Deep Learning for Computer Vision

Ahmed Hosny Abdel-Gawad

Senior AI/CV Engineer

Table Content

Part One	From Traditional Computer Vision to Deep Learning
Part Two	Practical Convolution Neural Nets
Part Three	Computer Vision Applications

1 From Traditional CV to DL

1.1

From Traditional Convolution Neural Networks to Deep Learning

Soft introduction about OpenCV and what exactly is traditional computer vision.

1.2

Convolution Neural Networks (CNNs)

Motivations behind CNNs, Image Classifications, calculation of sizes of filters, input and output layers.

1.3

Convolution Neural Network Meta Architectures

How to Design CNNs and the well-known architectures.

1.1 From Traditional ConvNets to DL

Semantic gap and CV tasks

The gap between what a computer sees and what we want it to see.

Traditional CV Pipeline

Traditional images processing techniques and its limitations.

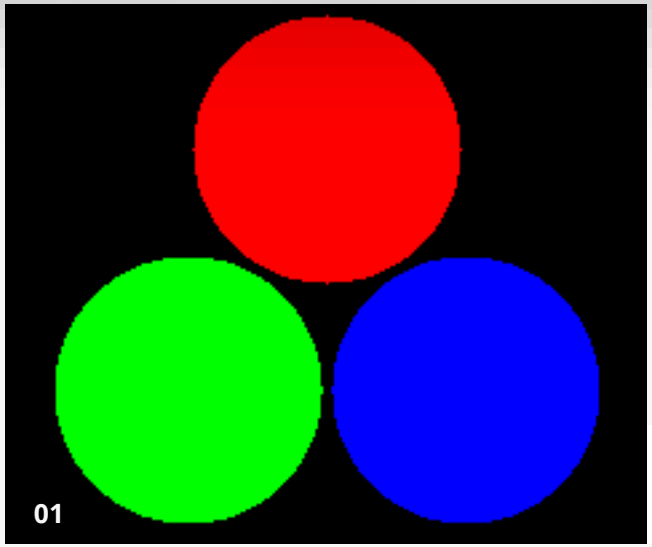
From traditional to learnable convolution filters

Introducing the learning processes and convolution neural networks.

ConvNets and GPU

Why GPUs works perfect with convolution neural networks.

Semantic Gap



01

What Does A Computer See?

Using RGB model to help us understand how a computer looks at an image.

02

What We Want the Computer to see?

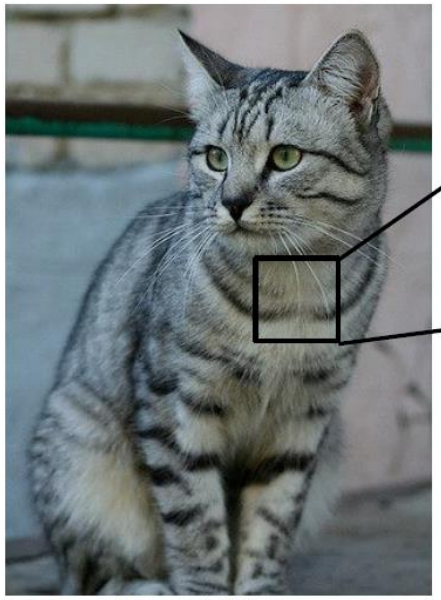
The core computer vision task: Image classification.

03

OpenCV Primer

Introduction to OpenCV.

What Does A Computer See?



