



UFCSPA

Universidade Federal de Ciências da Saúde
de Porto Alegre

PPG-TIGSa

Programa de Pós-Graduação
em Tecnologia da Informação
e Gestão em Saúde

Aprendizado de Máquina Profundo Multimodal para Auxílio-Diagnóstico de Câncer

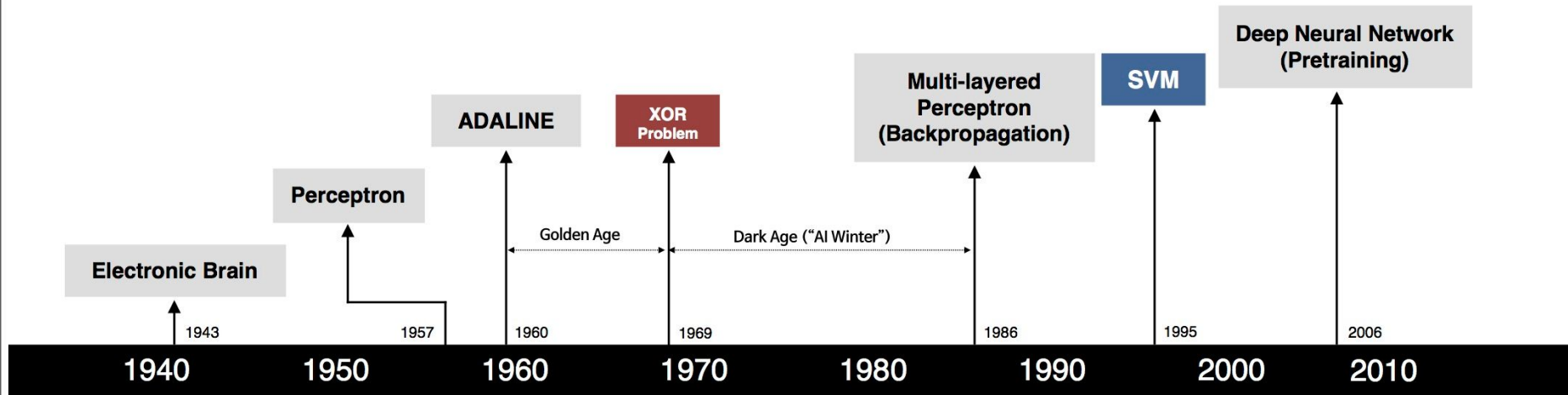
Alan Baronio Menegotto

Porto Alegre, RS, Brasil
Novembro de 2019

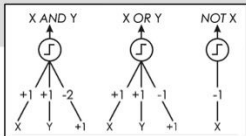
Agenda

- Contextualização
- Ferramentas CAD
- Deep Learning
- Multimodal Deep Learning
- Estratégias de Fusão de Dados
- Exemplos

Contextualização



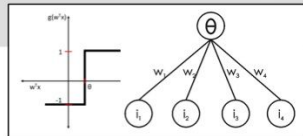
S. McCulloch - W. Pitts



- Adjustable Weights
- Weights are not Learned



F. Rosenblatt



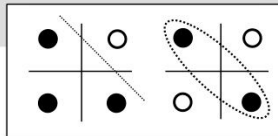
- Learnable Weights and Threshold



B. Widrow - M. Hoff



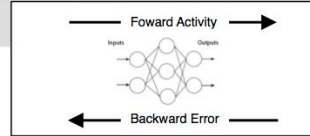
M. Minsky - S. Papert



- XOR Problem



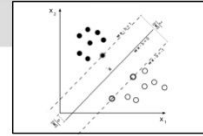
D. Rumelhart - G. Hinton - R. Williams



- Solution to nonlinearly separable problems
- Big computation, local optima and overfitting



