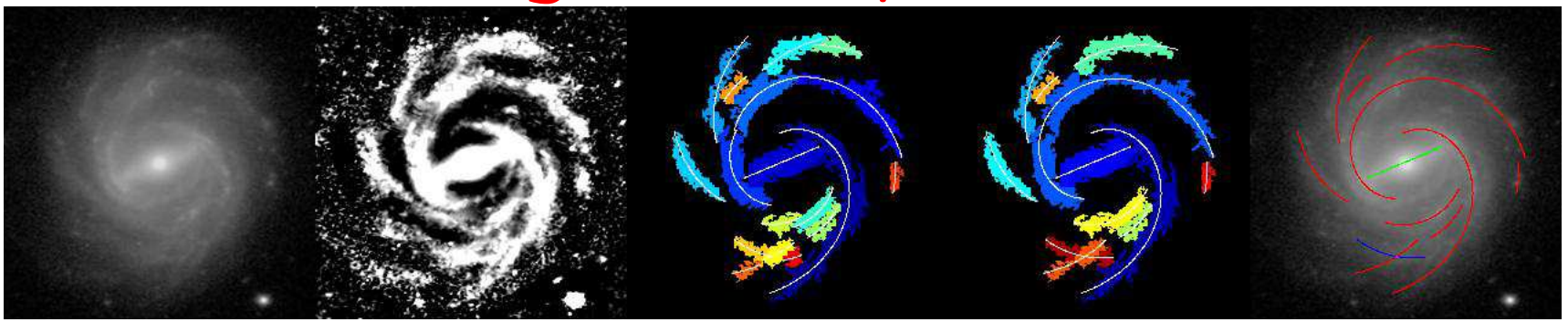
Extracting Structural Information from Images of Spiral Galaxies



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Computer vision is hard. Find the tiger!

(courtesy of Kobus Barnard, U. Arizona)

This looks trivial! Why is it so hard?

- you have an unfair advantage over the computer
- if you can't find the tiger, the tiger will find you

$\Rightarrow$ strong evolutionary pressure to recognize stuff

- 25-50% of your brain is devoted to vision
- that's a lot of compute power

The reason I'm showing you all this is simply to demonstrate that although the stuff I'm about to show you looks trivial to the untrained eye, it's really not. I want to impress upon you the mind-boggling amount of pain and suffering that computer vision people are going through in order to create algorithms to do what you can do with a casual glance.

Vision is easy for humans

On the next slide, two images.

Question: which galaxy has more arms, the **left** one or the **right** one?

You have 1 second.

Are you ready?

Vision is easy for humans

(Gosh, I hope this works...)

How did we do?

Vision is easy for humans

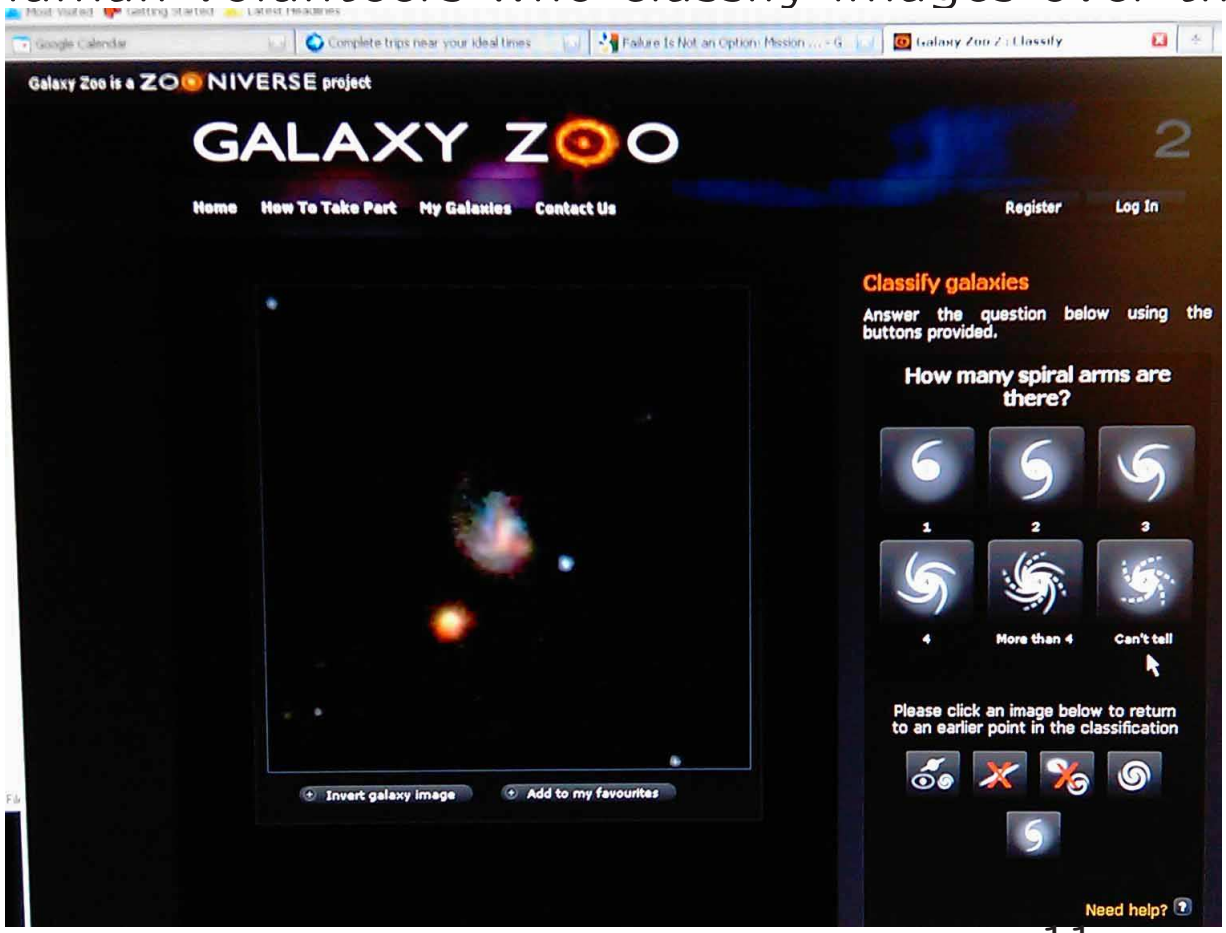
(Gosh, I hope this works...)