This image by Nikita is licensed under CC-BY 2.0

```
[[105 112 108 111 104  99 105  99  96 103 112 119 104  97  93  87]
 [ 91  98 102 106 104  79  98 103  99 105 123 136 110 105  94  85]
 [ 76  85  90 105 128 105  87  96  95  99 115 112 106 103  99  85]
 [ 99  81  81  93 120 131 127 100  95  98 102  99  96  93 101  94]
 [106  91  61  64  69  91  88  85 101 107 109  98  75  84  96  95]
 [114 108  85  55  55  69  64  54  64  87 112 129  98  74  84  91]
 [133 137 147 103  65  81  80  65  52  54  74  84 102  93  85  82]
 [128 137 144 140 109  95  86  70  62  65  63  63  60  73  86 101]
 [125 133 148 137 119 121 117  94  65  79  80  65  54  64  72  98]
 [127 125 131 147 133 127 126 131 111  96  89  75  61  64  72  84]
 [115 114 109 123 150 148 131 118 113 109 100  92  74  65  72  78]
 [ 89  93  90  97 108 147 131 118 113 114 113 109 106  95  77  80]
 [ 63  77  86  81  77  79 102 123 117 115 117 125 125 130 115  87]
 [ 62  65  82  89  78  71  80 101 124 126 119 101 107 114 131 119]
 [ 63  65  75  88  89  71  62  81 120 138 135 105  81  98 110 118]
 [ 87  65  71  87 106  95  69  45  76 130 126 107  92  94 105 112]
 [118  97  82  86 117 123 116  66  41  51  95  93  89  95 102 107]
 [164 146 112  80  82 120 124 104  76  48  45  66  88 101 102 109]
 [157 170 157 120  93  86 114 132 112  97  69  55  70  82  99  94]
 [130 128 134 161 139 100 109 118 121 134 114  87  65  53  69  86]
 [120 112  96 117 150 144 120 115 104 107 102  93  87  81  72  79]
 [123 107  96  86  83 112 153 149 122 109 104  75  80 107 112  99]
 [122 121 102  80  82  86  94 117 145 148 153 102  58  78  92 107]
 [122 164 148 103  71  56  78  83  93 103 119 139 102  61  69  84]]
```

What the computer sees

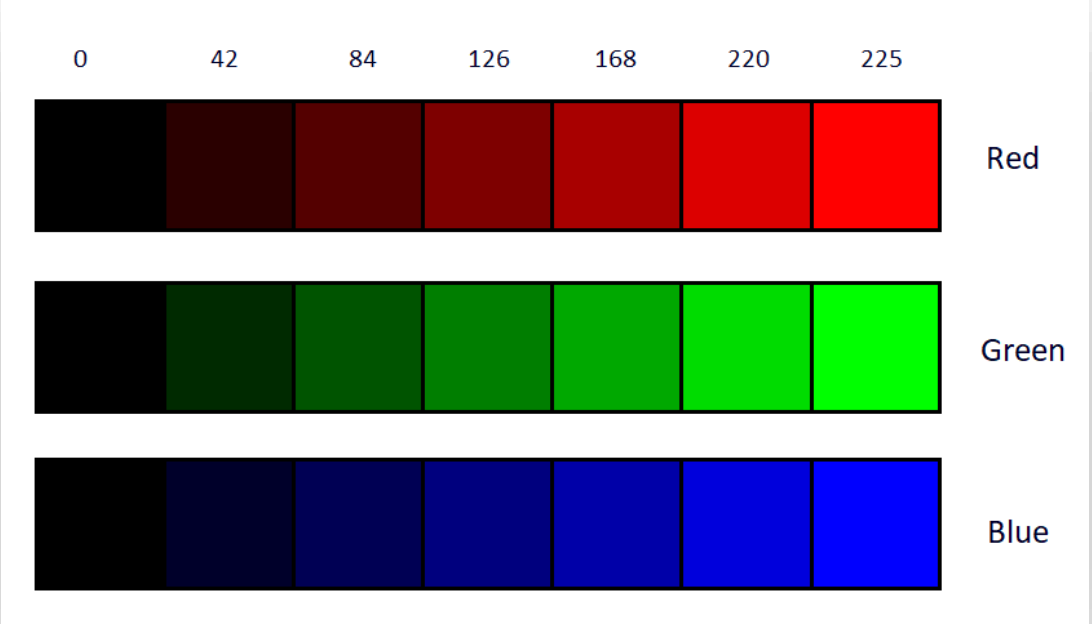
An image is just a big grid of numbers between [0, 255]:

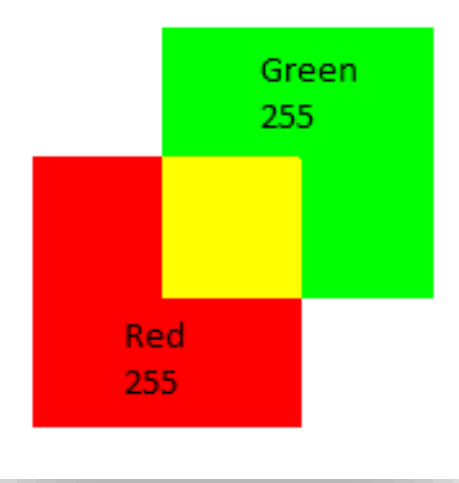
e.g. 800 x 600 x 3
(3 channels RGB)

What Does A Computer See?

Every major color has a range from 0 to 255, we can infer that higher the value, the brighter is the color.

When we combine two colors, say red and green, the resulting color is Yellow. It is represented in the three dimensional space as 255,255,0 (R,G,B).

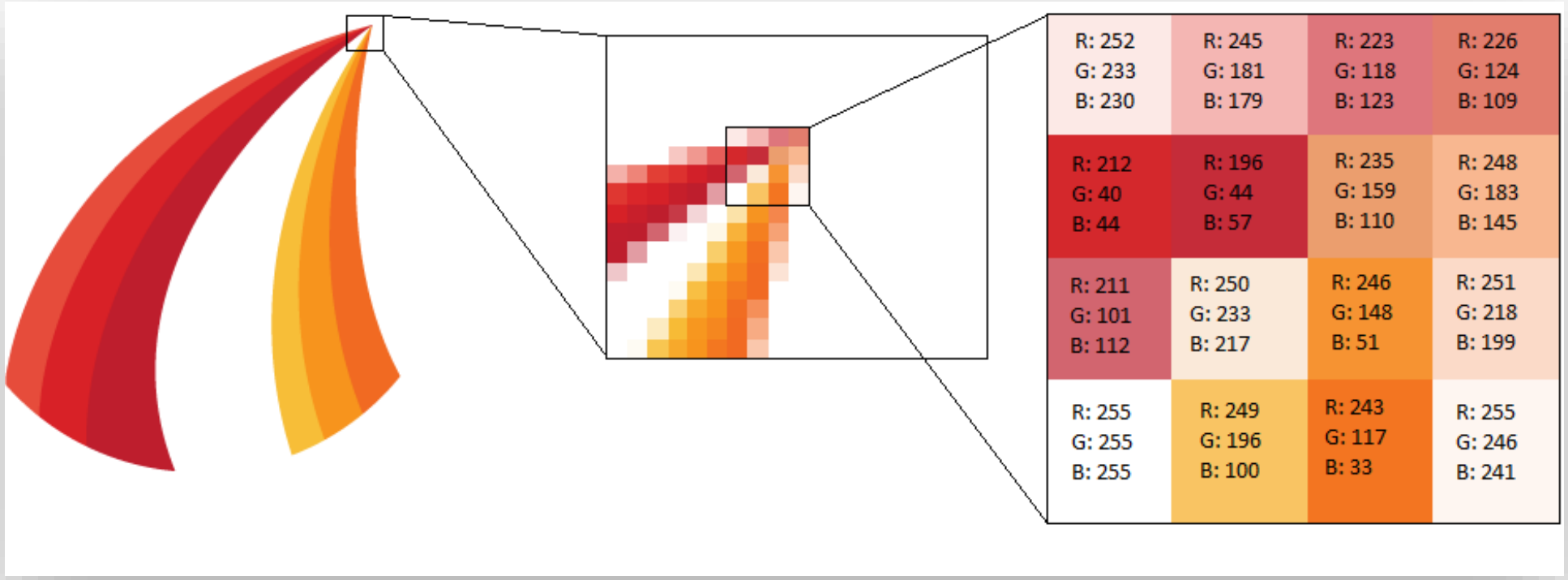




What Does A Computer See?

An image is made up of pixels placed adjacent to one another. These colored pixels are made up of three channels which are placed one behind the another.

