

Técnicas de Deep Learning e Datawarehousing aplicadas a dados reais do domínio médico

Aluno: Daniel Mário de Lima

Orientador: Prof. Dr. José Fernando Rodrigues Jr.

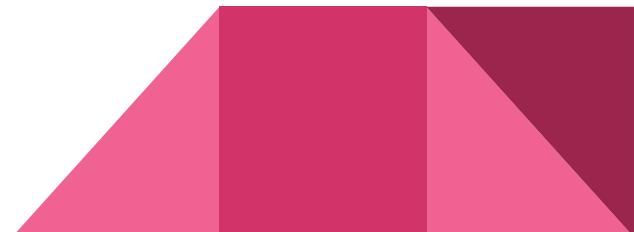
2019-03-15

Roteiro

- Introdução
 - Motivação
 - Objetivos
 - Conceitos
 - SI em Saúde
 - Pesquisa Clínica
 - KDD
 - Deep Learning
 - Trabalhos Relacionados
 - DL em Dermoscopia
 - openEHR
 - Experimentos
 - ETL do SI³ para OMOP-CDM
 - DermaDL
 - Conclusão
-

Introdução

- 2010 – 2020
- Web 2.0 ---> 3.0
- Paralela/Distribuída
- Computação em Nuvem
- Redes Sociais
- Big Data
- KDD em Larga Escala
- Redes Neurais
- ILSVRC

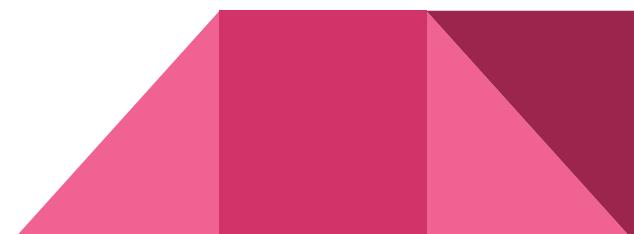


Introdução

- 2010 – 2020
- Web 2.0 ---> 3.0
- Paralela/Distribuída
- Computação em Nuvem
- Redes Sociais
- **Big Data**
- **KDD em Larga Escala**
- Redes Neurais
- ILSVRC

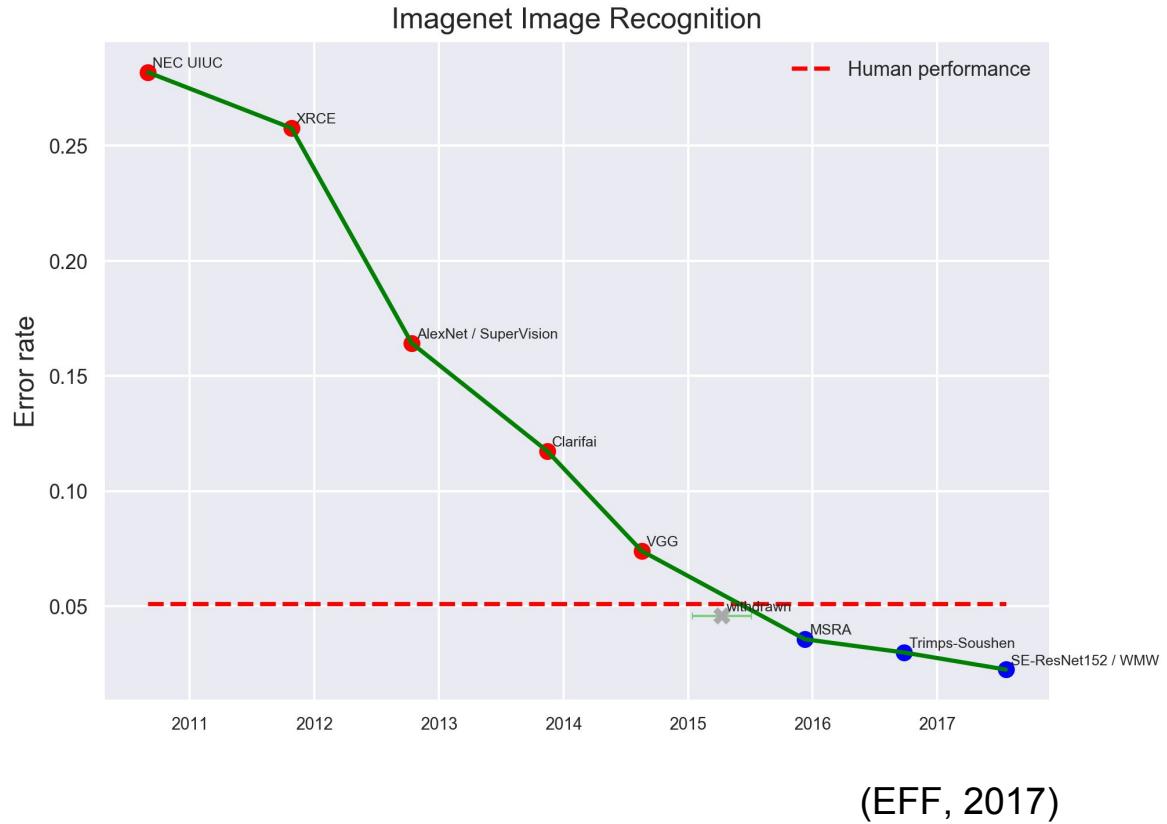
- Volume
- Velocidade
- Variedade
- Veracidade
- Valor

(Gudivada,
Baeza-Yates,
Raghavan, 2015)

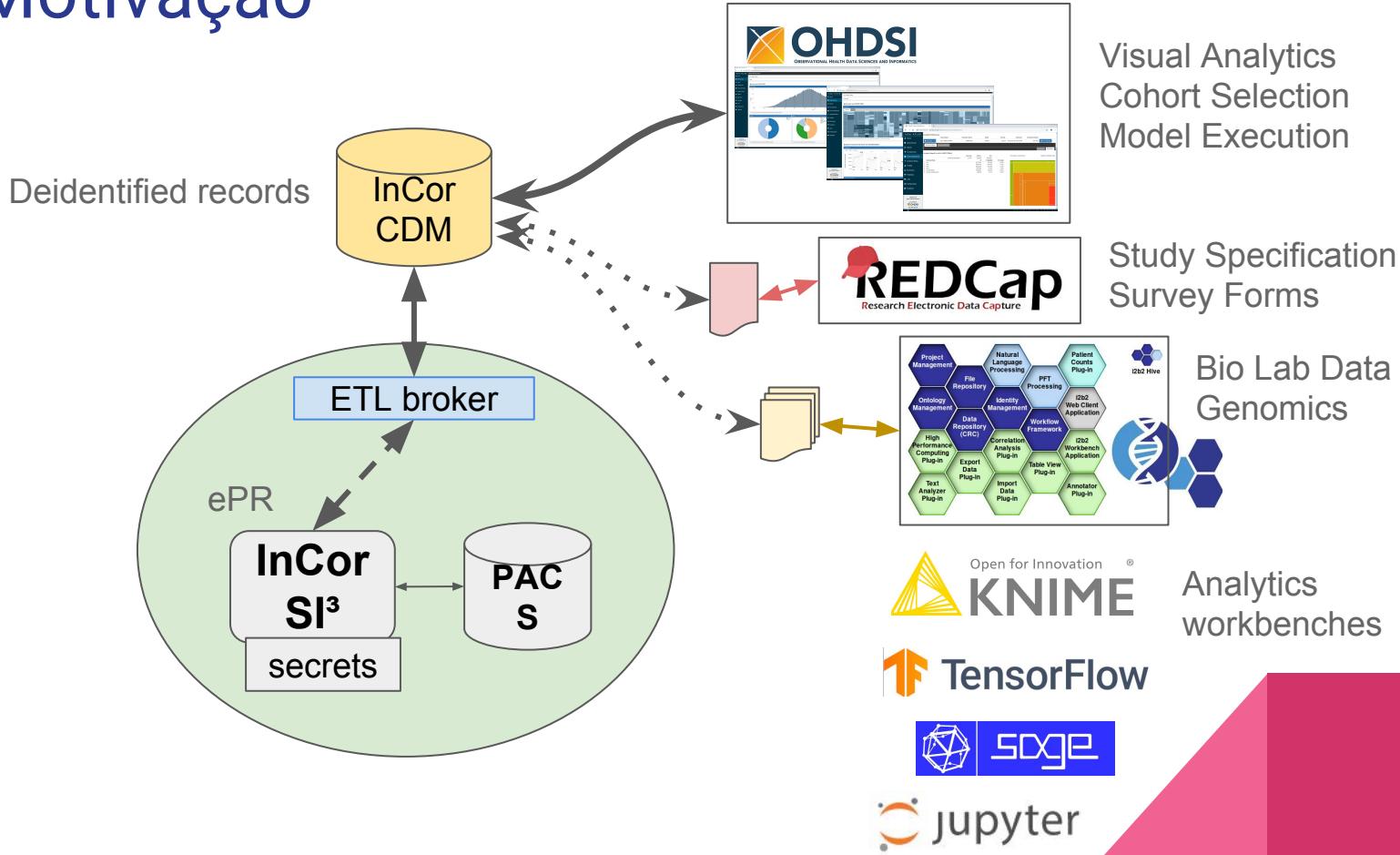


Introdução

- 2010 – 2020
- Web 2.0 ---> 3.0
- Paralela/Distribuída
- Computação em Nuvem
- Redes Sociais
- Big Data
- KDD em Larga Escala
- **Redes Neurais**
- **ILSVRC**



Motivação



Objetivo Geral

Ampliar o aproveitamento dos dados médicos e da capacidade de diagnóstico automatizado através da integração e homogeneização das diversas fontes de dados em um Sistema de Informações de Saúde, e do uso de modelos do estado-da-arte de aprendizado de máquina, conhecidos por Deep Learning.

Objetivos específicos

- Projetar nova ETL (extração-transformação-e-carga) dos dados do InCor;
- Curar um banco de dados anonimizado e padronizado em um modelo internacional para a pesquisa clínica;
- Implementar e avaliar técnicas de Deep Learning em domínios de dados de imagens médicas;
- Implementar ferramenta mobile baseada em Deep Learning para diagnóstico de câncer de pele;
- Desenvolver ferramentas de Deep Learning para ampliar o aproveitamento dos dados do InCor.

Conceitos

SI em Saúde

Sistemas de Informações Hospitalares

- HIS (Hospital Information System)
- Registra todas as atividades hospitalares
- Pacientes, Material, Enfermagem, Administrativo, Faturamento, Farmácia...

Prontuários eletrônicos

- ePR (electronic patient record)
- Registra interações do paciente com profissionais de saúde
- Admissões, Consultas, Exames, Medicação, Procedimentos...

