Medical Image Retrieval

Challenges And Successful Approaches

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René Donner
Co-Founder & CTO, rene@contextflow.com

What do Radiologists do?

Metric Learning

contextflow Tech Stack

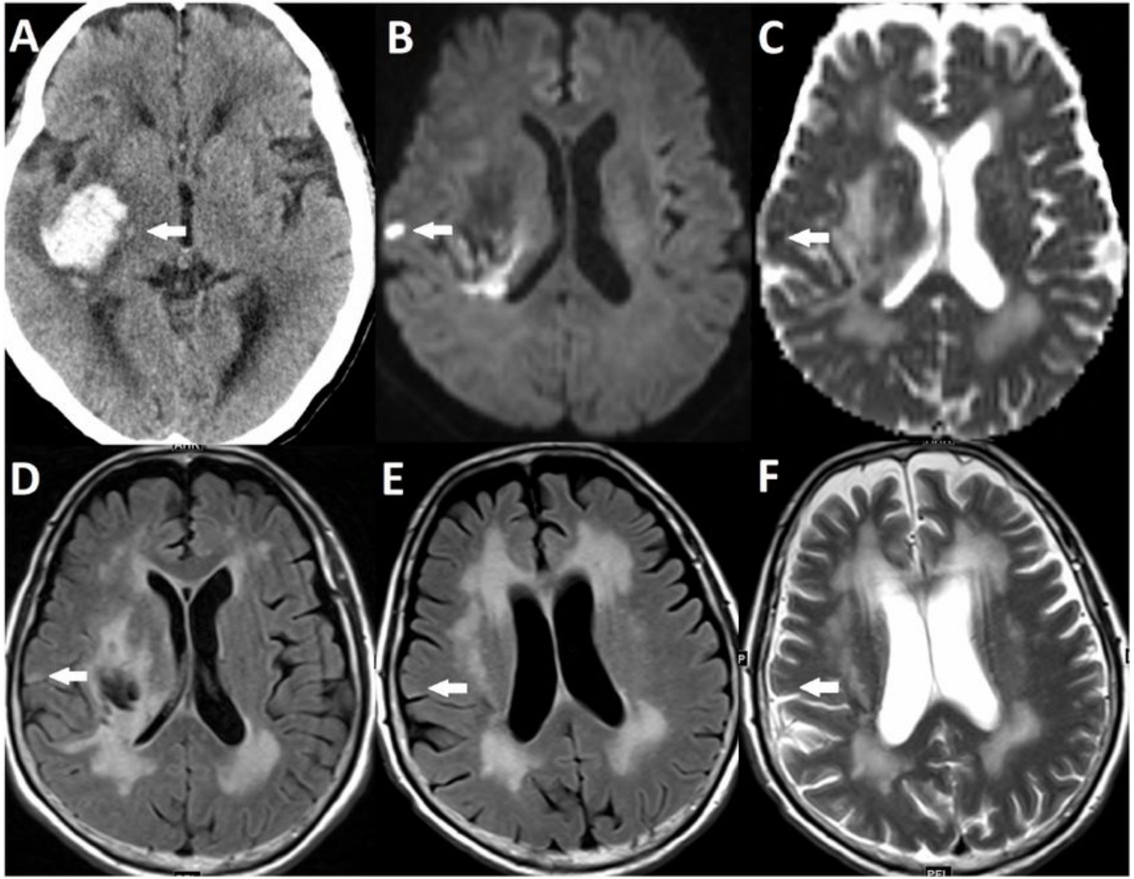
What do radiologists do?

X-Ray / Radiograph

X-Ray / Radiograph

MRI

MRI

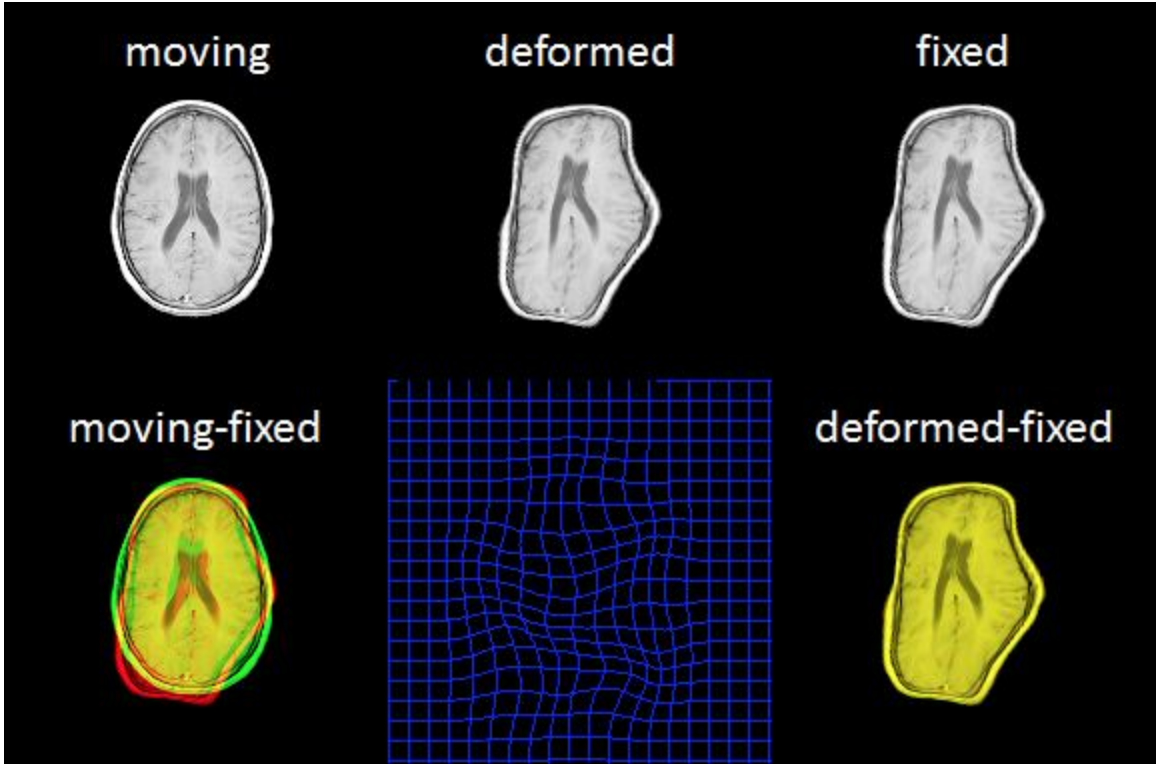


https://www.researchgate.net/figure/Example-of-a-DWI-lesion-not-visible-on-follow-up-MRI-A-CT-showing-ICH-in-right-putamen_fig1_265176457/Publications

CT / Volume Rendering

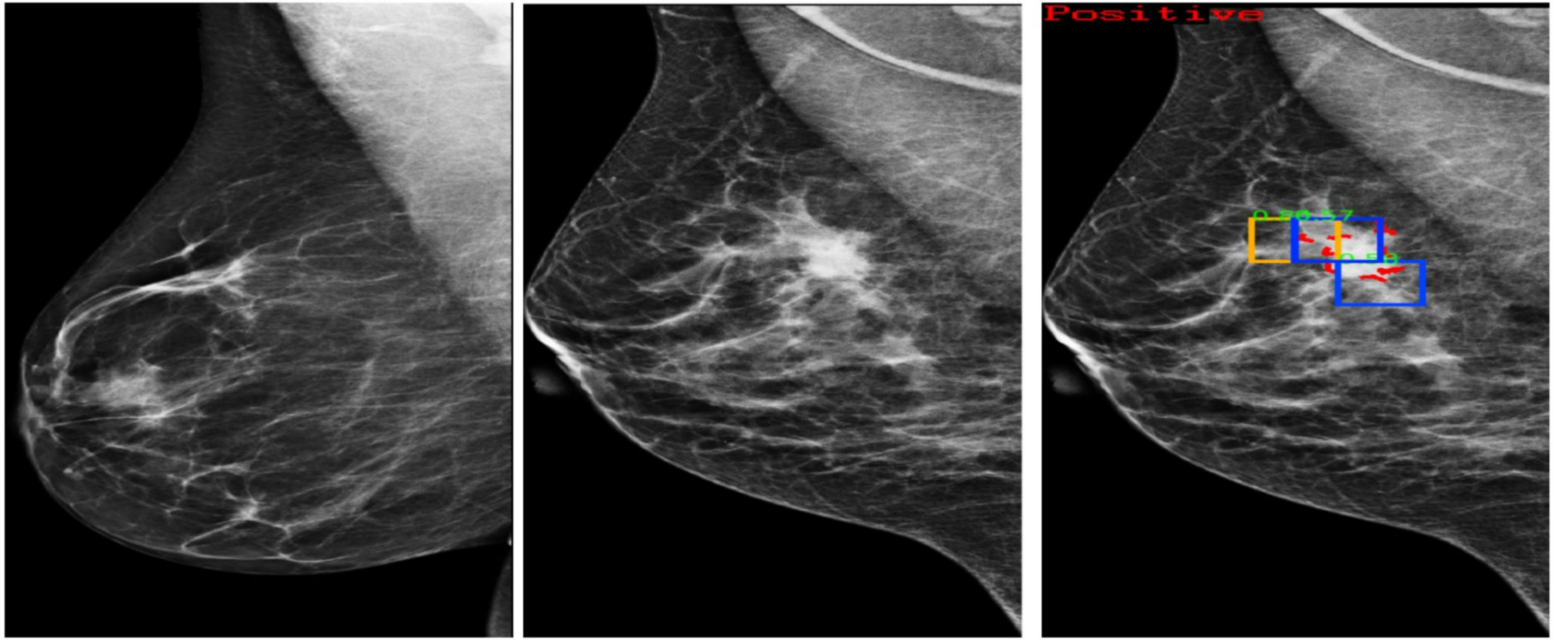
ML/DL Topics in Medical Imaging

Registration



https://www.mathworks.com/matlabcentral/fileexchange/50702-fordanic-image-registration

Classification



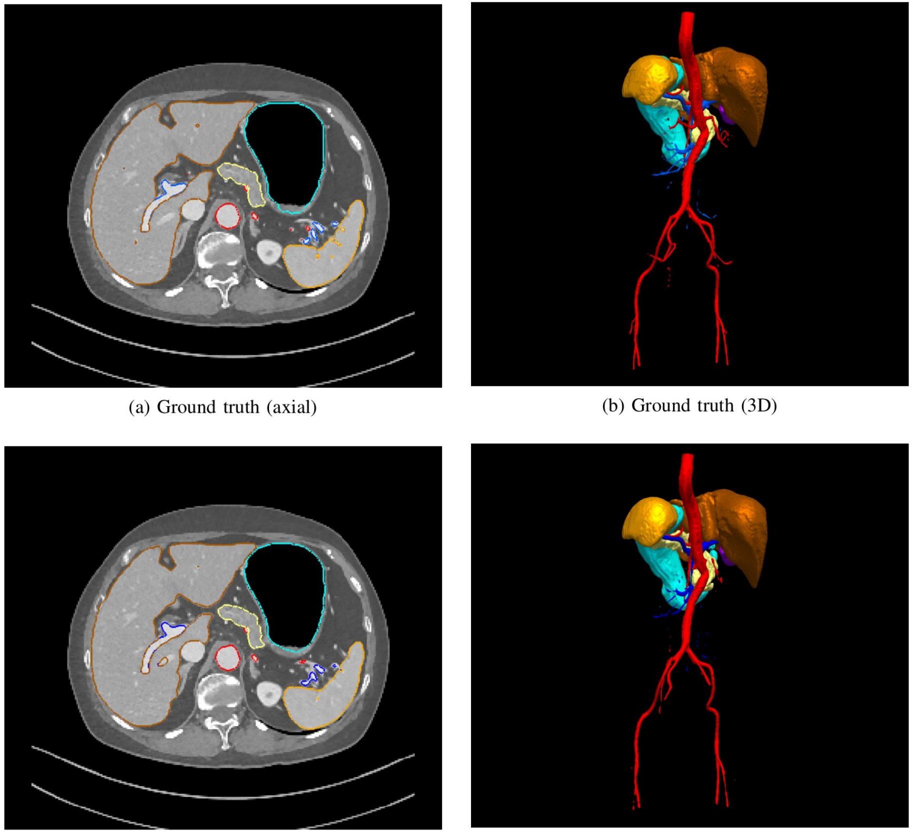
(a) Negative-Normal

(b) Positive-Highly Suspicious as Malignant

(c) Method Result

https://www.cs.bgu.ac.il/~rba/Publications

Semantic Segmentation



(a) Ground truth (axial)
(b) Ground truth (3D)
(c) Segmentation (axial)
(d) Segmentation (3D)