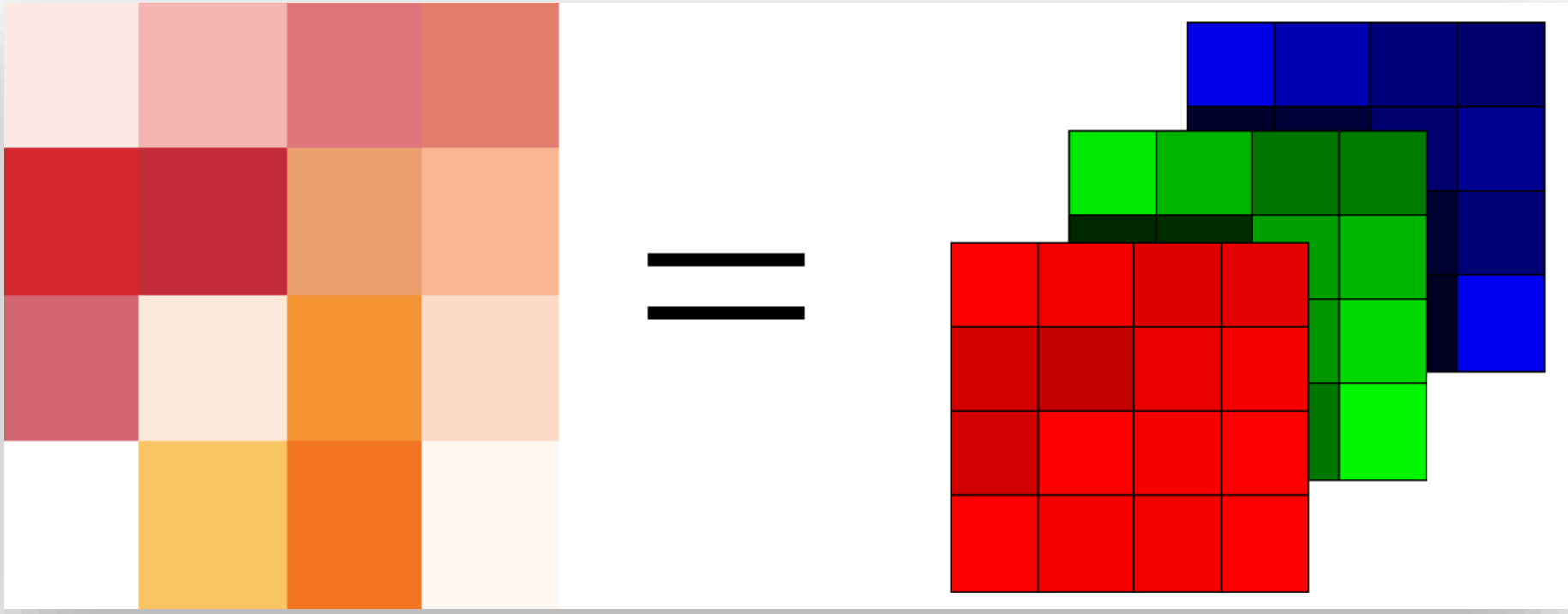
The below pixelated image is a combination of the three channels which are placed one behind the other.



What Does A Computer See?

An image is made up of pixels placed adjacent to one another. These colored pixels are made up of three channels which are placed one behind the another.

The below pixelated image is a combination of the three channels which are placed one behind the other.