Pesquisa Clínica

Diagnóstico Baseado em Evidências (Cruz e Pimenta, 2005)

- V. opiniões, casos, estudos descritivos, relatórios
- IV. estudos não experimentais por mais de uma fonte
- III. ensaio não-randomizado, coortes, séries temporais, caso-controle
- II. ensaio randomizado, i.e. “RCT” (randomized controlled trial)
- I. revisão sistemática de RCTs

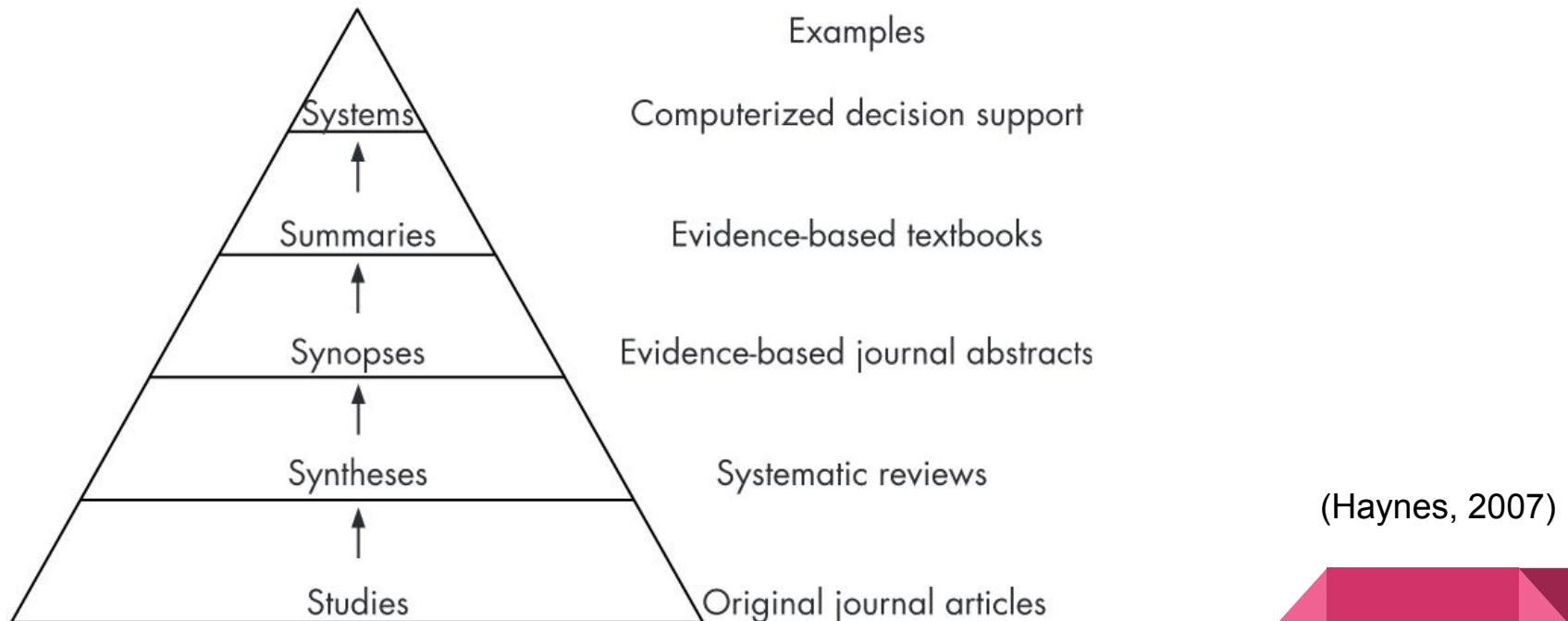
Pesquisa Clínica

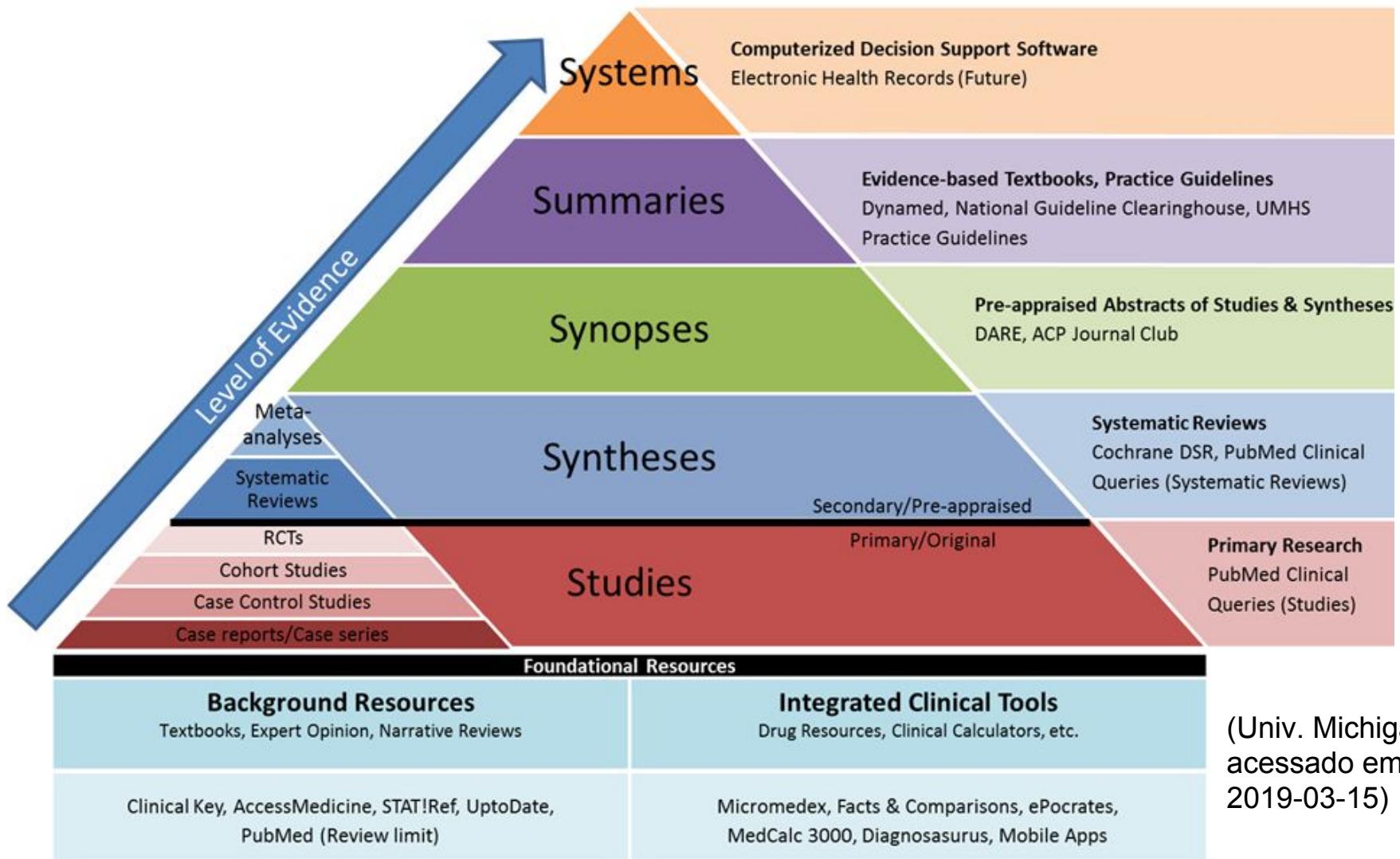
Diagnóstico Baseado em Evidências (Cruz e Pimenta, 2005)

- I. revisão sistemática de RCTs
- II. ensaio randomizado, i.e. “RCT” (randomized controlled trial)
- III. ensaio não-randomizado, coortes, séries temporais, caso-controle
- IV. estudos não experimentais por mais de uma fonte
- V. opiniões, casos, estudos descritivos, relatórios



Modelo “5S”



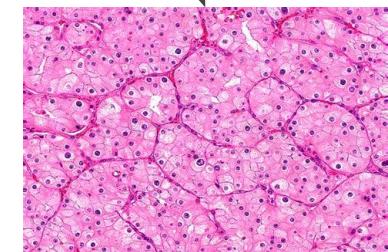


(Univ. Michigan,
acessado em
2019-03-15)

Diagnóstico Dermatológico

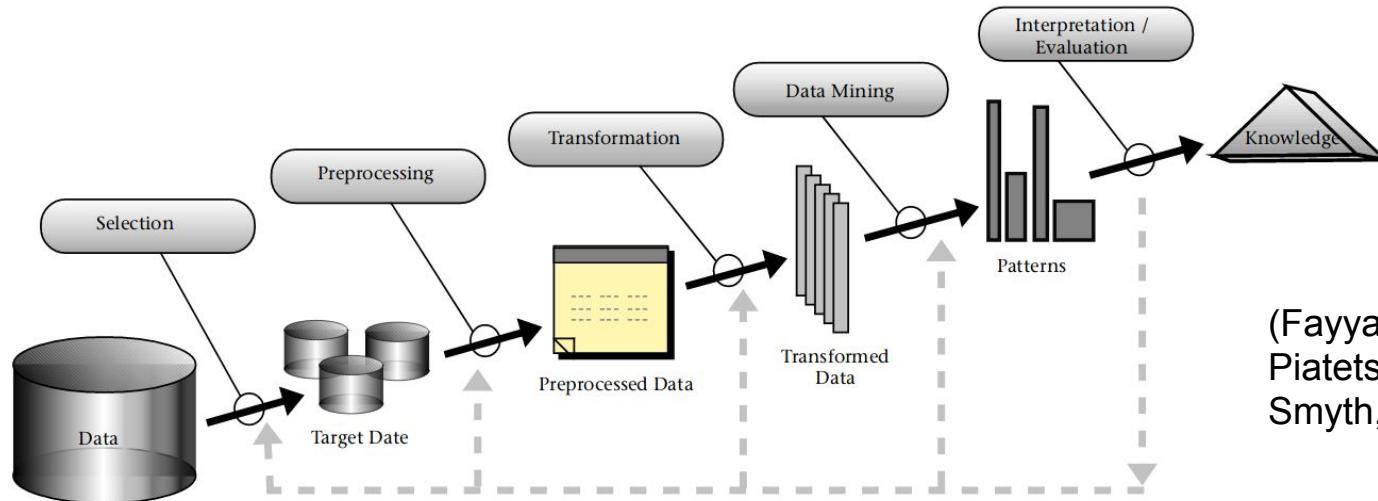


**Assimetria
Bordas irregulares
Cores variadas
Diâmetro >6mm
Evolução**
(Abbasi et al, 2004)



KDD

Descoberta de Conhecimento em Bases de Dados



(Fayyad,
Piatetsky-Shapiro,
Smyth, 1996)

Coleta de Dados Médicos

Ética

- Moral, códigos legais, *Ethos*, Hipócrates, Spinoza
- Nuremberg Trials (1945-49)
- Belmont Report (1979)
 - Respect for Persons, Beneficence, Justice
- Health Insurance Portability and Accountability Act (HIPAA)
 - Protected Health Information (PHI)
 - name, address, birth date, Social Security Number
 - De-Identified Health Information
 - Research clause

OLTP vs OLAP

On-Line Transaction Processing

- Armazenamento de registros de um SI
- ACID (atomicidade, consistência, isolamento, durabilidade)
- Desempenho e escalabilidade
- Modelagem Relacional

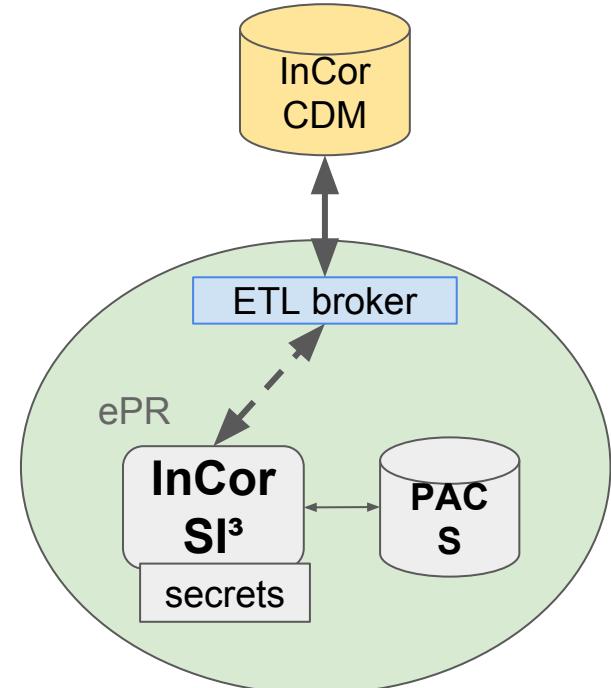
On-Line Analytical Processing

- Leitura e interpretação dos dados em um BD
- Organização, agregação e sumarização dos valores
- Modelagem Multidimensional (hipercubo / cubo OLAP)
- Ou execução sobre BD Relacional (ROLAP)