https://arxiv.org/abs/1803.08691

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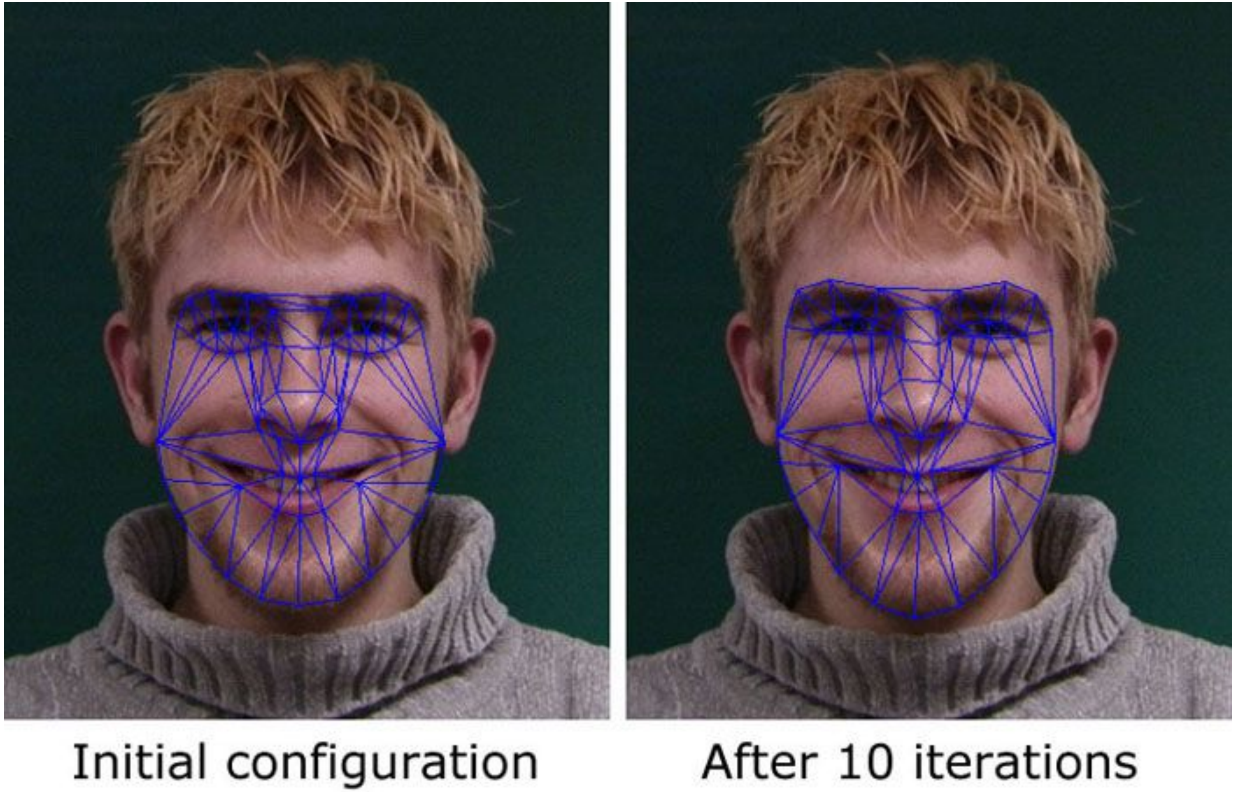
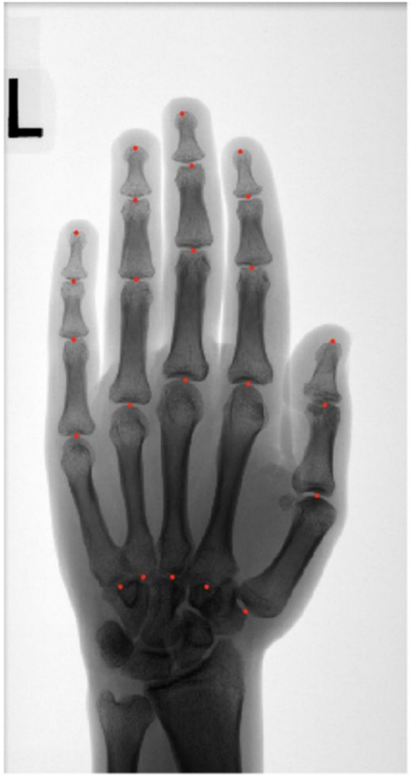
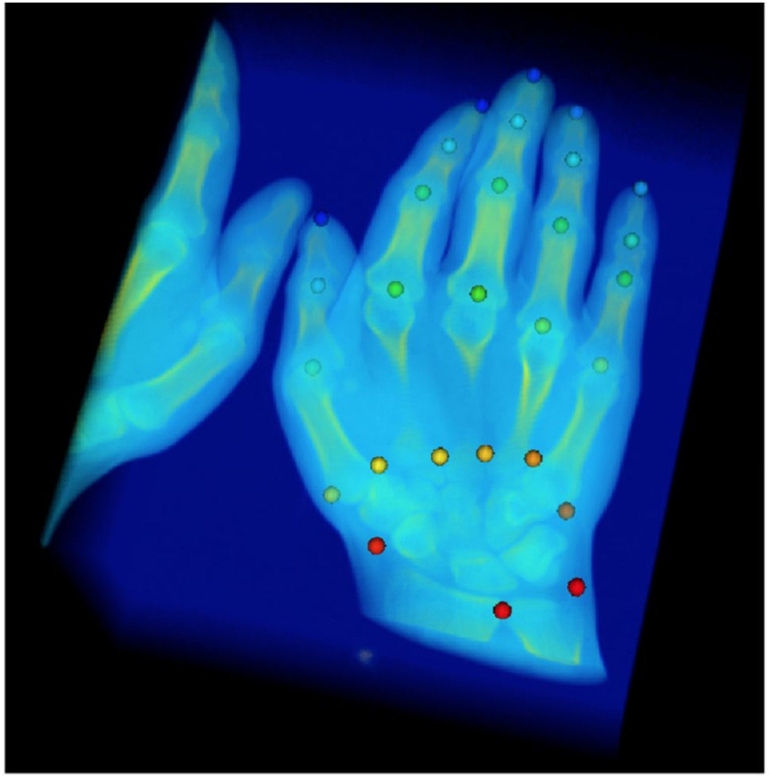
Segmentation

