# Features

# How to describe a butterfly?

Colour?

Number of…
- Spots?
- Antennae?
- Legs?

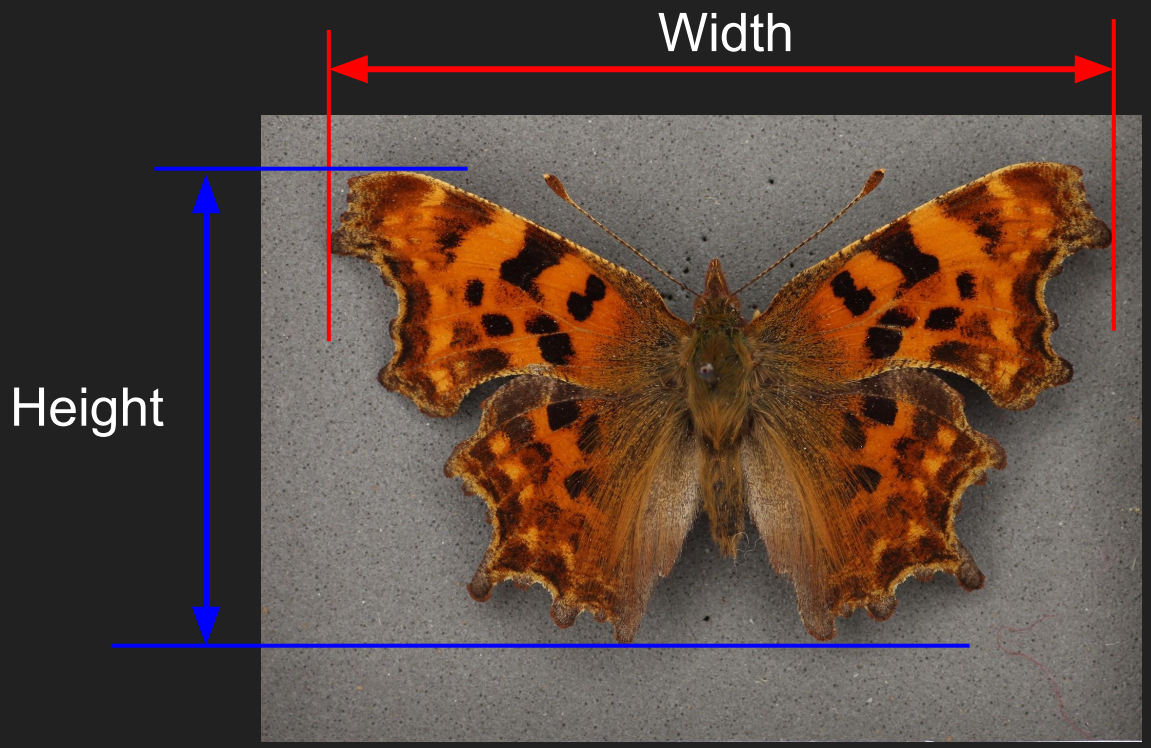
Patterns?

Location captured?

Shape?

Size?