ETL

Extract, Transform & Load

Uso de linguagens de definição (DDL) e manipulação (DML) de dados para transportar dados coletados de BDs diferentes ao **armazém de dados (data mart)** para análise.



```

> AG_TRANSFUSIONAL
> AMBULATORIO
> APEX_030200
> APEX_040100
> APEX_040200
> CAIXA
> CALLCENTER
> CIR_CIRURGIA
> CMP
> COCI
> COM
> COP_SEG
> CTXSYS
> DBA_FABIO
> DBA_VALDEMIR
> EASY
> ENFERMAGEM
> FABIANO
> FONETICA
> GENEHY
> GREA
> GSMADMIN_INTERNAL
> GUICHELATTES
> HELPDESK
> HISTORICO
> INFOSAUDE
> INFOSAUDE_SI3
> INF_GER
> INTEGRACAO
> JAVA_ADMIN
> JOB_OPER
> KIT_INCOR
> LAUDO
> LAUDO_SI3
> MAGIC
> MAILING
> MANUT_HIST
> MASS
> MAT
> MOBILEADMIN
> MYSQL_DRIVER
> NFTI_HC_SIR

```

keys

object_id
table_id
new_key

```

INSERT INTO person
--CREATE OR REPLACE VIEW v_person AS
SELECT
    person.id,
    gender.id,
    EXTRACT(YEAR FROM paci_dt_nasc) AS year_of_birth,
    NULL AS month_of_birth,
    NULL AS day_of_birth,
    birth_datetime,
    race.concept_id,
    ethnicity.concept_id,
    location.id,
    provider.id,
    care_site.id,
    person.source_value,
    gender.source_value,
    gender.concept_id,
    race.concept_id,
    race.source_value,
    ethnicity.source_value,
    ethnicity.concept_id
FROM PACIENTE.PAC_PACIENTE paciente
JOIN keys.keys
    ON person.rel = 1302
    AND person.src = paci_id
LEFT JOIN gender
    ON gender.src = paciente.paci_tp_sexo
LEFT JOIN color
    ON paci_sg_cor = color.src

```

person

person_id
year_of_birth
month_of_birth
gender_concept_id
race_concept_id
gender_source_val
race_source_value
...

```

INSERT INTO visit_occurrence
--CREATE OR REPLACE VIEW v_visit_occurrence AS
SELECT
    item.id,
    visit_occurrence_id,
    person.id,
    visit.concept_id,
    trunc(adm_dt_ingresso, 'DD') AS visit_start_date,
    visit_start_datetime,
    trunc(coalesce(said_dt_hr, adm_dt_fim_am_hosp_dia, adm_dt_ingresso), 'DD') -- REVIEW
    AS visit_end_date,
    visit.visit_datetime,
    32085 AS visit_type_concept_id,
    provider.id,
    care_site.id,
    visit.visit_source_value,
    visit.visit_source_concept_id,
    admitting_source_concept_id,
    admitting_source_value,
    discharge_to_concept_id,
    discharge_to_source_value,
    preceding_visit_occurrence_id
FROM KEYS.item
JOIN PACIENTE.ADM_ADMISSAO
    ON item.rel = 2478 -- (SELECT id FROM tables WHERE schema = 'PACIENTE' AND name = 'ADM_ADMISSAO')
    AND item.src = adm_nr || '||adm_anol' || '||adm_inst_cd'
JOIN KEYS.person
    ON person.rel = 1302 -- (SELECT id FROM tables WHERE schema = 'PACIENTE' AND name = 'PAC_PACIENTE')
    AND person.src = to_char(adm_paci_id)
JOIN visit
    ON visit.src = adm_tp
LEFT JOIN PACIENTE.SAL_SAIDA
    ON said_dt_hr_canc = adm_dt
    AND said_anol_ano = adm_an
    AND said_inst_cd = adm_inst_cd
    AND said_dt_hr_canc IS NULL

```

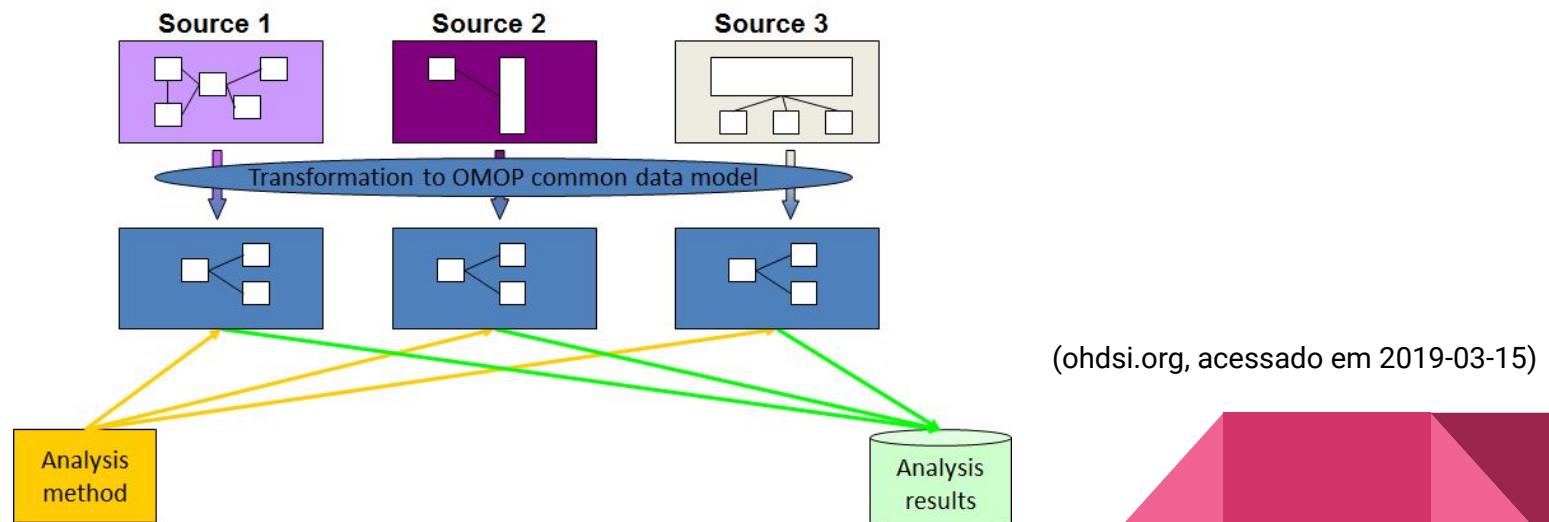
visit

visit_id
person_id
concept_id
start_date
end_date
...

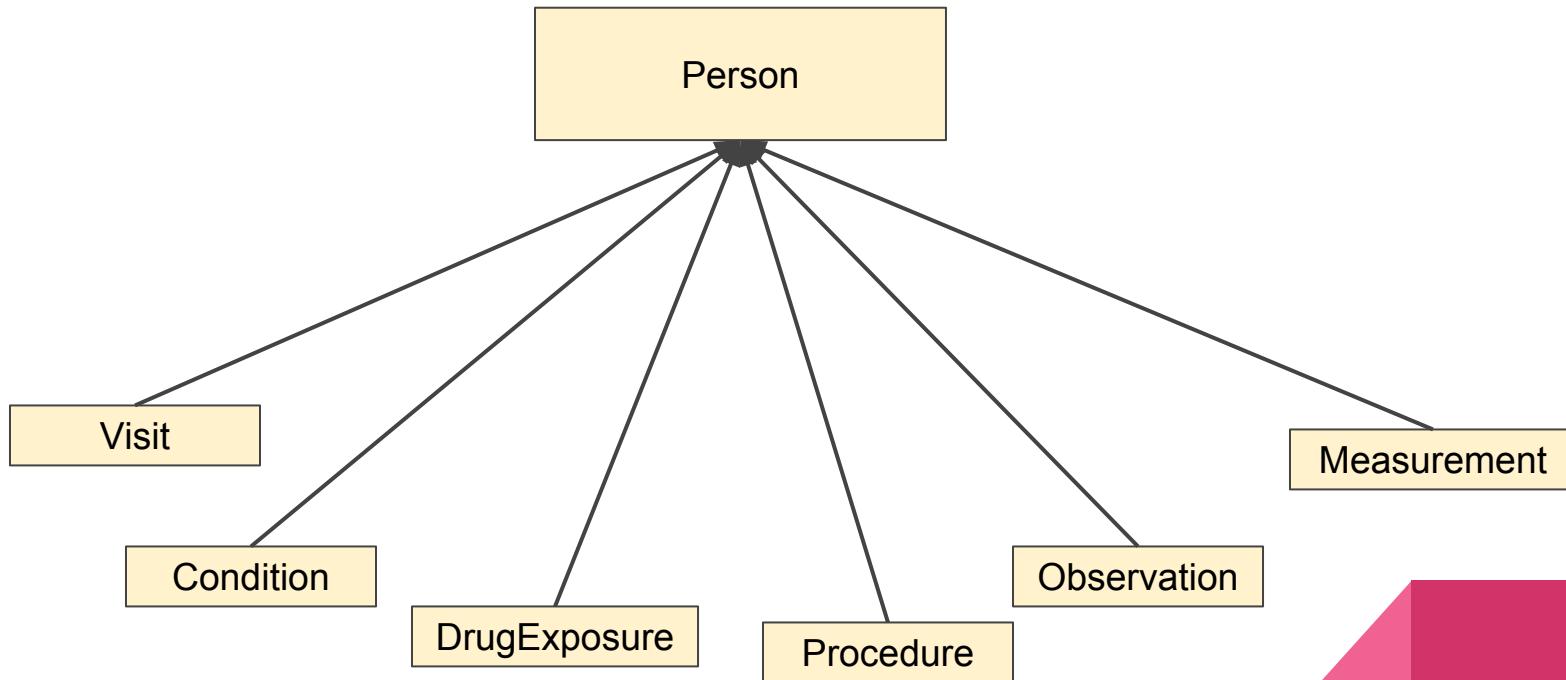
OMOP --> OHDSI

Observational Medical Outcomes Partnership

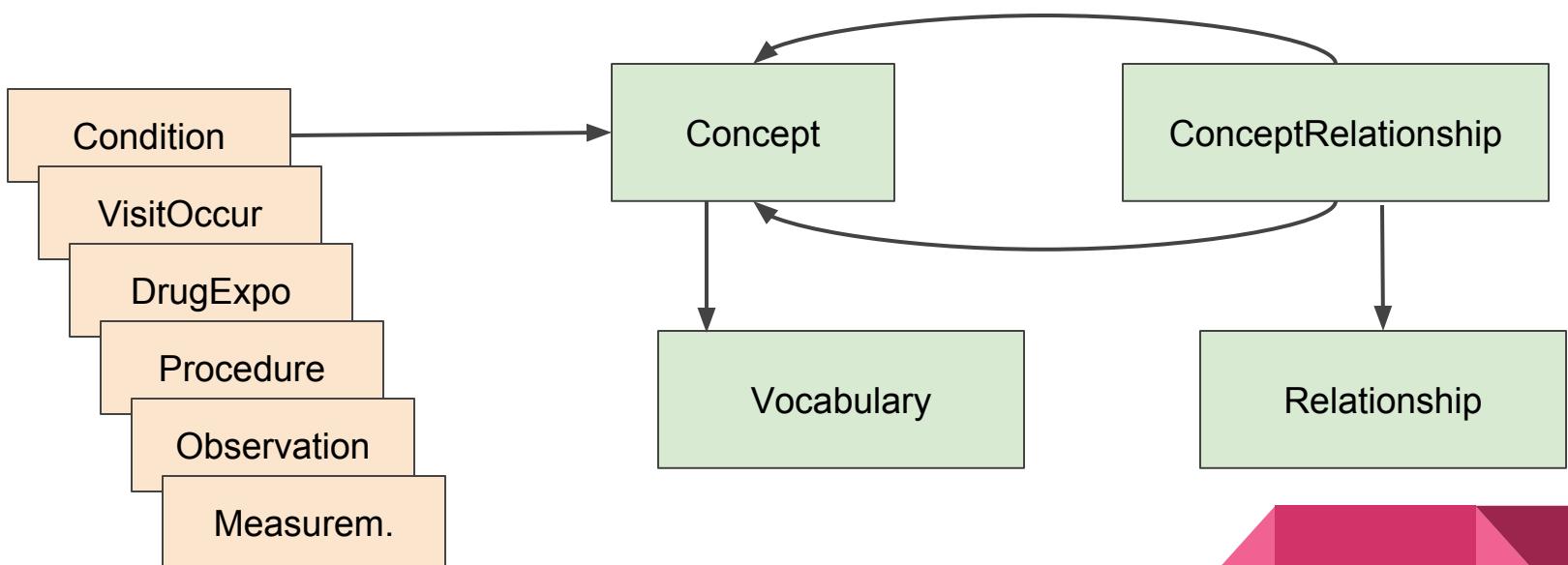
Observational Health Data Sciences and Informatics



