

Computer Vision and Image Processing

Prof. André Gustavo Hochuli

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Topics

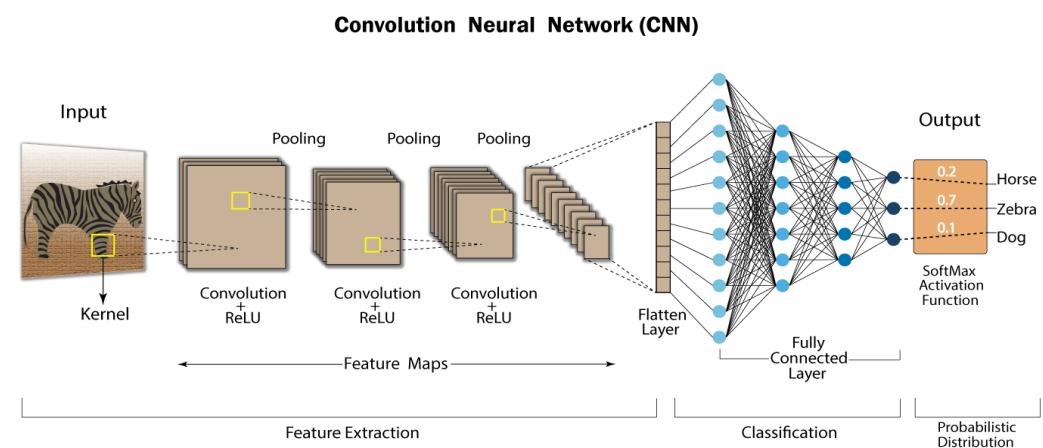
- **Apresentação do Professor**
- **O que esperar da disciplina?**
- **Ferramentas do estado da arte**
 - **Google Colab**
 - **OpenCV**
 - **Tensorflow**
 -
- **Exercícios**

Prof. André Gustavo Hochuli

- Formação
 - Ciência da Computação [2004, PUCPR]
 - Mestre [2007, PPGIA/PUCPR]
 - Doutor [2018, PPGINF/UFPR]
- Experiência Profissional
 - P&D em Visão Computacional [2008-2013]
 - Professor Universitário [2014 - Atual]
- Linhas de Pesquisa
 - Aprendizagem de Máquina e Reconhecimento de Padrões

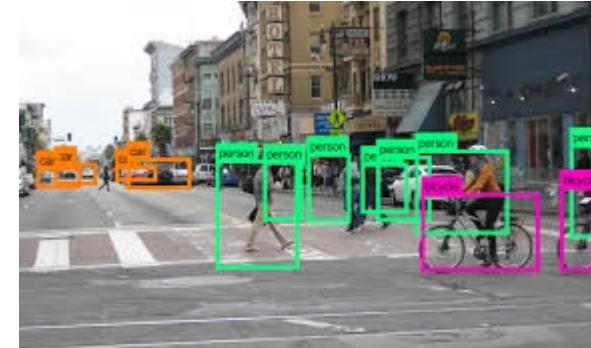


Hobbies:
Aviação
Futebol
Tecnologia



O que esperar da disciplina ?

- Processamento de Imagens
 - Aprendizagem de Máquina
 - Resolução de problemas
 - Desafios encontrados no cotidiano
 - Aulas teóricas e práticas
 - Espaço para o estudante debater e trazer problemas/dúvidas
 - Conteúdo incremental
 - Trabalhos práticos
 - Provas práticas
-
- OBS: Material didático em língua inglesa.



Plano de Ensino (Resumo)

| |
|---|
| RA1: Compreender o problema proposto e desenvolver uma solução computacional |
| RA2: Identificar as ferramentas de visão computacional para o desenvolvimento da solução |
| RA3: Codificar programas utilizando as construções fundamentais de visão computacional |
| RA4: Treinar modelos de aprendizagem de máquina capazes de resolver o problema de maneira automática |
| RA5: Identifica problemas e propõe melhoria analisando o resultado da solução |

| Resultado de Aprendizagem (RA) | PjBL 1 (Grupo - Somativa) (Peso no RA) | Prova 1 – (Somativa) (Peso no RA) | PjBL 2 (Grupo - Somativa) (Peso no RA) | Prova 2 – (Somativa) (Peso no RA) |
|---------------------------------------|---|--|---|--|
| RA1 | 2,5 | 2,5 | 2,5 | 2,5 |
| RA2 | 2,5 | 2,5 | 2,5 | 2,5 |
| RA3 | 5 | - | 5 | - |
| RA4 | 5 | - | 5 | - |
| RA5 | 2,5 | 2,5 | 2,5 | 2,5 |

