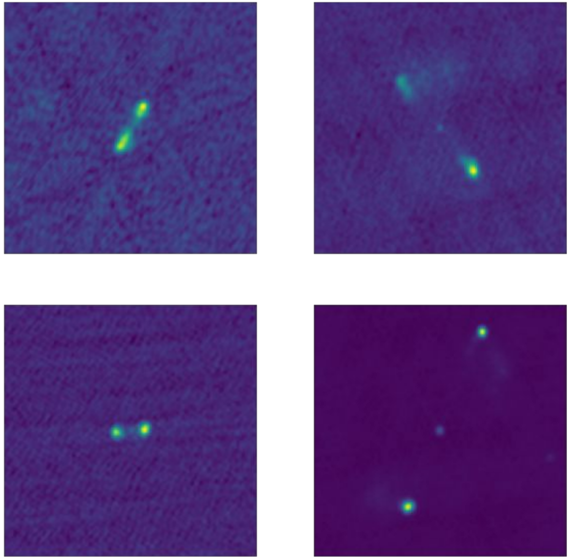
Many tasks can be learned through gradient descent.

Image: Groening et al./Twentieth Century Fox

Classifying radio galaxies

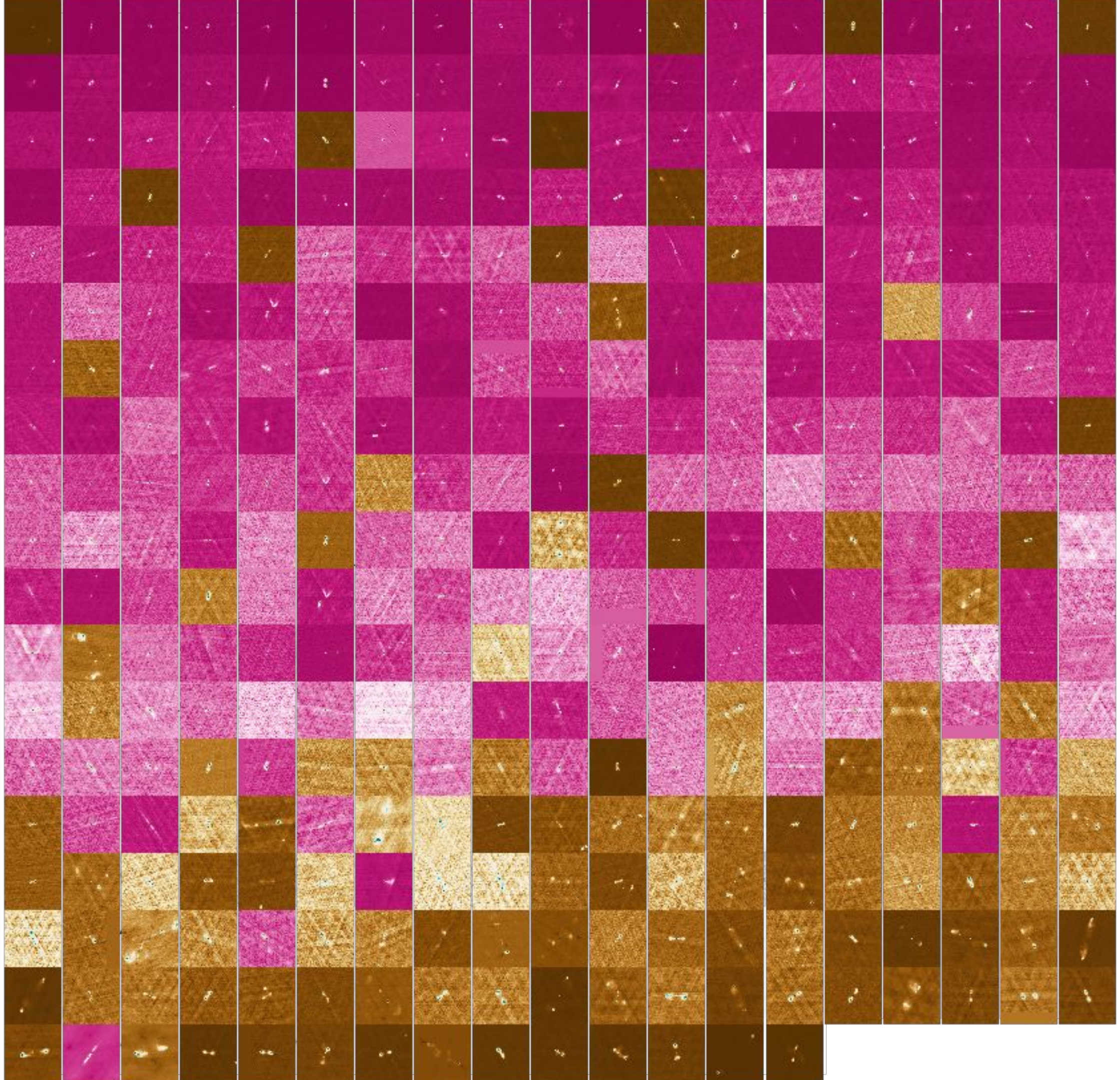
- Task: Classify radio galaxies as *Fanaroff-Riley Type I* or *Fanaroff-Riley Type II*
- $f(\boldsymbol{x})$ outputs a number closer to 0 for FR-I and 1 for FR-II