Common Data Model (CDM)



Metadados CDM



Exemplo

Person

person_id	year_of_birth	gender_concept_id
128172	1985	8205

Condition_occurrence

condition_occurrence_id	person_id	condition_concept_id	start_date	end_date
8127	128172	812739	2015-01-02	2017-01-01

Concept

concept_id	concept_name	vocabulary_id
812739	PNEUMONIA	InCor

Exemplo

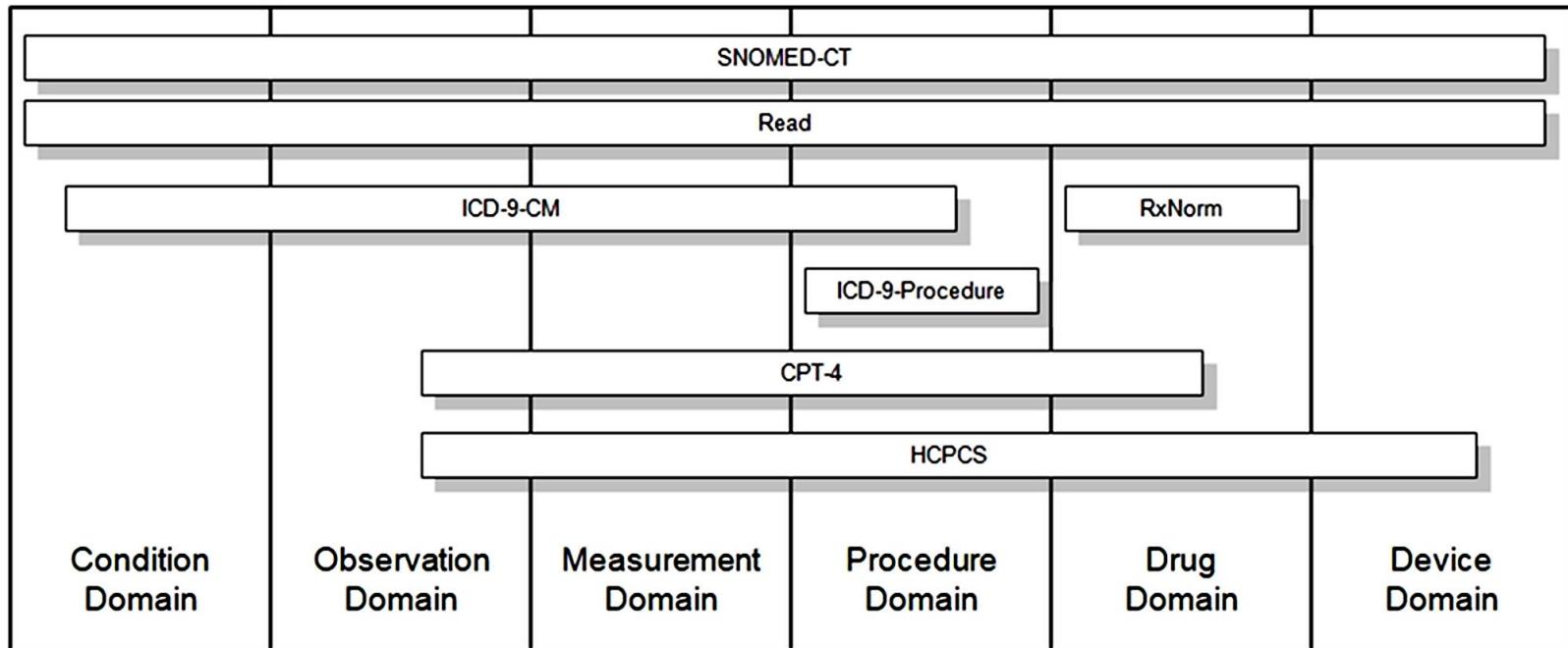
- Concept

concept_id	concept_name	vocabulary_id
812739	PNEUMONIA	InCor
53084003	Bacterial pneumonia	SNOMED-CT
8783836492	J15 - Pneumonia bacteriana não classificada em outra parte	CID-10

- Concept_relationship

concept_id_1	concept_id_2	relationship_id
812739	53084003	Maps to
812739	8783836492	Subsumes
53084003	8783836492	Subsumes

Vocabulários utilizados no CDM



Mineração de Dados

Análise de dados exploratória, através suas propriedades (matemáticas e estatísticas) computáveis.

Fayyad et al, 1996:

- Regressão
- Classificação
- Análise de agrupamentos
- Sumarização, redução de dimensionalidade
- Modelagem de dependências
- Detecção de anomalias, mudanças e desvios

Alguns métodos de Mineração de Dados

Árvores de decisão e regras: Apriori, ID3, C4.5

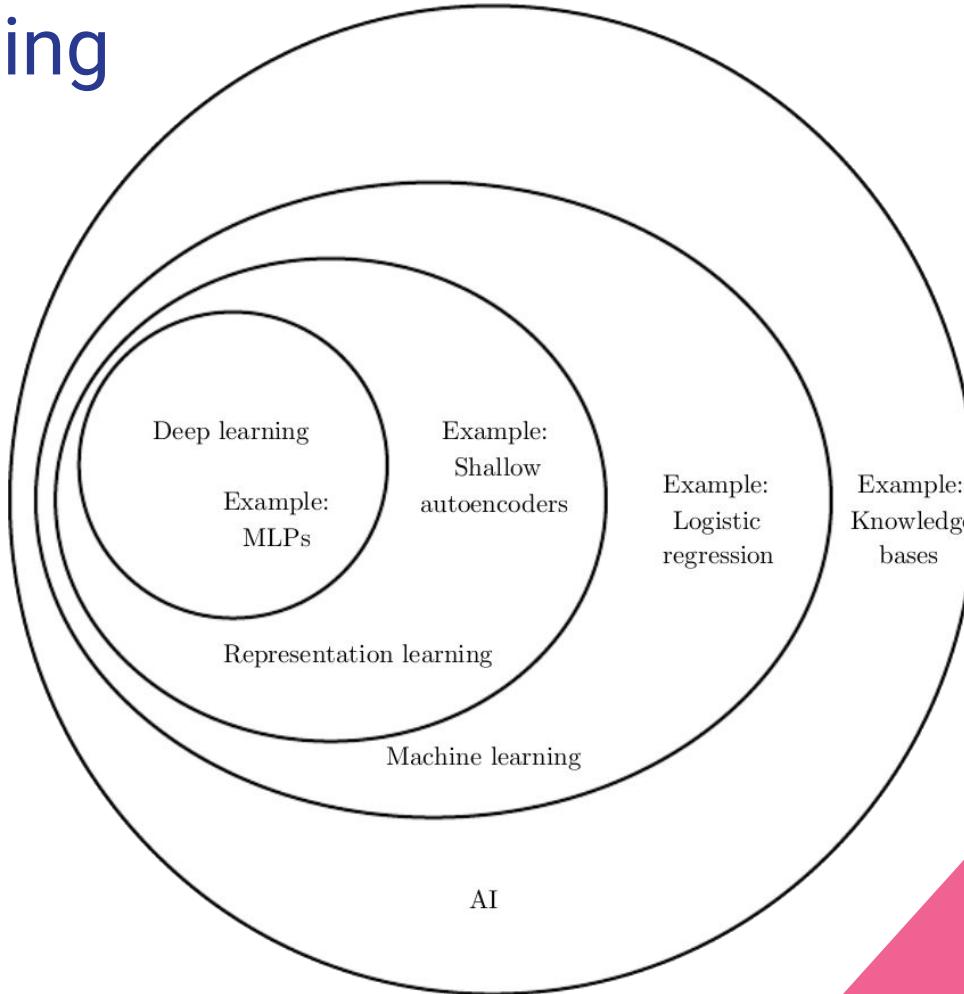
Regressão e classificação não-linear: NNs, Logit, SVM

Por instâncias (exemplos): k-means, método de Ward, GMM

Grafos de dependências probabilísticos

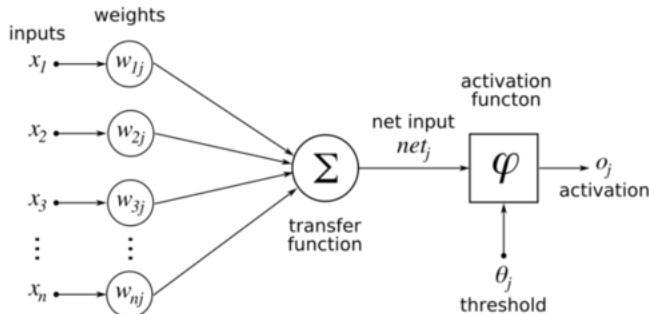
Programação Lógica Indutiva

Deep Learning

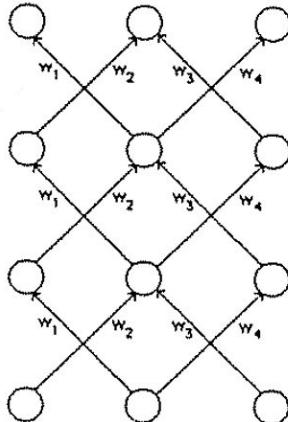


(Goodfellow, 2016)

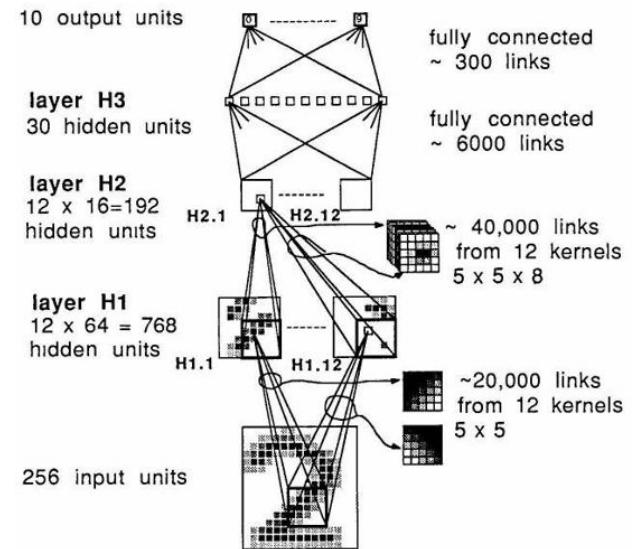
Redes Neurais ---> CNNs



(Rosenblatt, 1957)