$$\text{Nota Final} = \frac{1}{5} \sum_{i=1}^5 RA_i$$

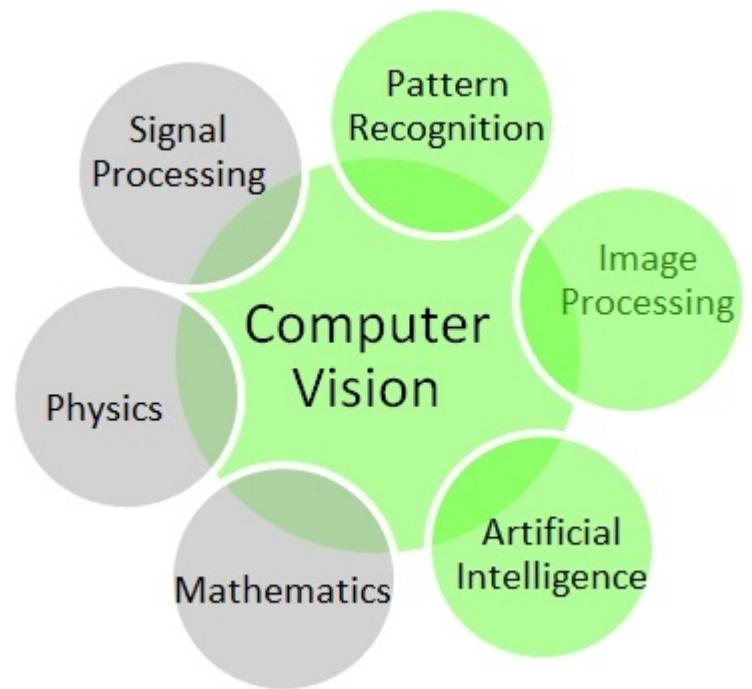
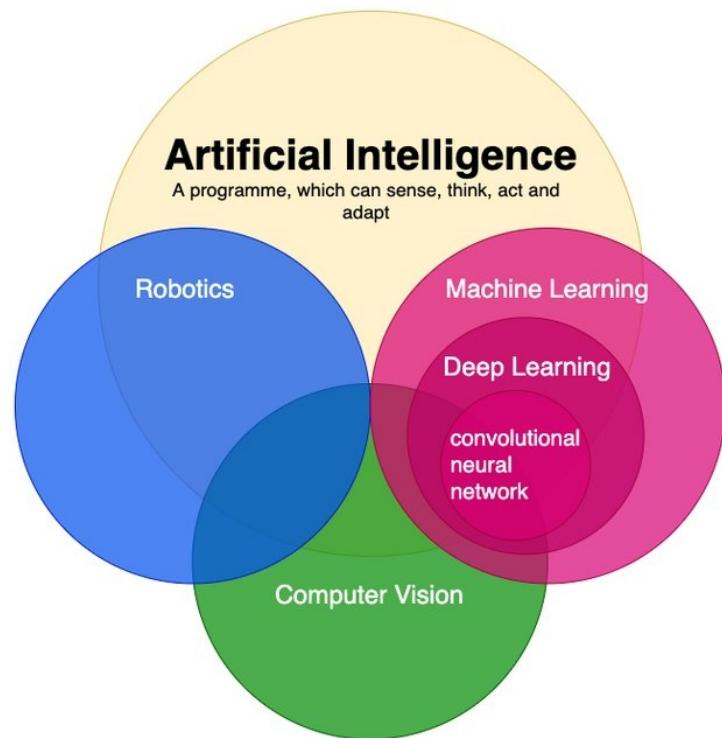
- 02 RECUPERAÇÕES BIMESTRAIS: SOMATIVAS 1 E SOMATIVAS 2
- PLANO DE ENSINO COMPLETO DISPONIBILIZADO NO (CANVAS)

Plano de Ensino (Resumo)

| Período | Datas | RAs | Atividades | CH |
|----------|---------------|-----------|--|-----|
| Agosto | 31/07 - 21/08 | 1,2,3,5 | Aquisição e Manipulação de Imagens Processamento de Imagens e Segmentação | 16 |
| | Até 28/08 | 1,2,3,5 | Avaliação Somativa (PjBL1/TDE1) | 4+6 |
| Setembro | 04/09 - 18/09 | 1,2,3,4,5 | Extração de Características Reconhecimento de Padrões | 12 |
| | Até 25/09 | 1,2,3,4,5 | Avaliação Somativa 1(Individual) *Recuperação Ra's (Somativas #1) | 4 |
| Outubro | 02/10 - 23/10 | 1,2,3,4,5 | Deep Learning | 16 |
| | Até 30/10 | 1,2,3,4,5 | Avaliação Somativa (PjBL 2/TDE2) | 4+6 |
| Novembro | 06/11 | 1,2,3,4,5 | Deep Learning | 4 |
| | Até 3/11 | 1,2,3,4,5 | Avaliação Somativa 2 (Individual) | 4 |
| | 20/11 | 1,2,3,4,5 | Entrega das Notas Recuperação R.A's (Somativas #2) | 4 |
| | 27/11 | 1-5 | Exame Final | - |
| Dezembro | 04/12 | - | Encerramento e Publicação das Notas no Portal | - |

* Cronograma pode sofrer alterações de acordo com a necessidades e ocorrências durante o semestre.

What is Computer Vision (CV) ?



