

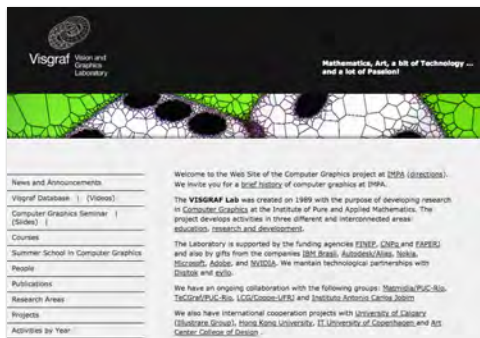
Image Analysis and Synthesis: *New Contexts*

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IMPA

Outline

- Background: the VISGRAF Laboratory
- Basic Concepts: Mathematics for Media
- Computer Vision: Fundamentals and Tools
- *IMPA Virtual Campus*
- Big Data and Deep Learning
- *Project Rio Olympics 2016*

VISGRAF Laboratory

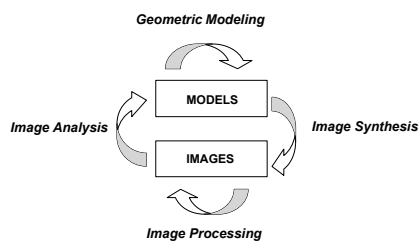


Basic Concepts

- Computational Applied Mathematics
- Media Objects
- Levels of Abstraction
- *The Plenoptic Function*
- Image Models

Integrated View

- Digital Media

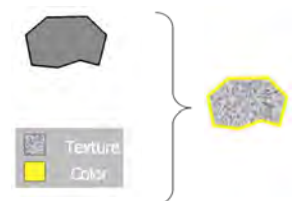


Media Objects

$$o = (U, f)$$

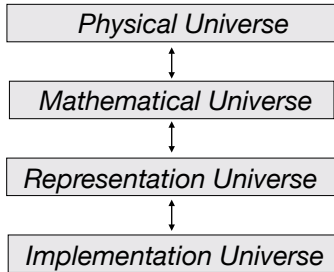
$$f : U \subset \mathbb{R}^m \rightarrow \mathbb{R}^n$$

- Support U
 - Shape / Geometry
- Properties f
 - Attributes /



Levels of Abstraction

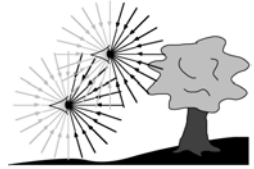
- Paradigm of 4 Universes



Plenoptic Function

Complete description of Visual Information in a 3D environment

- $I_\lambda = P(x, y, z, \theta, \phi, t)$
Holographic Image



- $P : \mathbb{R}^3 \times \mathbb{S}^2 \times \mathbb{R} \mapsto \mathcal{E}$
6D Phase Space

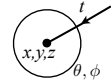
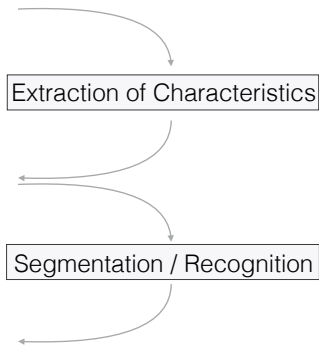


Image Models

- Low Level**
(Raw Image)
 - pixels, etc
- Intermediate Levels**
(Structured Model)
 - edges, texture, etc
- High Level**
(Cognitive Information)
 - regions, objects, etc