A core task in CV: Image Classification

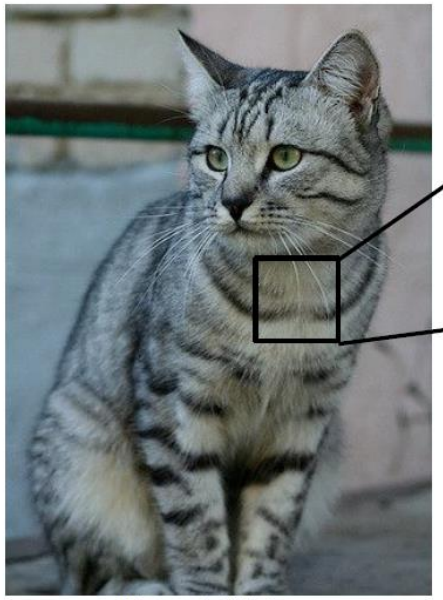
Image Classification

This image by Nikita is licensed under CC-BY 2.0

(assume given set of discrete labels)
{dog, cat, truck, plane, ...}

→ cat

The Problem: Semantic Gap



This image by Nikita is licensed under CC-BY 2.0

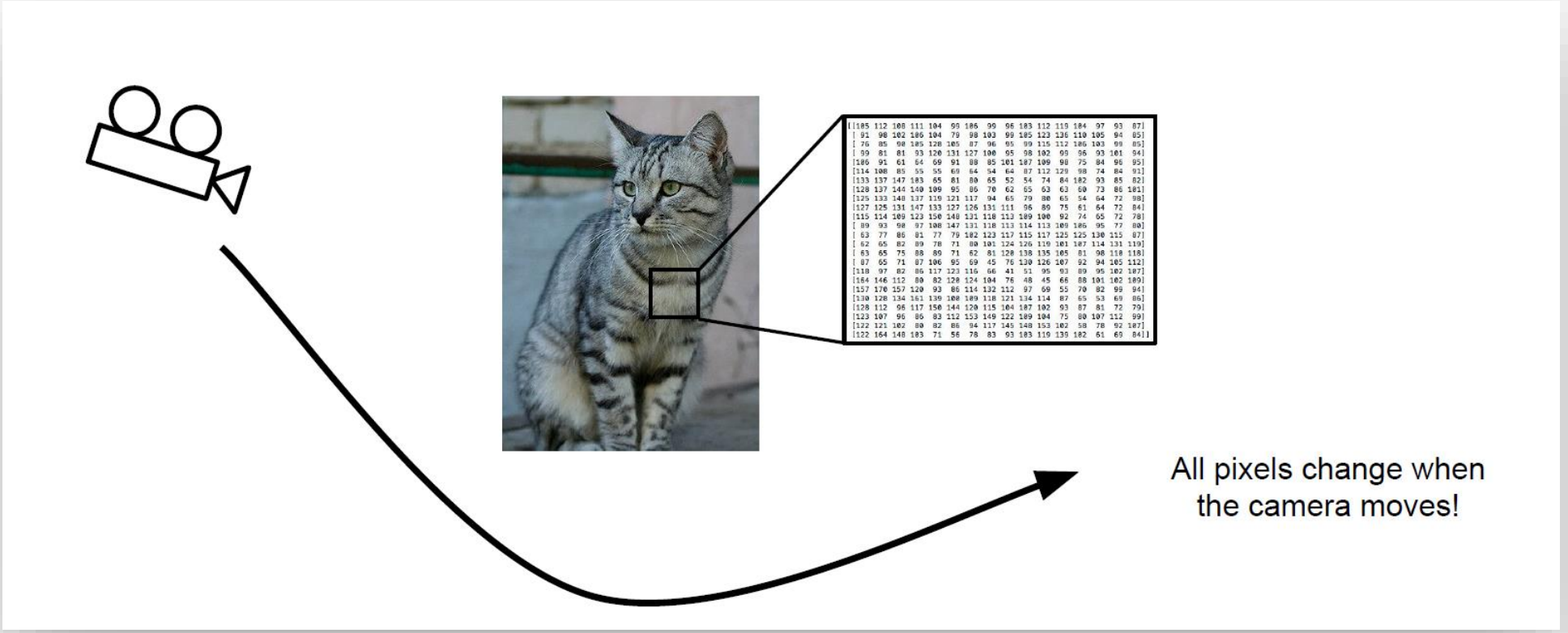
```
[[105 112 108 111 104  99 105  99  96 103 112 119 104  97  93  87]
 [ 91  98 102 106 104  70  98 103  99 105 123 136 110 105  94  85]
 [ 76  85  90 105 128 105  87  96  95  99 115 112 106 103  99  85]
 [ 99  81  81  93 120 131 127 100  95  98 102  99  96  93 101  94]
 [106  91  61  64  69  91  88  85 101 107 109  98  75  84  96  95]
 [114 108  85  55  55  69  64  54  64  87 112 129  98  74  84  91]
 [133 137 147 103  65  81  80  65  52  54  74  84 102  93  85  82]
 [128 137 144 140 109  95  86  70  62  65  63  63  60  73  86 101]
 [125 133 148 137 119 121 117  94  65  79  80  65  54  64  72  98]
 [127 125 131 147 133 127 126 131 111  96  89  75  61  64  72  84]
 [115 114 109 123 150 148 131 118 113 109 100  92  74  65  72  78]
 [ 89  93  90  97 108 147 131 118 113 114 113 109 106  95  77  80]
 [ 63  77  86  81  77  79 102 123 117 115 117 125 125 130 115  87]
 [ 62  65  82  89  78  71  80 101 124 126 119 101 107 114 131 119]
 [ 63  65  75  88  89  71  62  81 120 138 135 105  81  98 110 118]
 [ 87  65  71  87 106  95  69  45  76 130 126 107  92  94 105 112]
 [118  97  82  86 117 123 116  66  41  51  95  93  89  95 102 107]
 [164 146 112  80  82 120 124 104  76  48  45  66  88 101 102 109]
 [157 170 157 120  93  86 114 132 112  97  69  55  70  82  99  94]
 [130 128 134 161 139 100 109 118 121 134 114  87  65  53  69  86]
 [120 112  96 117 150 144 120 115 104 107 102  93  87  81  72  79]
 [123 107  96  86  83 112 153 149 122 109 104  75  80 107 112  99]
 [122 121 102  80  82  86  94 117 145 148 153 102  58  78  92 107]
 [122 164 148 103  71  56  78  83  93 103 119 139 102  61  69  84]]
```