# How to describe a butterfly?

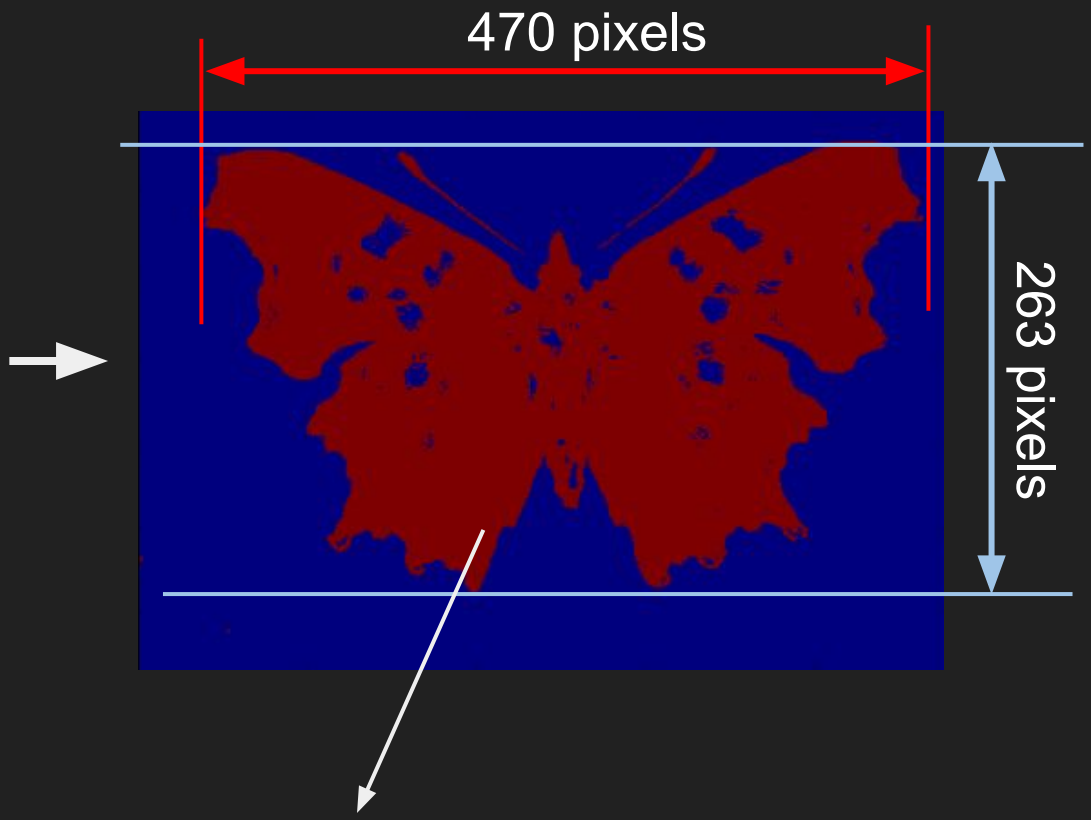



$$\mathbf{x} = (\text{width}, \text{height})$$

Feature vector

Feature

# Automating features



# Deep learning

# “Shallow Features”

Up until now our features were either measured by hand or we had some automated way of extracting them.

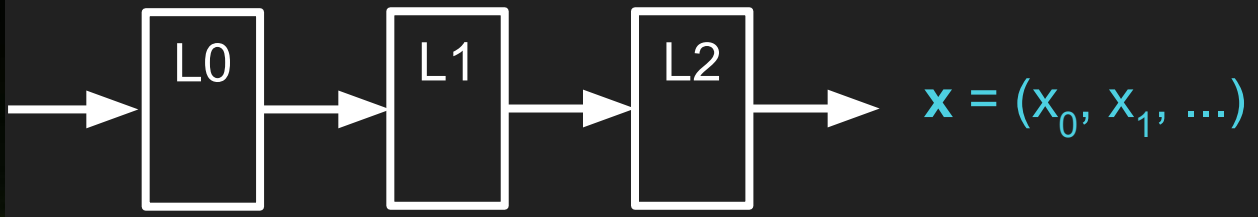

**x** = (width, height)

y = pieris rapae

https://commons.wikimedia.org/wiki/File:Small_white_male_Pieris_rapae.jpg

# Deep Learning

In deep learning we learn features directly from our data using hierarchical layers of intermediate features.