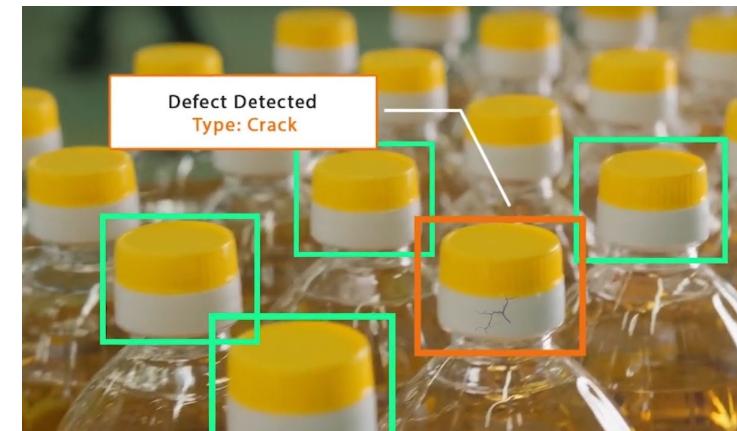
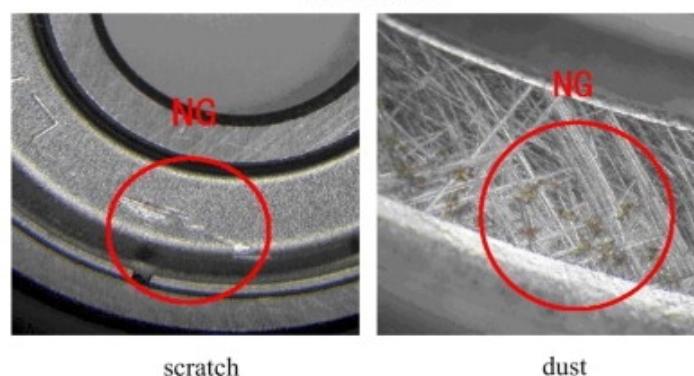
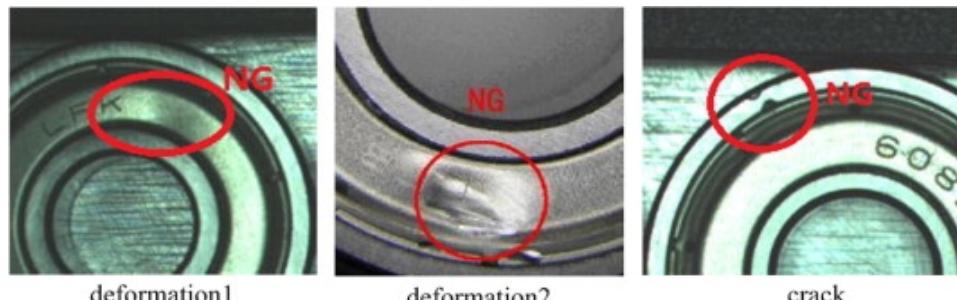
Tools & Libraries



Caffe

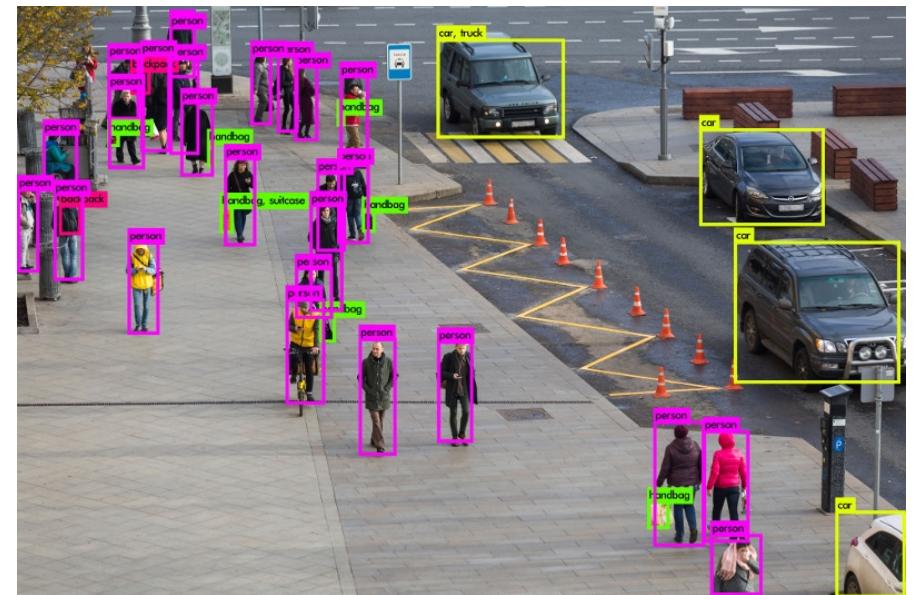
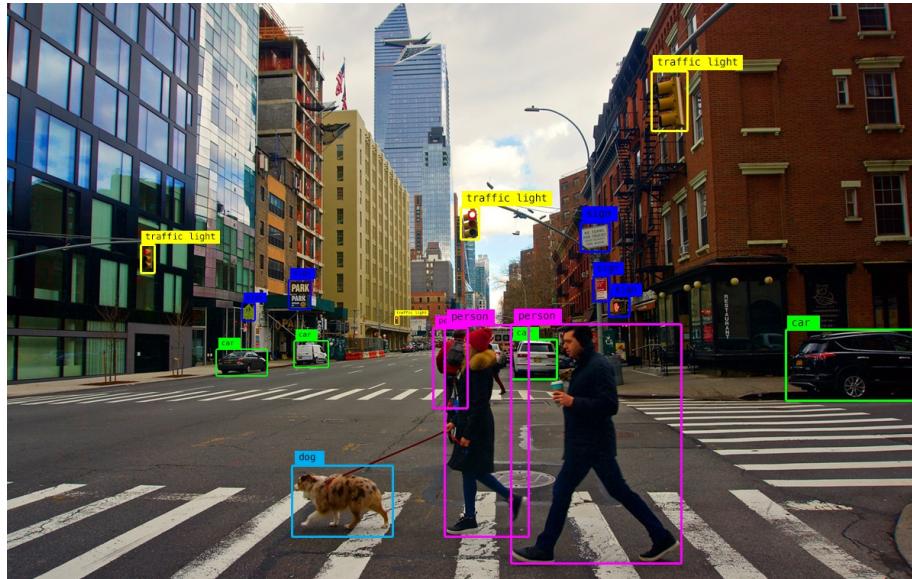
Computer Vision Applications