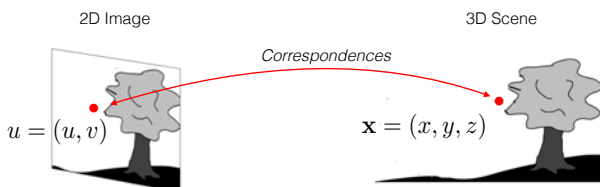
Computer Vision

- Fundamental Equation
- Projective Geometry
- 3D Reconstruction

Fundamentals

- Basic Equation

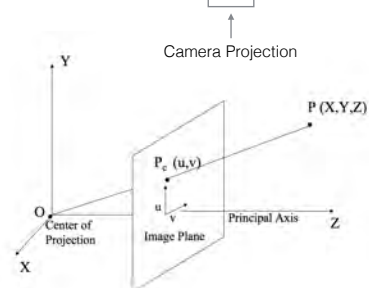
$$u = Px$$



Projective Geometry

- Camera Calibration

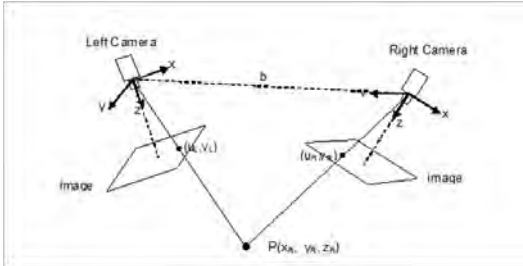
$$u_i = P x_i$$



3D Reconstruction

- Stereo Vision (*triangulation*)

$$u_{ij} = P_j \mathbf{x}_i$$

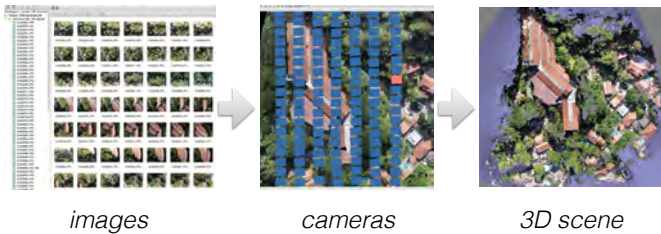


IMPA - Virtual Campus

- From Earth Imagery to 3D Model
- Immersive Holographic Visualisation

Model Creation

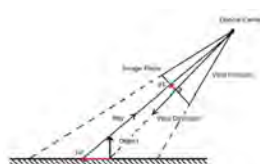
- Reconstruction from Images



Data Survey

Visualization

- Mesa 3D / PlanoVision (*embedded augmented reality*)
 - Stereoscopic Horizontal Oblique Projection
 - Viewpoint Tracking



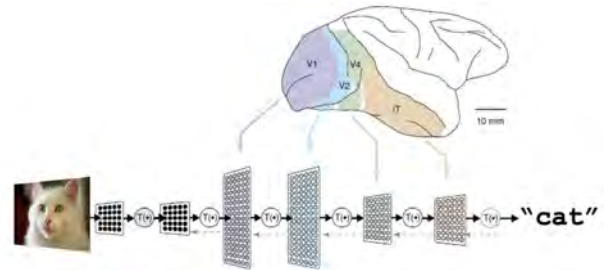
Stereo Visualization

A.I. and Learning

- Deep Neural Networks
- Images and Convolutional Nets
- Supervised Learning

Deep Neural Networks

- Based on what we know about the Brain



Mathematical Framework

- Perceptron
- Neural Nets

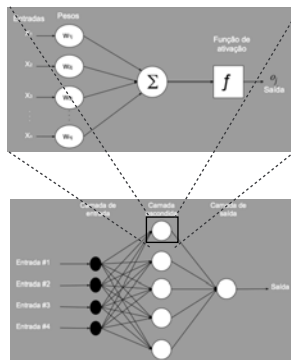
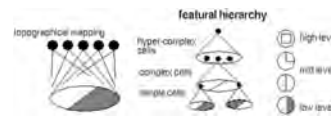
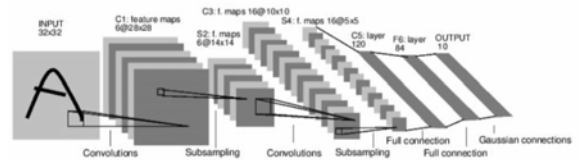


