计算机视觉班

The Last Lecture

Outline

- 课程总结
  - 深度学习的本质
  - 深度学习目前的进展
- 一个实例：鲸鱼识别

深度学习何处适用

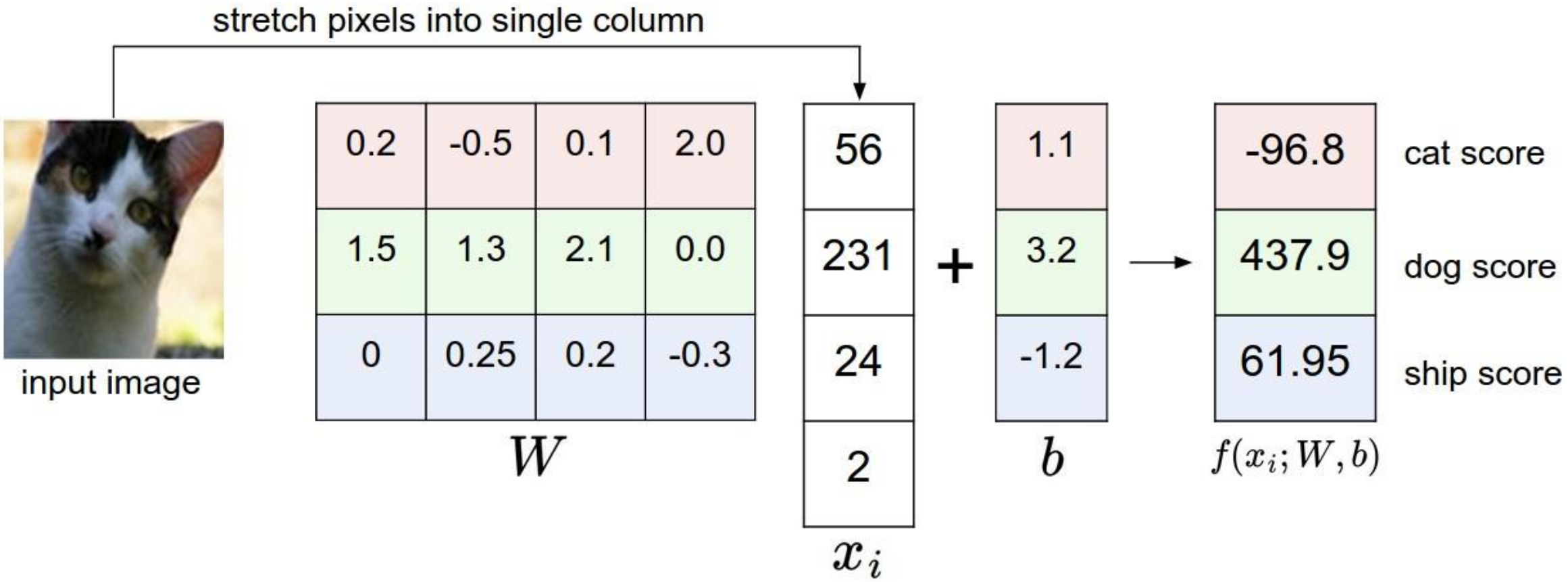
深度学习最重要的作用是表示学习

初始表示 与 合适表示 相距甚远时适用。

深度学习为何有效

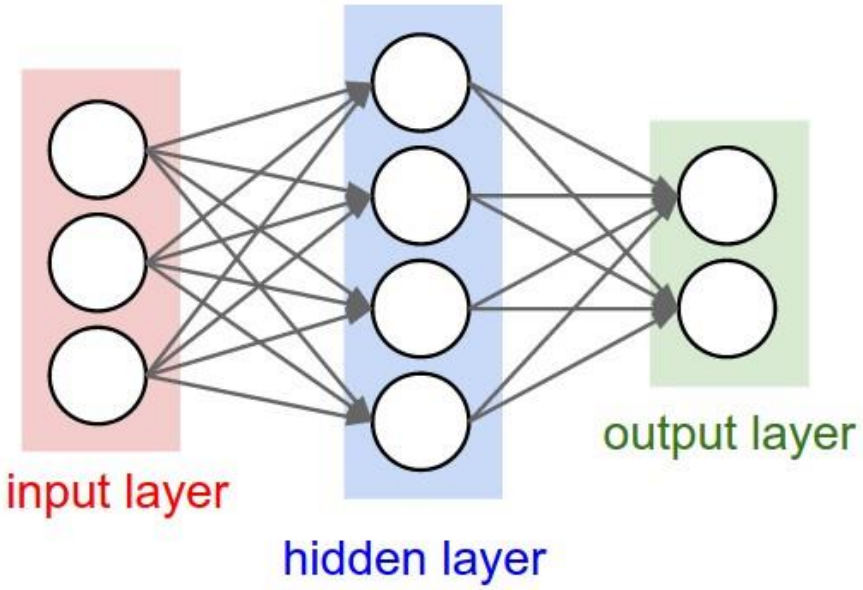
- 模型复杂度
- 大量数据
- 硬件崛起