How did we do?

Great! Let's give up on computers, and use humans!

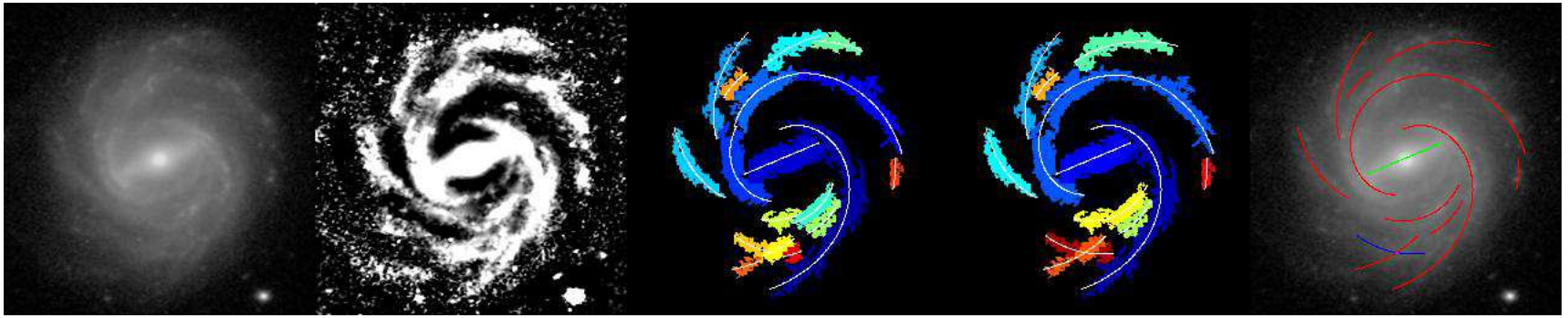
You're all hired.

You thought I was kidding... The **Galaxy Zoo Project** has 250,000 human volunteers who classify images over the web.



Problem: 250,000 humans isn't enough for 10^{11} galaxies, and humans are not good at objective quantitative measurement.

Our method



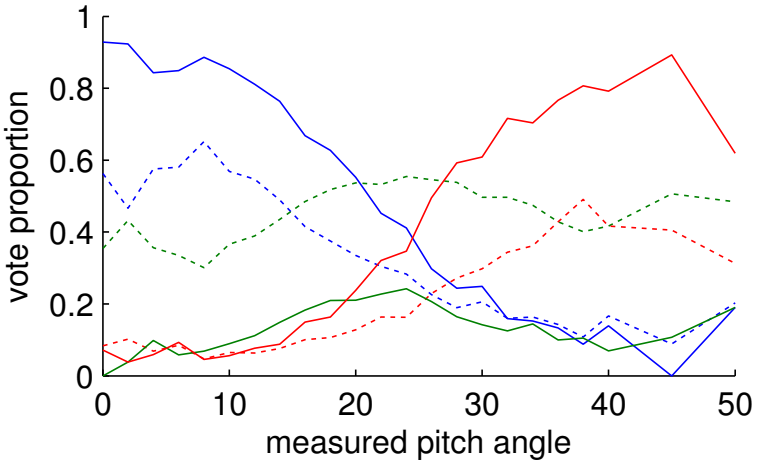
- input: PNG, JPG or FITS
- find, size + centre using 2D gaussian fit
- de-project to "circularize"
- cluster pixels to find blobs
- fit log-spiral arcs to blobs
- output: list of arm segments + their paramaters

30,000 galaxy comparison with 250,000 Humans (Galaxy Zoo 2)

1. Winding Direction

Min Discernibility Rate	0	60	80	90	95	100
Inclusion Rate	67.0	64.7	55.7	39.0	25.1	10.0
Majority Vote	79.5	79.8	81.0	83.1	84.6	84.8
Longest Arc alone	95.3	95.7	96.5	97.8	98.3	98.4
Length-weighted Vote	94.9	95.3	96.1	97.5	98.2	98.4

2. Winding tightness



100 galaxy comparison with $\sim$ 10 Humans

Pitch Angle