What the computer sees

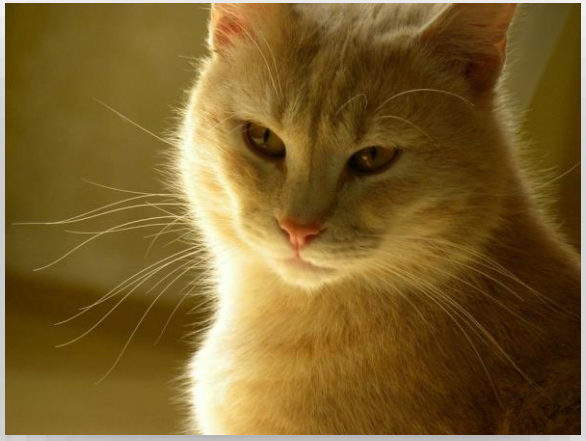
An image is just a big grid of numbers between [0, 255]:

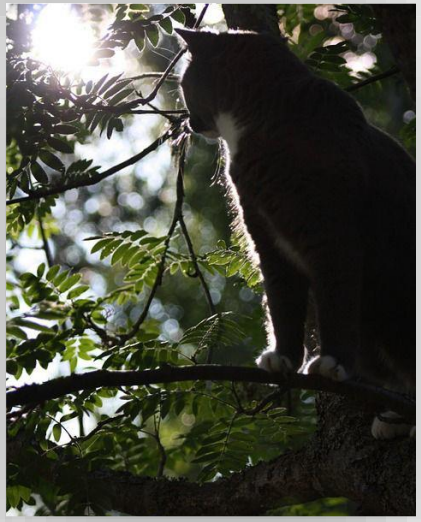
e.g. 800 x 600 x 3
(3 channels RGB)