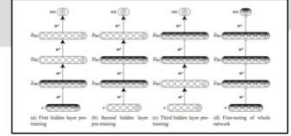
V. Vapnik - C. Cortes



- Limitations of learning prior knowledge
- Kernel function: Human Intervention

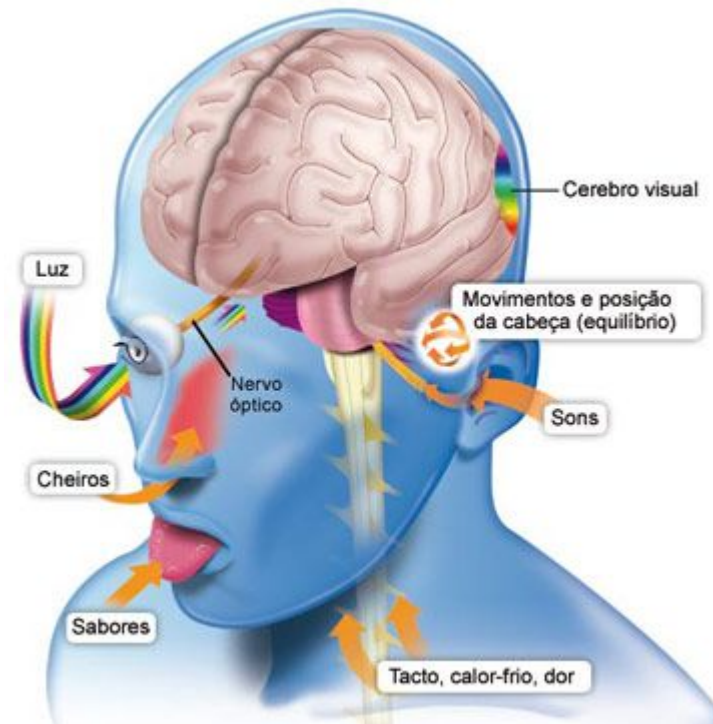
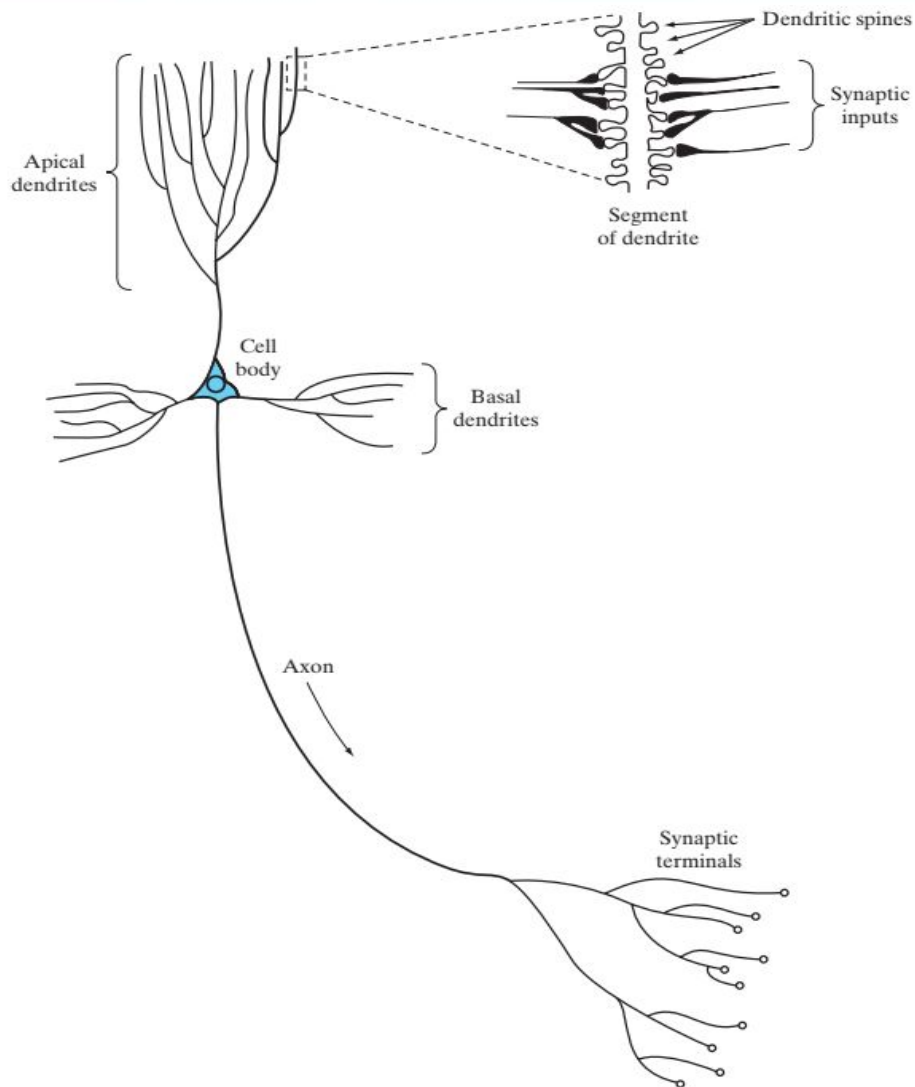


G. Hinton - S. Ruslan



- Hierarchical feature Learning

Contextualização



Ferramentas CAD

- Surgiram na década de 1960-1970
 - 1963: Diagnóstico de Osteosarcoma
 - 1972: Câncer de Mama
 - 1973: Reconhecimento de padrões em raio X de tórax



Ferramentas CAD

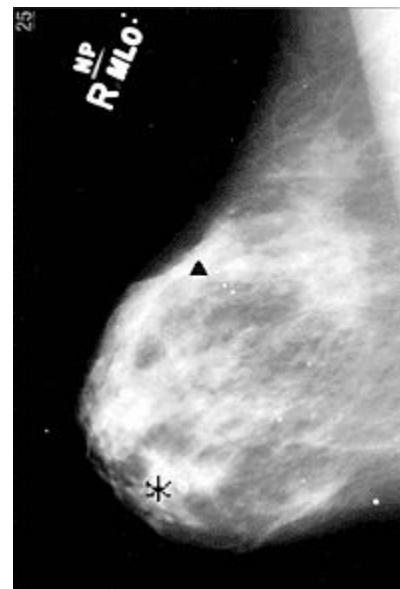
- Na década de 1980 no Kurt Rossmann Laboratories popularizaram-se os sistemas CAD para radiologia:
 - 1987: Auxílio-Diagnóstico de nódulos pulmonares
 - 1987: Auxílio-Diagnóstico de microcalcificações em mamografia



Kunio Doi

Ferramentas CAD

- 1998: primeiro sistema aprovado pelo FDA para auxílio-diagnóstico de microcalcificações em mamografias



Ferramentas CAD

- Sistemas que auxiliam o processo de trabalho do profissional assistencial mas não são responsáveis pela decisão diagnóstica e conduta:
 - Segmentação de Imagens
 - Auxílio-Diagnóstico (Classificação)
 - Prognóstico de Tratamento
 - Prognóstico de Cura
 - Cálculo de Sobrevida
 - Criação e enriquecimento de imagens

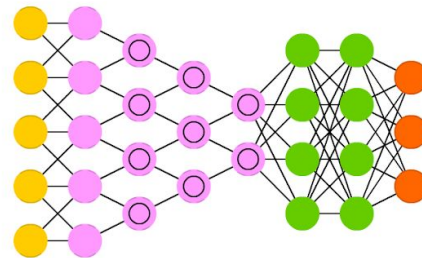
- Computer-Aided Detection (CADe):
 - Principal objetivo: localização dos nódulos
 - Usualmente composto das fases:
 - Segmentação
 - Seleção de nódulos
 - Análise de nódulos
 - Eliminação de falsos positivos

- Computer-Aided Diagnosis (CADx):
 - Principal Objetivo: classificação
 - Usualmente composto das fases:
 - Extração de características
 - Classificação das características

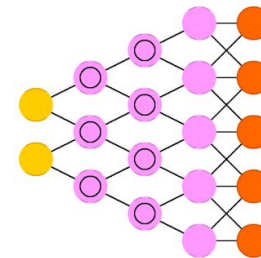
Deep Learning

-  Backfed Input Cell
-  Input Cell
-  Noisy Input Cell
-  Hidden Cell
-  Probabilistic Hidden Cell
-  Spiking Hidden Cell
-  Output Cell
-  Match Input Output Cell
-  Recurrent Cell
-  Memory Cell
-  Different Memory Cell
-  Kernel
-  Convolution or Pool

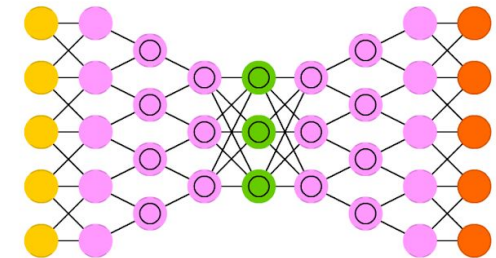
Deep Convolutional Network (DCN)