- Defect Detection and Quality Assurance



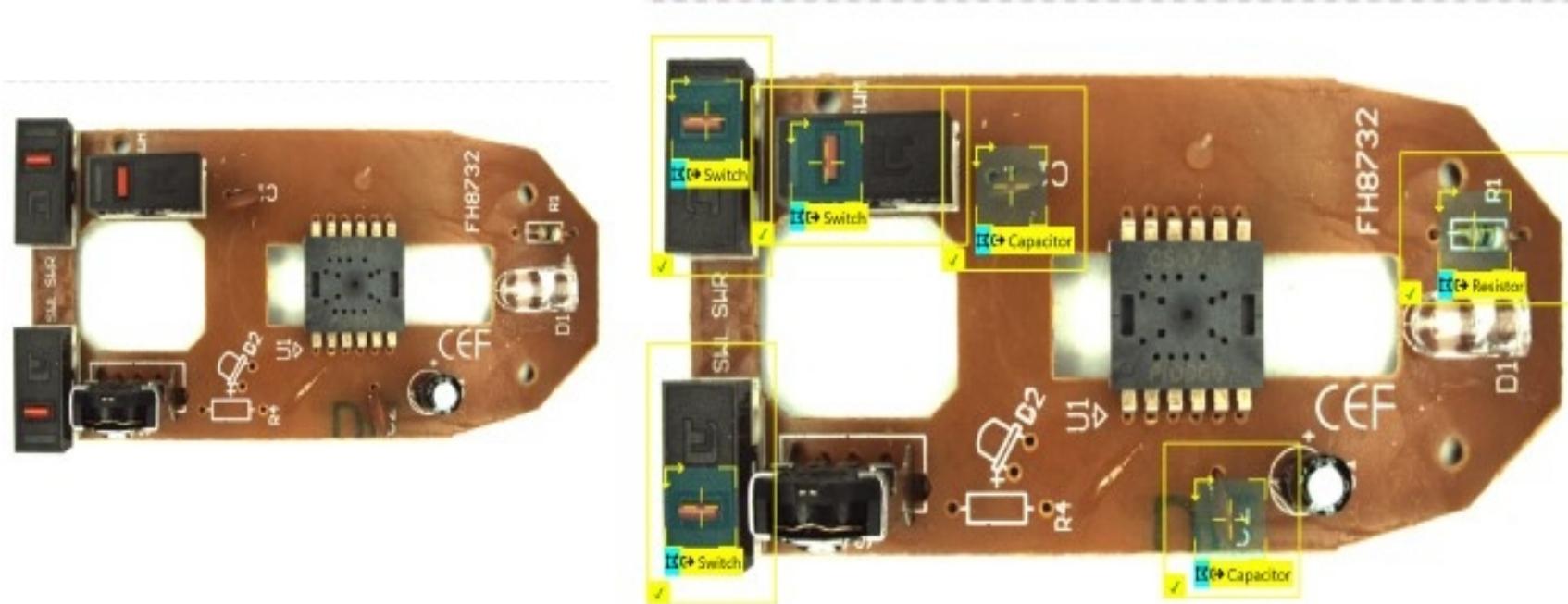
Computer Vision Applications

- **Video Surveillance and Analytics**



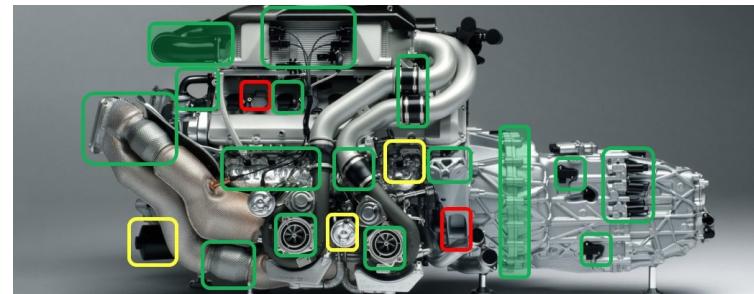
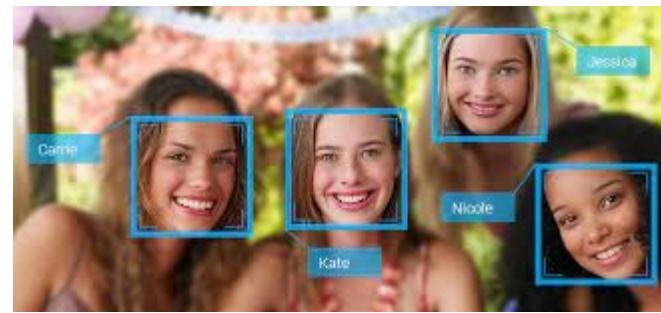
Computer Vision Applications

- **Assembly Verification**



Computer Vision Applications

- ...and....