Sorting by $f(\boldsymbol{x})$

- We can sort the radio galaxies by the output of $f(\boldsymbol{x})$
- What do different parts of the list tell us?



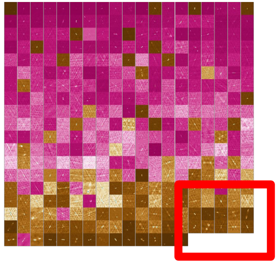
Radio galaxies sorted by $f(\boldsymbol{x})$. Orange galaxies are FR-IIs, while pink galaxies are FR-Is.

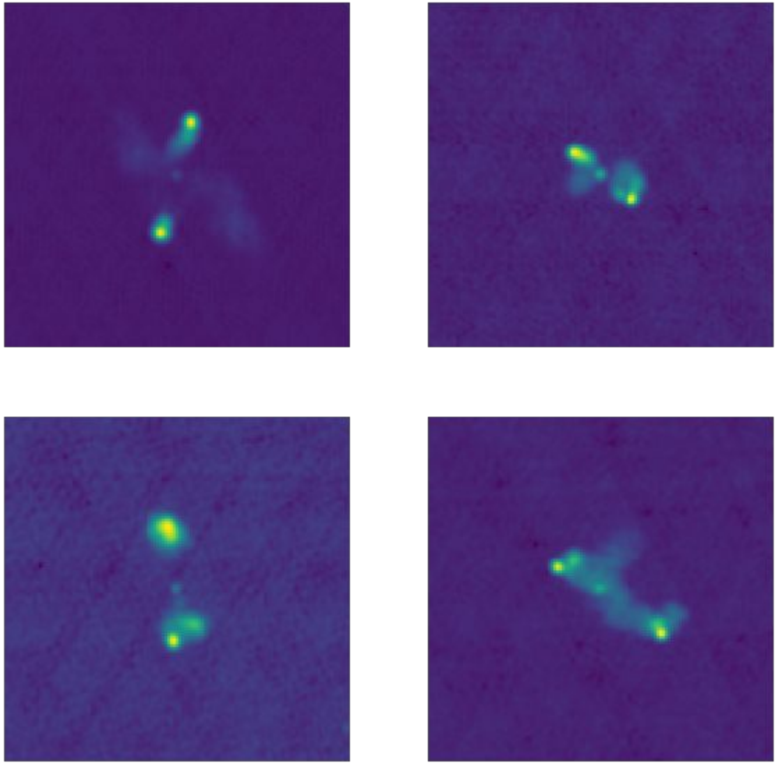
Images: FIRST

The top end

- Maximum $f(\boldsymbol{x}) \rightarrow$ most like an FR-II (or least like an FR-I?)