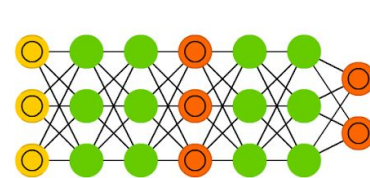
Deconvolutional Network (DN)



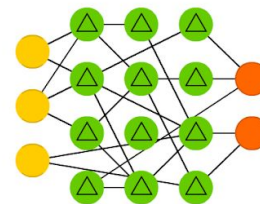
Deep Convolutional Inverse Graphics Network (DCIGN)



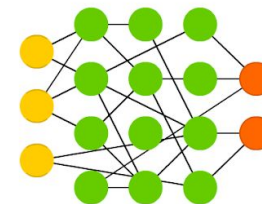
Generative Adversarial Network (GAN)



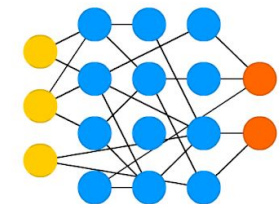
Liquid State Machine (LSM)



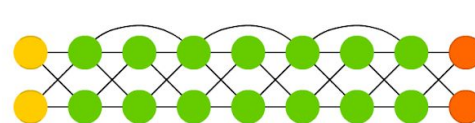
Extreme Learning Machine (ELM)



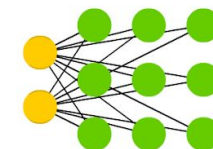
Echo State Network (ESN)



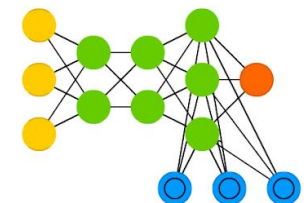
Deep Residual Network (DRN)



Kohonen Network (KN)

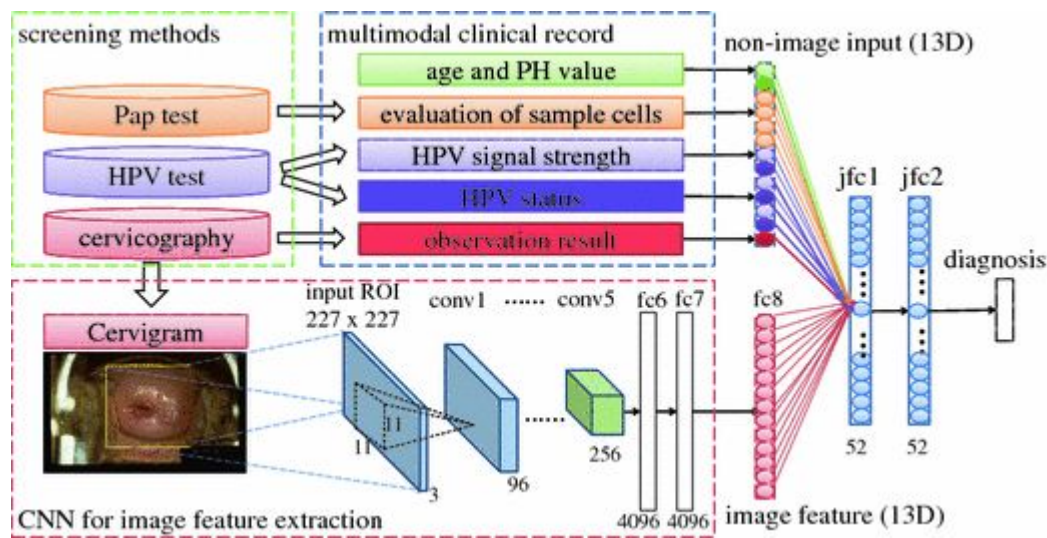


Neural Turing Machine (NTM)



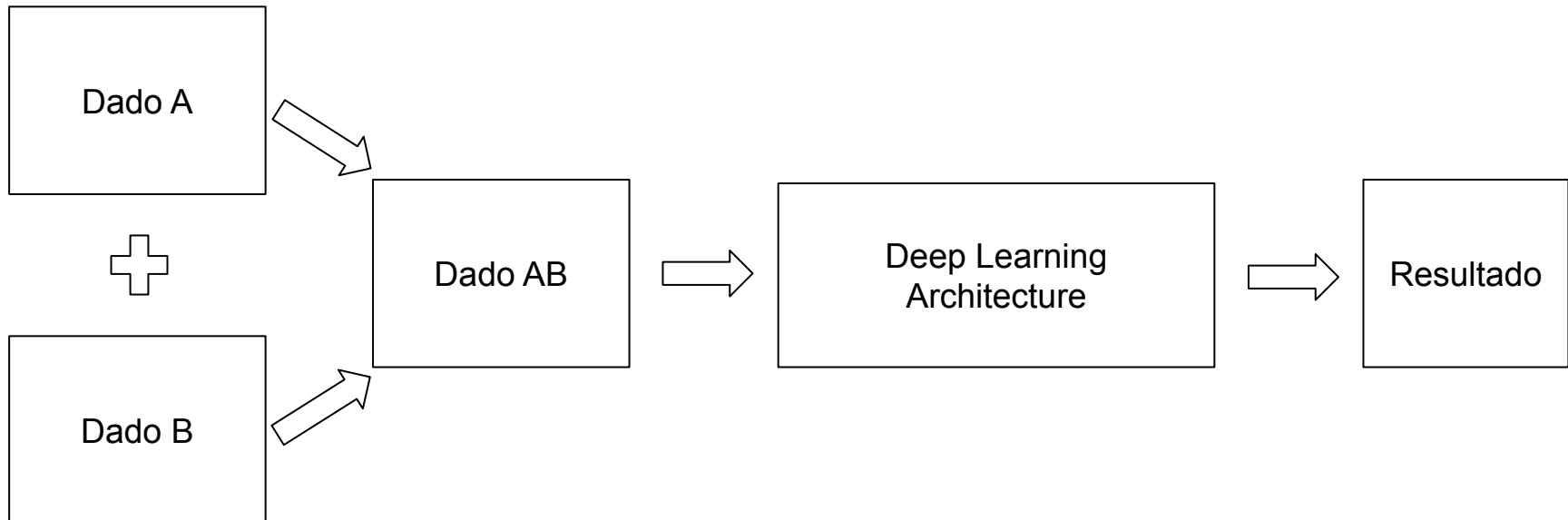
Multimodal Deep Learning

- Área começou a ser re-estudada no começo desta década
- Utilizam arquiteturas profundas que aceitam múltiplas entradas