Image Understanding

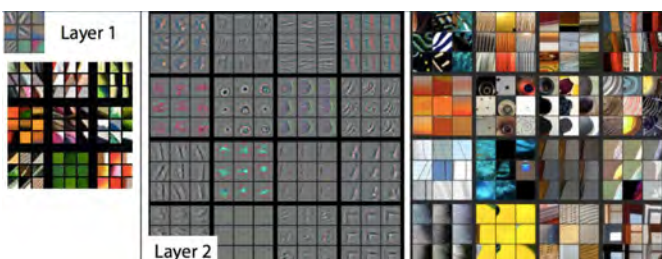
- Convolution Operators



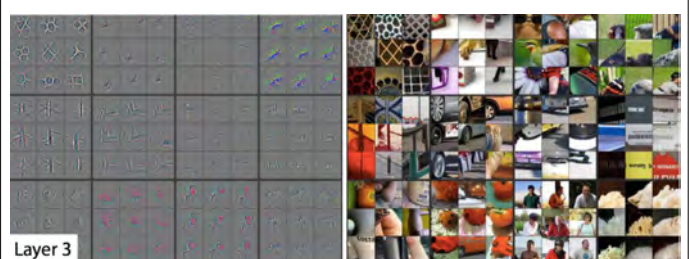
- Convolutional Neural Networks



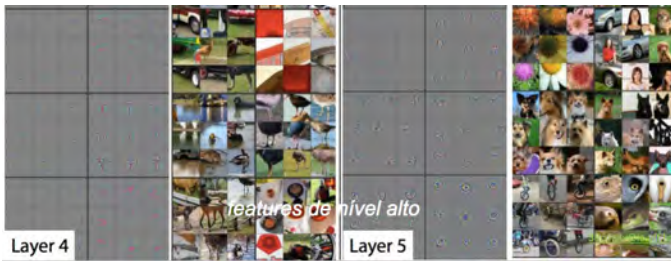
Feature Hierarchy (1,2)



Feature Hierarchy (3)

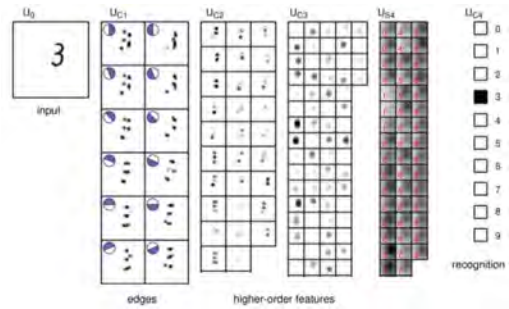


Feature Hierarchy (4)



Supervised Learning

- Image Classification



Rio 2016 Olympics

- Big Data + Deep Learning
- Current Research
- Preliminary Results

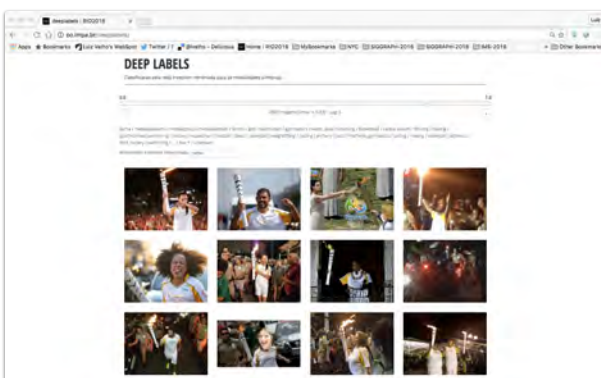
Training for the Games

- Retraining Google Model
 - 30 Olympic Sport Modalities + Torch

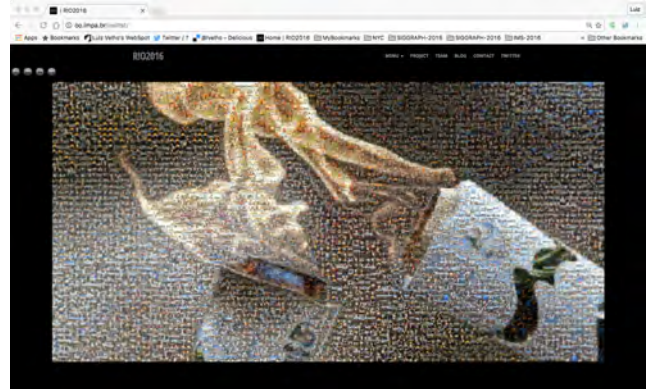
The Inception Architecture (GoogLeNet, 2014)