Maximally Fanaroff-Riley II

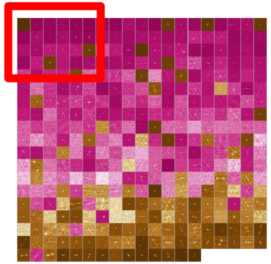


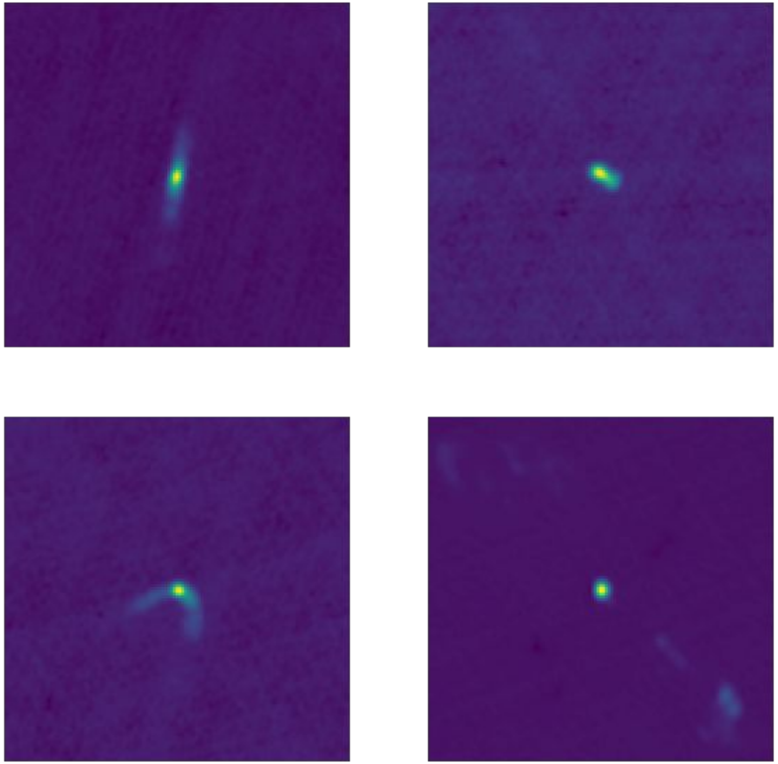


The bottom end

- Minimum $f(\boldsymbol{x})$ → most like an FR-I (or least like an FR-II?)

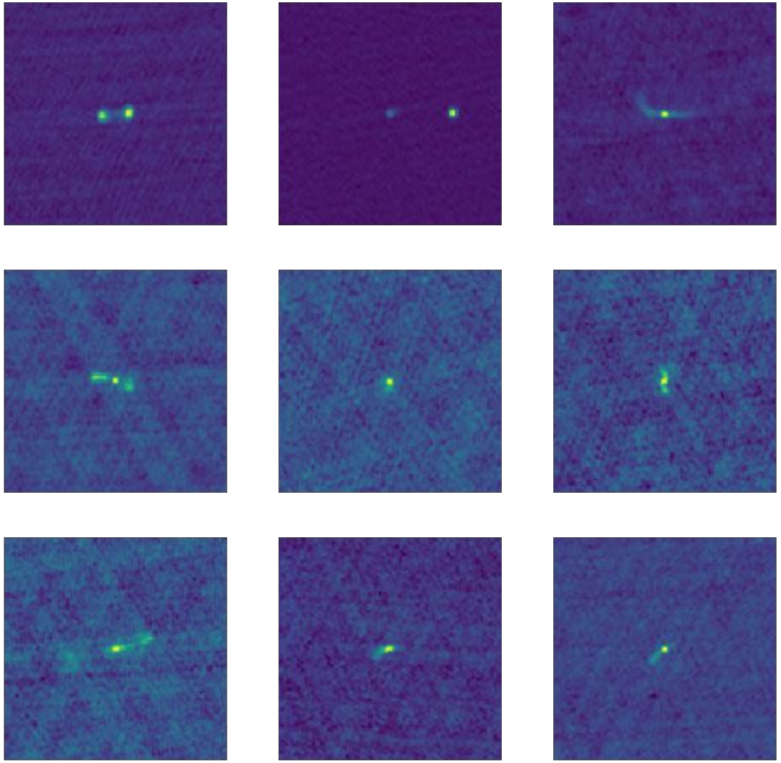
Maximally
Fanaroff-Riley I

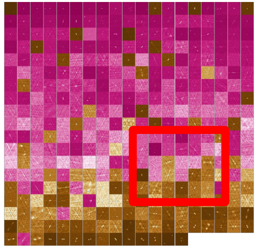




The middle

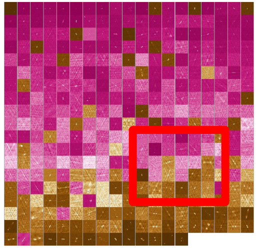
- Uncertain objects
    - Not quite like an FR-I
    - Not quite like an FR-II