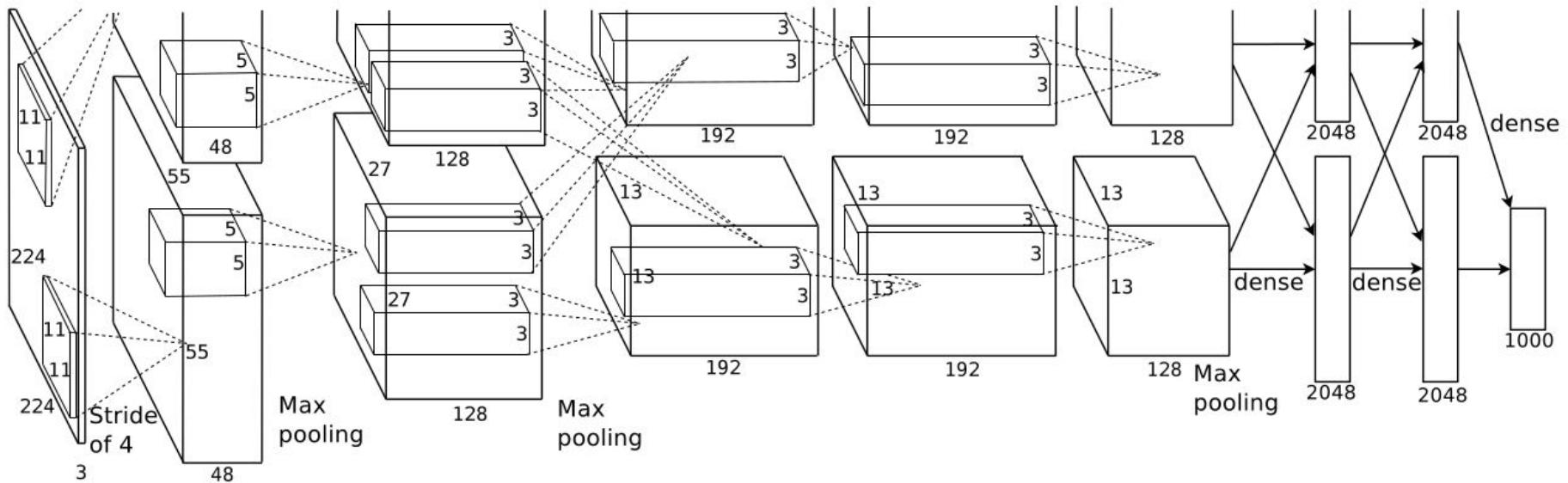


(Rumelhart et al, 1986)



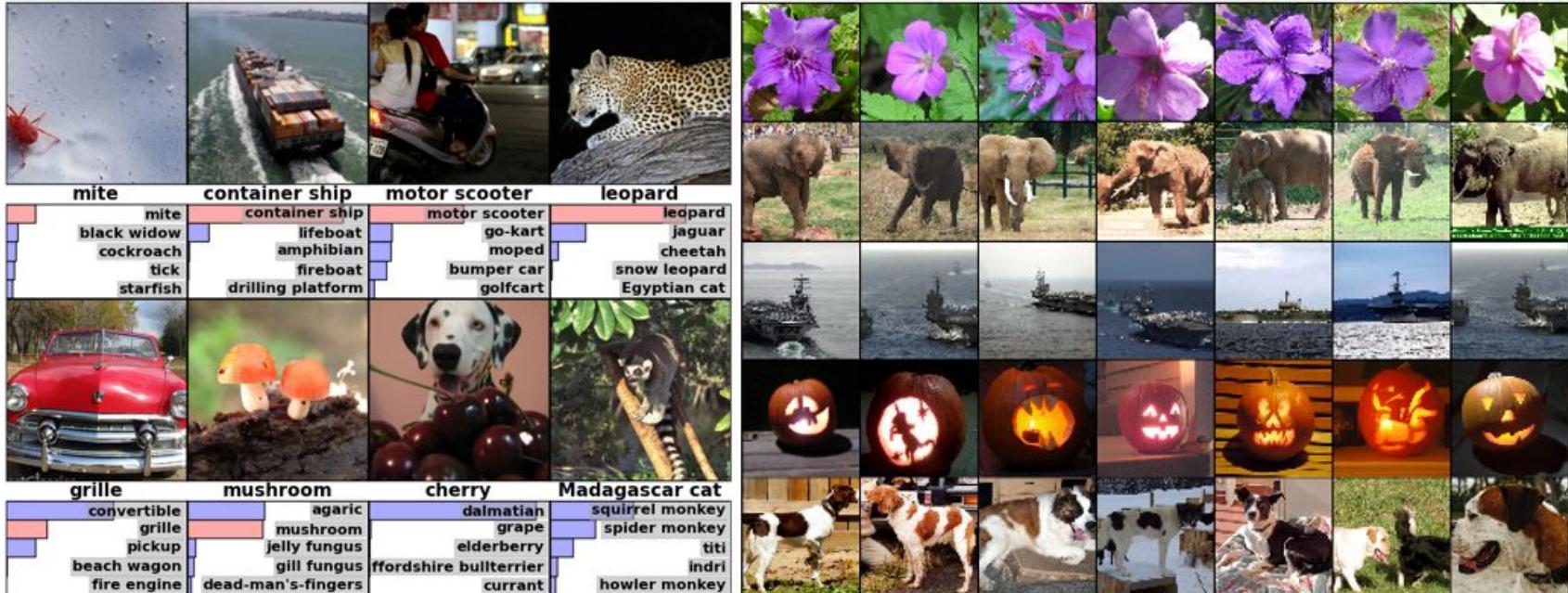
(LeCun et al, 1989)

Deep CNNs ---> Deep Learning



(Krizhevsky,
Sutskever,
Hinton, 2012)

ILSVRC



(Krizhevsky et al, 2012)

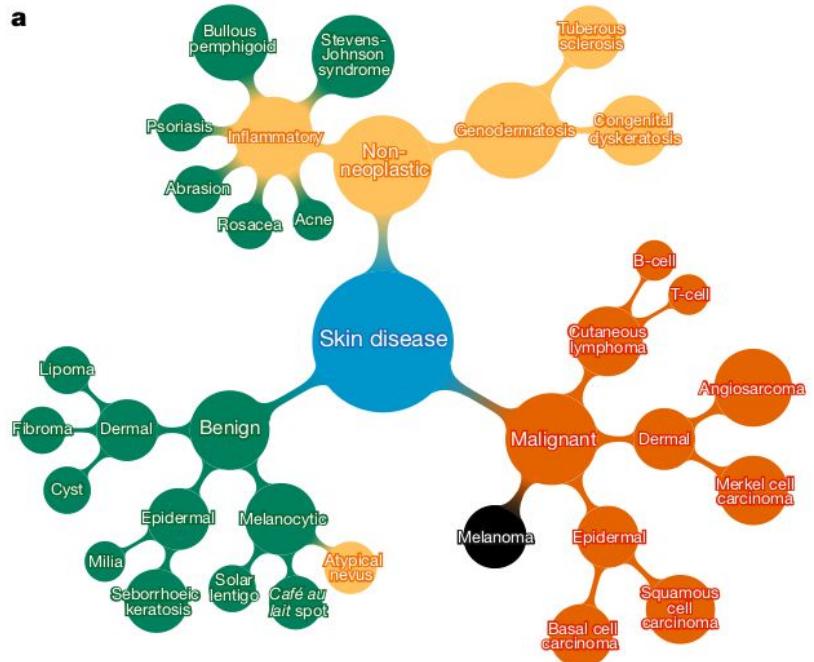
Deep Learning

- Vários modelos, Inception, VGG, YOLO, ResNet
- Versões mobile: ShuffleNet, MobileNet
- Deep Autoencoders
- Redes Adversariais Gerativas (GANs)
- Redes Recorrentes: RNN, RCNN, GRU, LSTM
- Representação de texto: Word2Vec e derivados
- Transferência de aprendizado (subspace learning), ajuste de modelos gerais (pré-treinados) para um domínio específico.

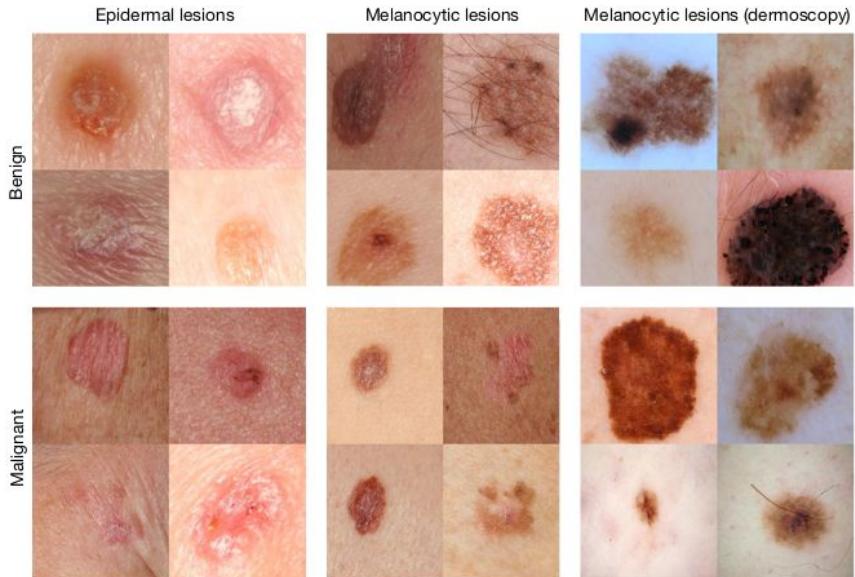
Trabalhos Relacionados

DL em Dermatologia

a



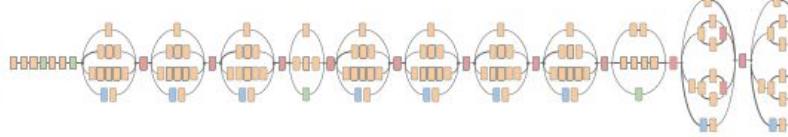
b



Esteva et al, 2017

DL em Dermatologia

Skin lesion image



- Convolution
- AvgPool
- MaxPool
- Concat
- Dropout
- Fully connected
- Softmax

Deep convolutional neural network (Inception v3)

Training classes (757)

Acral-lentiginous melanoma
Amelanotic melanoma
Lentigo melanoma
...

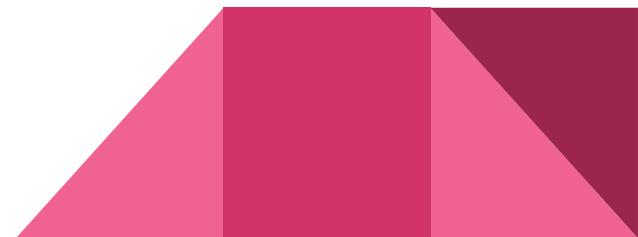
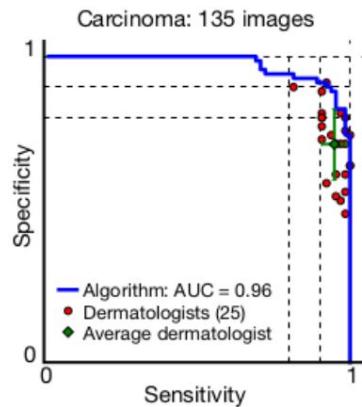
Blue nevus
Halo nevus
Mongolian spot
...