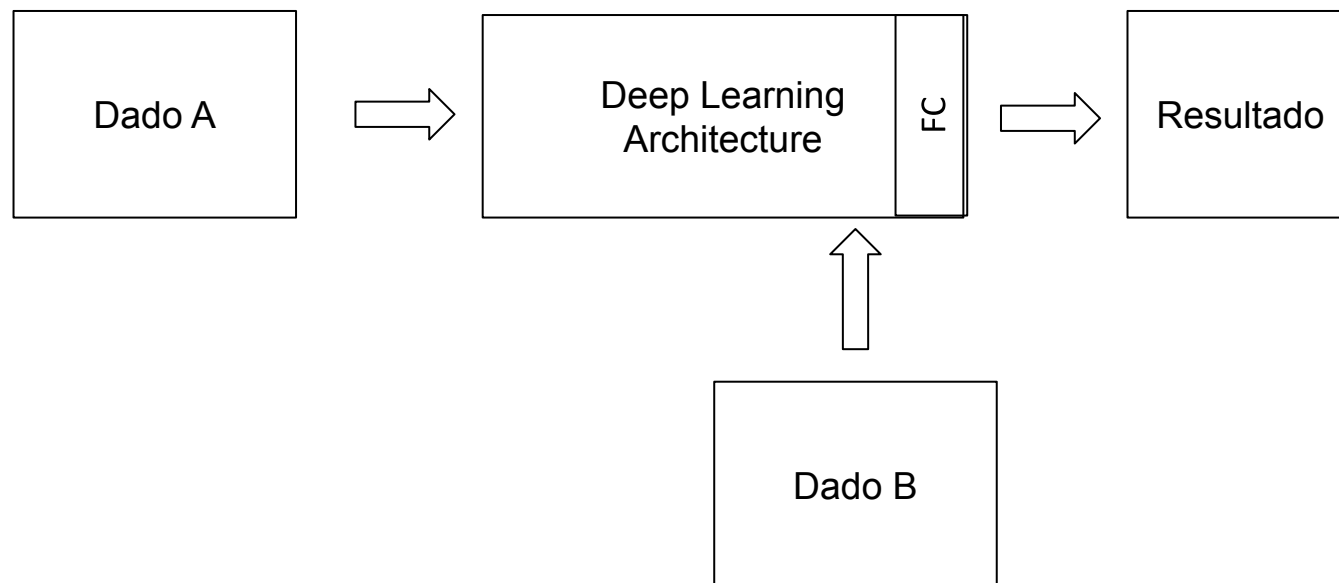
Estratégias de Fusão de Dados

- Fusão Antecipada



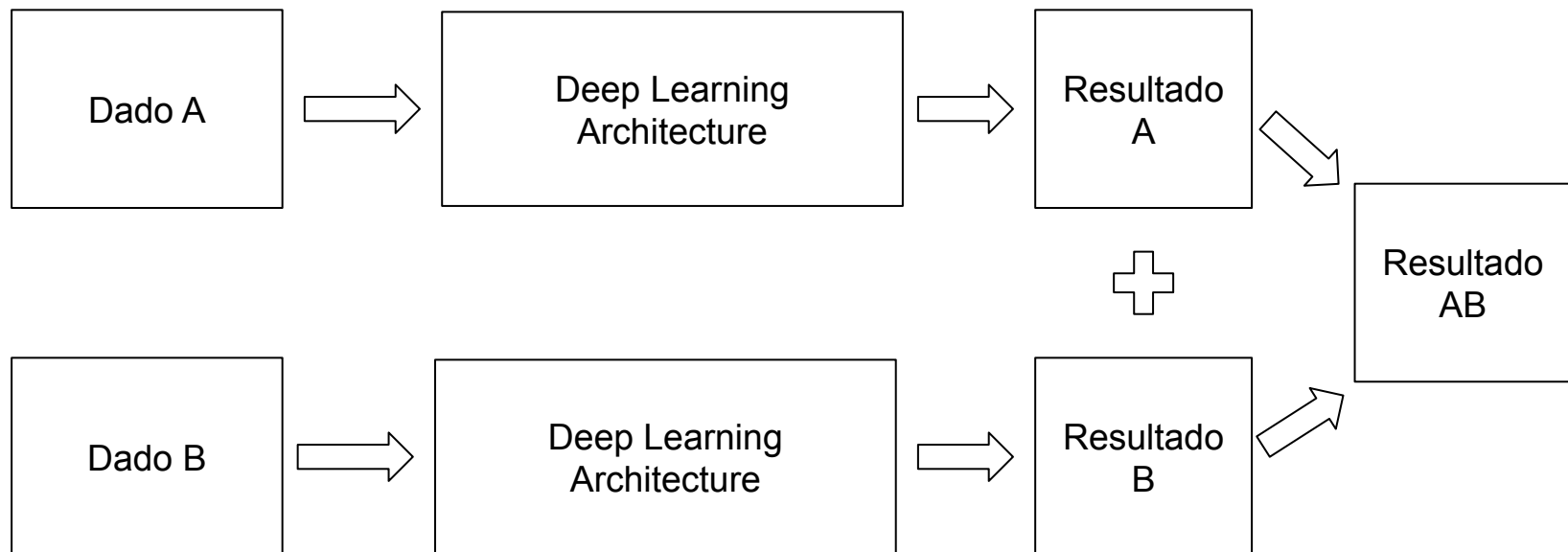
Estratégias de Fusão de Dados

- Fusão Intermediária



Estratégias de Fusão de Dados

- Fusão Tardia



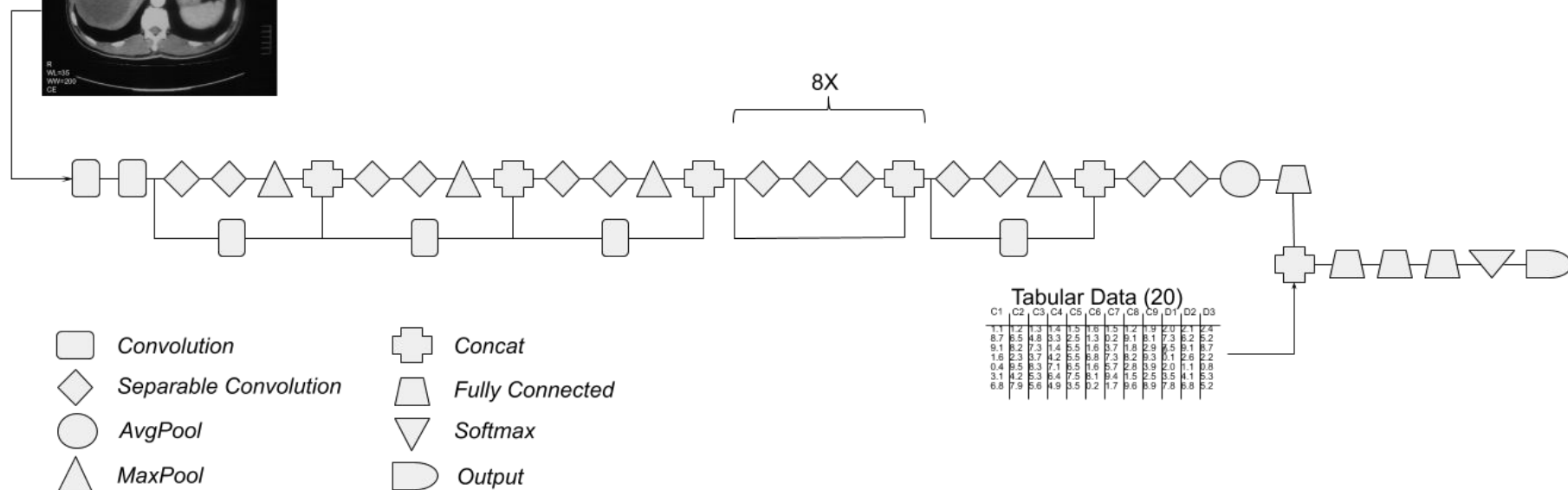
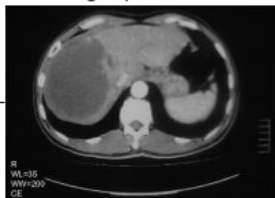
Exemplos