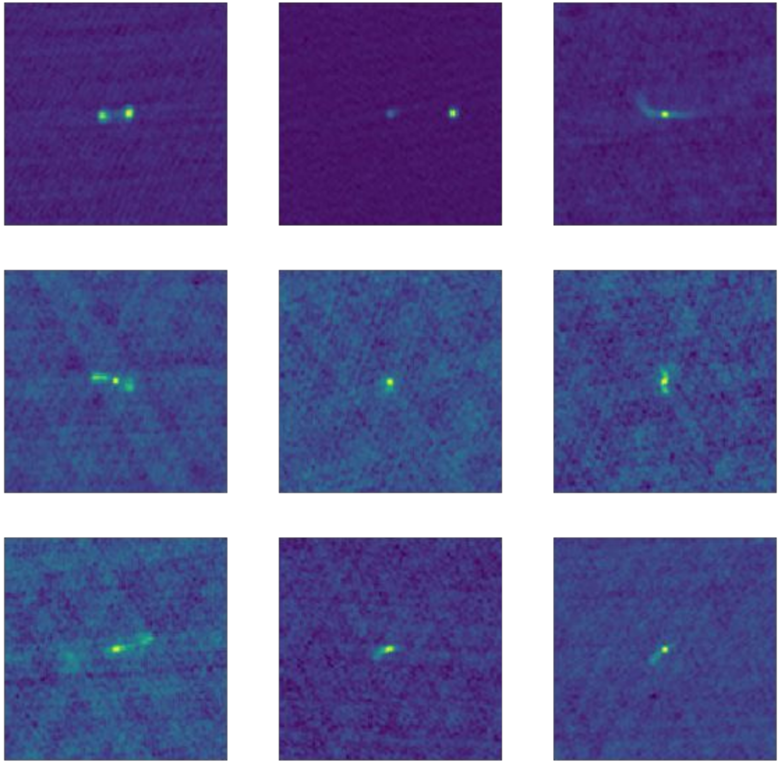




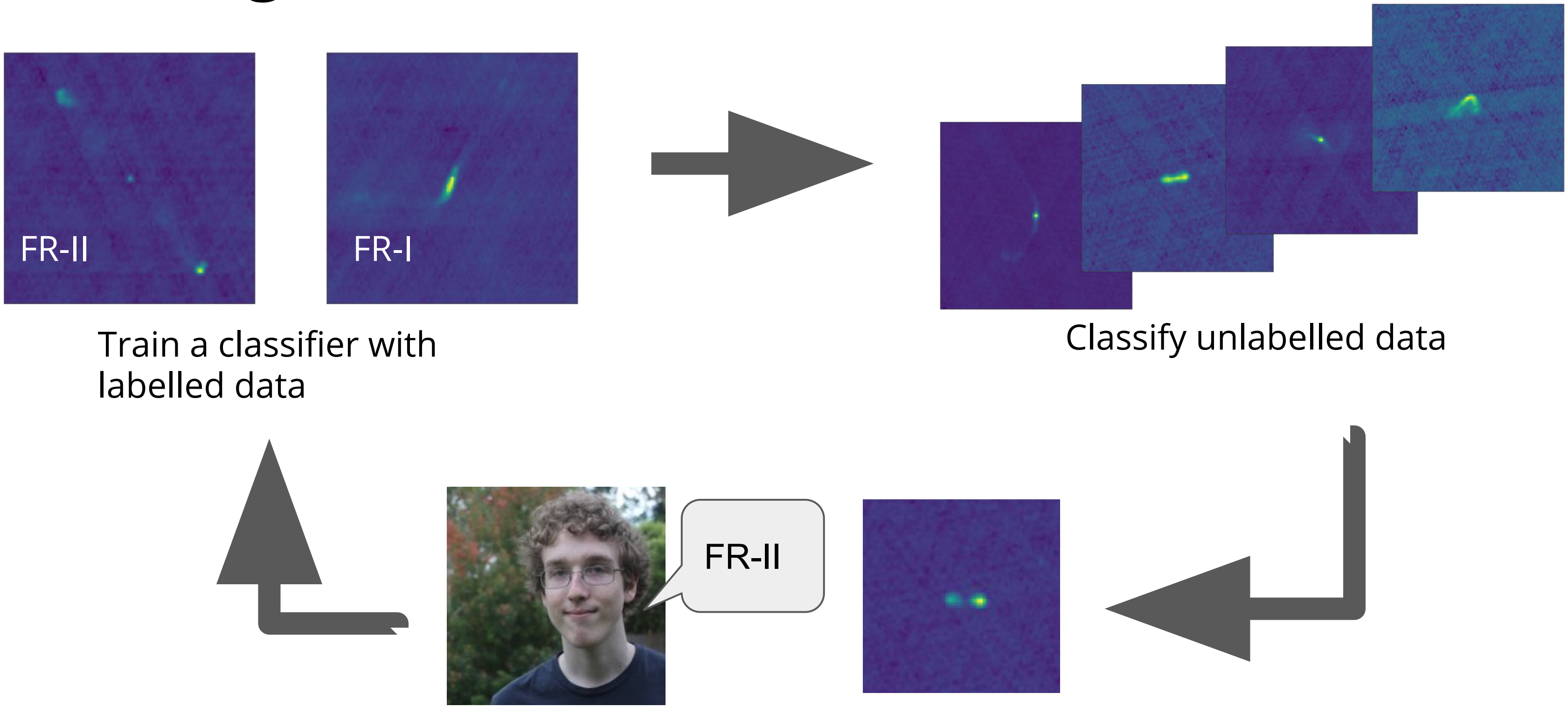
The middle

- Physically interesting?
  - Are these really halfway between an FR-I and an FR-II?
  - Are these uncertain for some meaningful reason?
- Interesting for learning?
  - Does something about these objects confuse the classifier?
  - If training focused more on objects like this, would we get a better classifier?