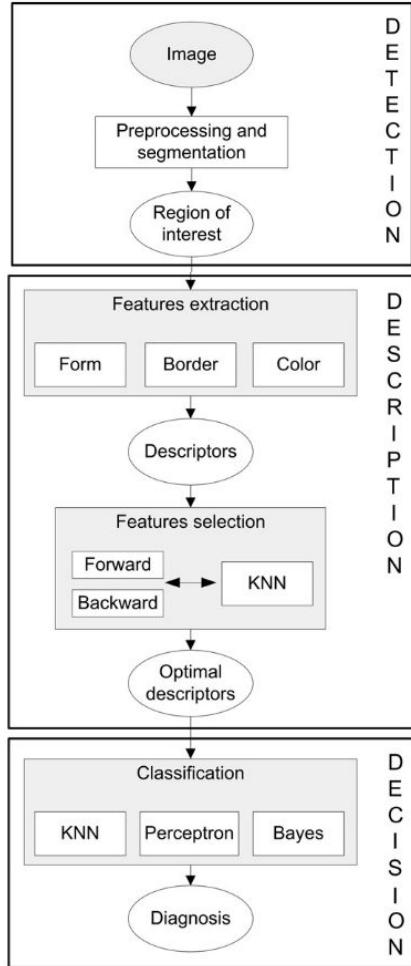
Inference classes (varies by task)

92% malignant melanocytic lesion

8% benign melanocytic lesion

Esteva et al, 2017





(Ruiz et al, 2011)



Figura 6. Imagem de entrada (esquerda), resultado da aplicação do filtro com o algoritmo de segmentação *Statistical Region Merging* (centro) e resultado da aplicação do algoritmo de detecção de borda Canny (direita).

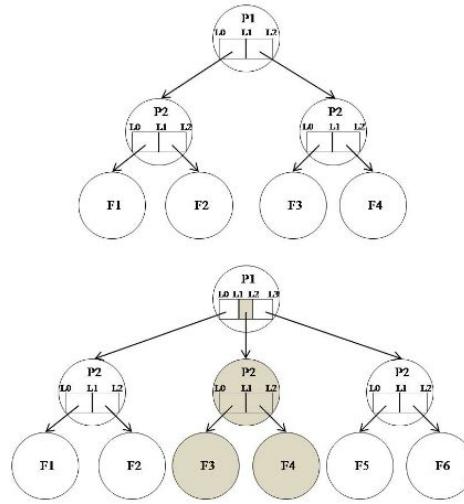
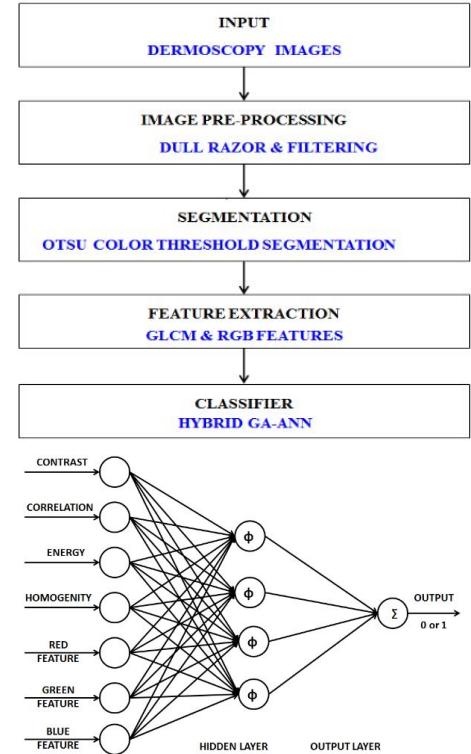


Figura 10. Adaptatividade aplicada à árvore de decisão.

(Ganzeli et al, 2011)



(Aswin et al, 2014)

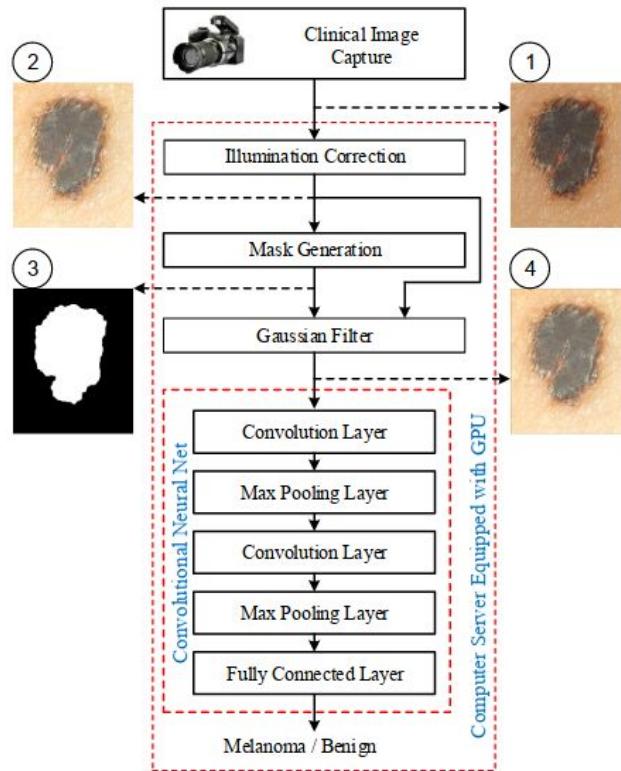
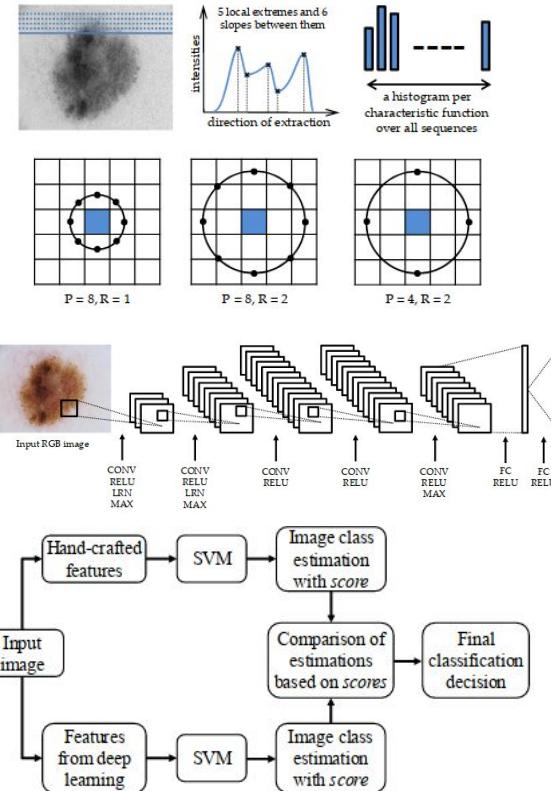
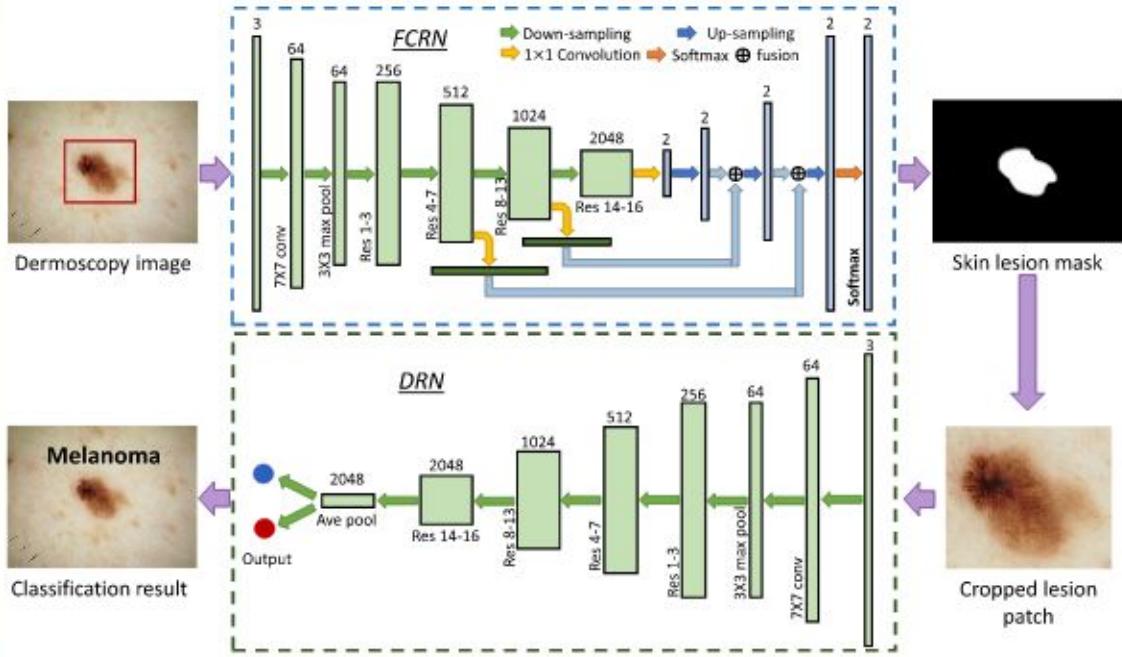
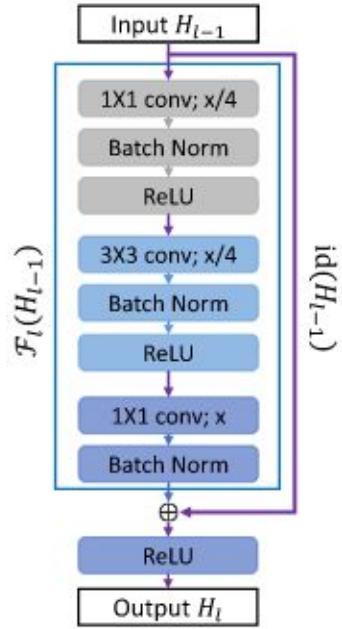


Figure 1. Block diagram of the proposed melanoma detection method for implementation on a GPU equipped server.

(Nasr-Esfahani et al, 2016)



(Majtner et al, 2016)

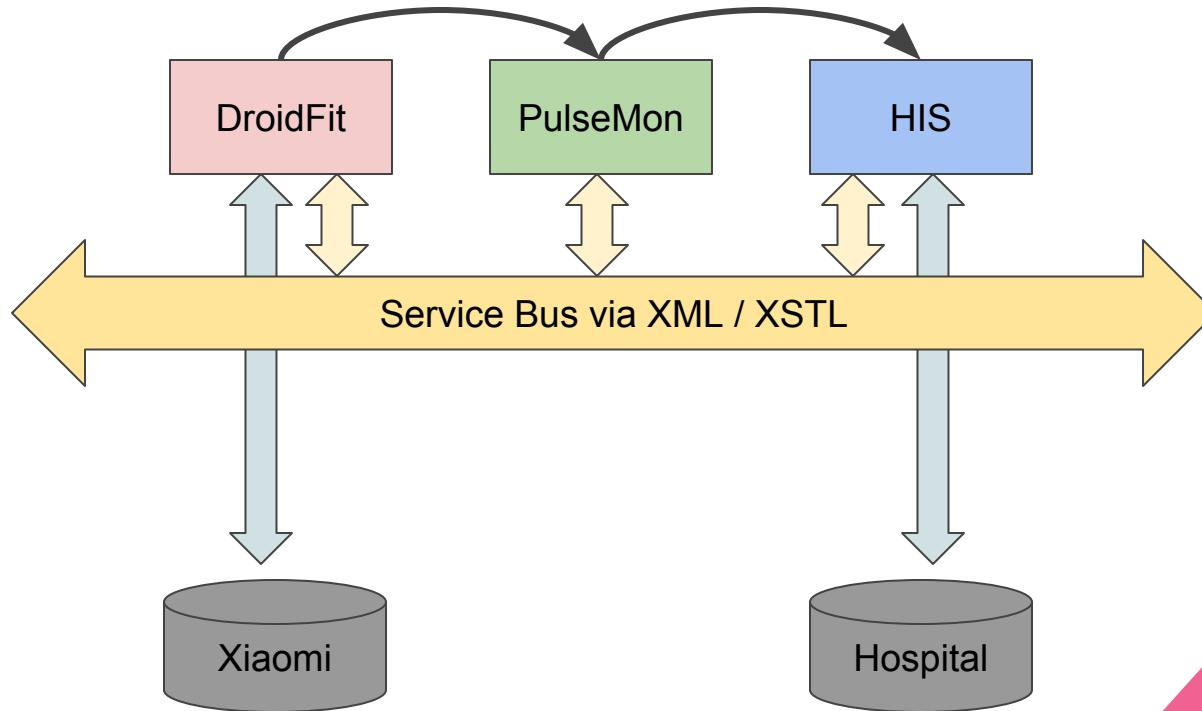


(Yu et al, 2017)