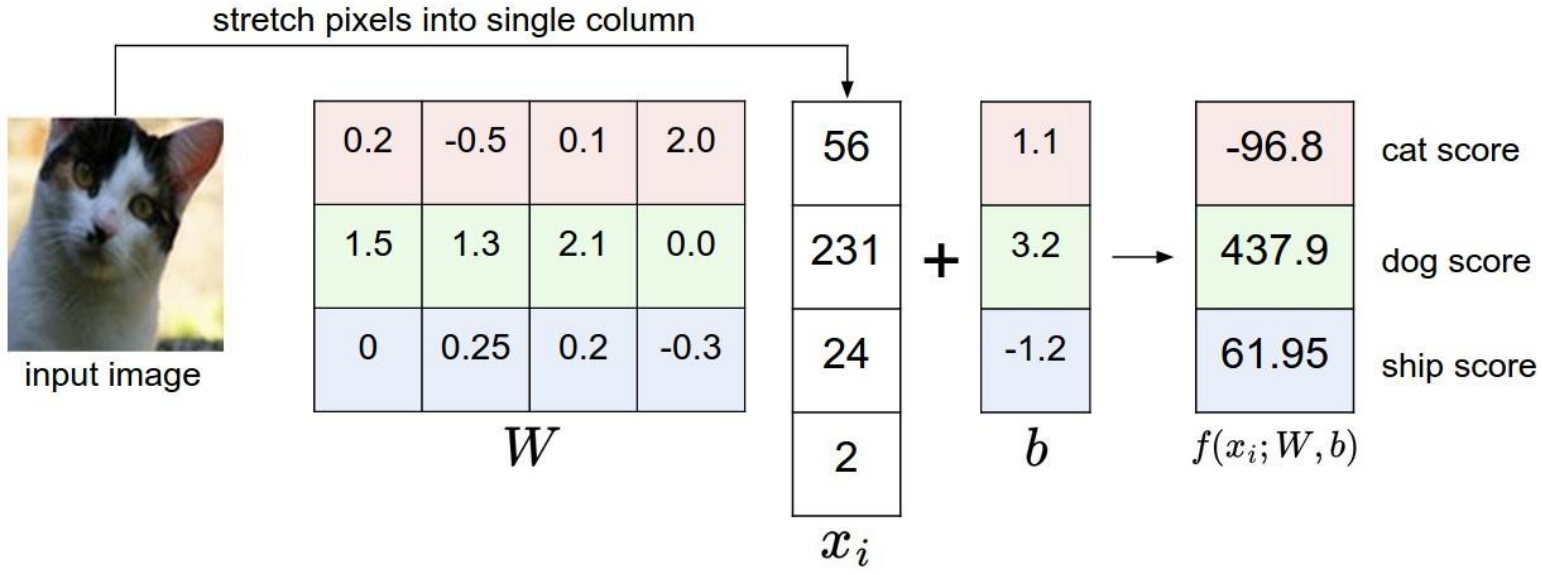
Linear Models



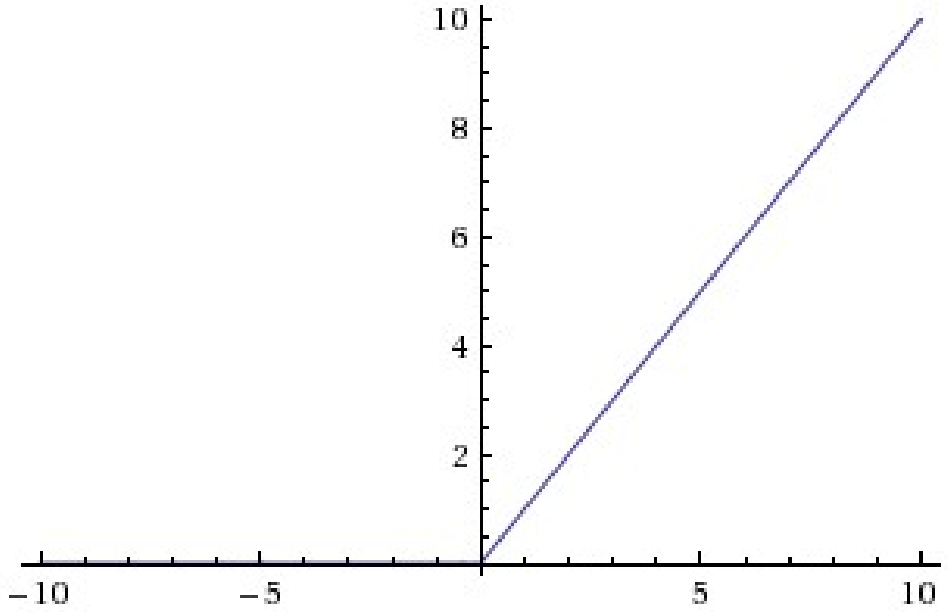
Linear Weights Visualized

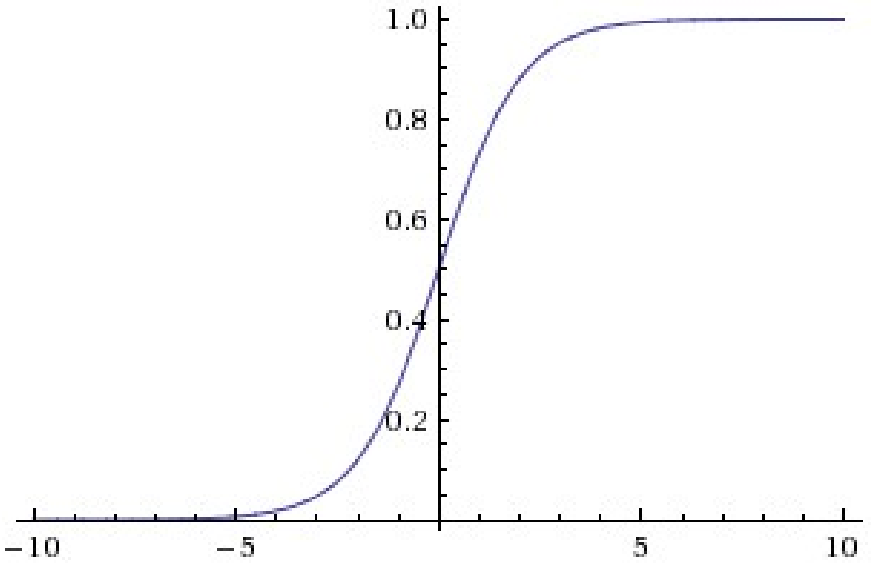
Now, Neural Networks

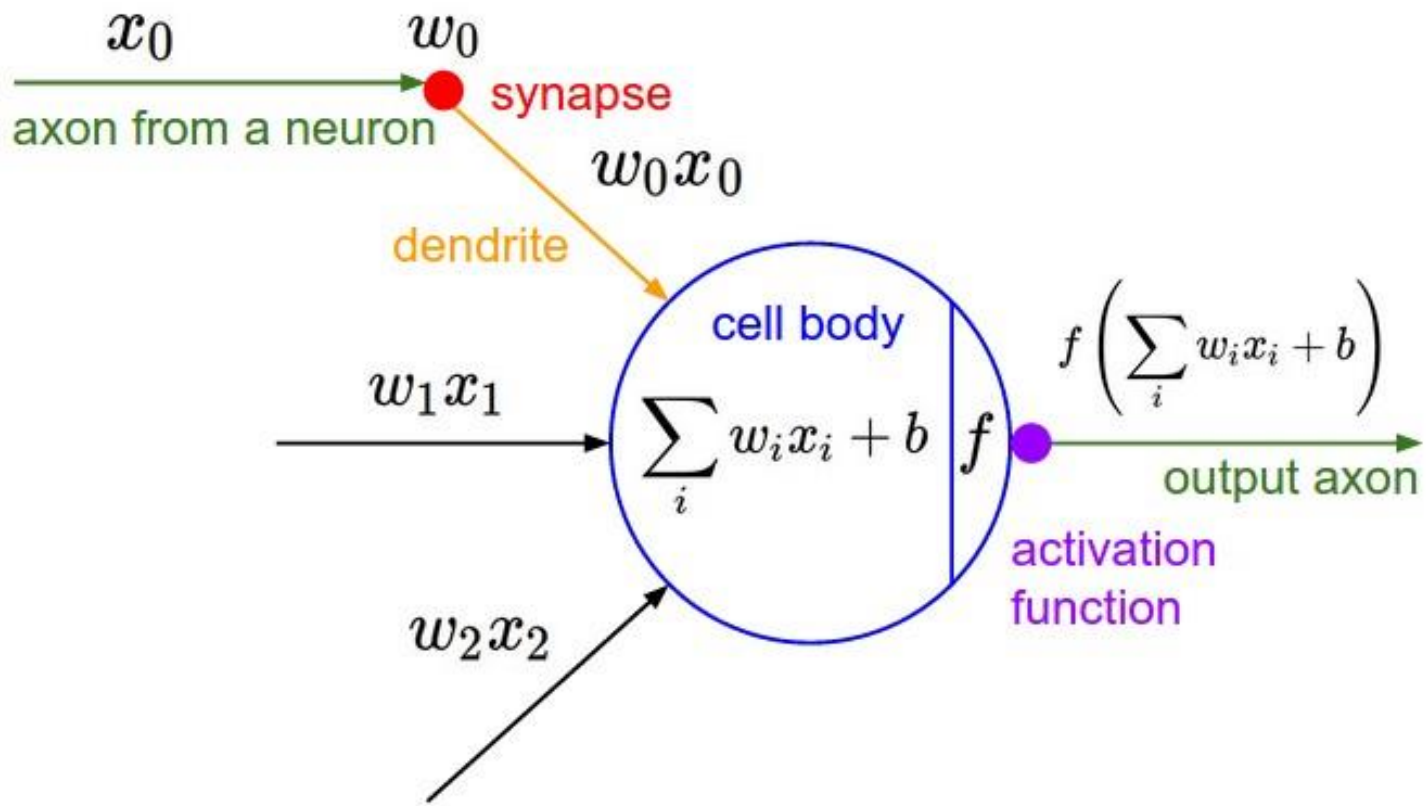




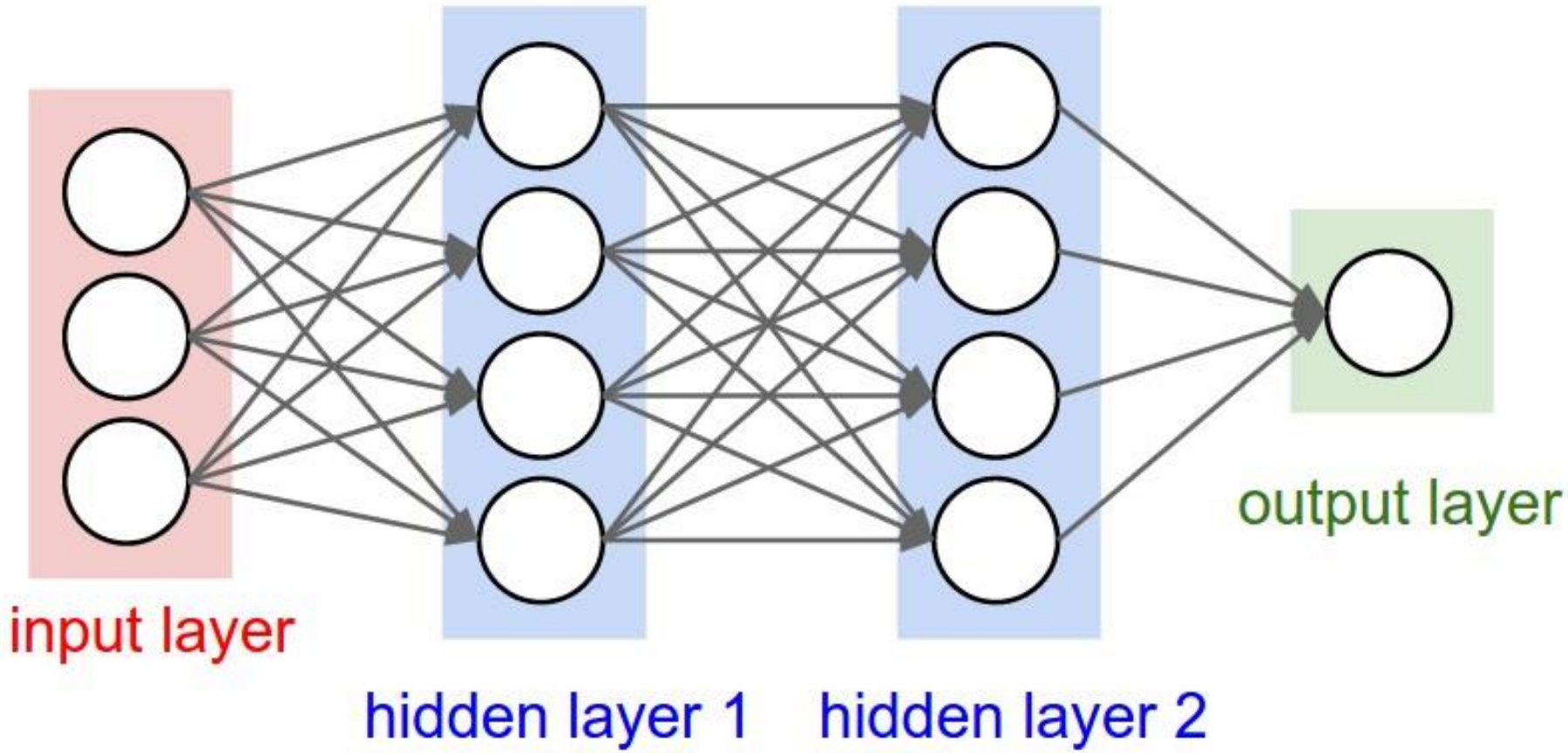