Building a better classifier

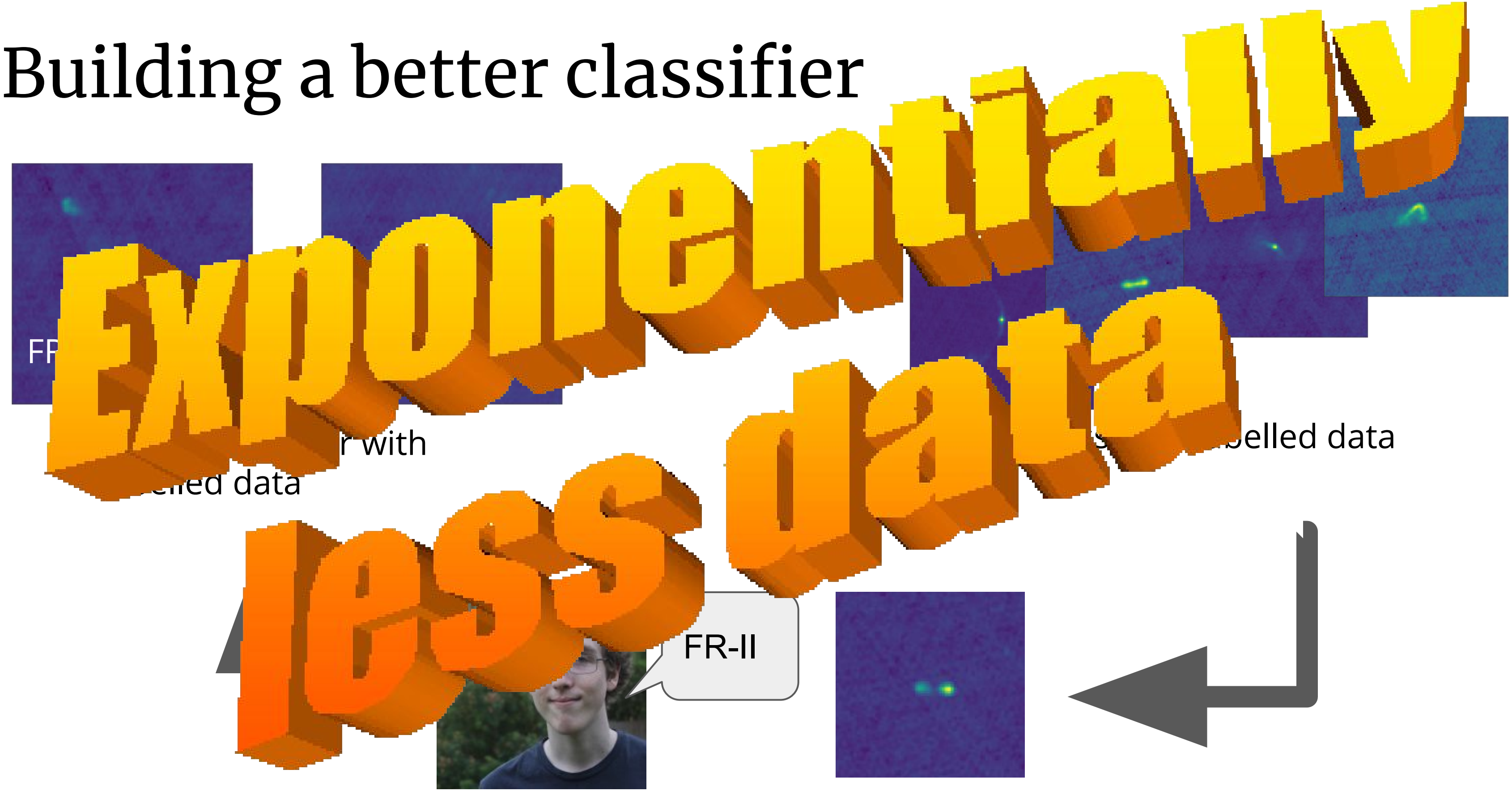


Train a classifier with labelled data

Classify unlabelled data

Label the middle