- Uma Arquitetura de Aprendizado Profundo Multimodal para Auxílio no Diagnóstico de Hepatocarcinoma
 - Identificar a arquitetura e estratégia de fusão dos dados com maior precisão
 - Quantificar diferença de precisão entre redes multimodal e unimodal para diagnóstico de HCC

Exemplos

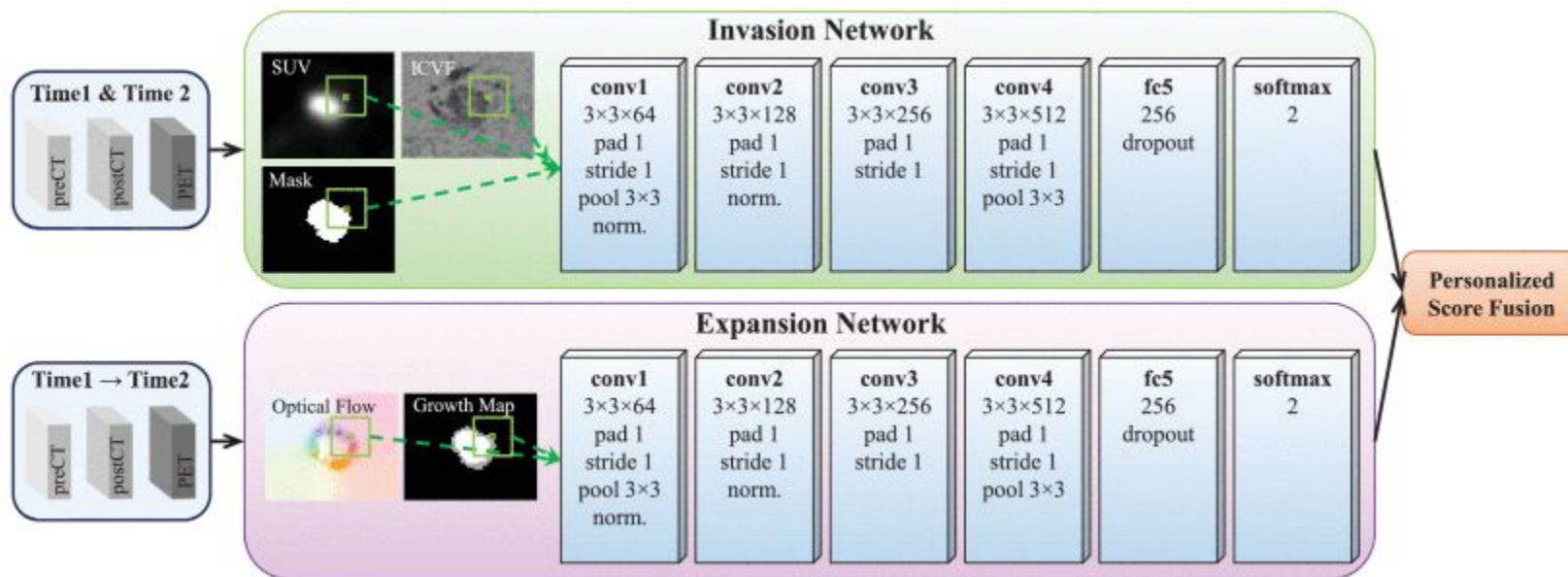
Xception Multimodal (Fusão Intermediária)

CT Image (299 x 299 x 3)