Inside a Neuron



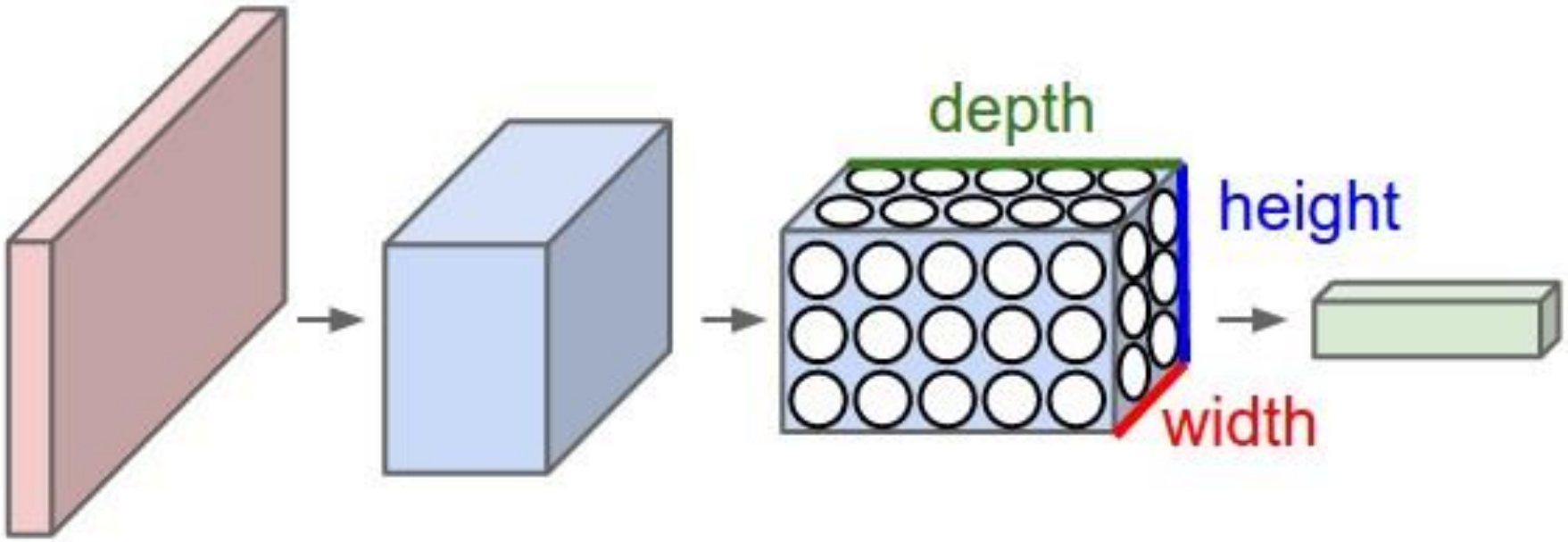



x_0
w_0
synapse
axon from a neuron
$w_0 x_0$
dendrite
cell body
$w_1 x_1$
$\sum_i w_i x_i + b$
f
$f\left(\sum_i w_i x_i + b\right)$
output axon
activation function
$w_2 x_2$