Building a better classifier



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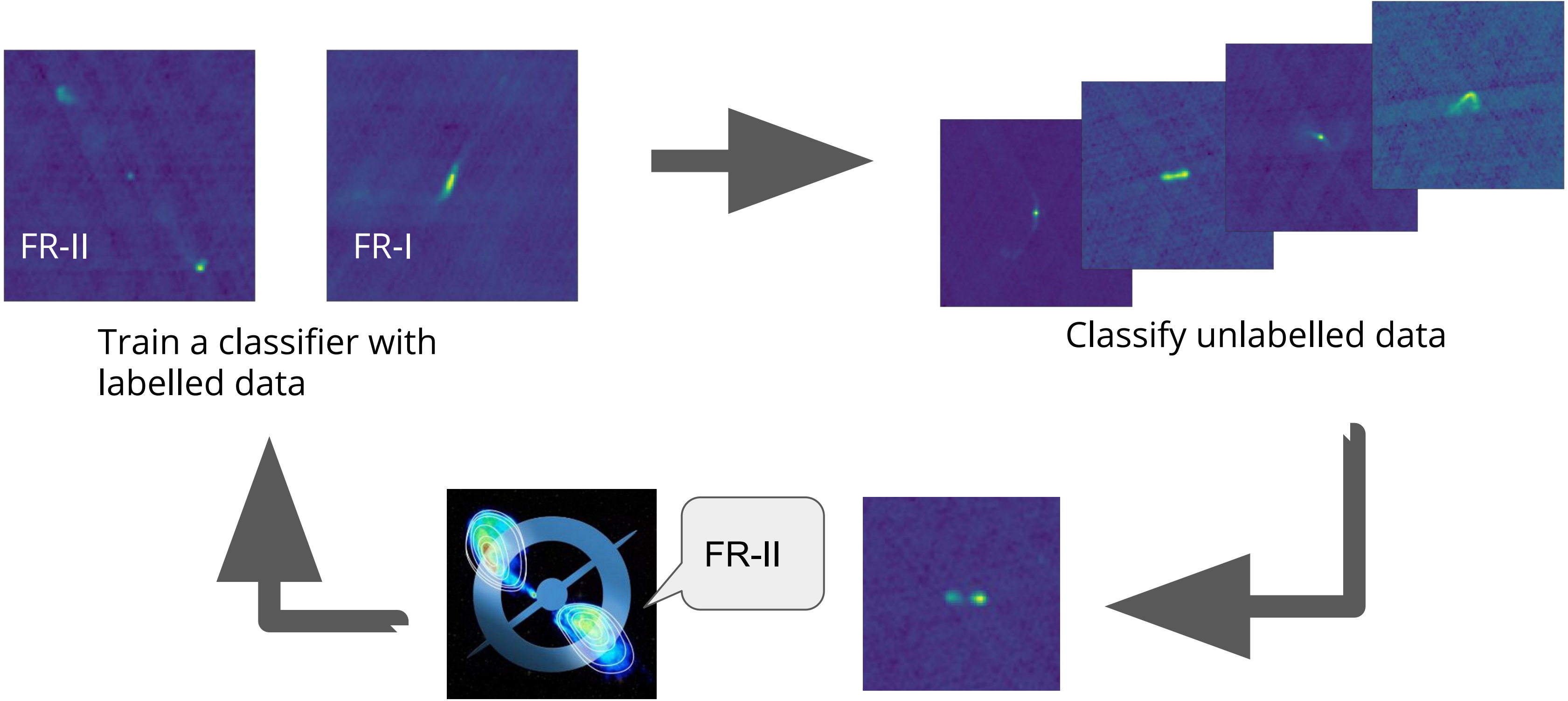
Label the middle