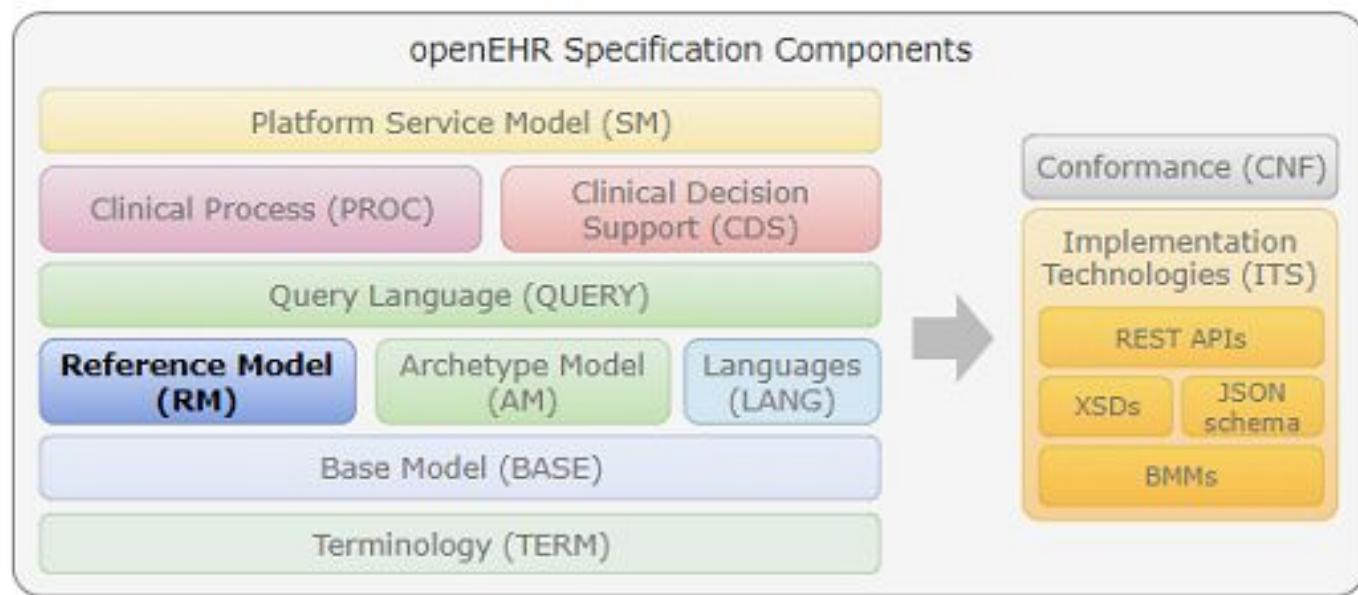
Obs

- Datasets abertos ou advindos de parcerias público-privadas
- Enfoque recente em Deep Learning
- Extração de features (Histogramas, LBP) quando se conhece o domínio
- Avaliação de modelos por estatísticas de recuperação / ROC:
 - Acurácia
 - Precisão × Revocação
 - Sensitividade × Specificidade
 - Área sob curva ROC (AUC)

openEHR

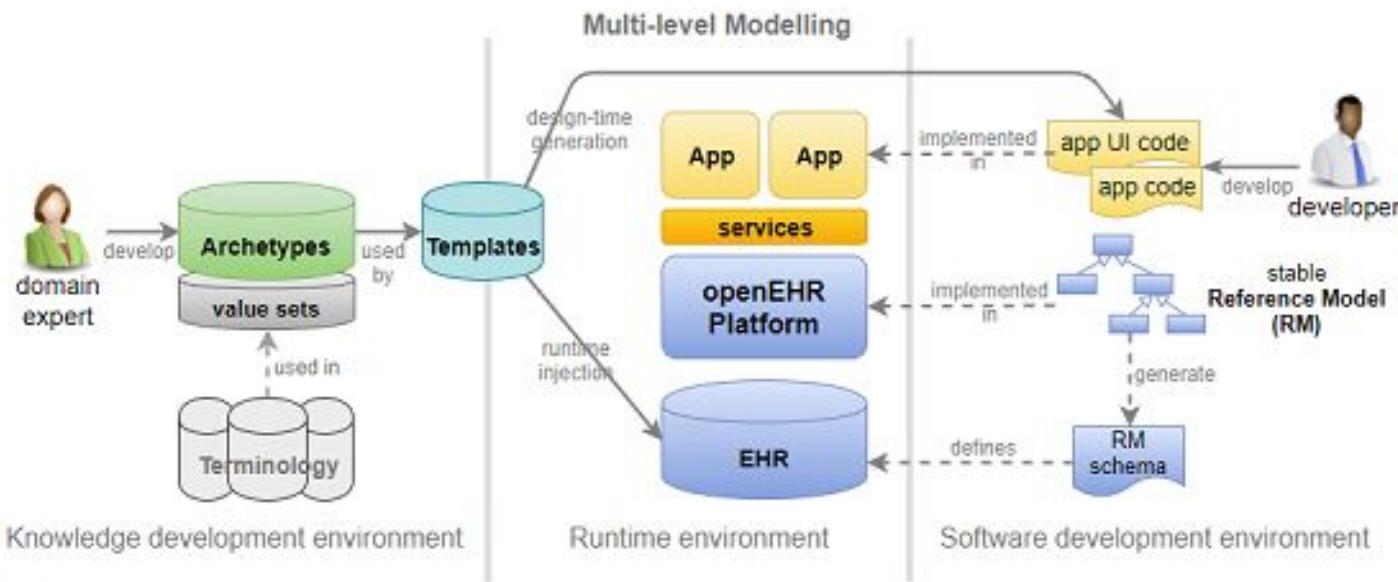


openEHR



(openehr.org, acessado em 2019-03-15)

openEHR



(openehr.org, acessado em 2019-03-15)

Experimentos

ETL do InCor SI³ para InCor-CDM

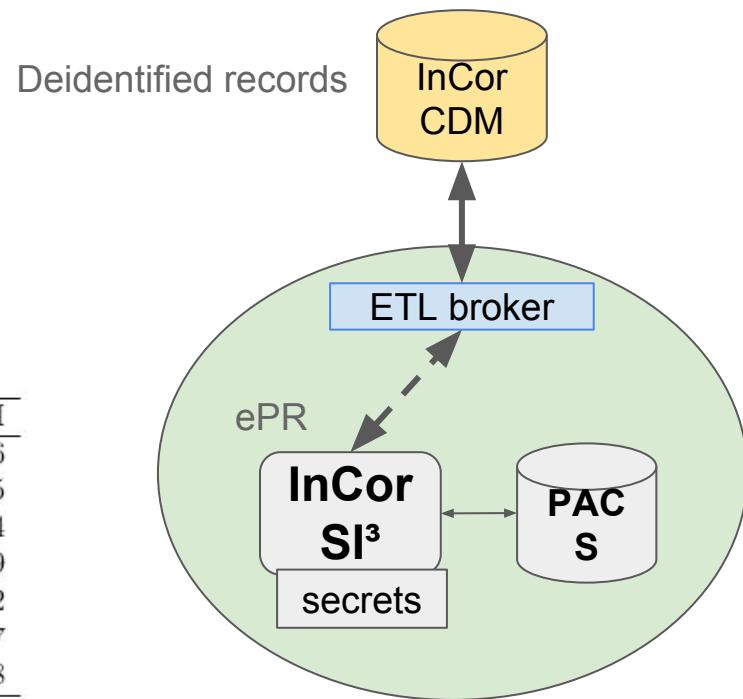
Objetivo: Preparar BD padrão CDM para
Pesquisa clínica (InCor-CDM)

Dataset: InCor SI³ (ePR / EHR)

Domínio	SI3-2016	Pauá	SI3-2018	InCor-CDM
Person	1.116	323	1.346	946
Visit Occurrence	6.427	5.686	7.499	7.305
Condition Occurrence	1.205	1.007	1.361	1.324
Procedure Occurrence	45.024	144	53.945	51.479
Drug Exposure	83.283	2.775	100.052	38.962
Measurement	22.025	20.528	31.095	30.177
Death	17	21	18	18

×1000

Método: ETL



ETL

1. Pseudonimizar Pacientes
2. Para cada tabela do CDM:
 - a. Buscar fontes de dados no SI³
 - b. Junção com paciente e seu pseudônimo
 - c. Truncar valores sensíveis (PHI) -- k-anonimização
 - d. Junção com tabelas de conceitos padrão
 - e. Projeção para o esquema do CDM

ETL

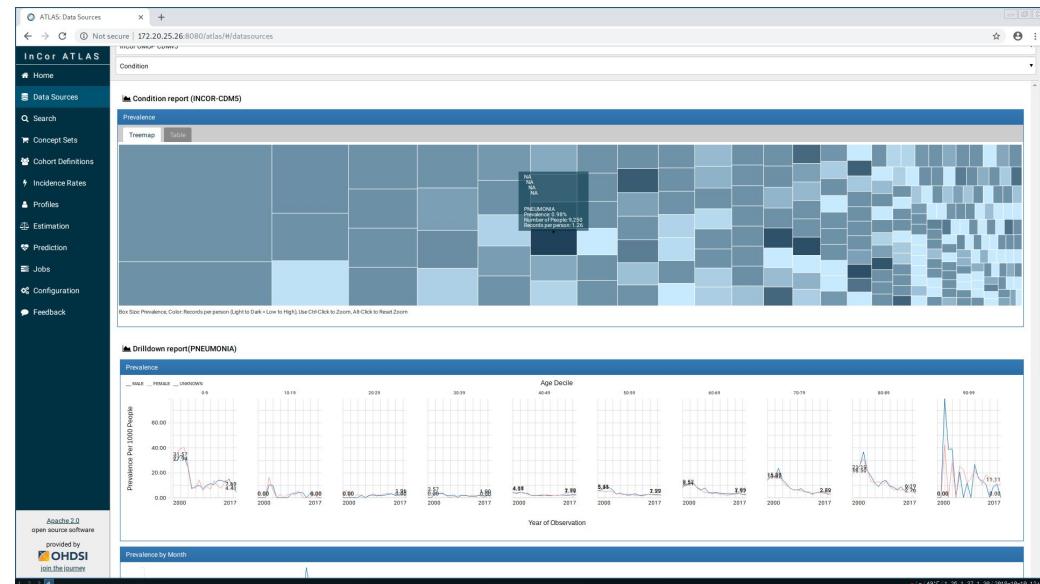
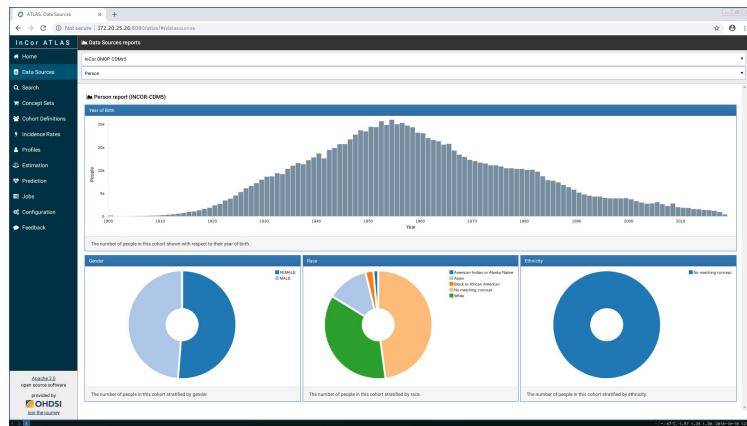
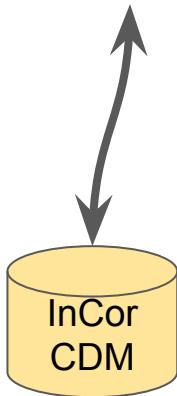
```
INSERT INTO omop.person
SELECT K.new_id
                  AS person_id,
       EXTRACT(YEAR FROM P.dt_nasc) AS year_of_birth,
       COALESCE(G.id, 0)          AS gender_concept_id
FROM si3.pac_paciente P
JOIN omop.keys K ON  K.table='pac_paciente'
                  AND K.src_id=P.paci_id
LEFT JOIN omop.gender_map G ON P.tp_sexo=G.src;
```

Avaliação

1. Ferramentas da OHDSI (Achilles Heel):

Integridade referencial, consistência, dados faltantes e veracidade.