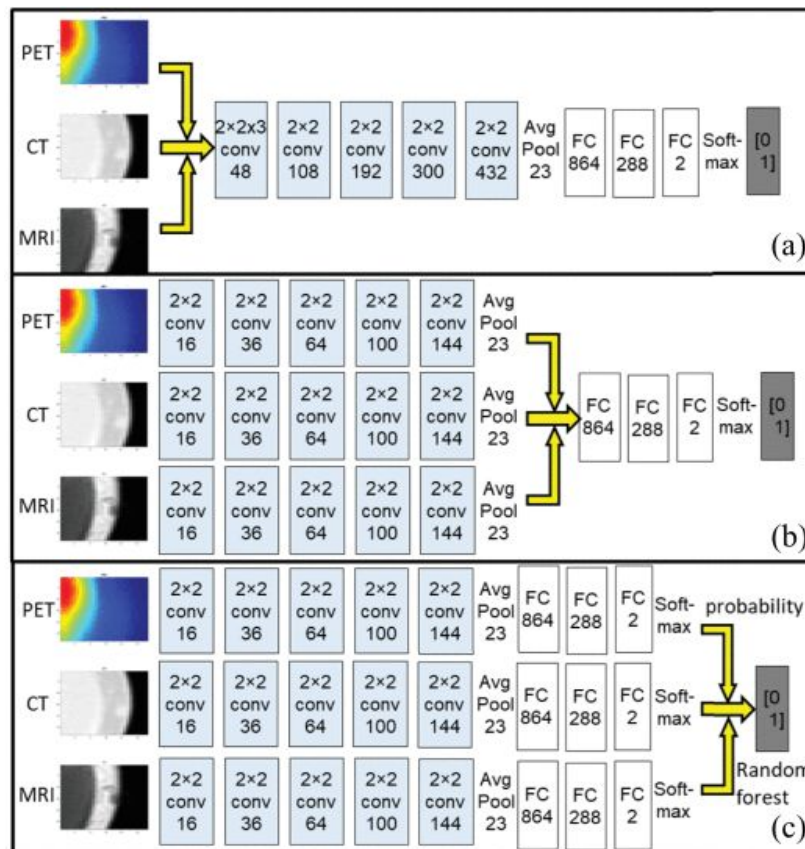
Exemplos

Prognóstico de Expansão e Invasão de Células Cancerígenas



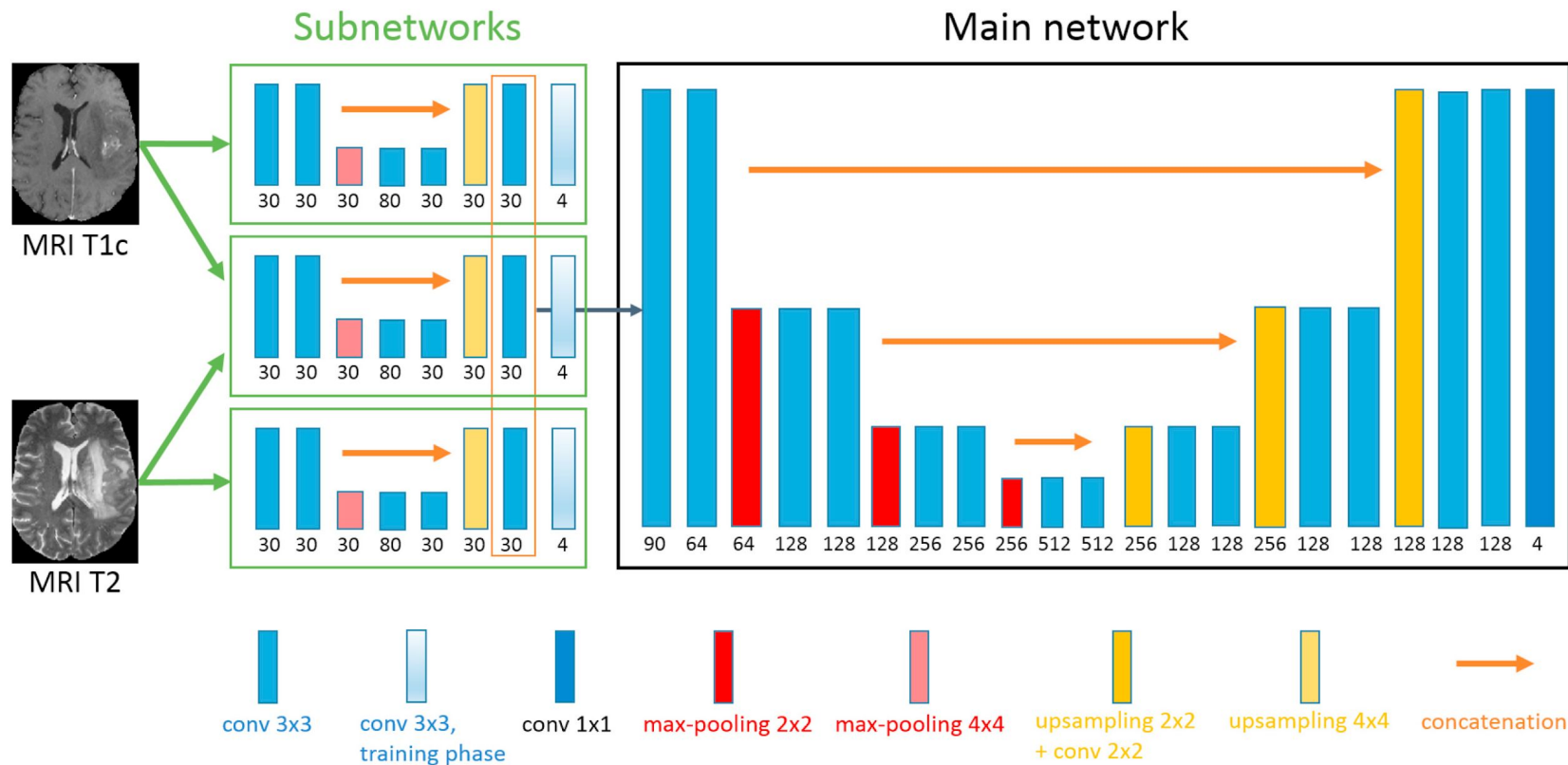
Exemplos

Segmentação de Sarcoma de Tecidos Moles



Exemplos

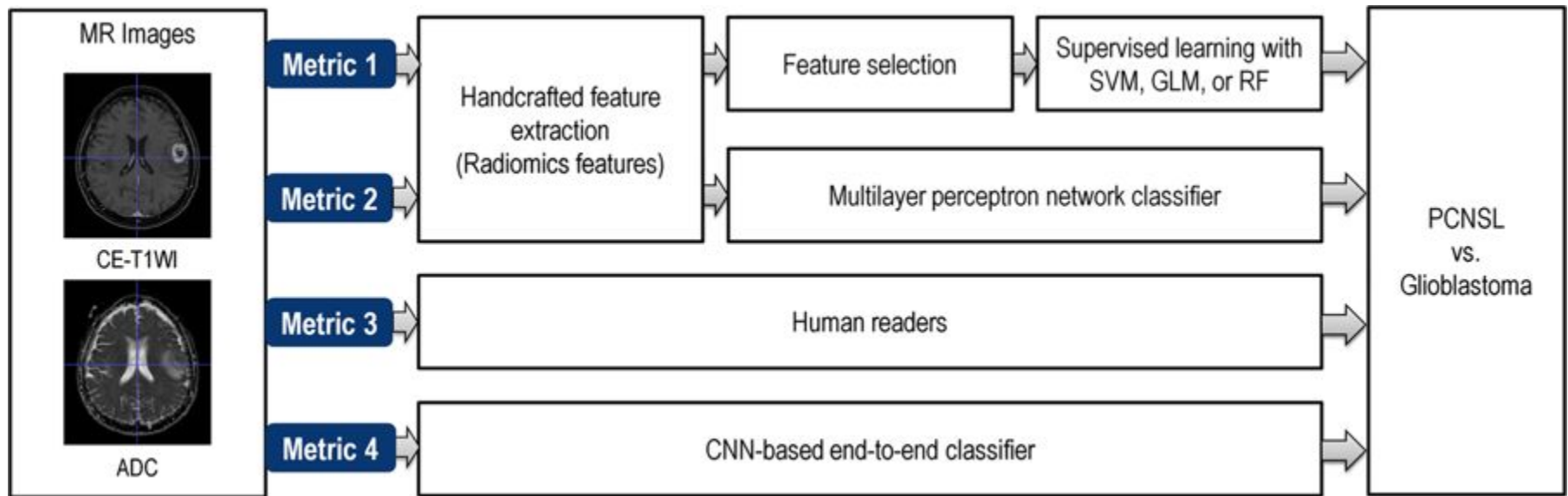
Segmentação de Gliomas



Fonte: MLYNARSKI, Pawel et al. 3D convolutional neural networks for tumor segmentation using long-range 2D context. **Computerized Medical Imaging and Graphics**, v. 73, p. 60-72, 2019.