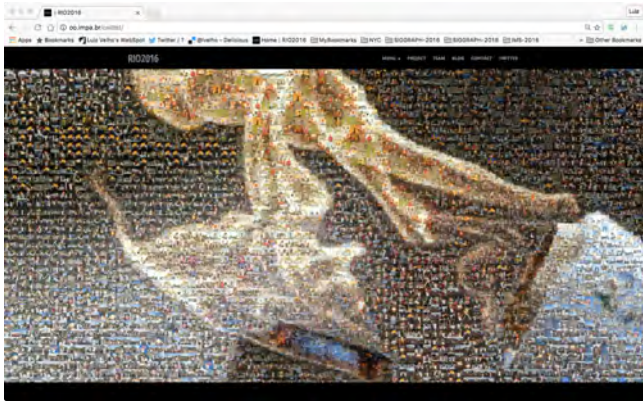
Torch Relay



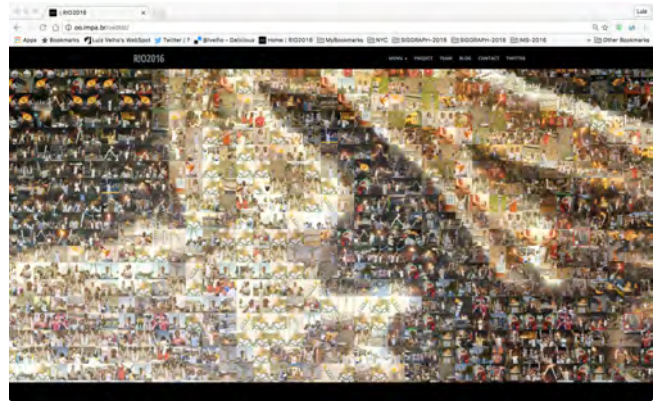
Mosaic of Flames



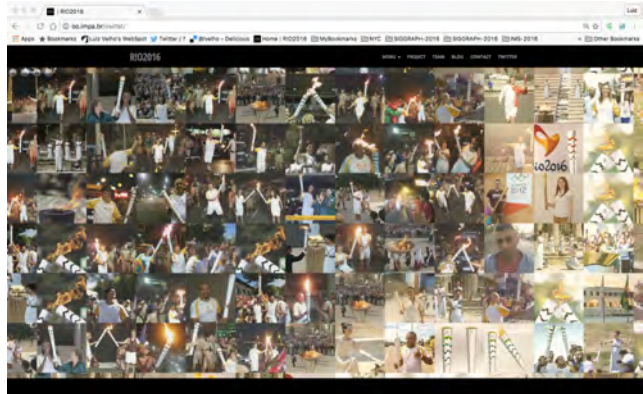
Mosaic of Flames



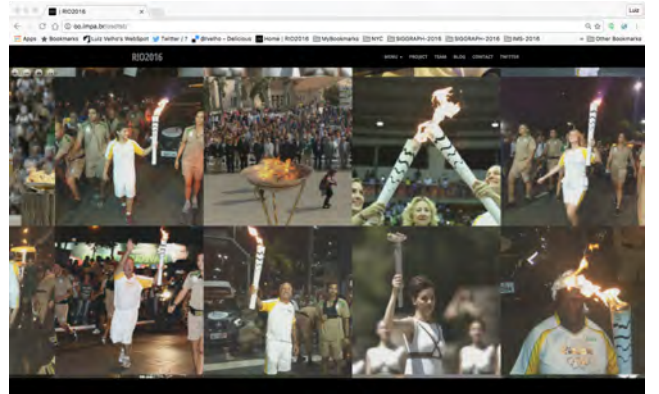
Mosaic of Flames



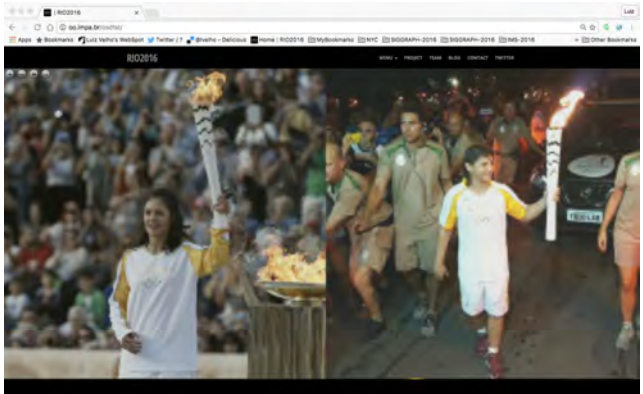
Mosaic of Flames



Mosaic of Flames



Mosaic of Flames



Thank You!