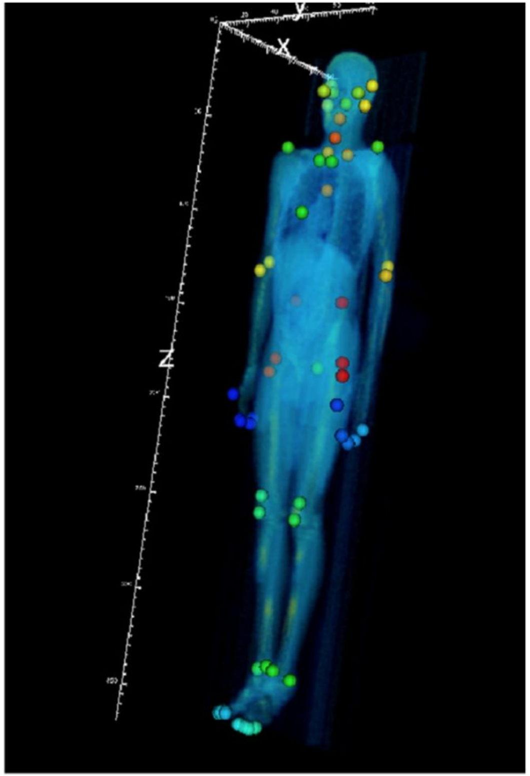


http://codecapsule.com/2010/08/12/active-appearance-models-in-c-plus-plus/

Localization







Localization

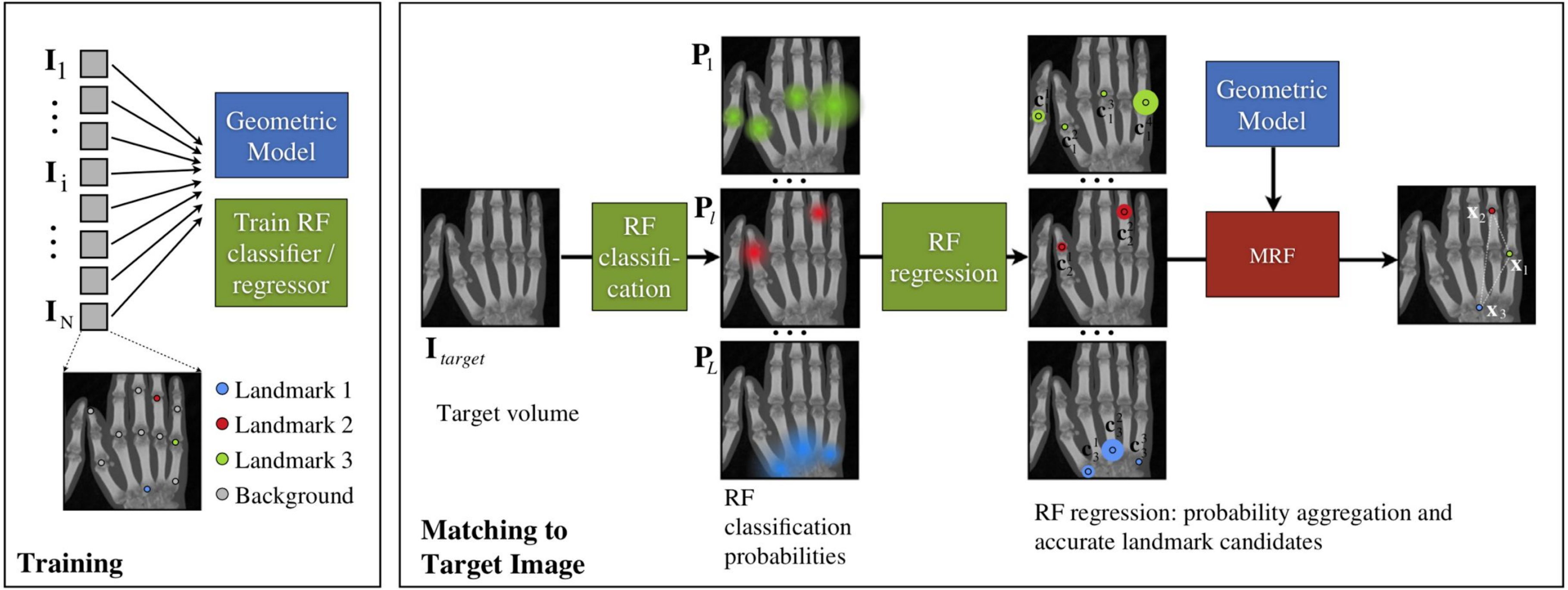


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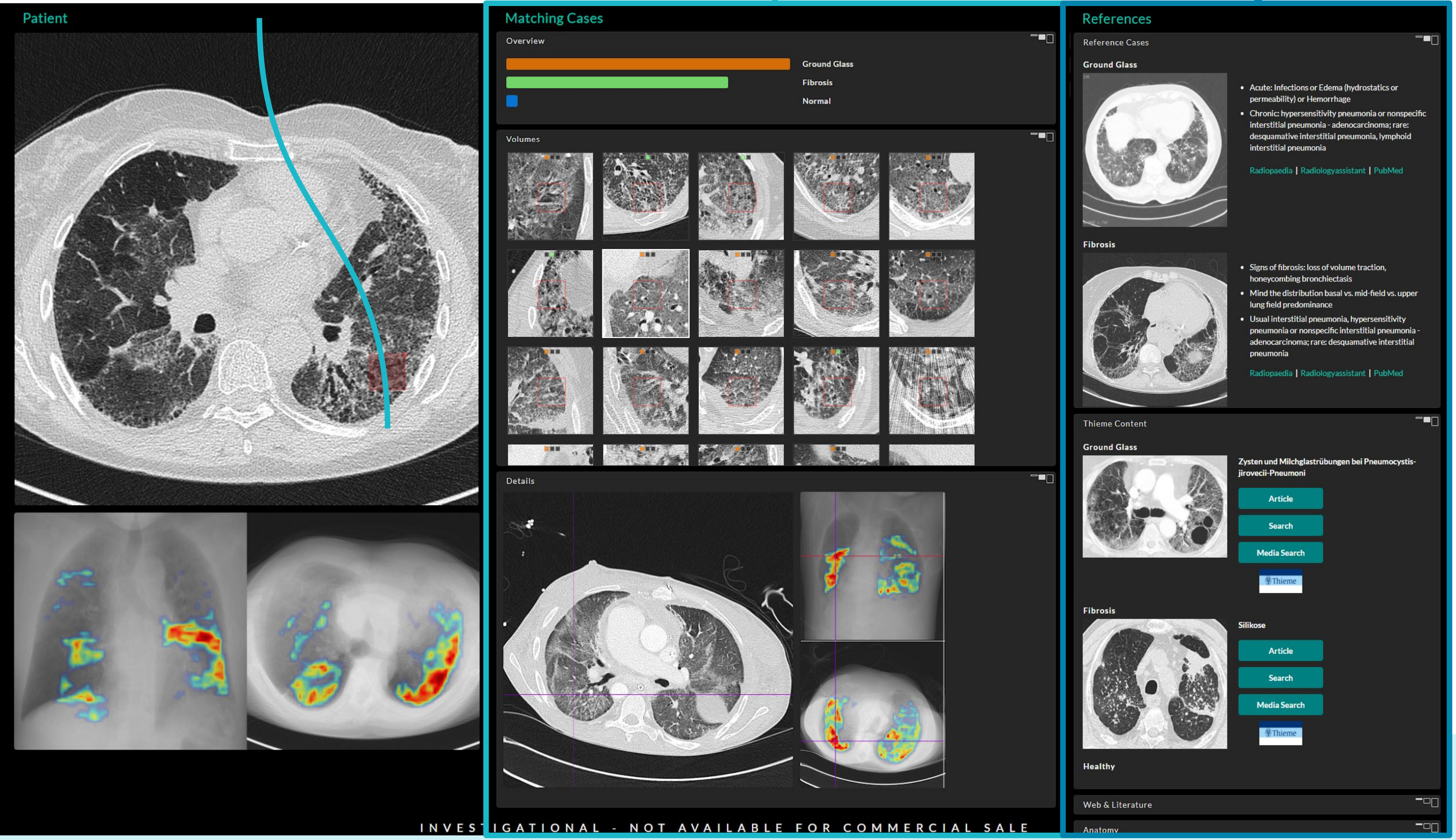
Image Retrieval

Mark region of interest

Find matching cases

See relevant references



Statistics on findings

Reference cases with bullet point information

Publications and anatomical drawings

Professional Reference Content

Challenges

What it is a “similar” image?

What it is a “similar” image?

Many TBs of medical images

What it is a “similar” image?

Many TBs of medical images

Quick indexing / instant retrieval

Architecture Overview

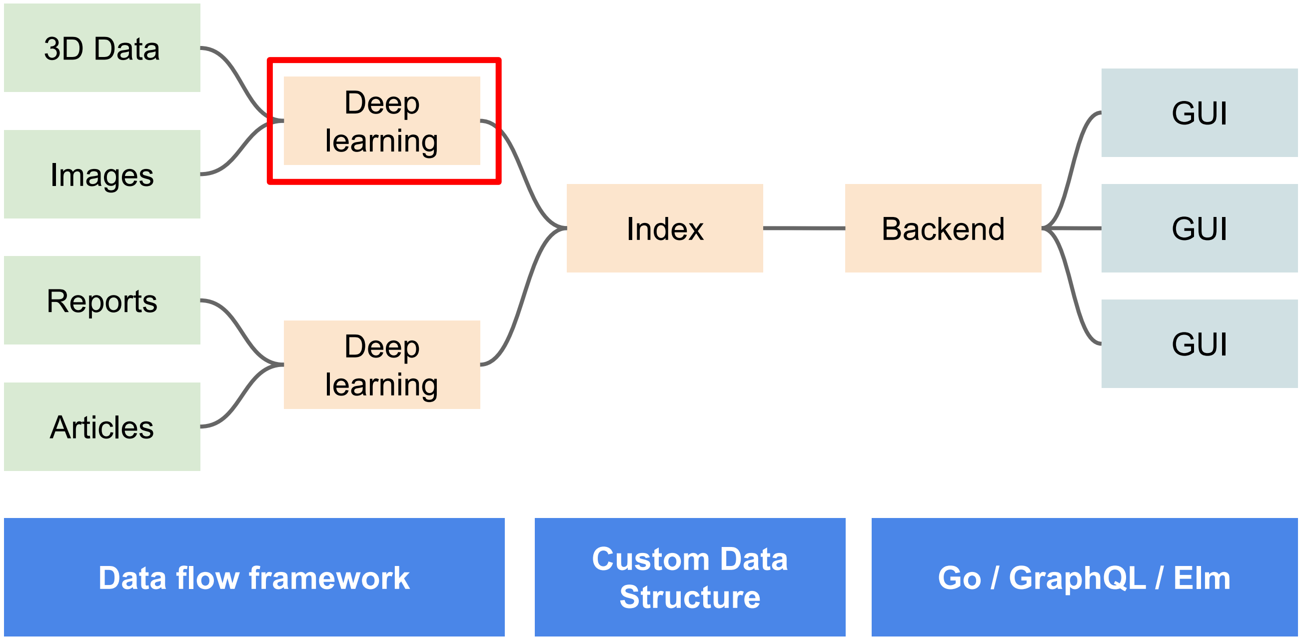
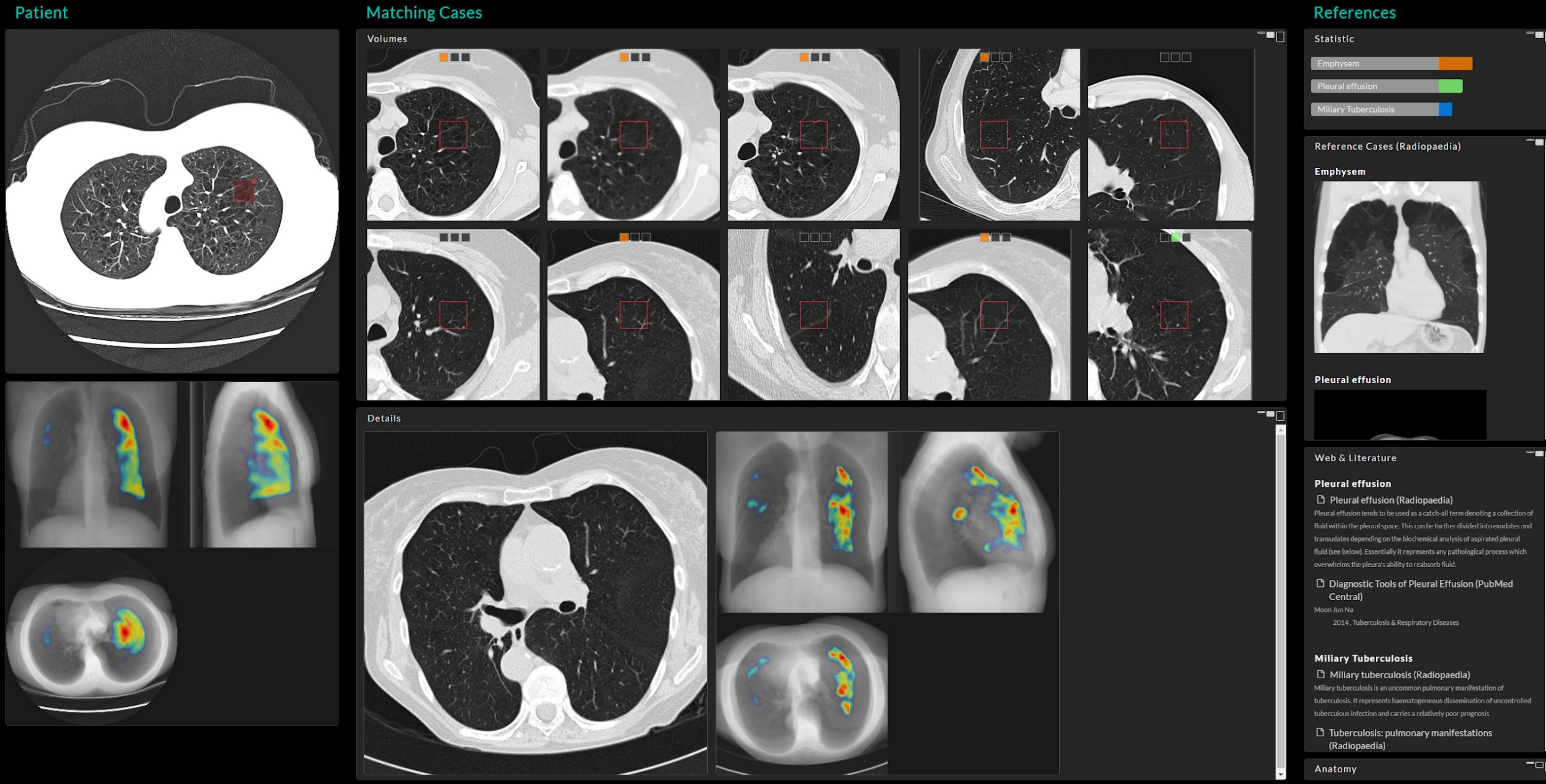


Image Retrieval



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Deep learning vs classical machine learning

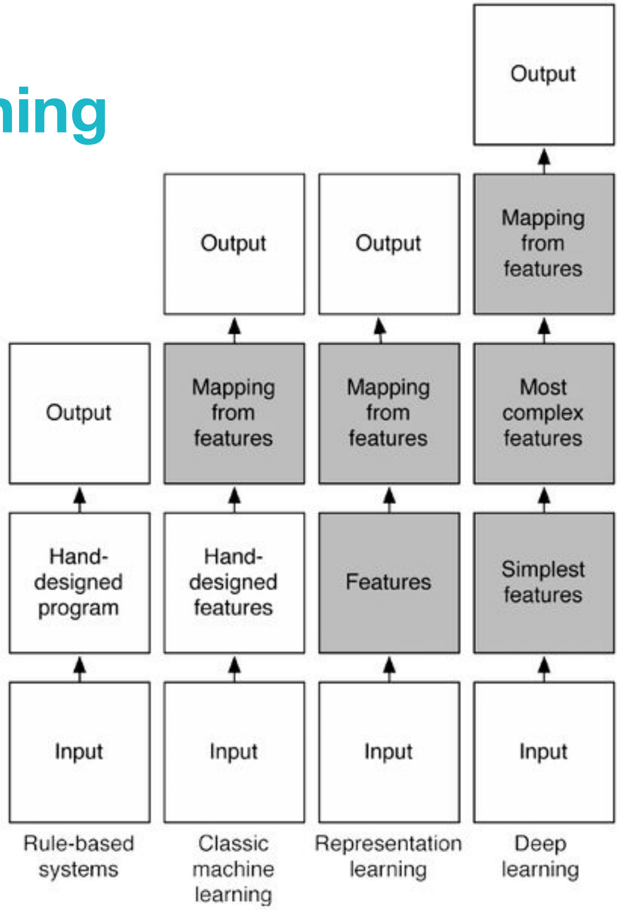

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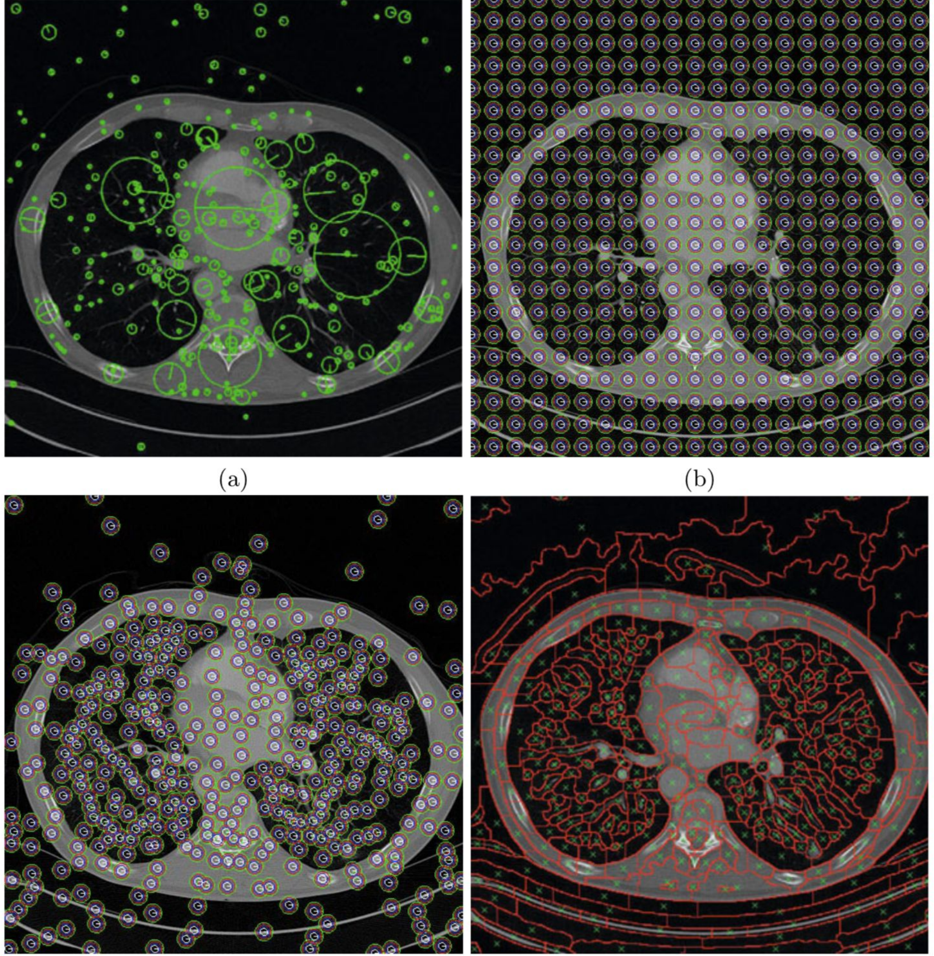
Image Retrieval before DL