Multi-layer NN

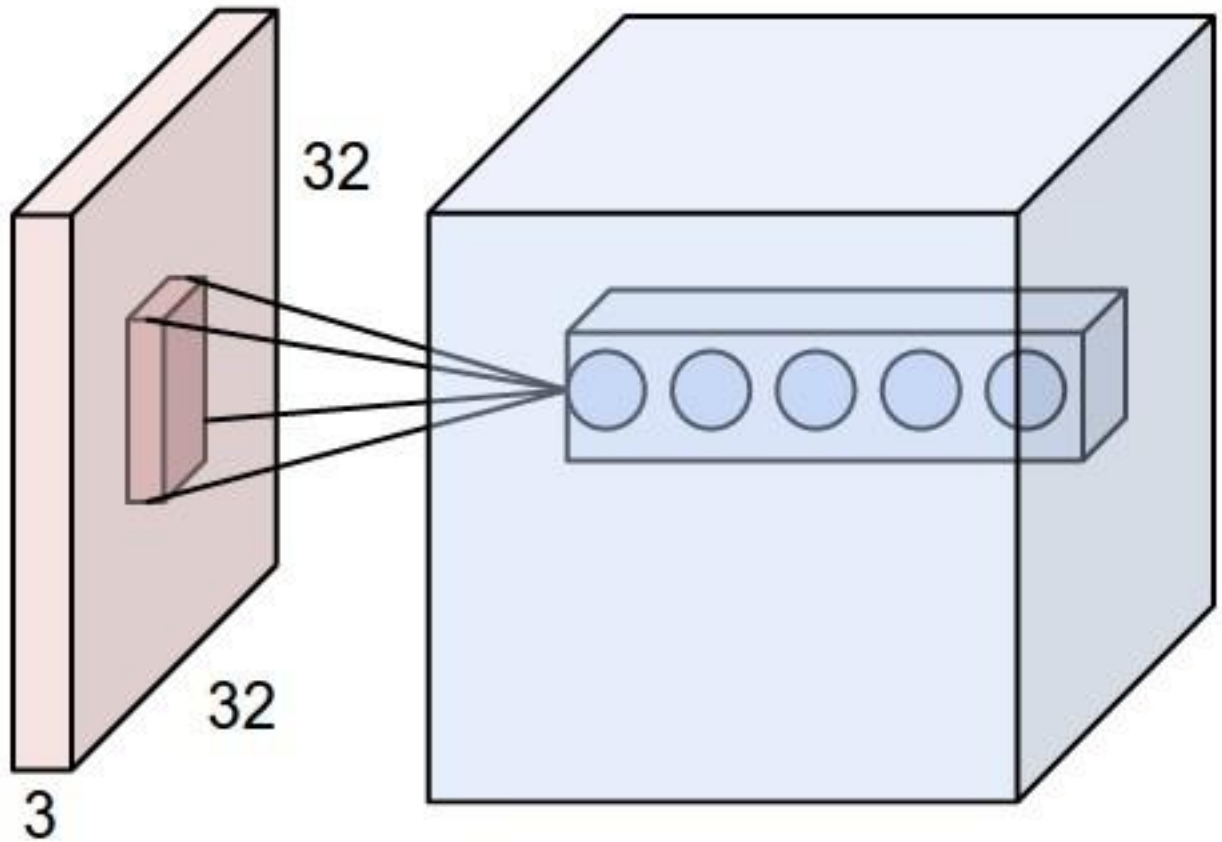


Convolutional Networks



Key ideas

1. Local connectivity
2. Shared Weights (parameter sharing)


32
32
3

神经网络发展回顾

- 40年代 萌芽期：Hebb 学习规则 1945
- 58-69 繁荣期 perceptron 1959 -------电子计算机
- 69年-80年 冰河期
- 85-95 繁荣期 -------x86系列/内存条
- 95-10 沉寂期
- 10-now 繁荣期 ------GPU通用计算

- 冷 10年 热15年

往哪儿走

- 鲁棒性：
  - 可重用
  - 可演进
  - 可了解
- Learnware = model + specification

计算机视觉和机器学习的关系

机器学习方法解决CV问题具有通用性
Eg：CNN/LSTM 不仅仅可以用来做CV

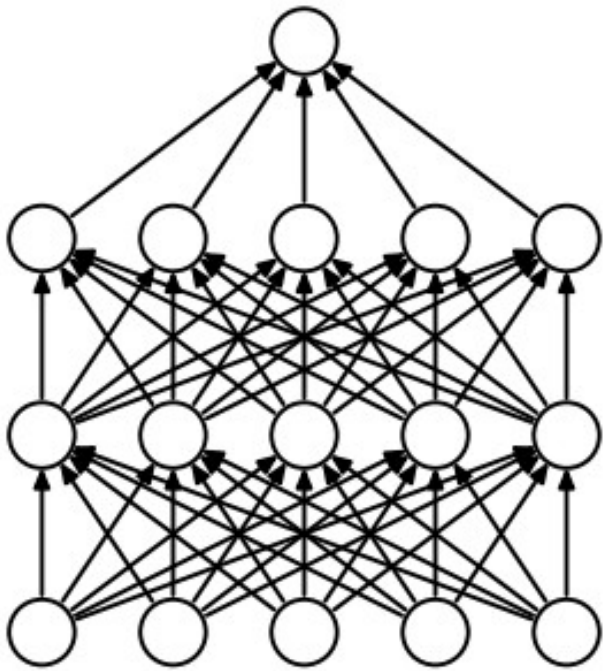
深度学习：（目前）最少领域知识的绝决方案

What makes AI great again

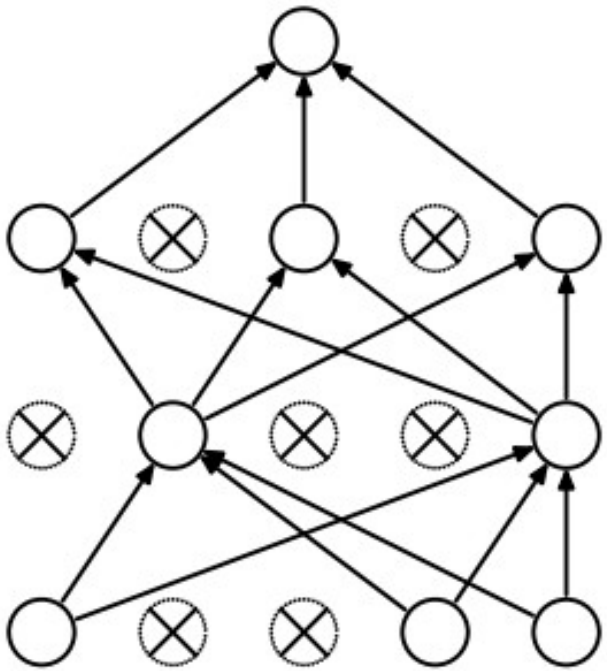
1. Compute (the obvious one: Moore's Law, GPUs, ASICs),
2. Data (in a nice form, not just out there somewhere on the internet - e.g. ImageNet),
3. Algorithms (research and ideas, e.g. backprop, CNN, LSTM), and
4. Infrastructure (software under you - Linux, TCP/IP, Git, TensorFlow,Theano, etc.).