Challenges: Viewpoint variation



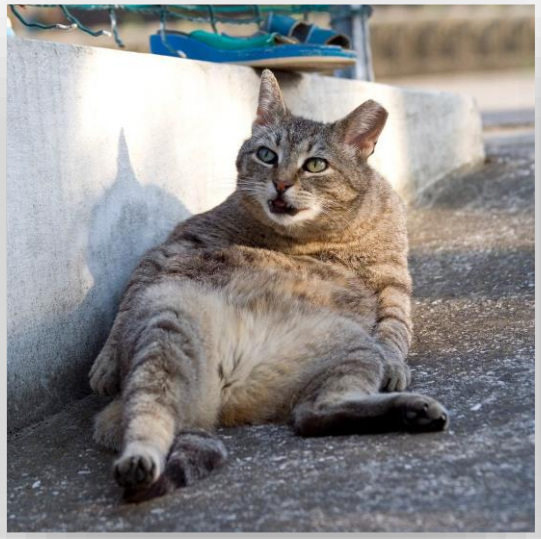
Challenges: Illumination

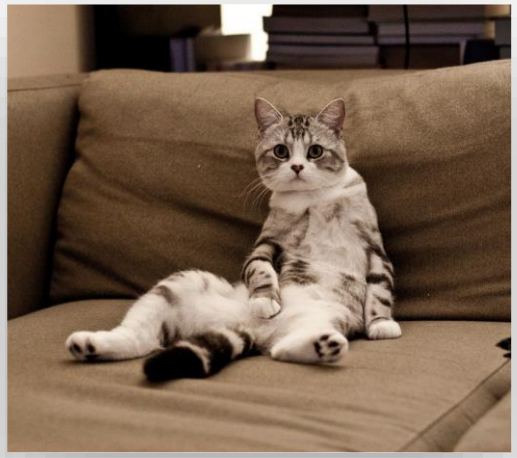


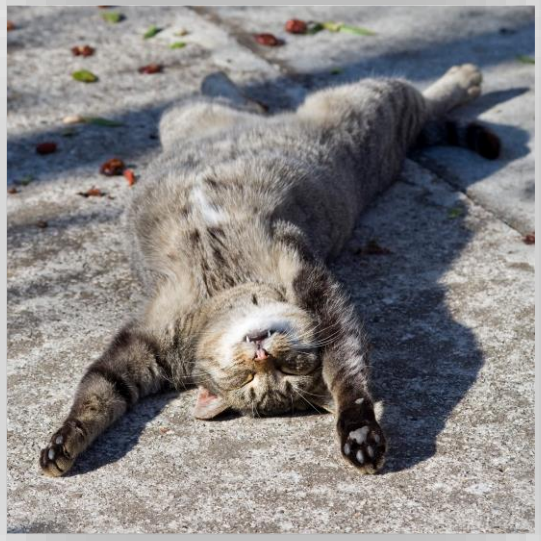


We need the computer to classify all of them as cats!

Challenges: Deformation



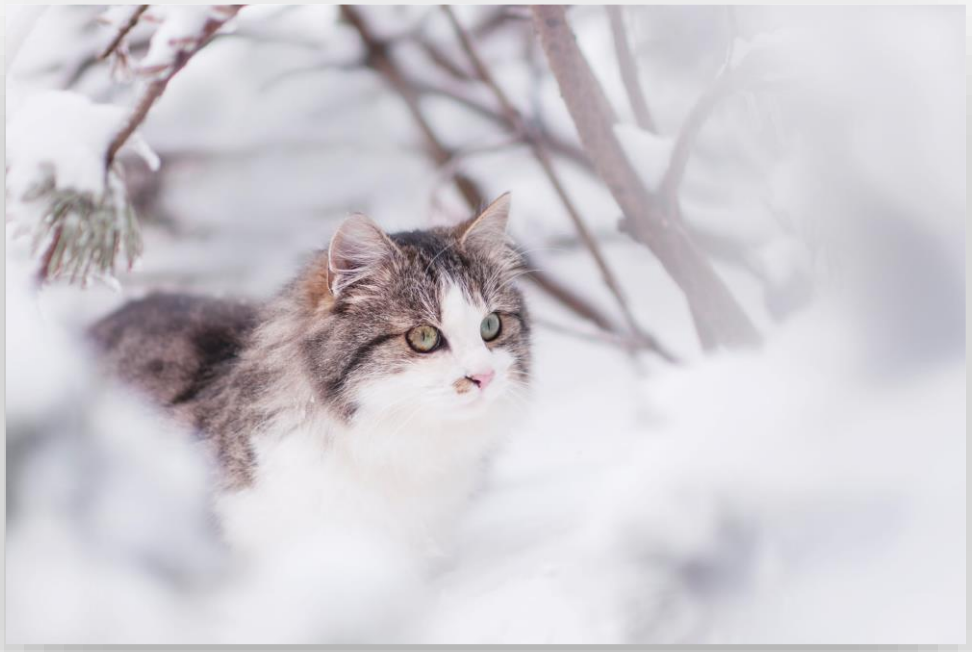




Again, we need the computer to classify all of them as cats!