Superpixel-Based Interest Points for Effective Bags of Visual Words Medical Image Retrieval

Sebastian Haas[1,⋆], René Donner[1], Andreas Burner[1], Markus Holzer[1], and Georg Langs[1,2]

[1] Computational Image Analysis and Radiology Lab, Department of Radiology, Medical University of Vienna, Austria
sebastian.haas@meduniwien.ac.at
[2] Computer Science and Artificial Intelligence Laboratory, Massachusetts Institute of Technology, Cambridge, MA, USA



(a) (b) (c) (d)

Fig. 2. An example lung image showing interest point position, orientation and scale for a) SIFT b) DENSE c) superpixel d) shows the the superpixel regions as well as the

Image Retrieval before DL

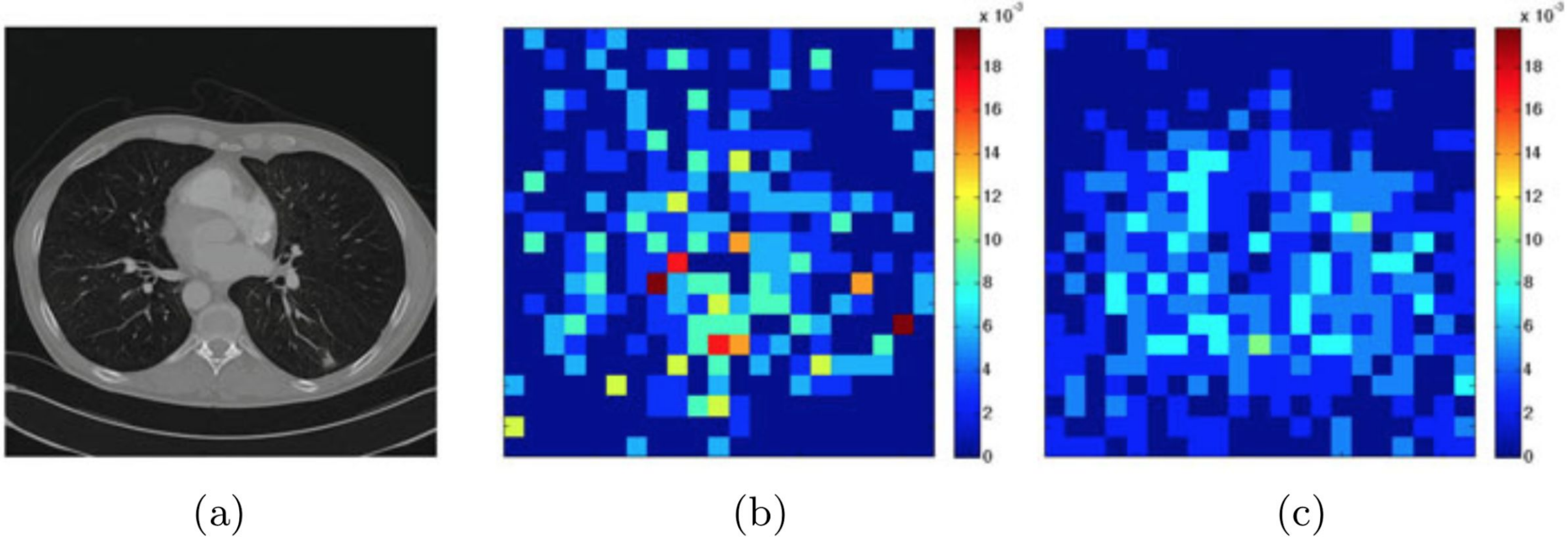


Fig. 3. Based on the image shown in a) the distribution of the SIFT and superpixel interest points are shown in b) and c), respectively. The number of interest points per type are normalized to obtain comparable heat maps. Note the more even and more concentrated distribution in the area of the medical object of interest.

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Image Retrieval before DL

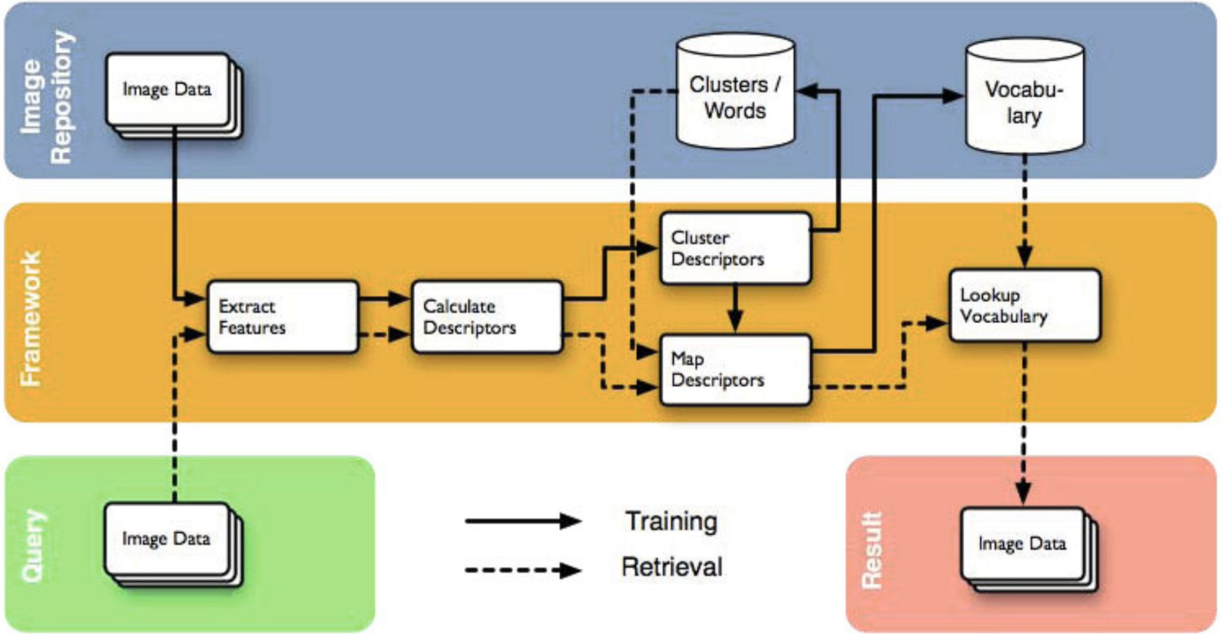
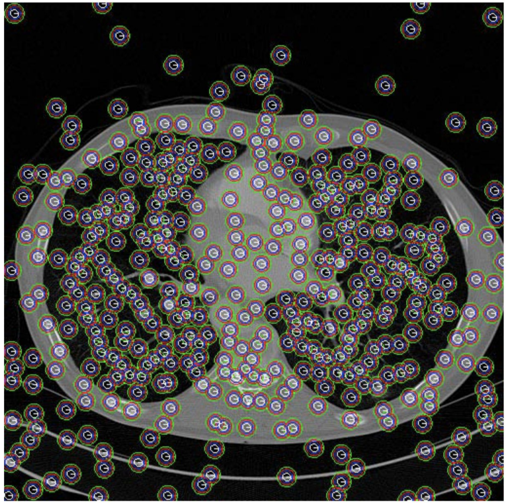


Fig. 1. Schematic overview of the Bag of Visual Words framework



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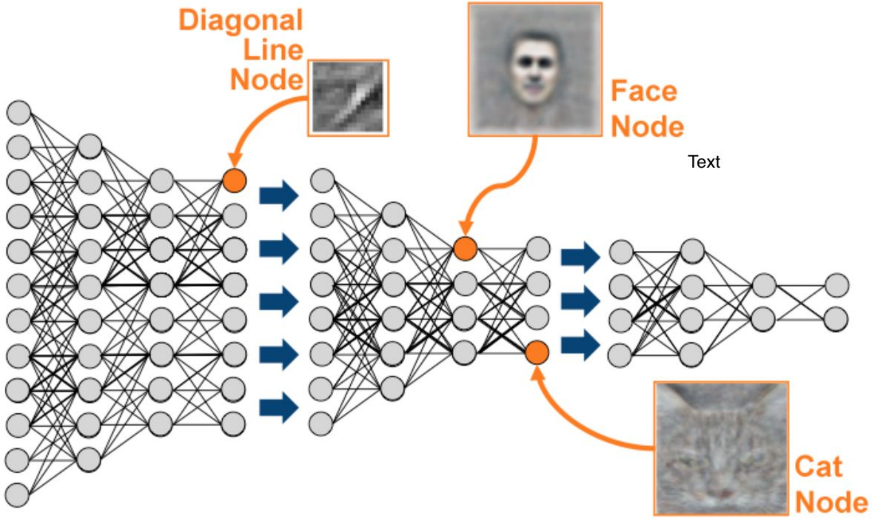
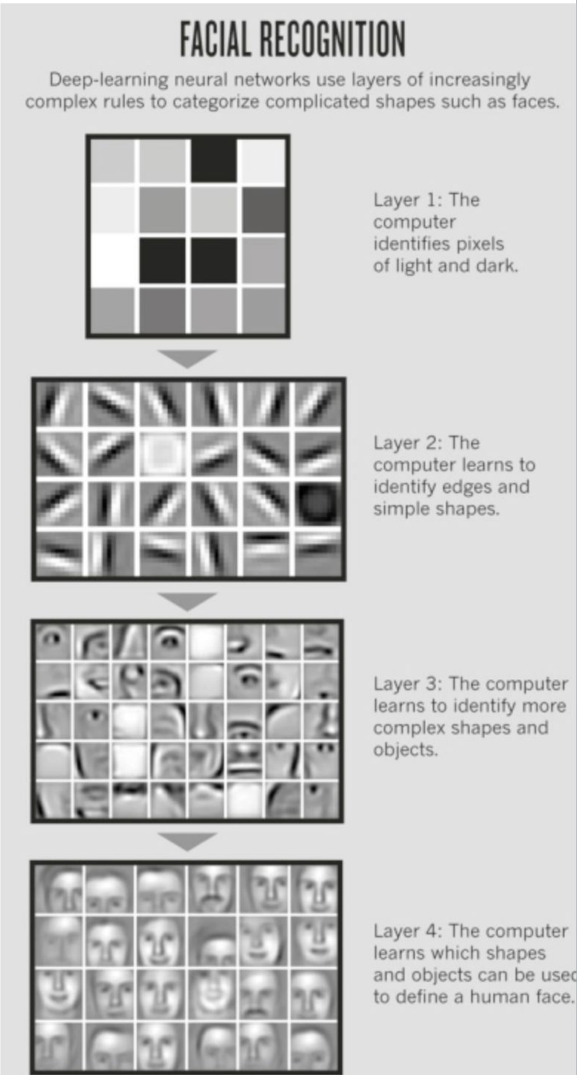
Deep Learning Approach