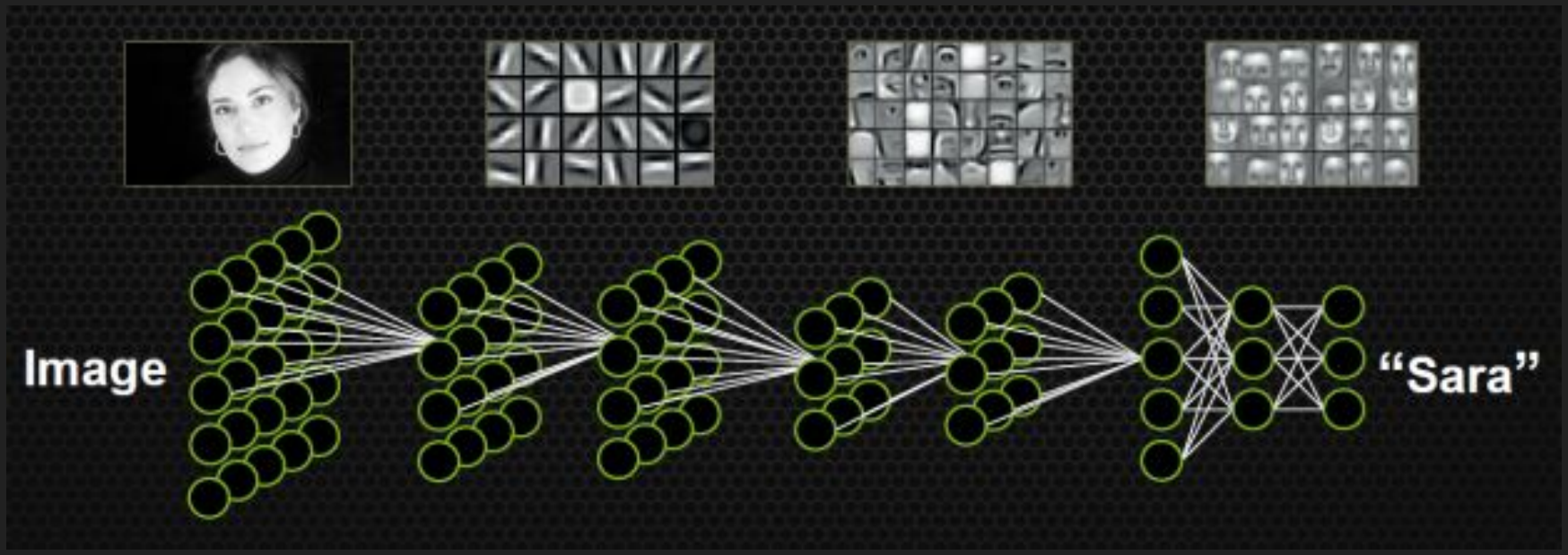



y = pieris rapae

https://commons.wikimedia.org/wiki/File:Small_white_male_Pieris_rapae.jpg

# Deep Learning

In the context of images we can think of this like a hierarchical representation. We first model low level features such as edges, up to parts such as eyes, and finally to collections of parts.




Also referred to as: Neural networks; Convolutional neural networks

http://devblogs.nvidia.com/parallelforall/accelerate-machine-learning-cudnn-deep-neural-network-library/

# Case study 1

# Predicting species presence

*Verbascum thapsus*
(common mullein)

# Predicting species presence

Target variable:

- Species absence/presence

Features:

- Data from GIS layers
- Proximity to roads/paths

Reference:

Cutler, D. Richard, et al. "Random forests for classification in ecology." Ecology88.11 (2007): 2783-2792.