Challenges: Occlusion

Challenges: Background Clutter



Challenges: Intraclass variation

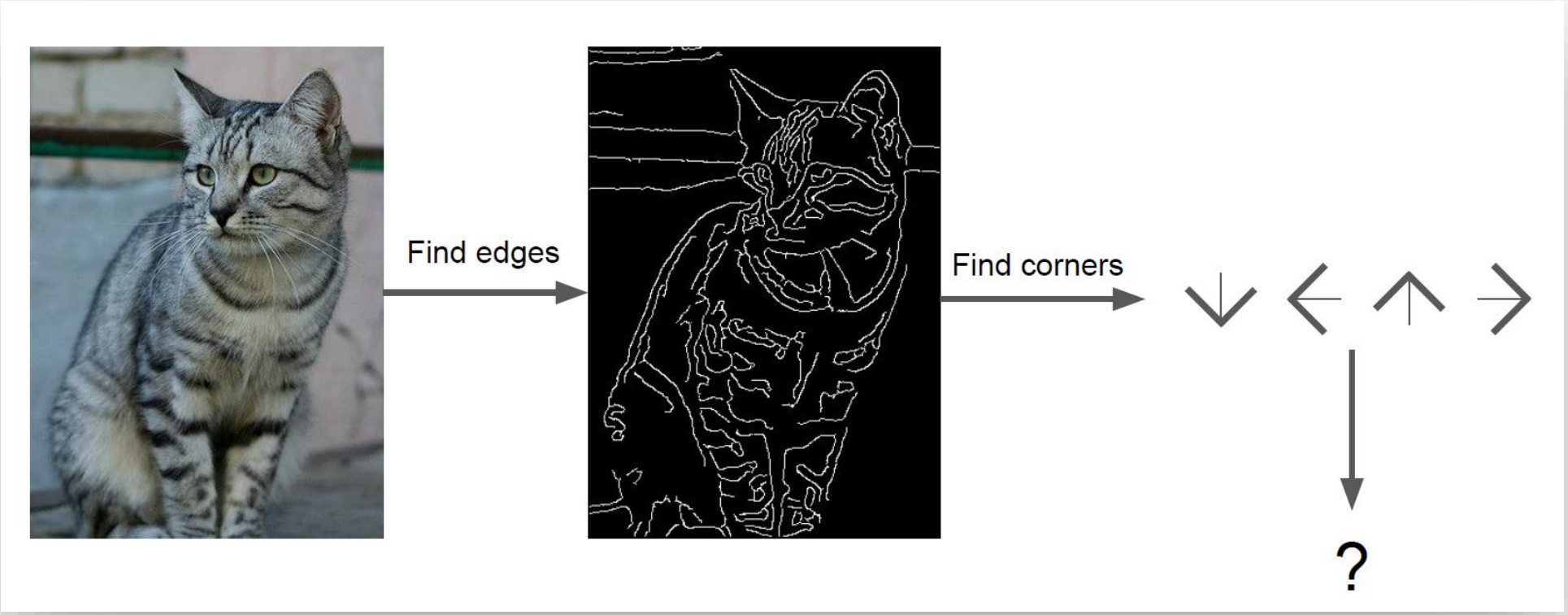
An Image Classifier

```
def classify_image(image):
  # Some magic?
  return class_label
```

Unlike e.g. sorting a list of numbers,

No obvious way to hard-code the algorithm for recognizing a cat, or other classes.

Attempts: Traditional CV



Thank You!