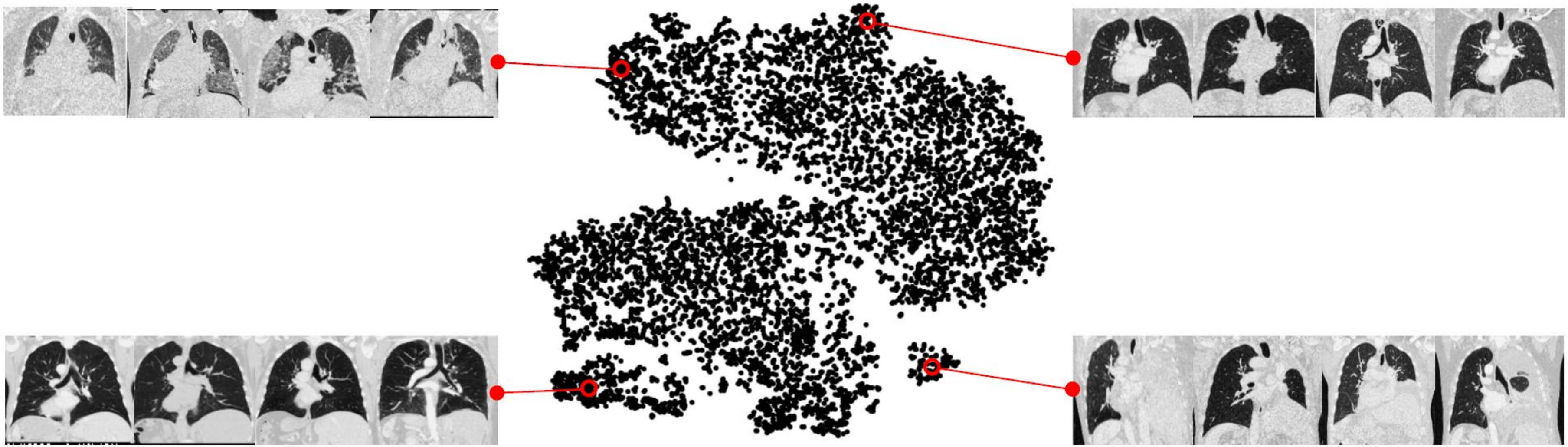
Text



http://theanalyticsstore.ie/deep-learning/

http://stats.stackexchange.com/questions/114385/what-is-the-difference-between-convolutional-neural-networks-restricted-boltzma

Medical Embeddings



Hofmanninger, MICCAI
2016

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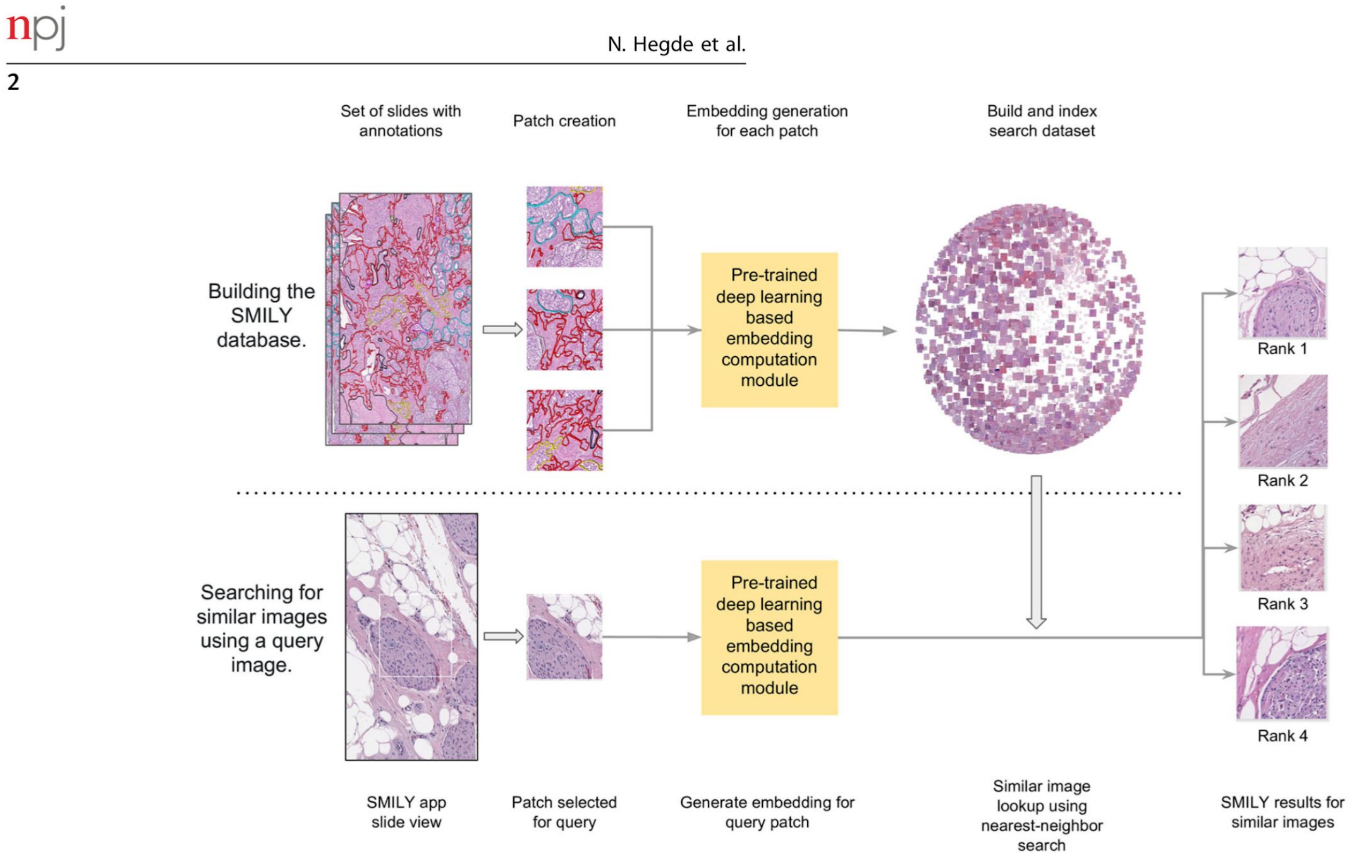
Image Retrieval

ARTICLE OPEN

Similar image search for histopathology: SMILY

Narayan Hegde[1], Jason D. Hipp[1], Yun Liu[1], Michael Emmert-Buck[2], Emily Reif[1], Daniel Smilkov[1], Michael Terry[1], Carrie J. Cai[1], Mahul B. Amin[3], Craig H. Mermel[1], Phil Q. Nelson[1], Lily H. Peng[1], Greg S. Corrado[1] and Martin C. Stumpe[1,4]



Metric Learning

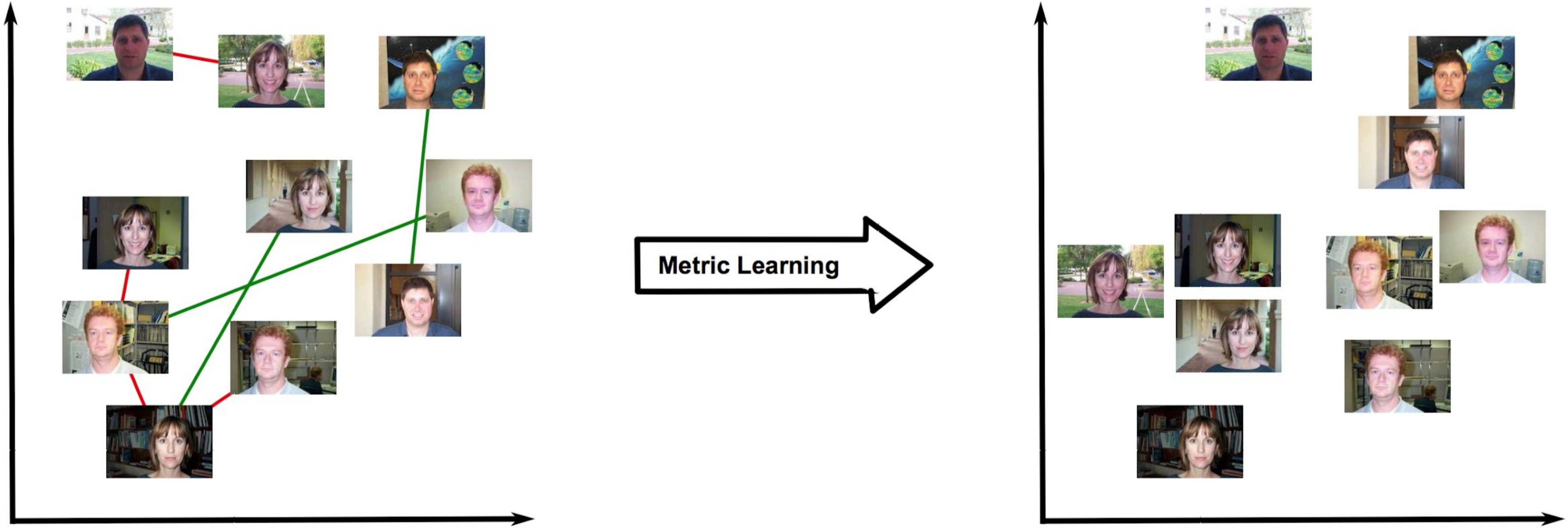
Metric Learning, distance learning, similarity learning

Classification, regression: CNNs, RNNs

Generative Adversarial Networks (GANs)

Clustering, recommender systems, retrieval …?

Metric Learning



https://arxiv.org/abs/1306.6709v4

Siamese Networks

Signature Verification using a "Siamese" Time Delay Neural Network

Jane Bromley, Isabelle Guyon, Yann LeCun, Eduard Säckinger and Roopak Shah
AT&T Bell Laboratories
Holmdel, NJ 07733
jbromley@big.att.com

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Siamese Networks

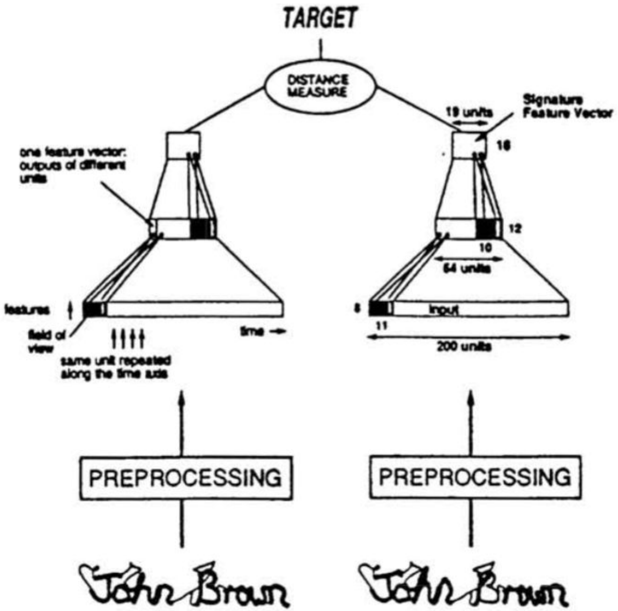

Figure 1: Architecture 1 consists of two identical time delay neural networks. Each network has an input of 8 by 200 units, first layer of 12 by 64 units with receptive fields for each unit being 8 by 11 and a second layer of 16 by 19 units with receptive fields 12 by 10.

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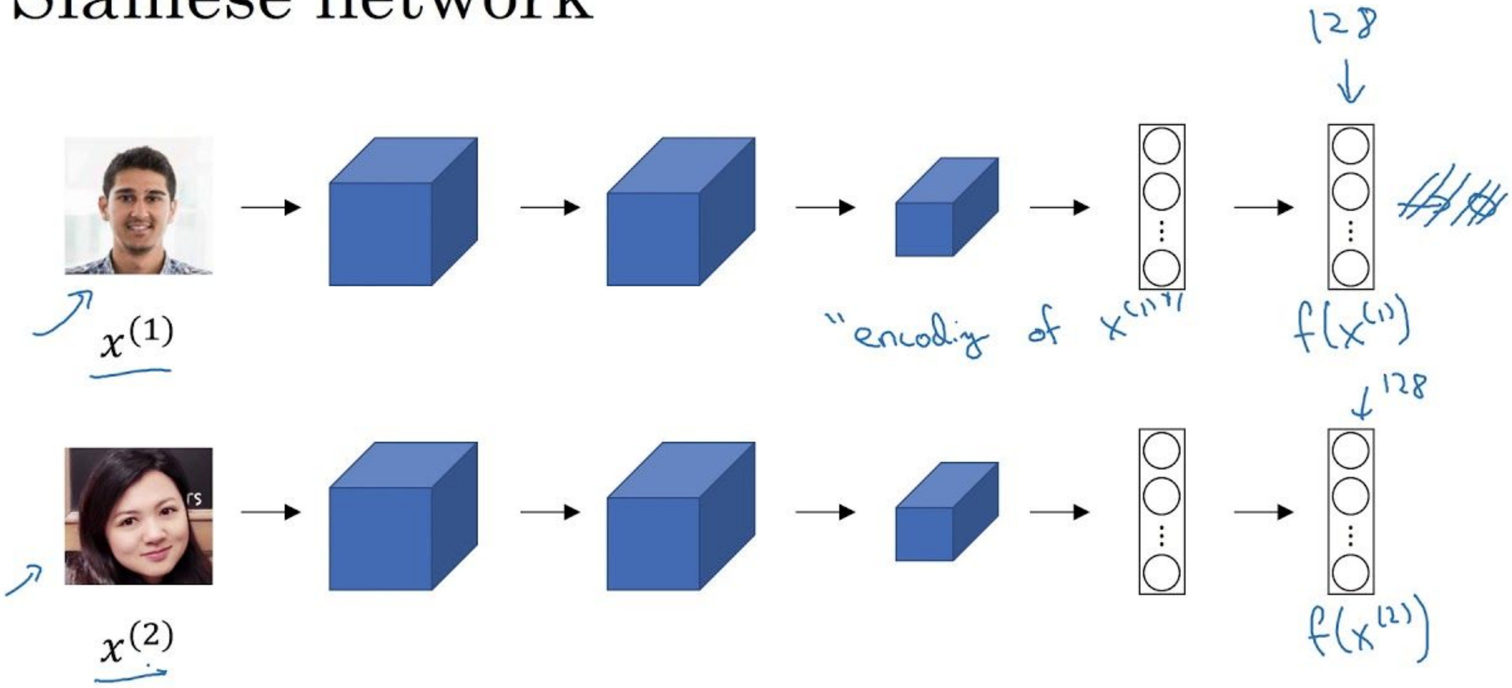
Siamese network