Getting better results from citizen science



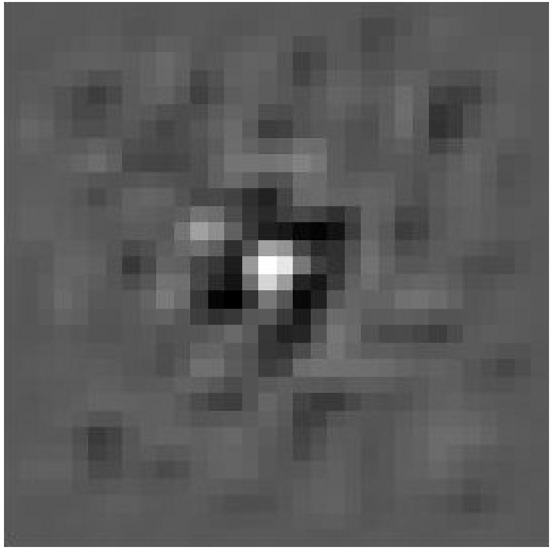
Train a classifier with labelled data

Classify unlabelled data

Label the middle

Analysing the classifier

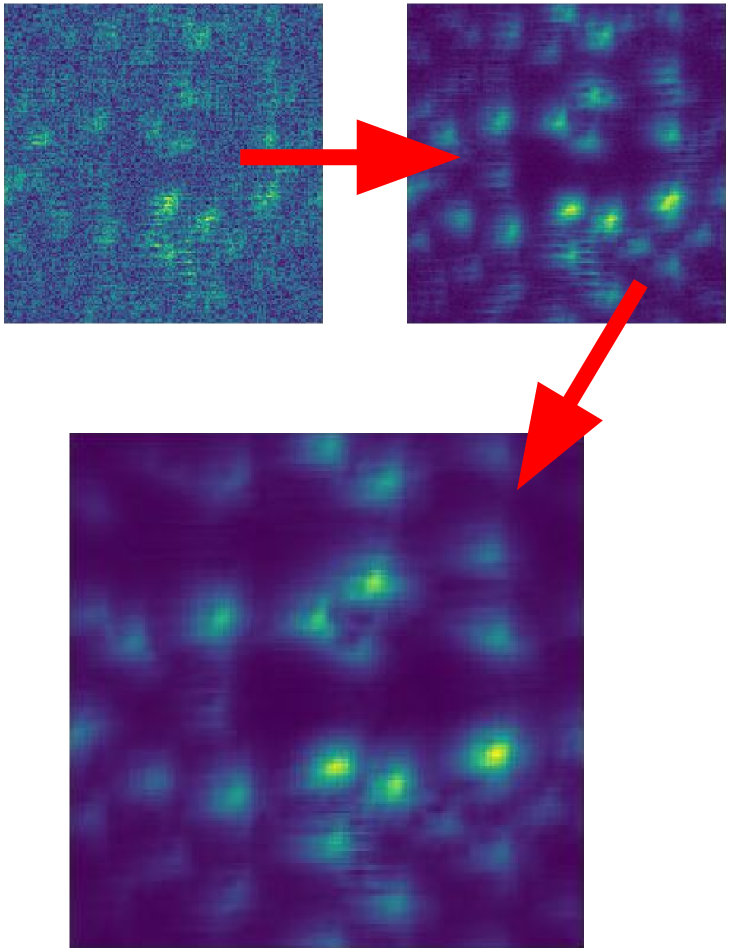
- How do we know what our black box is doing?
- If the classifier is differentiable, differentiate it



Gradients indicate how much each pixel contributes to the “FR-II-ness” of an image.

Maximising *f*(*x*)

- If your classifier is differentiable, you can differentiate it
- Use the gradient to make your inputs more like the target class
- $\boldsymbol{x}^{(t+1)} = \boldsymbol{x}^{(t)} + \varepsilon \nabla f_{\boldsymbol{x}}$
- ...But a classifier's idea of the target class might be different to yours



What can you do with a classifier?

- Classify objects
- Sort a list of objects
  - Top and bottom of list tell you classes you care about
  - Middle of list provides “interesting” cases
  - “Interesting cases” useful for learning and science
- Analyse your classifier
  - Classifier may not be looking for what you expect