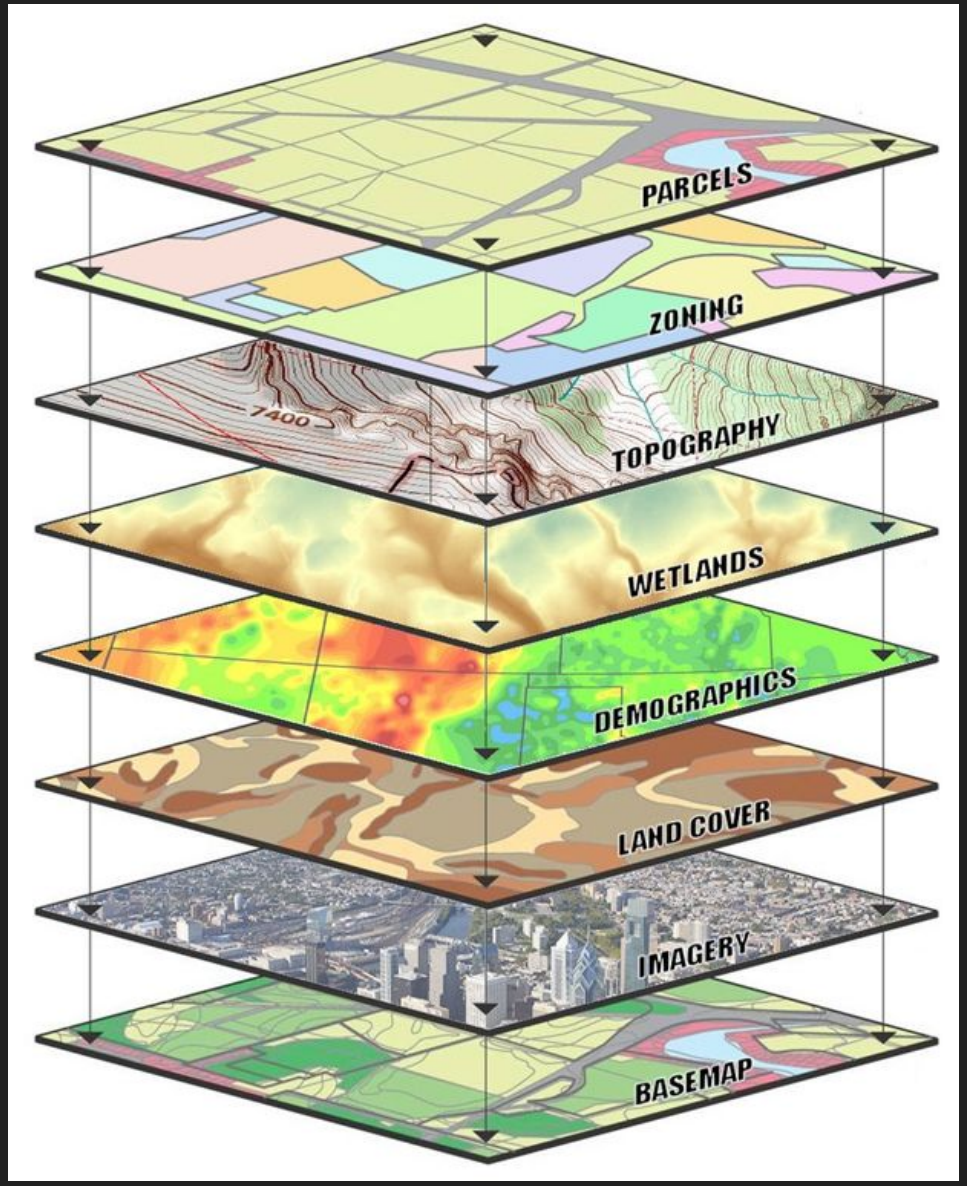
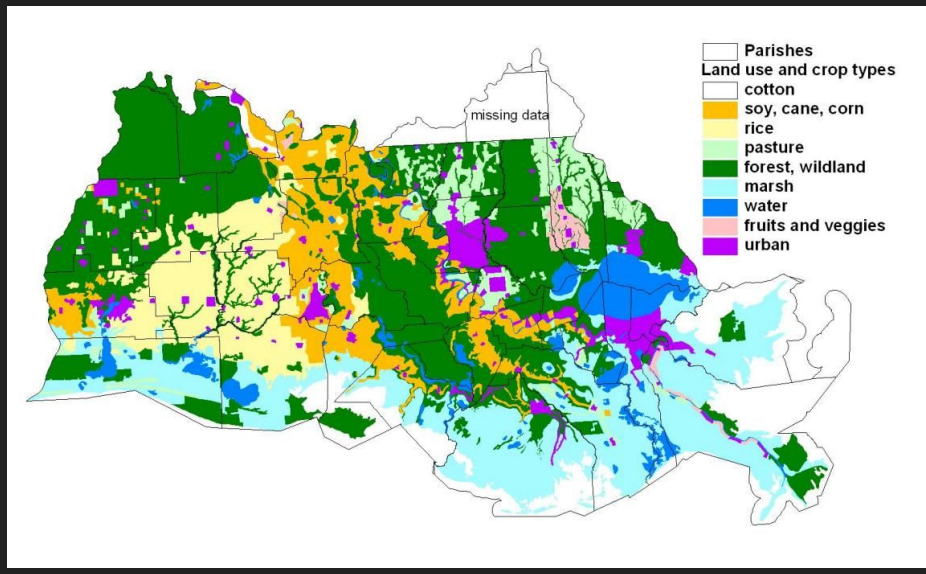