Exemplos

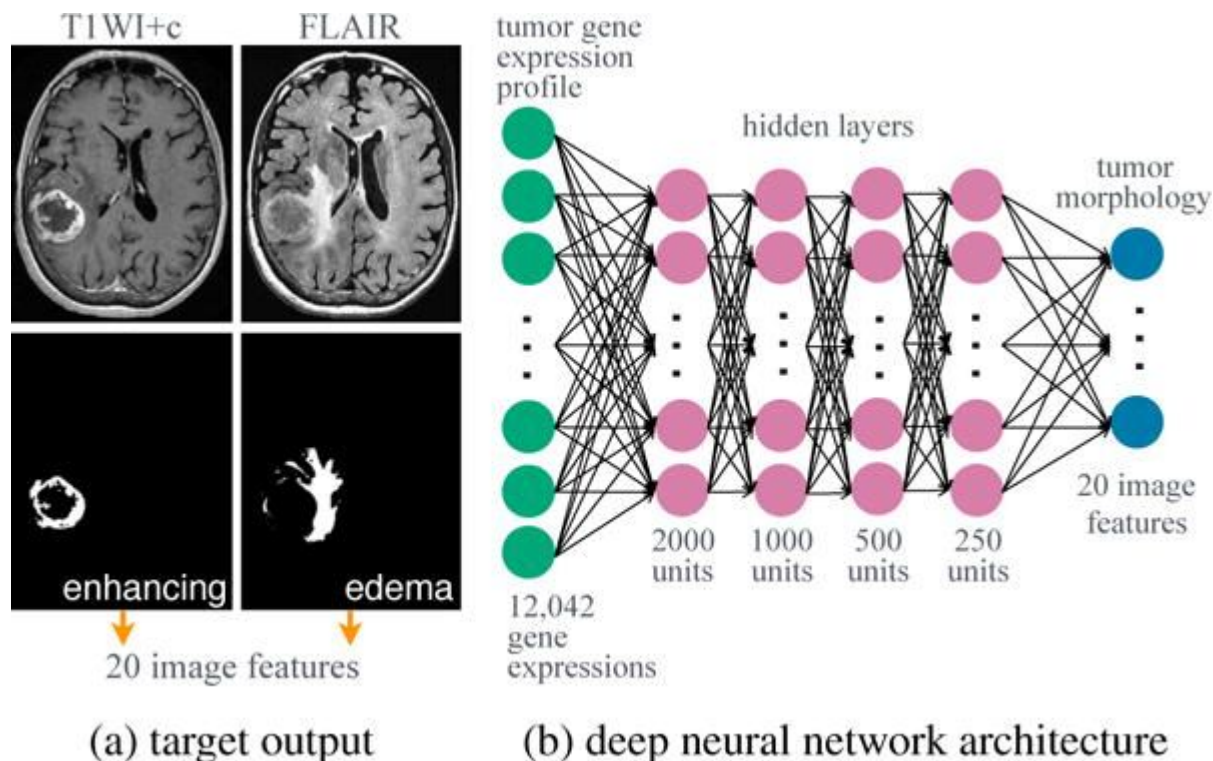
Auxílio-Diagnóstico de Tumor Cerebral (Glioblastoma vs Linfoma)



Fonte: YUN, Jihye et al. Radiomic features and multilayer perceptron network classifier: a robust MRI classification strategy for distinguishing glioblastoma from primary central nervous system lymphoma. *Scientific reports*, v. 9, n. 1, p. 5746, 2019.