The Dark Knowledge

Dropout



(a) Standard Neural Net

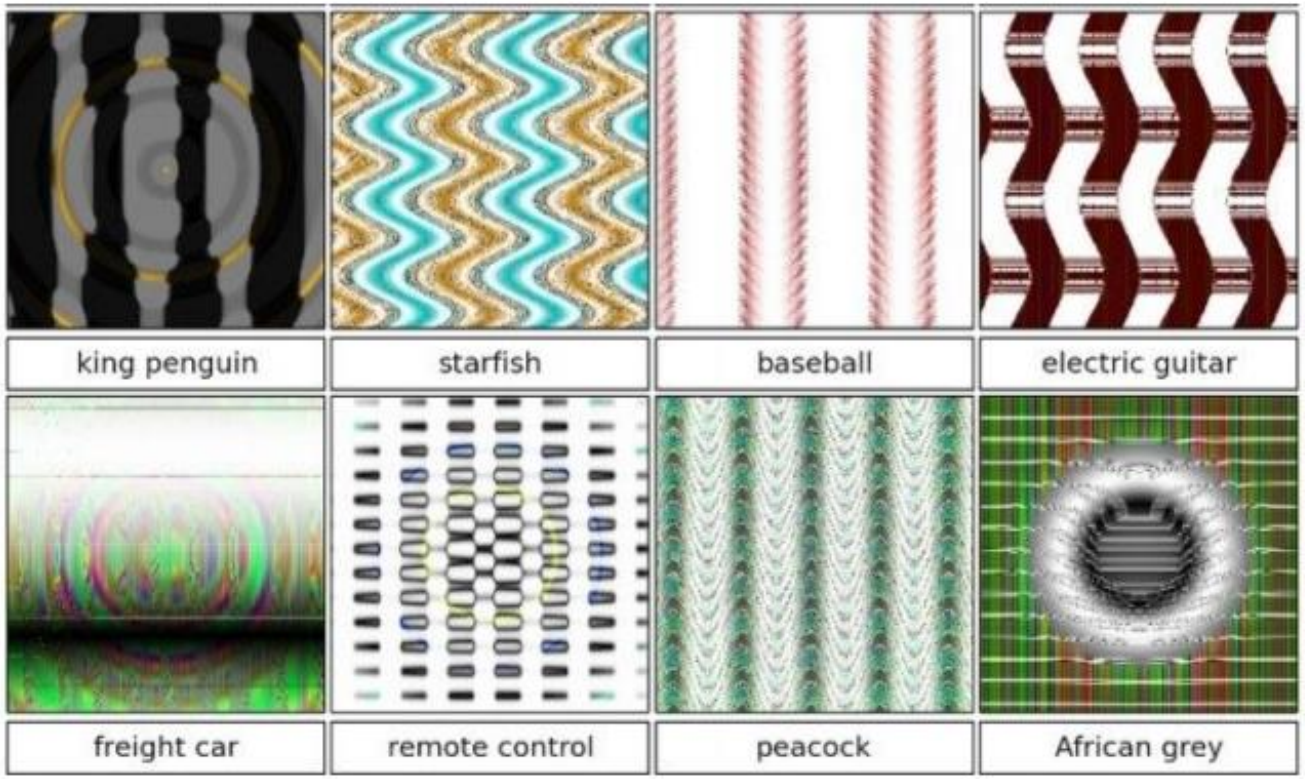


(b) After applying dropout.

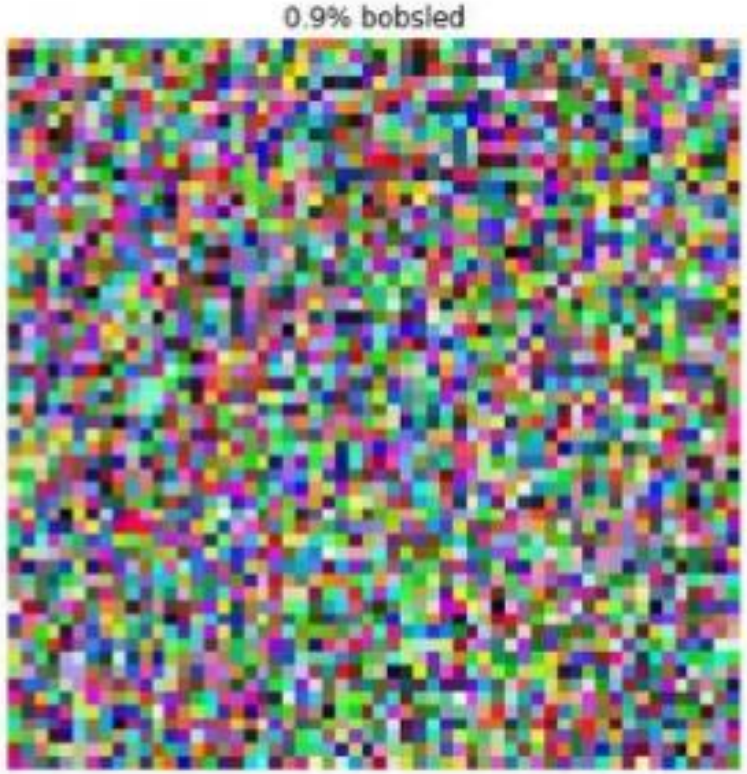
Fool your Conv-net

[Deep Neural Networks are Easily Fooled: High Confidence Predictions for Unrecognizable Images Nguyen, Yosinski, Clune, 2014]

>99.6% confidences



mix in a tiny bit of
Goldfish classifier weights



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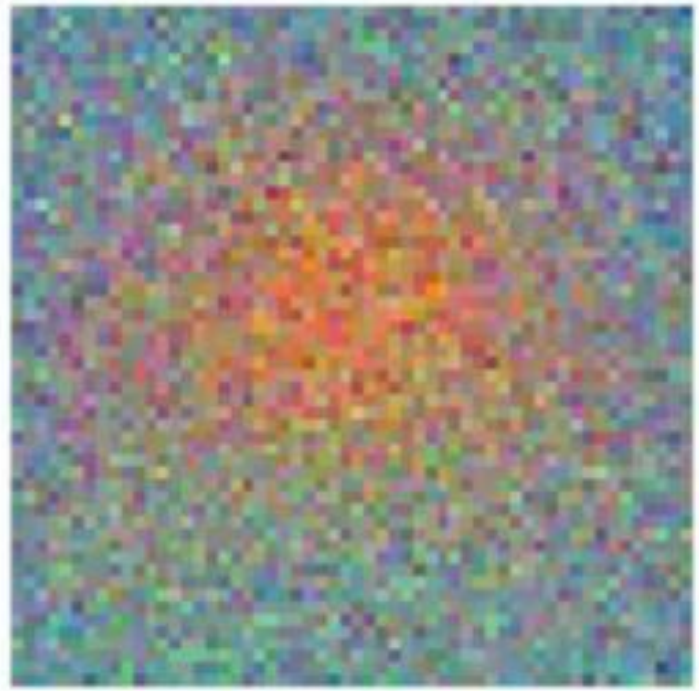


=

100% Goldfish

Lets fool a binary linear classifier:

x	2	-1	3	-2	2	2	1	-4	5	1
w	-1	-1	1	-1	1	-1	1	1	-1	1
adversarial x	1.5	-1.5	3.5	-2.5	2.5	1.5	1.5	-3.5	4.5	1.5

← input example

← weights

class 1 score before:

-2 + 1 + 3 + 2 + 2 - 2 + 1 - 4 - 5 + 1 = -3

=> probability of class 1 is 1/(1+e^(-(-3))) = 0.0474

-1.5+1.5+3.5+2.5+2.5-1.5+1.5-3.5-4.5+1.5 = 2

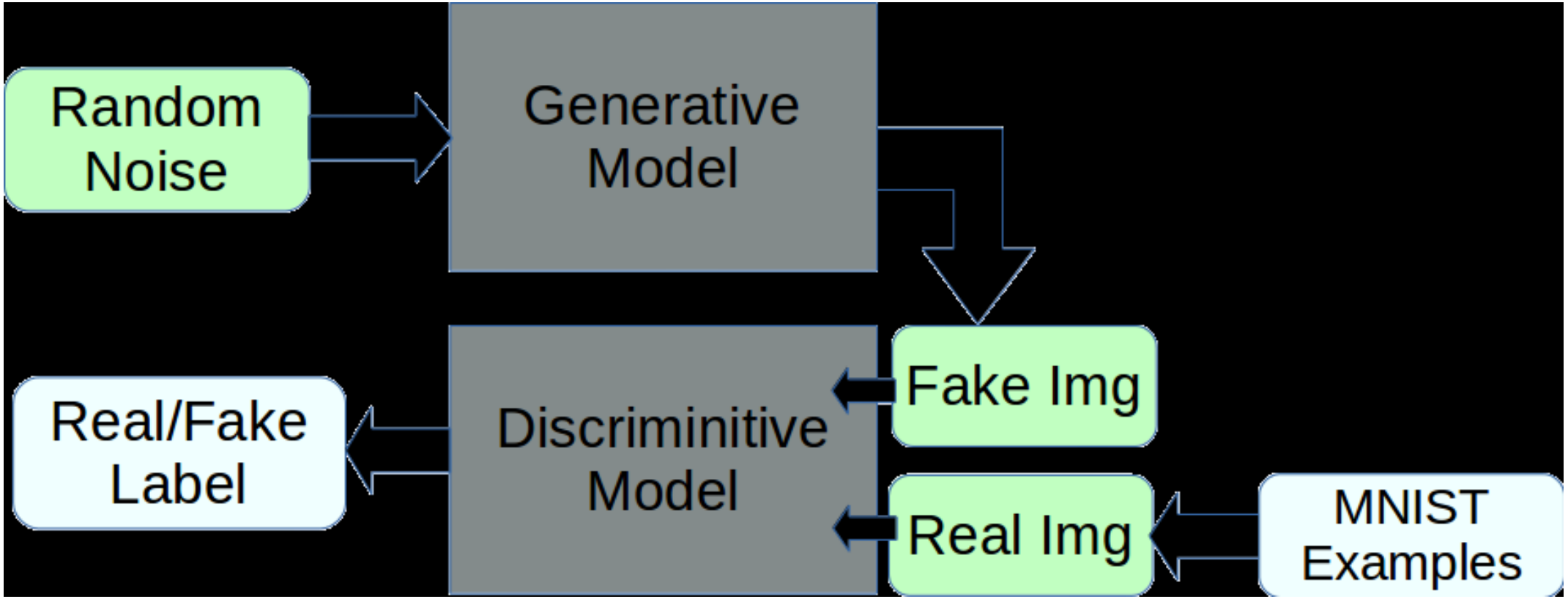
=> probability of class 1 is now 1/(1+e^(-(2))) = 0.88

i.e. we improved the class 1 probability from 5% to 88%

This was only with 10 input dimensions. A 224x224 input image has 150,528.

(It's significantly easier with more numbers, need smaller nudge for each)