Image from: http://www.co.ontario.ny.us/index.aspx?NID=1176

# Case study 2

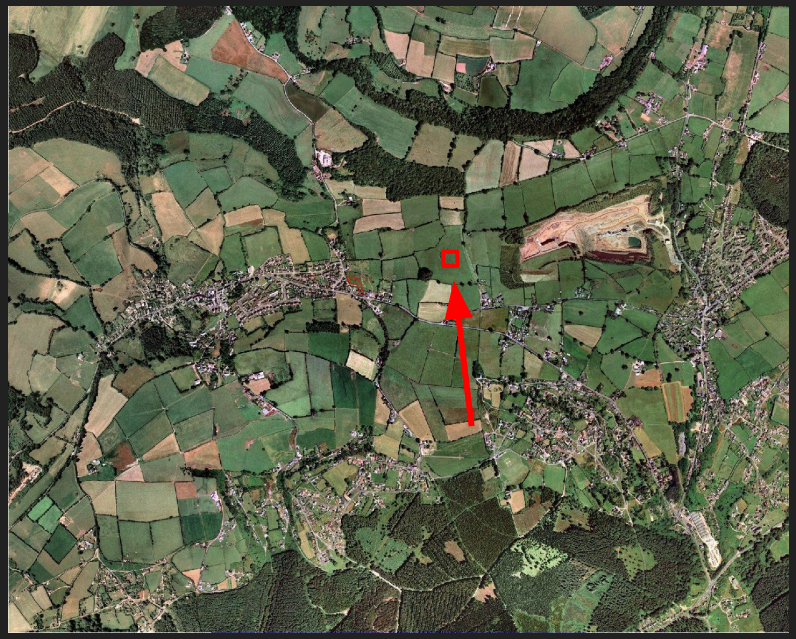
# Land type classification from aerial images

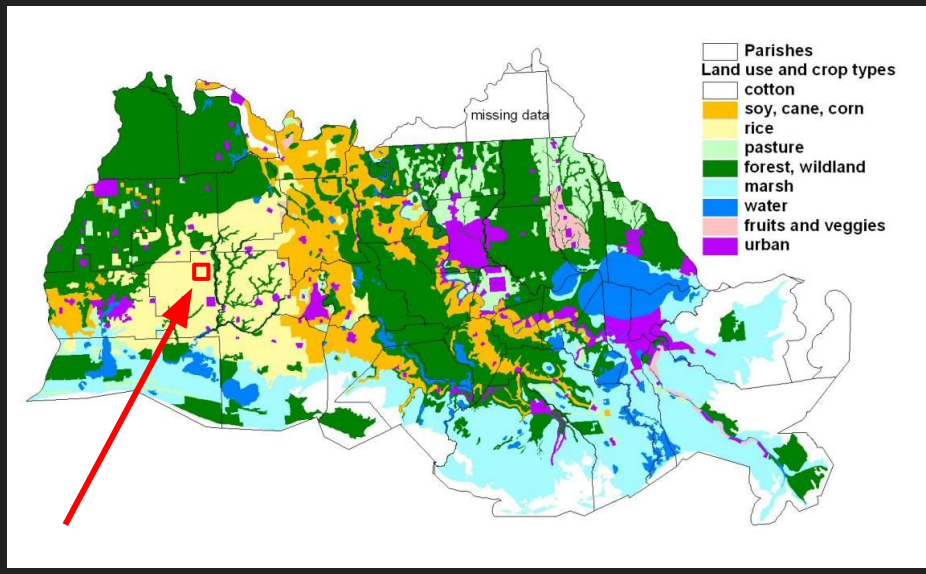



Input: Aerial photo

Output: Map of land use

# Land type classification from aerial images






Input: Pixel from aerial photo

Output: Land type in single pixel of output map

# Land type classification from aerial images

Input: Pixel from aerial photo

Output: Is this pixel on land?

Training data: Some pixels we know the labels of

# Practical example

5_pixel_classification.R