[Taigman et. al., 2014. DeepFace closing the gap to human level performance]

Andrew Ng

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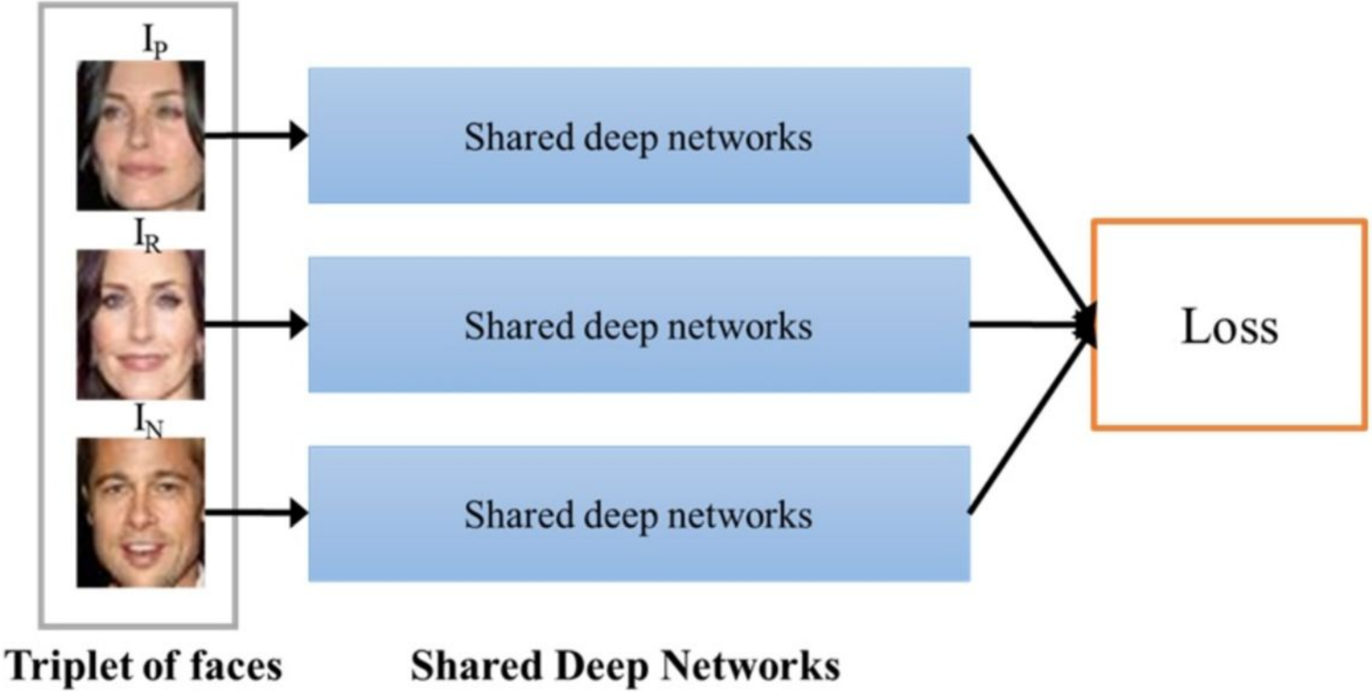
Triplet Networks



https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7844934

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Triplet Networks

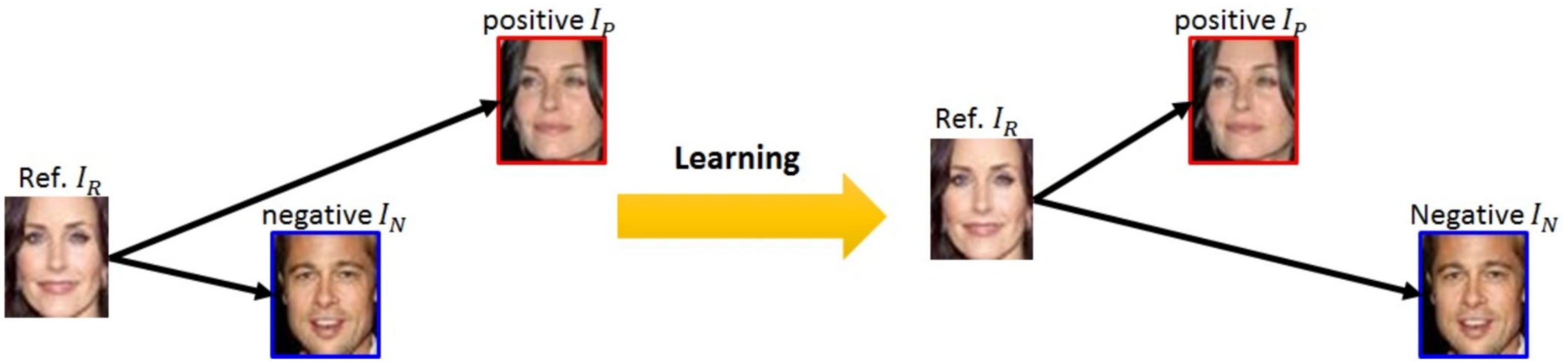
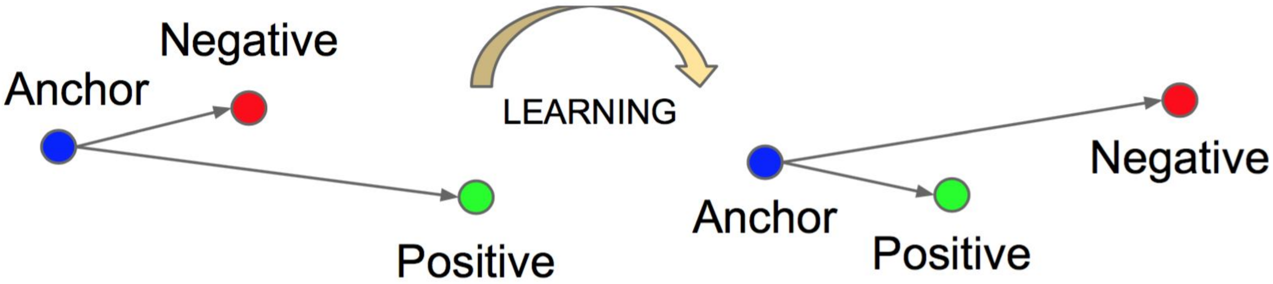


Fig. 3. The triplet loss minimize the distance between the given face image I_R and the positive face image I_P both of which have the same identity and maximize the distance between the given face image I_R and the negative face image I_N of the different identity.

https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7844934

Triplet Networks - Hinge Loss

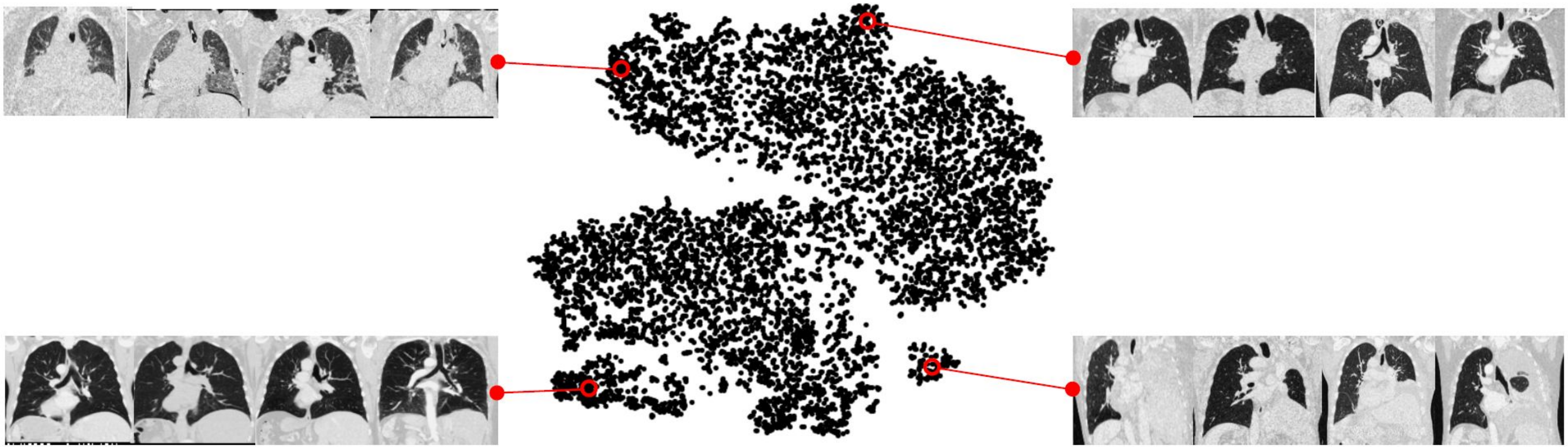


$$\sum_{i}^{N} \left[\| f(x_i^a) - f(x_i^p) \|_2^2 - \| f(x_i^a) - f(x_i^n) \|_2^2 + \alpha \right]_+$$