Jobs

- **This is a field with several projects and open positions around the world.**
 - **Linkedin**
 - **Glassdoor**

Image Processing

Basic Definitions

- **Basic Definitions**
 - **Pixel, Resolution and Scale**
- **Color Systems**
 - **GrayScale, RGB | BGR, CYMK, HSV**
 - **Color Conversion**
- **Binarization and Image Filtering**
- **Exercises**

Basic Definitions

Image and Pixel

- **Image: Matrix NxM**
- **Pixel** The smallest information of an image
- **Range from 0 (black) to 255 (white)**



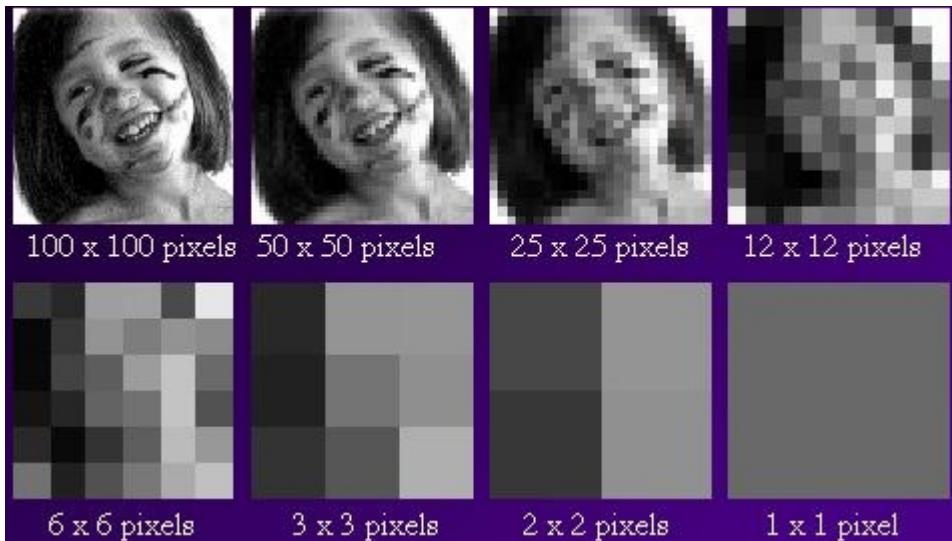
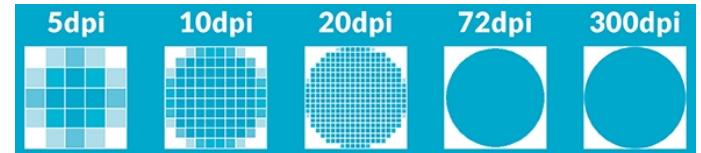
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|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 157 | 153 | 174 | 168 | 150 | 152 | 129 | 151 | 172 | 161 | 155 | 156 |
| 155 | 182 | 163 | 74 | 75 | 62 | 33 | 17 | 110 | 210 | 180 | 154 |
| 180 | 180 | 80 | 14 | 34 | 6 | 10 | 33 | 48 | 106 | 159 | 181 |
| 206 | 109 | 5 | 124 | 131 | 111 | 120 | 204 | 166 | 15 | 56 | 189 |
| 194 | 68 | 137 | 251 | 237 | 299 | 239 | 228 | 227 | 87 | 71 | 201 |
| 172 | 105 | 207 | 233 | 233 | 214 | 220 | 239 | 228 | 98 | 74 | 206 |
| 188 | 88 | 179 | 209 | 186 | 216 | 211 | 168 | 139 | 79 | 20 | 169 |
| 189 | 97 | 165 | 84 | 10 | 168 | 134 | 11 | 31 | 62 | 22 | 148 |
| 199 | 168 | 191 | 193 | 158 | 227 | 178 | 149 | 182 | 106 | 36 | 190 |
| 205 | 174 | 155 | 252 | 236 | 231 | 149 | 178 | 224 | 43 | 95 | 234 |
| 190 | 216 | 116 | 149 | 236 | 187 | 85 | 150 | 79 | 38 | 218 | 241 |
| 190 | 224 | 147 | 168 | 227 | 210 | 127 | 102 | 36 | 101 | 255 | 224 |
| 190 | 214 | 173 | 66 | 103 | 143 | 96 | 50 | 2 | 109 | 249 | 215 |
| 187 | 196 | 236 | 75 | 1 | 81 | 47 | 0 | 6 | 217 | 255 | 211 |
| 183 | 202 | 237 | 145 | 0 | 0 | 12 | 108 | 290 | 138 | 243 | 236 |
| 195 | 206 | 123 | 267 | 177 | 121 | 123 | 206 | 175 | 13 | 96 | 218 |

| | | | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 157 | 153 | 174 | 168 | 150 | 152 | 129 | 151 | 172 | 161 | 155 | 156 |
| 155 | 182 | 163 | 74 | 75 | 62 | 33 | 17 | 110 | 210 | 180 | 154 |
| 180 | 180 | 80 | 14 | 34 | 6 | 10 | 33 | 48 | 106 | 159 | 181 |
| 206 | 109 | 5 | 124 | 131 | 111 | 120 | 204 | 166 | 15 | 56 | 189 |
| 194 | 68 | 137 | 251 | 237 | 299 | 239 | 228 | 227 | 87 | 71 | 201 |
| 172 | 105 | 207 | 233 | 233 | 214 | 220 | 239 | 228 | 98 | 74 | 206 |
| 188 | 88 | 179 | 209 | 186 | 216 | 211 | 168 | 139 | 79 | 20 | 169 |
| 189 | 97 | 165 | 84 | 10 | 168 | 134 | 11 | 31 | 62 | 22 | 148 |
| 199 | 168 | 191 | 193 | 158 | 227 | 178 | 149 | 182 | 106 | 36 | 190 |
| 205 | 174 | 155 | 252 | 236 | 231 | 149 | 178 | 224 | 43 | 95 | 234 |
| 190 | 216 | 116 | 149 | 236 | 187 | 85 | 150 | 79 | 38 | 218 | 241 |
| 190 | 224 | 147 | 168 | 227 | 210 | 127 | 102 | 36 | 101 | 255 | 224 |
| 190 | 214 | 173 | 66 | 103 | 143 | 96 | 50 | 2 | 109 | 249 | 215 |
| 187 | 196 | 236 | 75 | 1 | 81 | 47 | 0 | 6 | 217 | 255 | 211 |
| 183 | 202 | 237 | 145 | 0 | 0 | 12 | 108 | 290 | 138 | 243 | 236 |
| 195 | 206 | 123 | 267 | 177 | 121 | 123 | 206 | 175 | 13 | 96 | 218 |

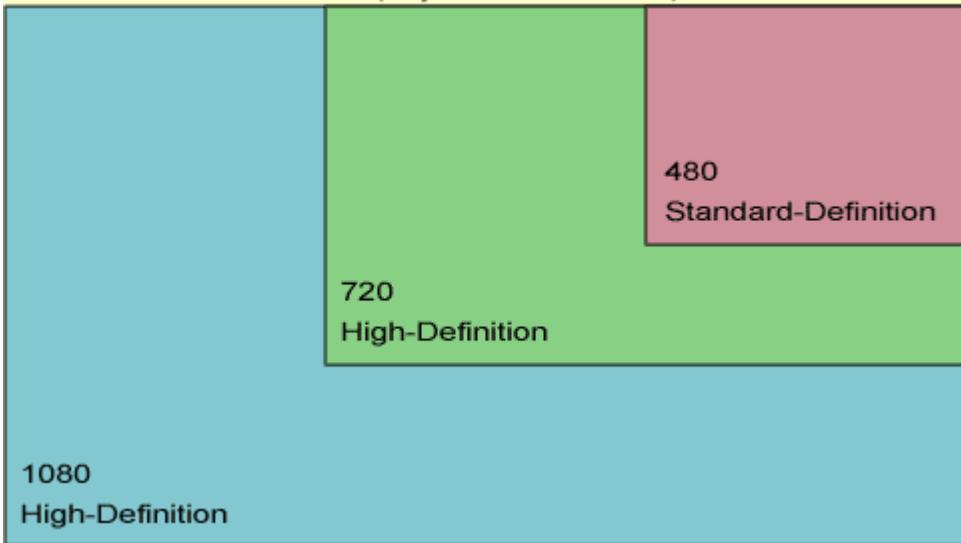
Basic Definitions

Image Resolution

- **Pixel per Inch (PPI) for digital devices**
- **Dots per Inch (DPI) for analog devices (printers)**
- **Range from 0 (black) to 255 (white)**