Solution： The GAN framework



提出问题比解决问题更重要

提出的问题：

- Image caption
- Attention
- Generating images

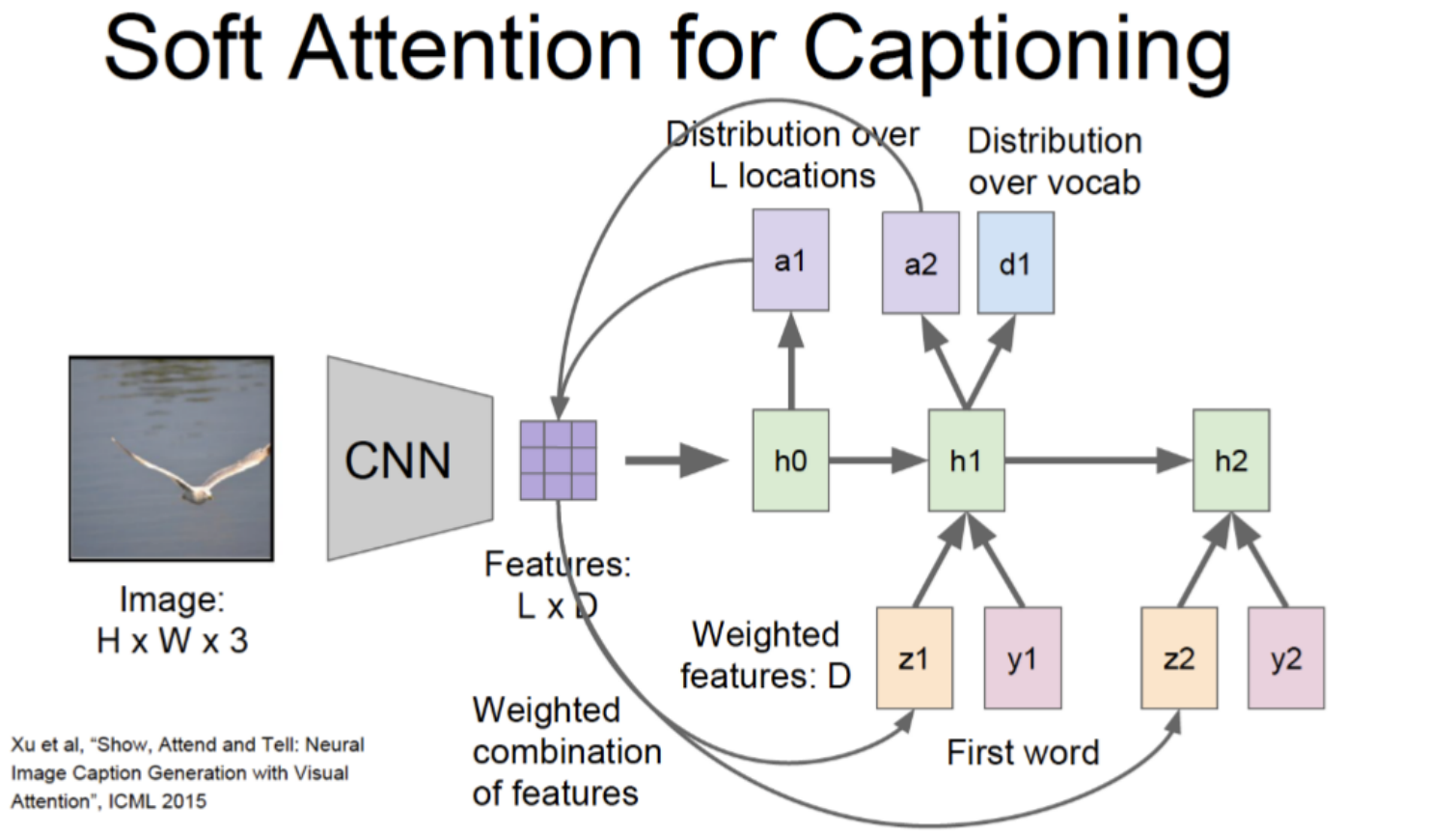
- 解决方案：
- 。。。总会有的

我们有什么 vs 我们想做什么

- Instance representation
- Temporal relationship

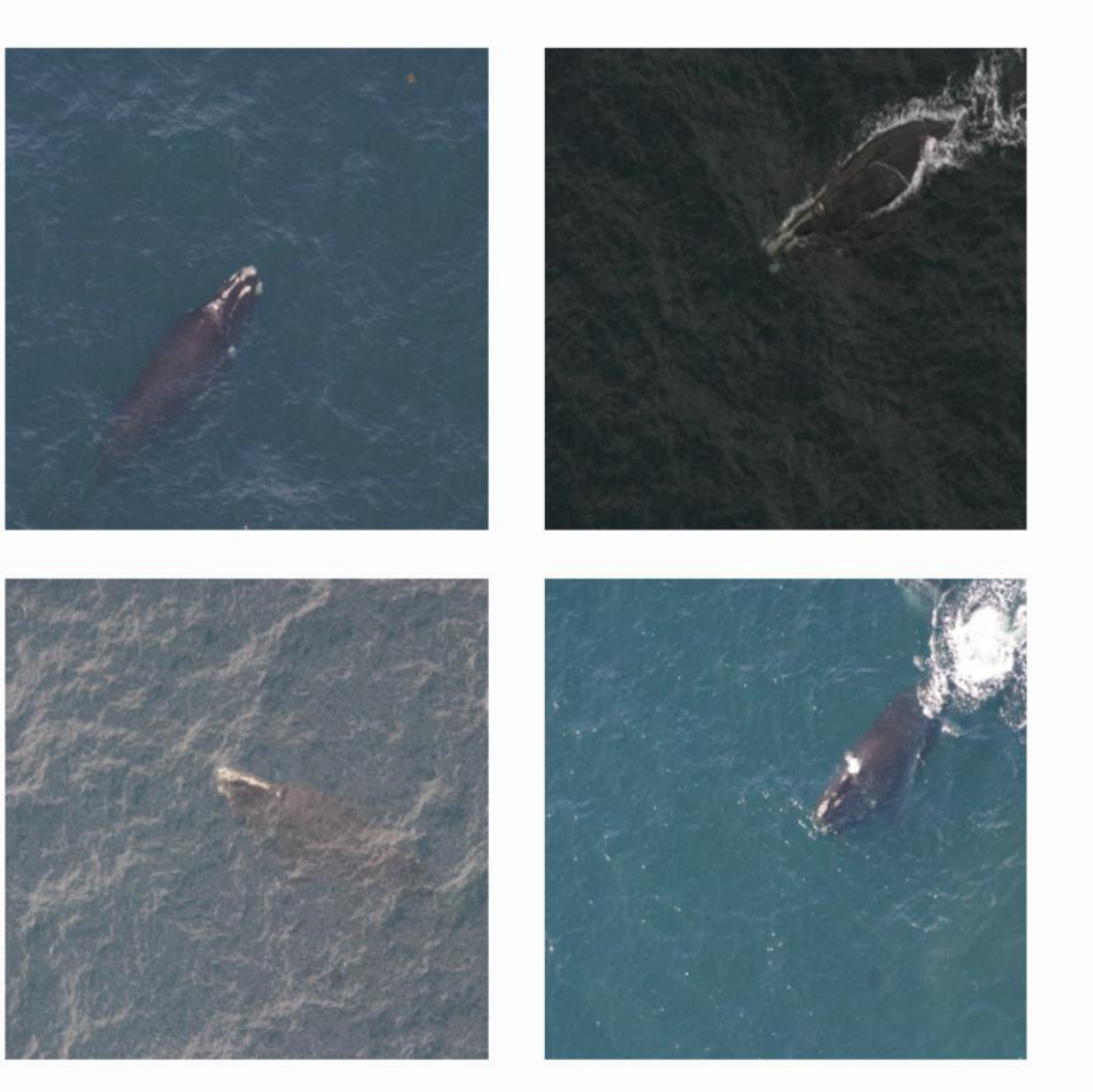
- Regression
- Classification

一个例子

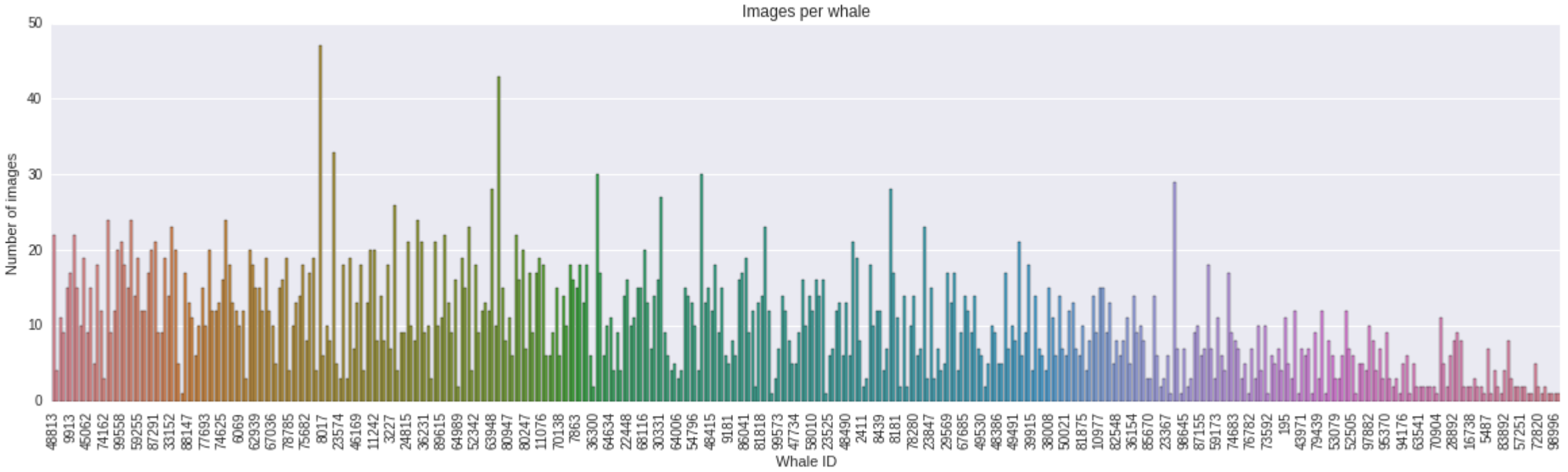

Soft Attention for Captioning
Distribution over
L locations
Distribution
over vocab
a1
a2
d1
CNN
h0
h1
h2
Image:
H x W x 3
Features:
L x D
Weighted
features: D
z1
y1
z2
y2
Weighted
combination
of features
First word
Xu et al, "Show, Attend and Tell: Neural Image Caption Generation with Visual Attention", ICML 2015