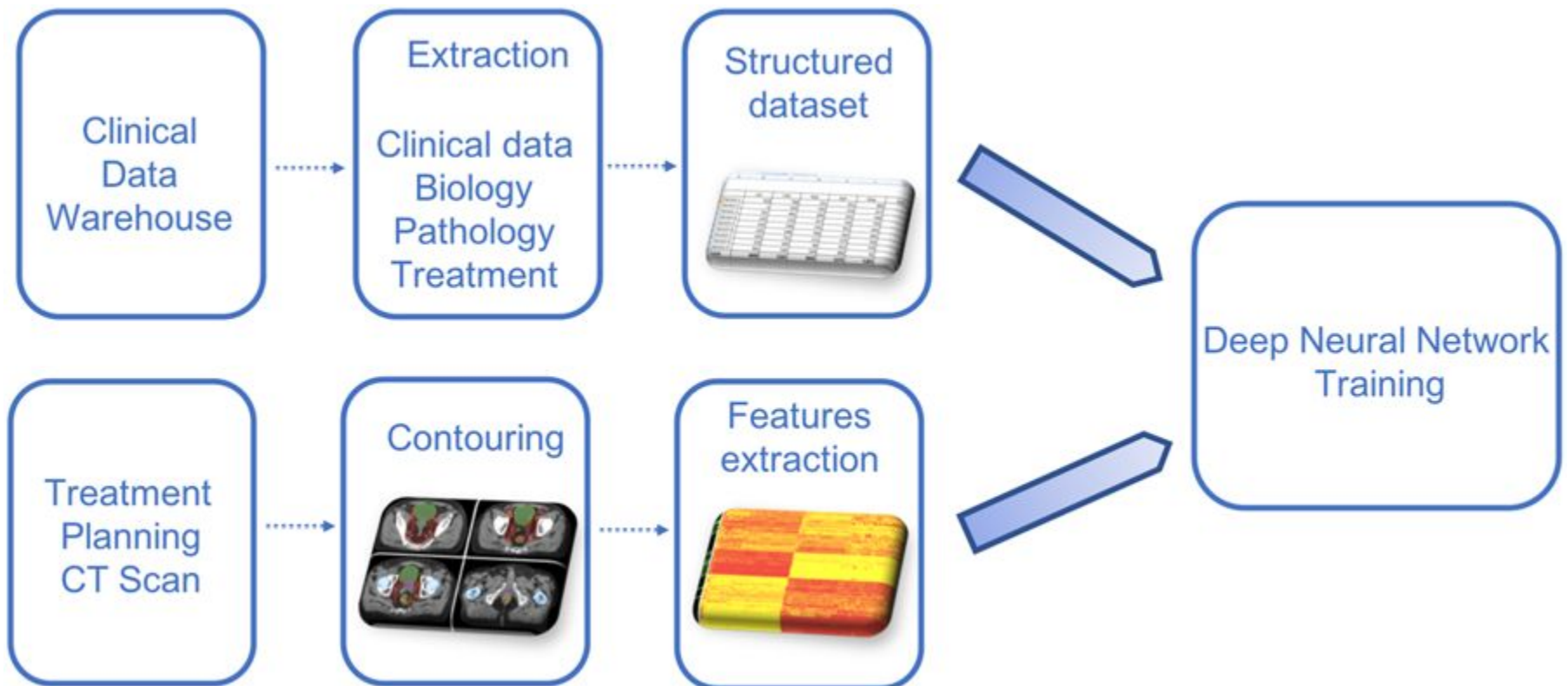
Exemplos

Prognóstico da morfologia do tumor e Enriquecimento de Imagens



Exemplos

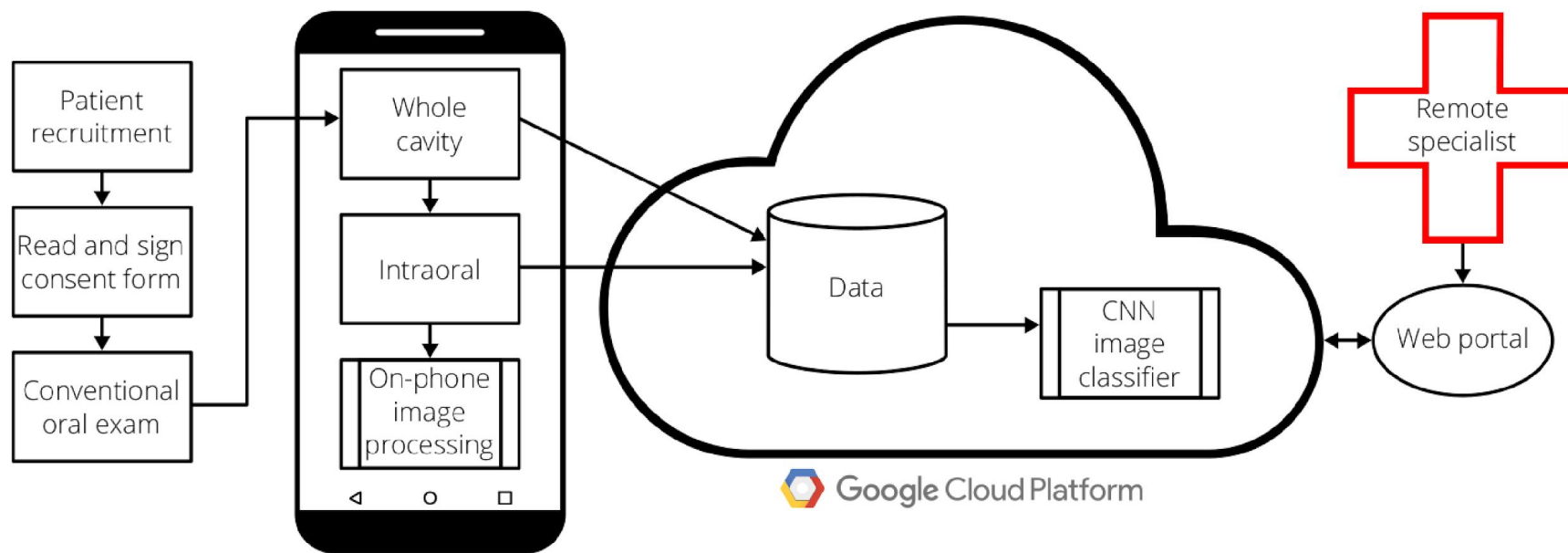
Prognóstico de Quimiorradiação



Fonte: BIBAULT, Jean-Emmanuel et al. Deep Learning and Radiomics predict complete response after neo-adjuvant chemoradiation for locally advanced rectal cancer. **Scientific reports**, v. 8, n. 1, p. 12611, 2018.

Exemplos

Auxílio-Diagnóstico de Câncer Bucal



Fonte: UTHOFF, Ross D. et al. Point-of-care, smartphone-based, dual-modality, dual-view, oral cancer screening device with neural network classification for low-resource communities. **PloS one**, v. 13, n. 12, p. e0207493, 2018.

Referências

- Doi, K. (2007). Computer-aided diagnosis in medical imaging: historical review, current status and future potential. Computerized medical imaging and graphics, 31(4-5), 198-211.
- RAMACHANDRAM, Dhanesh; TAYLOR, Graham W. Deep multimodal learning: A survey on recent advances and trends. IEEE Signal Processing Magazine, v. 34, n. 6, p. 96-108, 2017.
- GOODFELLOW, Ian; BENGIO, Yoshua; COURVILLE, Aaron. Deep learning. MIT press, 2016.
- MORENCY, LP.; Baltrusaitis, T., Tutorial on Multimodal Machine Learning, CMU Multimodal Communication and Machine Learning Laboratory. Disponível em:
<https://www.cs.cmu.edu/~morency/MMML-Tutorial-ACL2017.pdf>



Perguntas? Sugestões? Críticas?