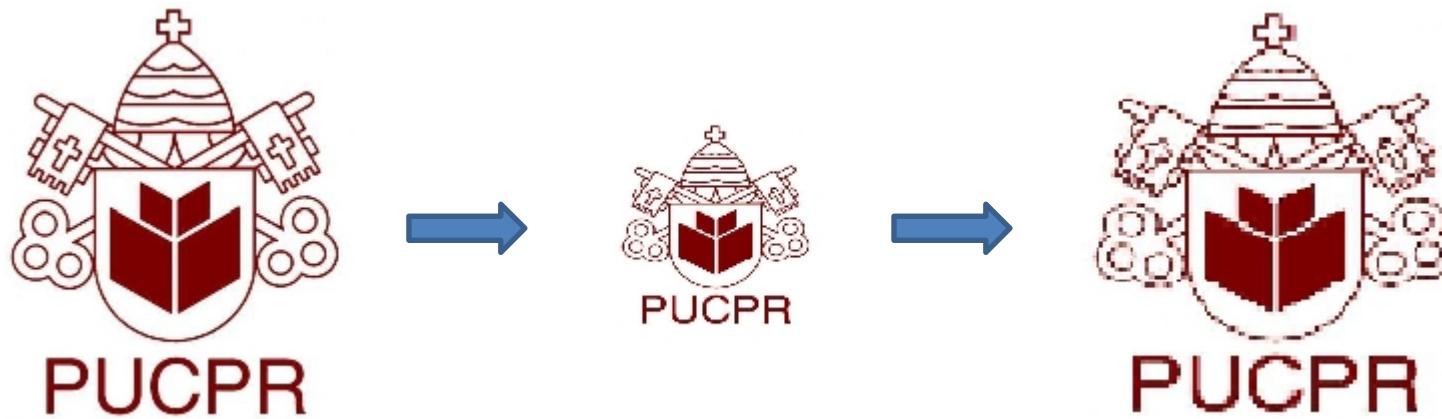


Standard Display Resolution Comparison



Basic Definitions

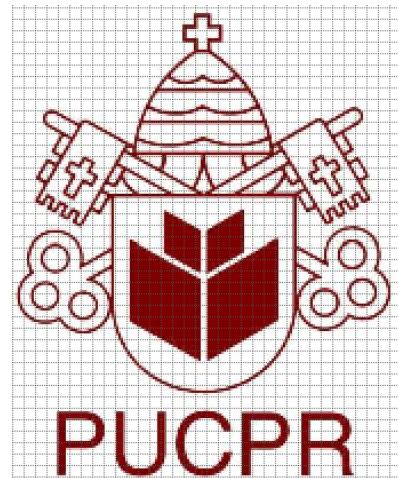
What is the problem?



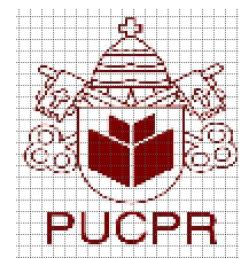
Basic Definitions

Downscale and Upscale (Resize)