Now， Kaggle Whale Challenge

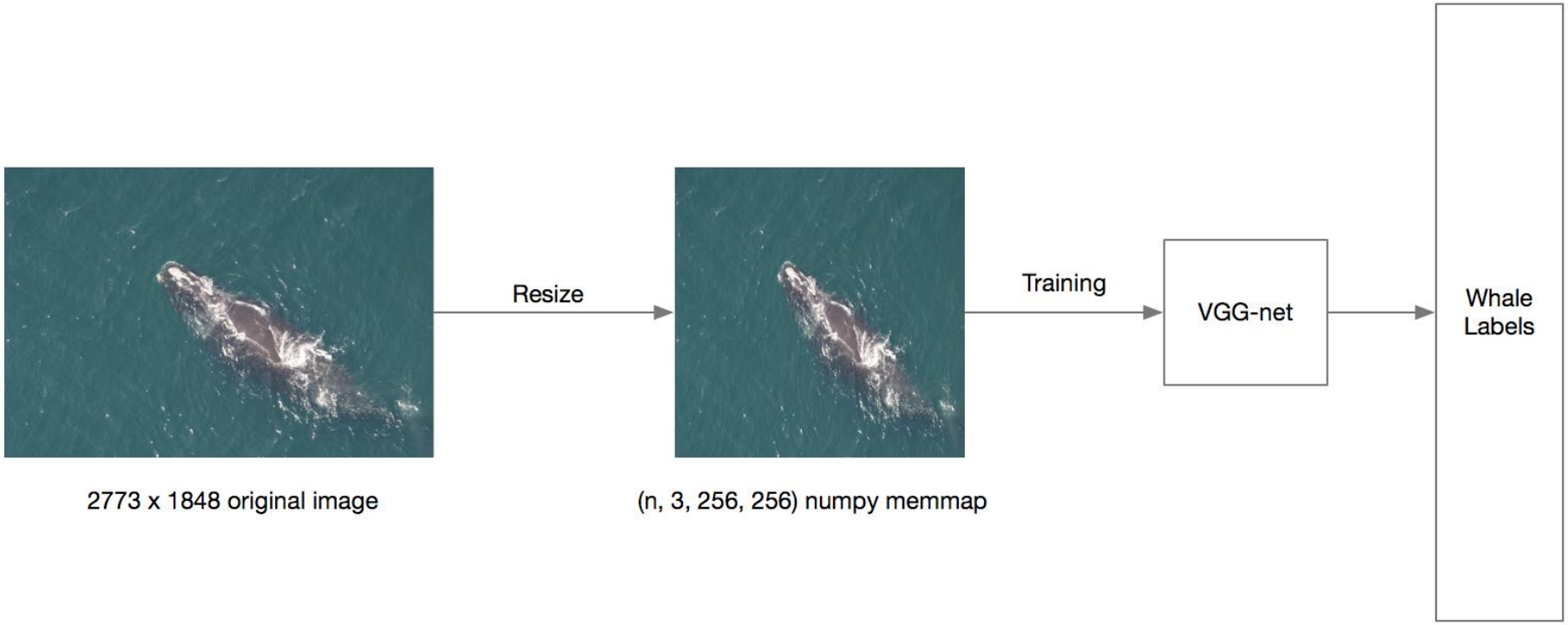
- Task

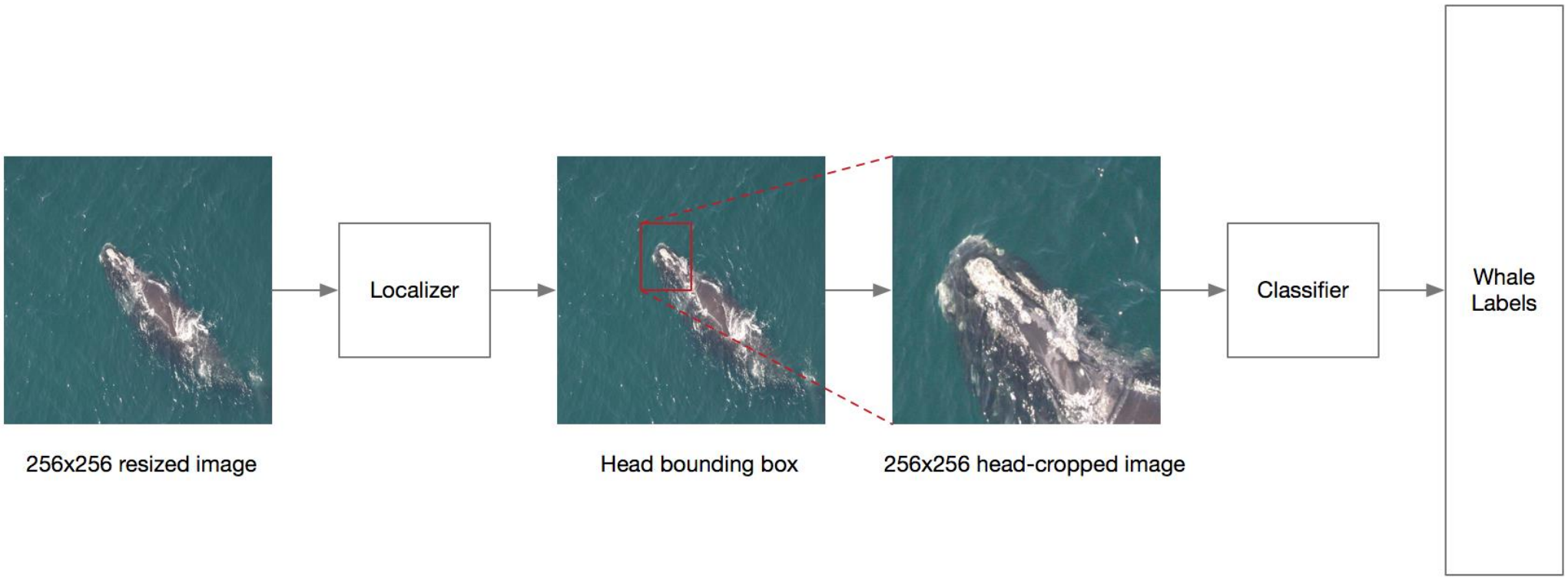


- 4237 images for 427 right whales



Baseline

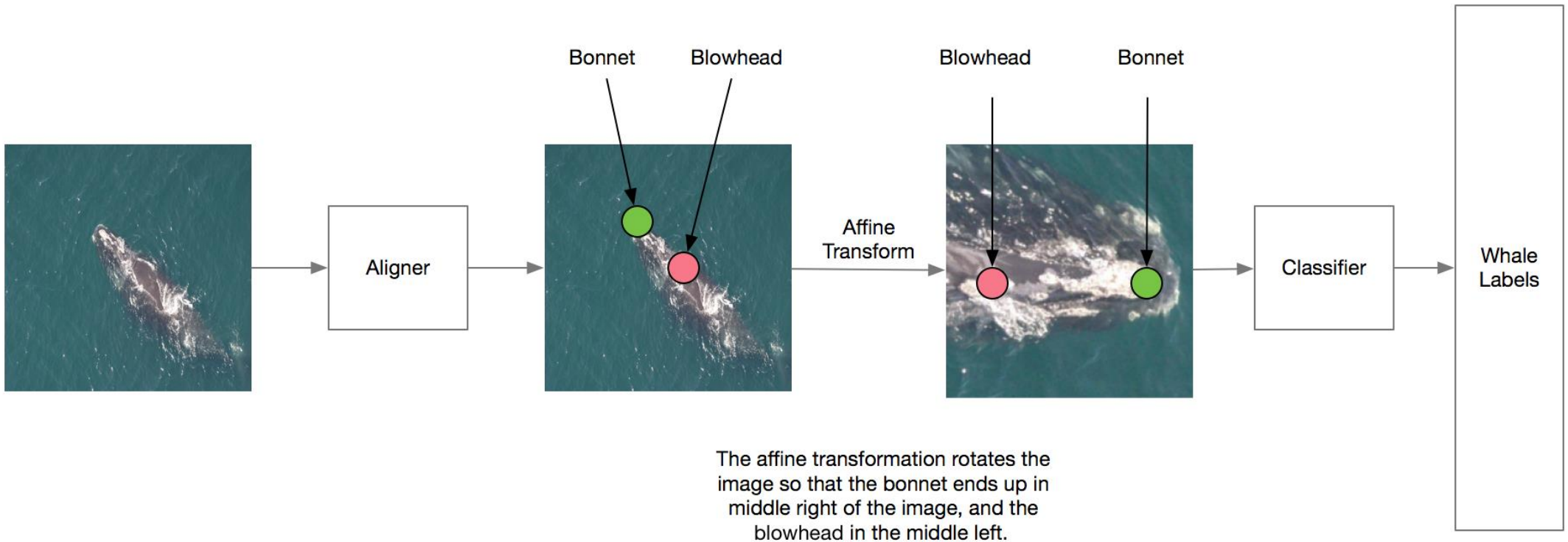

Resize
Training
VGG-net
Whale Labels
2773 x 1848 original image
(n, 3, 256, 256) numpy memmap


Localizer
Classifier
Whale Labels
256x256 resized image
Head bounding box
256x256 head-cropped image

How to get the bounding box

- 我们会什么？
- 分类 回归

- 我们想做什么？
- 获得bounding boxes



The affine transformation rotates the image so that the bonnet ends up in middle right of the image, and the blowhead in the middle left.

Second Example

车型识别

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Project codes

- Included in the attachment