Metric Learning

https://arxiv.org/abs/1712.05055v1

Medical Embeddings

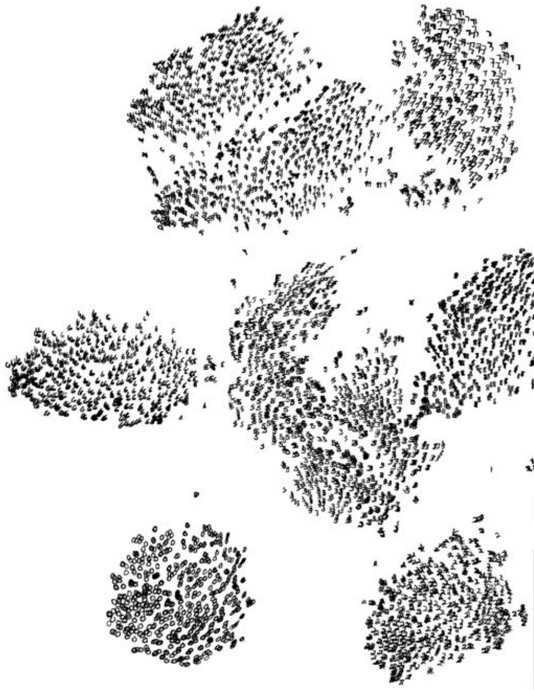


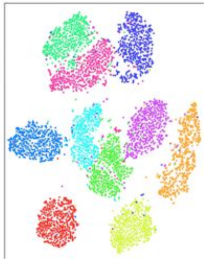
Hofmanninger, MICCAI 2016

Metric Learning - difference to dimensionality reduction

PCA

Kernel PCA

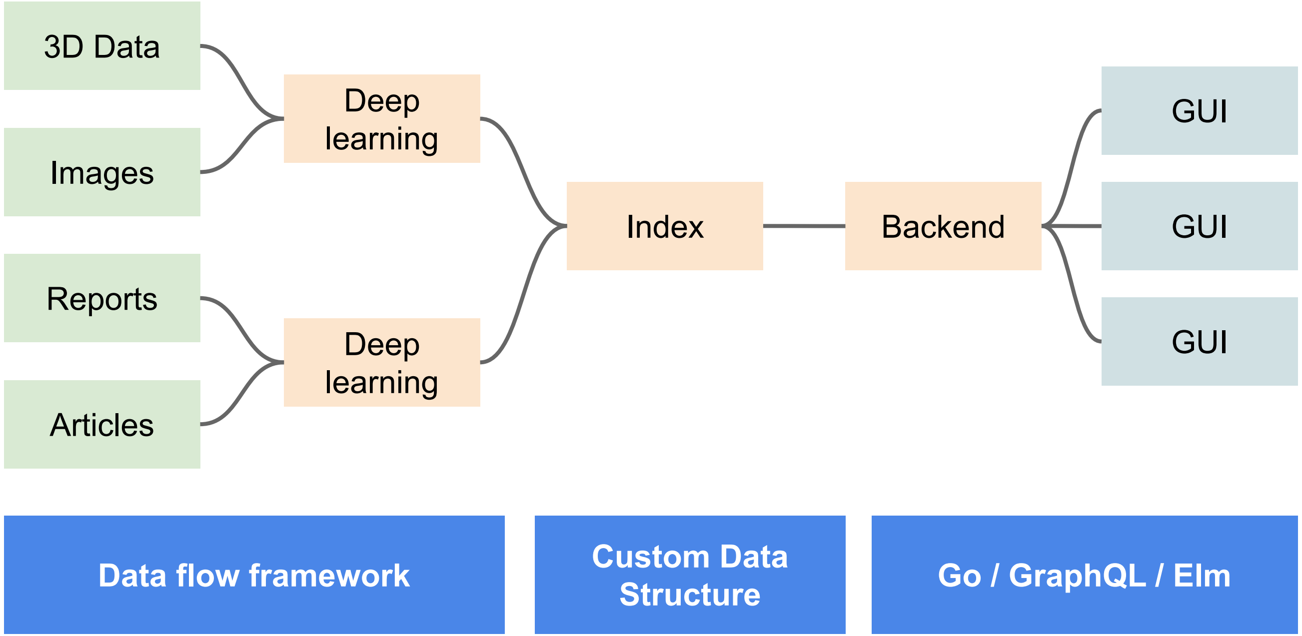




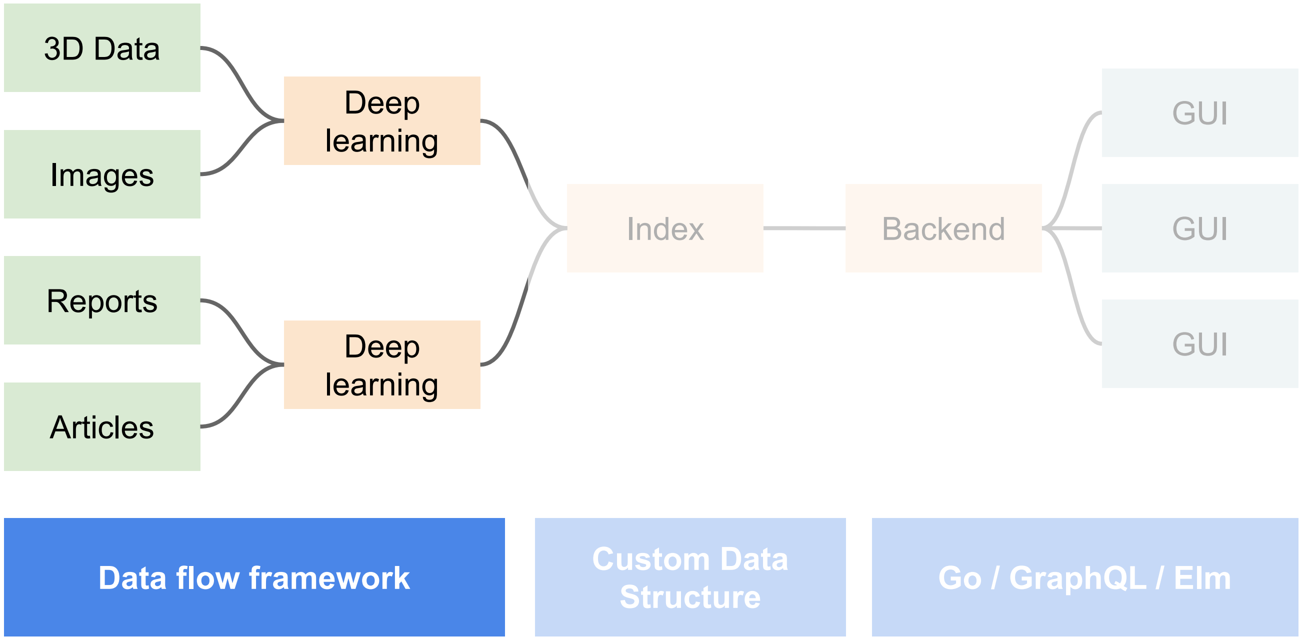
t-SNE

Tech Stack

Overview


3D Data
Images
Reports
Articles
Deep learning
Deep learning
Index
Backend
GUI
GUI
GUI
Data flow framework
Custom Data Structure
Go / GraphQL / Elm

Data flow framework



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Data Flow Framework

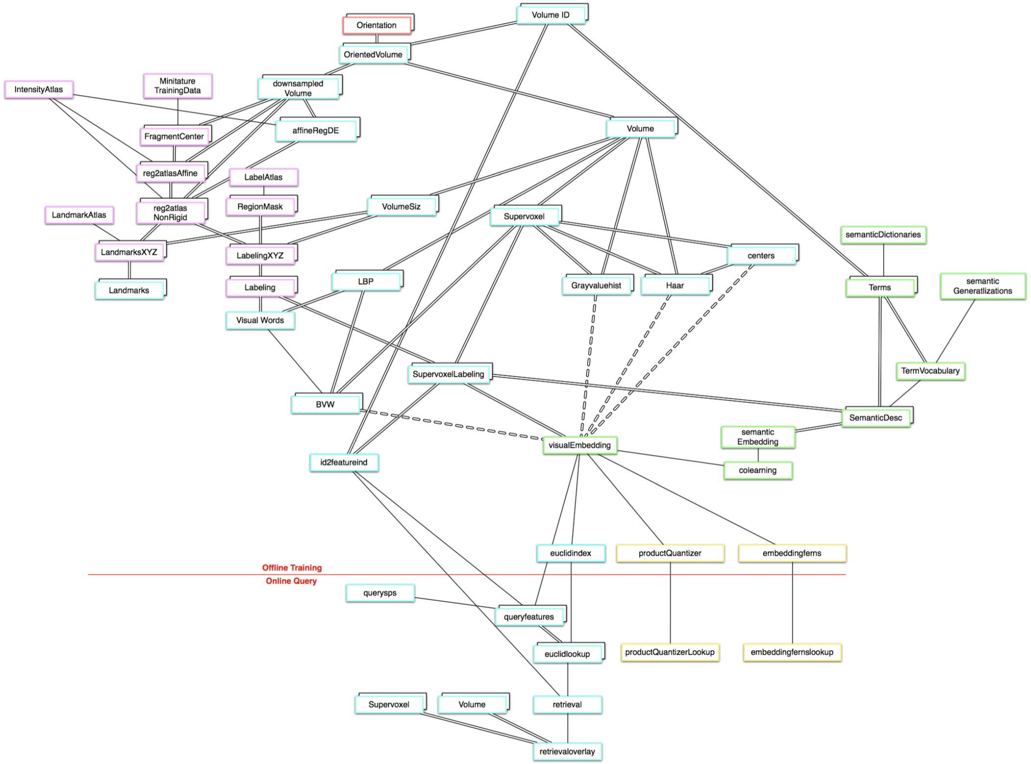
Scheduling

dependencies drive computation

Storage

no explicit state

Focus on algorithms



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Julia Programming Language

Easy to code

Like Python / Matlab

Focus on numerical computing and HPC

Fast

Like C. JIT compiled.

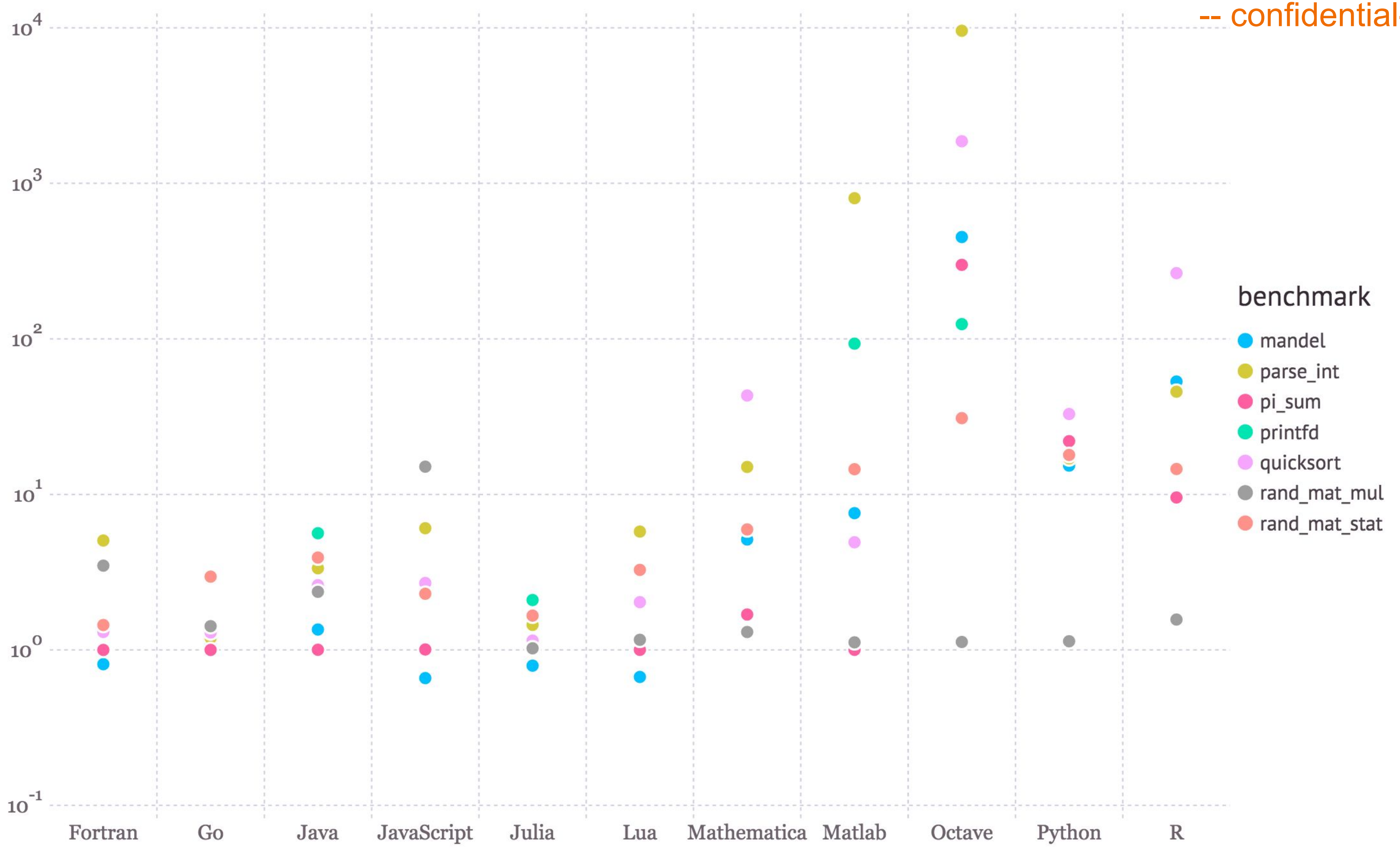
Easy parallelization, control over memory layout