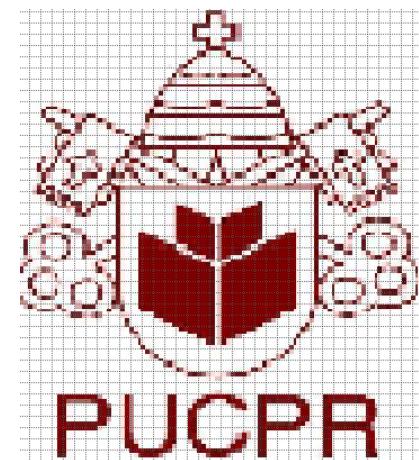
- Resolution loss
- Interpolation



160x200



96x106



160x200

Basic Definitions

ColorSpaces

- **Binary (0-1) - 1 Channel**



- **GrayScale (0-255) - 1 Channel**

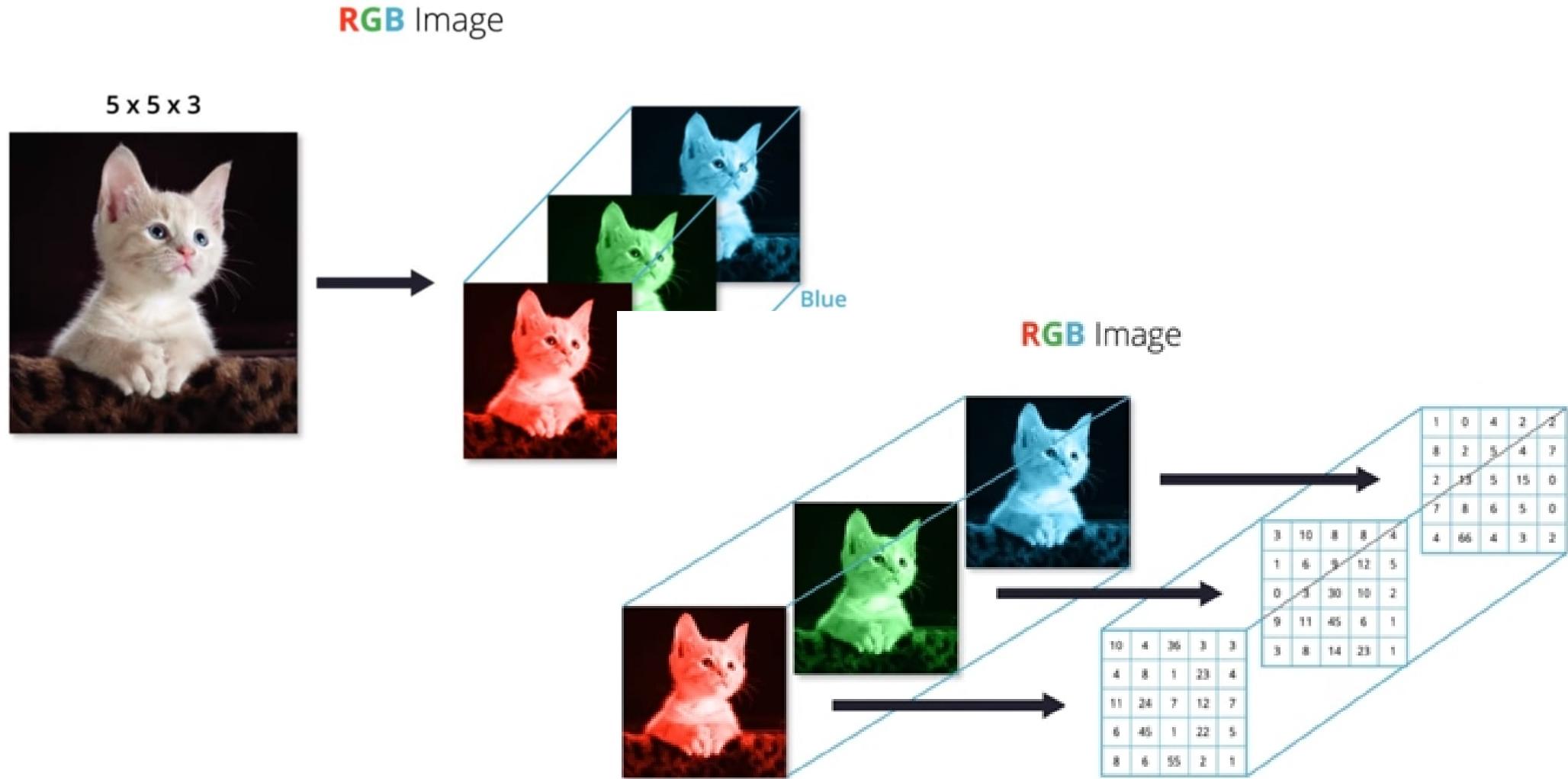


| | | | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 123 | 123 | 123 | 123 | 123 | 123 | 100 | 110 | 120 | 123 |
| 123 | 123 | 123 | 123 | 130 | 120 | 35 | 30 | 100 | 110 |
| 123 | 123 | 123 | 110 | 110 | 100 | 35 | 35 | 225 | 20 |
| 110 | 110 | 110 | 110 | 110 | 110 | 30 | 220 | 40 | 20 |
| 110 | 30 | 120 | 120 | 29 | 123 | 211 | 225 | 40 | 30 |
| 121 | 30 | 30 | 30 | 30 | 28 | 125 | 125 | 221 | 123 |
| 150 | 30 | 30 | 30 | 30 | 111 | 111 | 111 | 123 | 123 |
| 150 | 150 | 123 | 123 | 123 | 150 | 150 | 151 | 143 | 123 |

- Color RGB - 3 Channels
(Red, Green, Blue)Color

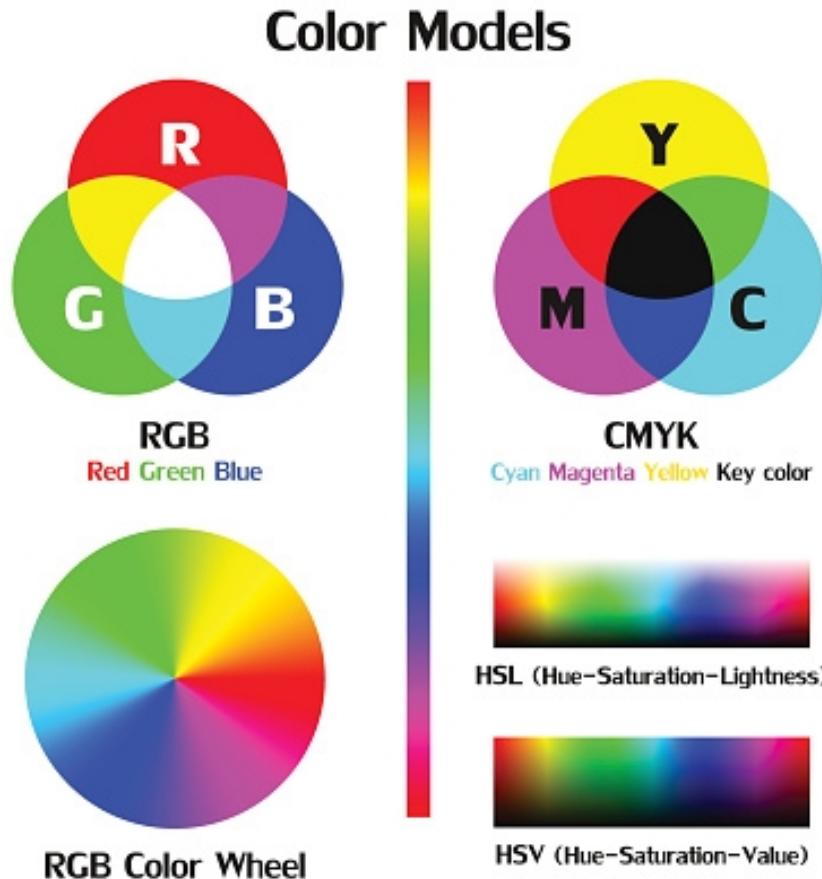


Basic Definitions



Basic Definitions

Others Color Spaces



Practice 01

Let's Code!!

<https://github.com/andrehochuli/teaching/tree/main/ComputerVision>

Lecture 01