Deep learning

Tensorflow, MXNet, Knet

CUDA, CuDNN

Julia



10^4
10^3
10^2
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Fortran
Go
Java
JavaScript
Julia
Lua
Mathematica
Matlab
Octave
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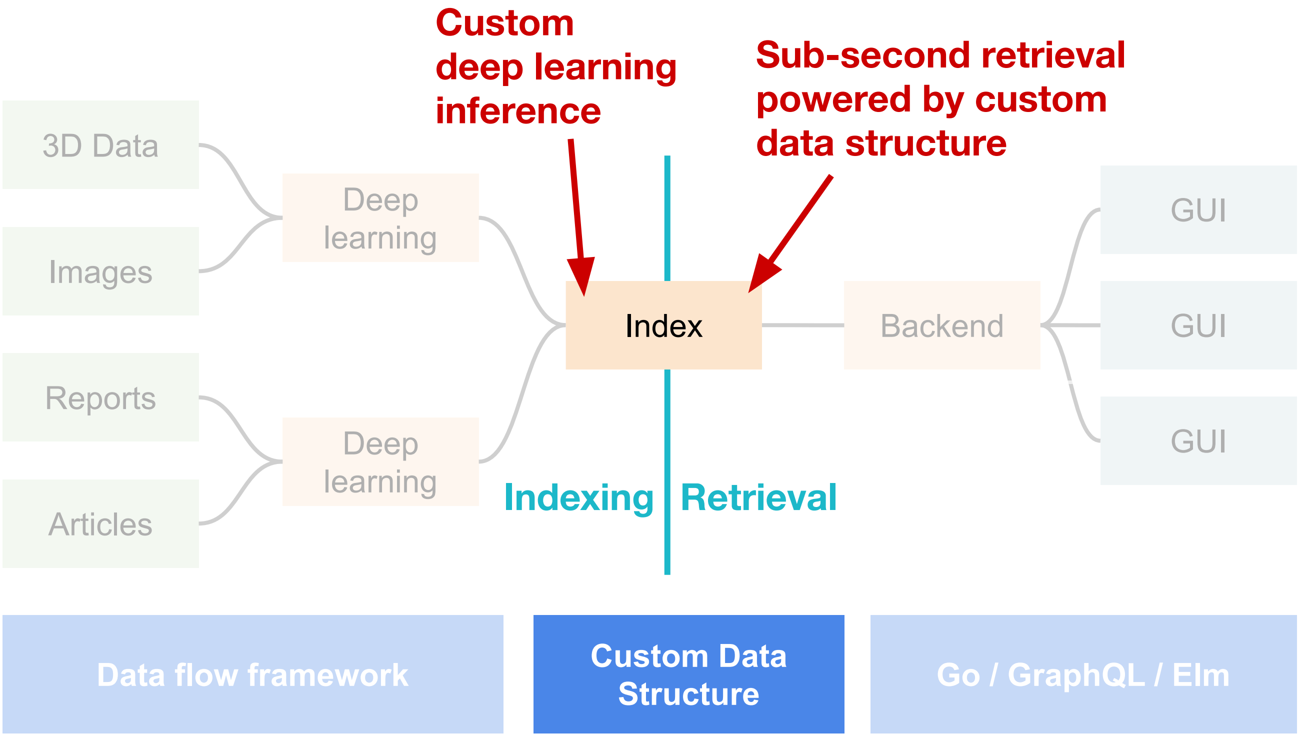
printfd
quicksort
rand_mat_mul
rand_mat_stat

Speed


Custom
deep learning
inference
Sub-second retrieval
powered by custom
data structure
3D Data
Images
Reports
Articles
Deep
learning
Deep
learning
Index
Backend
GUI
GUI
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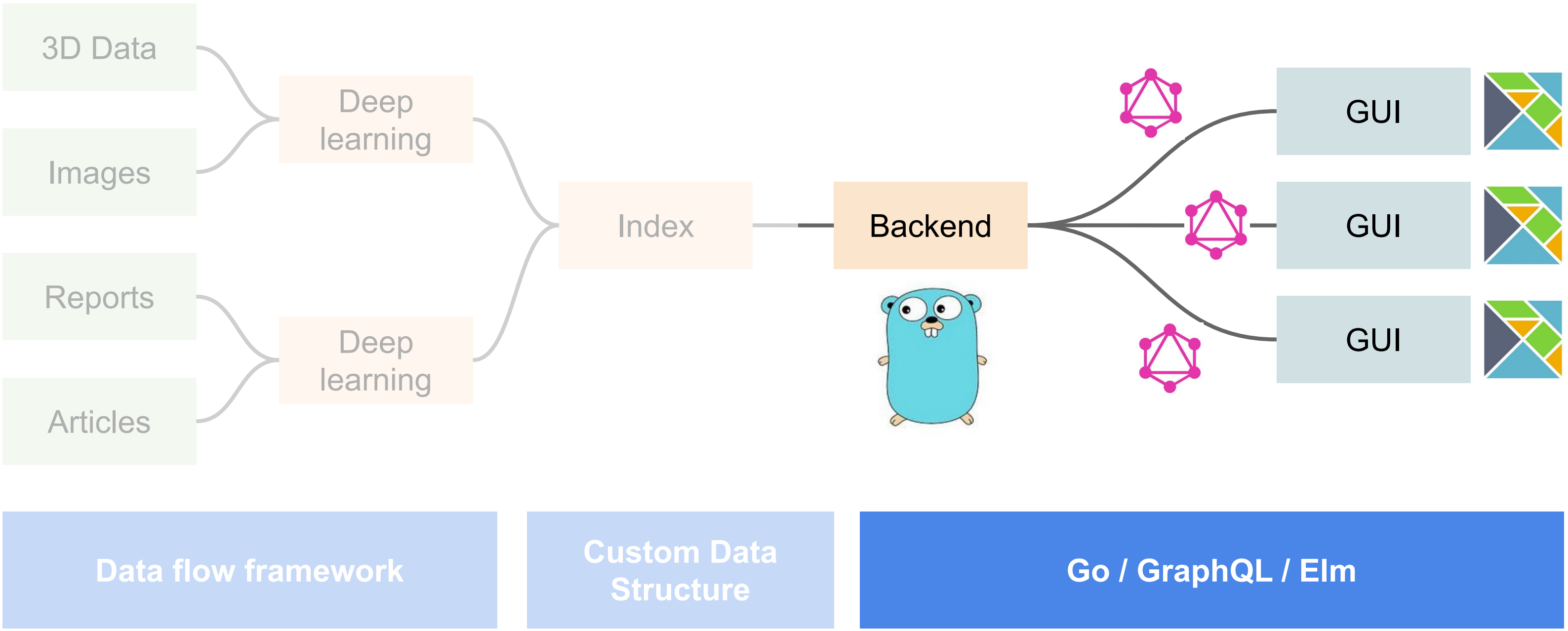
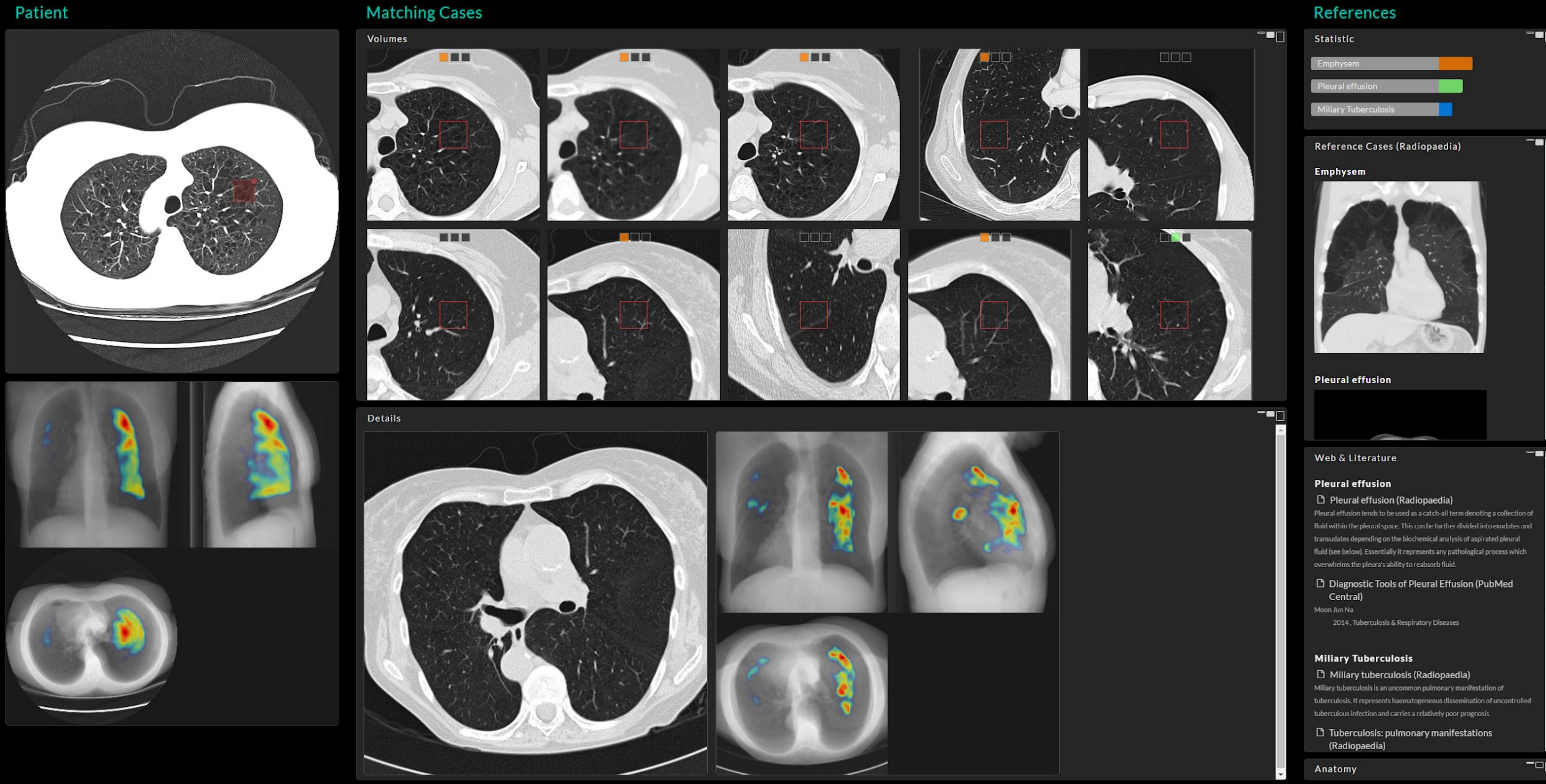
Indexing
Retrieval
Data flow framework
Custom Data
Structure
Go / GraphQL / Elm

Backend / Frontend





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Public Data Sets

Public Data Sets

visceral

Overview | Open Benchmarks | Workshops | Closed Benchmarks | Resources | Links | Contact Us

Overview

About VISCERAL

VISCERAL is an abbreviation for **Visual Concept Extraction Challenge in Radiology**.

The tasks and data can be used through the continuously running Benchmarks. These are:

- Anatomy3 Continuous
- Detection2
- Retrieval2

The software tools, deliverables and publications arising from the VISCERAL project are available on the Resources page.

The VISCERAL Consortium achieved these objectives.

This project is supported by the European Commission under the Information and Communication Technologies (ICT) Theme of the 7th Framework Programme for Research and Technological Development.

SEVENTH FRAMEWORK PROGRAMME

Microsoft Research

The cloud infrastructure for the benchmarks is supported by Microsoft Research on the Microsoft Azure Cloud.

Latest news

19/06/2017
VISCERAL cloud services suspended

18/08/2015
VISCERAL Anatomy Silver Corpus now available

17/08/2015
Segmentation Comparison Software and Publication

30/06/2015
VISCERAL Anatomy3 Proceedings Online

24/06/2015
Anatomy3, Retrieval2, Detection2 Benchmarks Open

>>All news

Next events

>>All events

Public Data Sets

Grand-challenges ALL CHALLENGES

Filters

- Modality
- Task type
- Structure

Displaying 174 of 174

All Challenges

Here is an overview of all challenges that have been organized within the area of medical image analysis that we are aware of. If you know any study that would fit in this overview, or want to advertise your challenge, please send an email to support@grand-challenge.org and we will add the challenge to the list on this page.

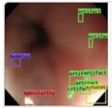
Active filters: 0

2019

C-NMC 2019

An effort to build an automated classifier for classification of normal vs malignant cells in B-ALL white blood cancer microscopic images that will overcome the problems associated with deploying sophisticated high-end machines with recurring reagent ...

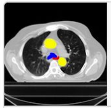
Patricipants: 11
Workshop: April 8, 2019
Associated with: ISBI 2019
Hosted on: grand-challenge.org



EAD2019

Endoscopic Artefact Detection (EAD) is a core problem and needed for realising robust computer-assisted tools. The EAD challenge has 3 tasks: 1) Multi-class artefact detection, 2) Region segmentation, 3) Detection generalisation.

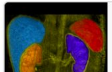
Patricipants: 73
Workshop: April 8, 2019
Associated with: ISBI2019
Hosted on: grand-challenge.org



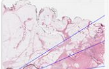
SegTHOR

Segmentation of THoracic Organs at Risk in CT images

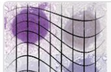
Workshop: April 8, 2019
Associated with: ISBI 2019
Hosted on: grand-challenge.org



CHAOS



BreastPathQ



ANHIR

Medical Image Retrieval

Challenges And Successful Approaches

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Co-Founder & CTO, rene@contextflow.com

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