Visual Analytics



ATLAS: Cohort Definitions +

Not secure | 172.20.25.26:8080/atlas/#/cohortdefinition/6

InCor ATLAS

- Home
- Data Sources
- Search
- Concept Sets
- Cohort Definitions
- Incidence Rates
- Profiles
- Estimation
- Prediction
- Jobs
- Configuration
- Feedback

Atenção: projeto em desenvolvimento – Pesquisa / Informática / InCor / HCFMUSP

Cohort #6

DCV Abrahao 2016

Definition Concept Sets Generation Reporting Export Warnings 13

enter a cohort definition description here

Initial Event Cohort

People having any of the following:

a visit occurrence of **Qualquer Admissão**

+ Add Initial Event + Add criteria attribute... Delete Criteria

with continuous observation of at least **0** days before and **0** days after event index date

Limit initial events to: **all events** per person.

Initial event inclusion criteria: From among the initial events, include:

having **all** of the following criteria:

+ Add criteria to group...

Limit cohort of initial events to: **all events** per person.

Remove initial event inclusion criteria

Additional Qualifying Inclusion Criteria

New qualifying inclusion criteria **18+** Copy Delete

1. **18+** enter an inclusion rule description

2. M/F

3. Dx

4. DCV

5. 2a admissao

6. evento subsequente

having **all** of the following criteria: + Add criteria to group...

with the following event criteria: + Add criteria attribute... Delete Criteria

x with age Between 18 and 80

Limit qualifying cohort to: **all events** per person.

Cohort Exit Criteria

Add a cohort exit criteria:

- Based on a fixed time period relative to initial event start or end date
- Based on the end of an era of persistent exposure to any drug within a defined concept set

The minimum date from amongst the selected cohort exit criteria occurring after the cohort entry date will be selected as the end date for the person's episode.

ATLAS: Cohort Definitions X +

Not secure | 172.0.25.26:8080/atlas/#/cohortdefinition/6 ☆ 🌐 ⚙

InCor ATLAS Atenção: projeto em desenvolvimento – Pesquisa / Informática / InCor / HCFMUSP 🔔

[Home](#)
[Data Sources](#)
[Search](#)
[Concept Sets](#)
Cohort Definitions
[Incidence Rates](#)
[Profiles](#)
[Estimation](#)
[Prediction](#)
[Jobs](#)
[Configuration](#)
[Feedback](#)

Cohort #6

DCV Abrahao 2016

Definition 🕒 Concept Sets Generation Reporting Export Warnings 13

Available CDM Sources

Source Name	Generation Status	People	Records	Generated	Generation Duration
InCor OMOP CDMv5	COMPLETE	23,339	23,339	10/26/2018 2:48:20 PM	470.431s 🕒 View Reports

Inclusion Report Cohort Features By Events By Person

Inclusion Report for InCor OMOP CDMv5

Inclusion Rule	Summary Statistics:	Match Rate	Matches	Total	Attrition Visualization	Switch to intersect view
		N	% Remain	% Diff		
1. Dx		497,263	52.56%	47.44%		Switch to intersect view
2. 18+		444,307	46.97%	5.60%		
3. M/F		417,555	44.14%	2.83%		
4. DCV		95,115	10.05%	34.08%		
5. 2a admissao		72,718	7.69%	2.37%		
6. evento subsequente		26,065	2.76%	4.93%		

Apache 2.0
open source software

provided by OHDSI
join the journey

Avaliação

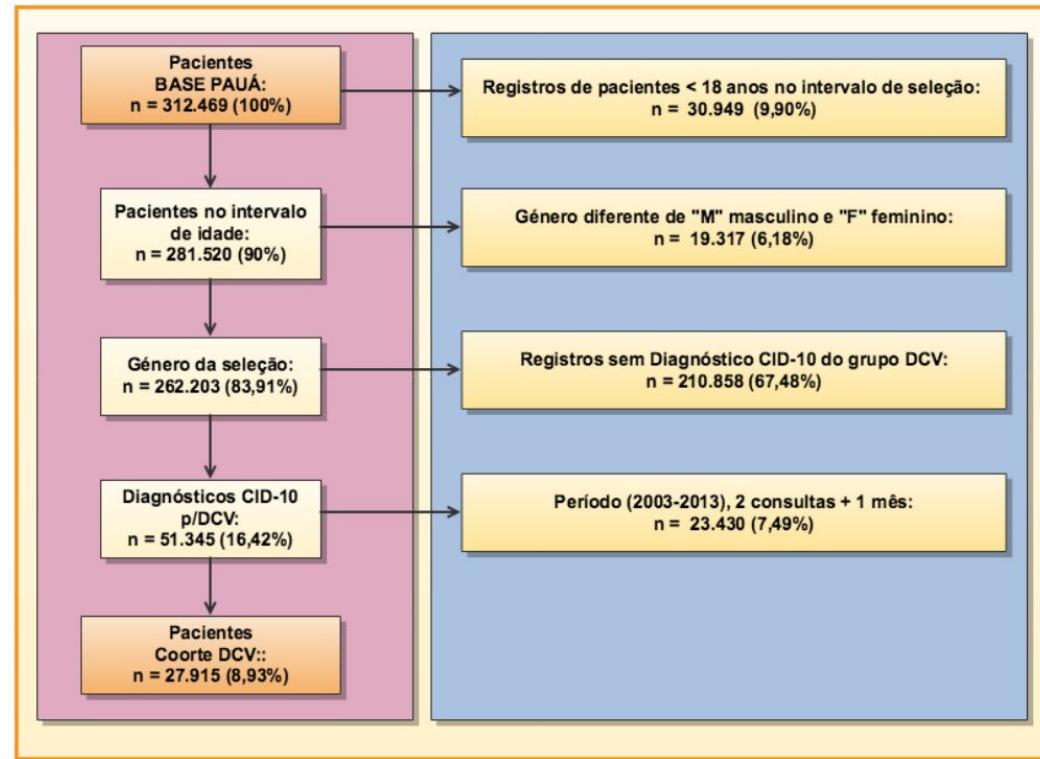
1. Ferramentas da OHDSI (Achilles Heel):

Integridade referencial, consistência, dados faltantes e veracidade.

2. Repetir estudo de (Abrahao et al, 2010) -- Coorte DCV

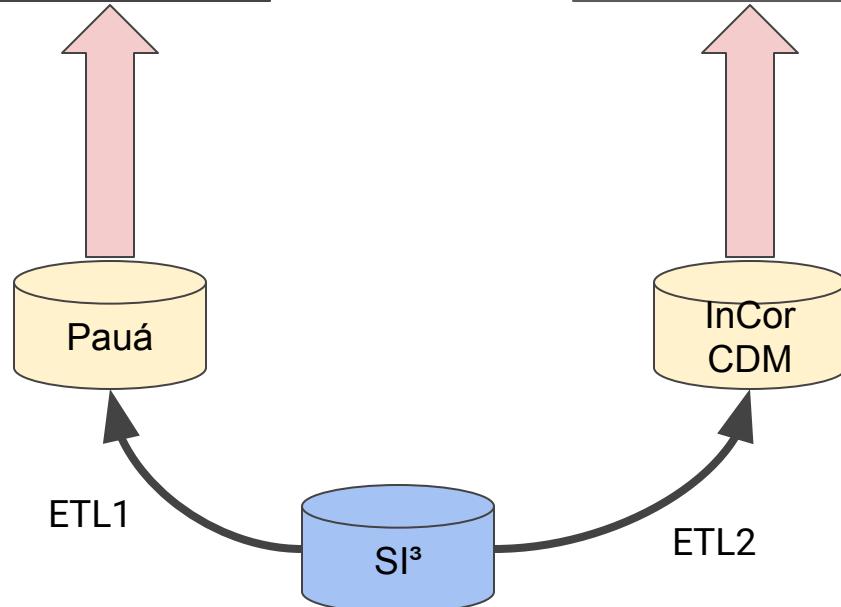
Seleção de pacientes com diagnóstico de doença cardiovascular e utilizando medicamentos “estatinas”.

Coorte DCV



(Abrahao et al, 2010)

Cliente SQL
(dbeaver)



Variação de parâmetros / thresholds

Table 5 – Varying condition start periods.

Criteria \ (years)	2003-2013	2000-2013	2000-2016
Initial		778,015	
Dx, 18+, M/F		303,847	
CVD	45,710	49,942	63,656
People	39,498	43,293	54,126

Table 6 – Varying 2nd visit event start after index.

Criteria \ (days)	All	365	180	90
Initial		778,015		
Dx, 18+, M/F		303,847		
CVD	45,710	44,228	43,950	43,667
People	39,498	35,457	32,767	29,414

Estatísticas de avaliação

Table 5 – Varying condition start periods.

Criteria	(years)	2003-2013	2000-2013	2000-2016
Initial			778,015	
Dx, 18+, M/F			303,847	
CVD		45,710	49,942	63,656
People		39,498	43,293	54,126

Table 6 – Varying 2nd visit event start after index.

Criteria	(days)	All	365	180	90
Initial			778,015		
Dx, 18+, M/F			303,847		
CVD		45,710	44,228	43,950	43,667
People		39,498	35,457	32,767	29,414

#	TPR	FPR	PPV	NPV	ACC	F1
1	.905	.041	.674	.990	.953	.772
2	.901	.040	.678	.990	.954	.774
3	.903	.040	.677	.990	.954	.774
4	.904	.041	.676	.990	.954	.773
5	.905	.041	.674	.990	.953	.772
6	.907	.052	.623	.990	.944	.738
7	.907	.052	.622	.990	.944	.738
8	.907	.052	.620	.990	.943	.736
9	.889	.040	.680	.990	.954	.775
10	.877	.031	.727	.988	.960	.795
11	.829	.027	.743	.983	.960	.784
12	.754	.023	.752	.976	.957	.753

Curva ROC (AUC = 0.938)

Table 5 – Varying condition start periods.

Criteria \ (years)	2003-2013	2000-2013	2000-2016
Initial		778,015	
Dx, 18+, M/F		303,847	
CVD	45,710	49,942	63,656
People	39,498	43,293	54,126

Table 6 – Varying 2nd visit event start after index.

Criteria \ (days)	All	365	180	90
Initial		778,015		
Dx, 18+, M/F		303,847		
CVD	45,710	44,228	43,950	43,667
People	39,498	35,457	32,767	29,414

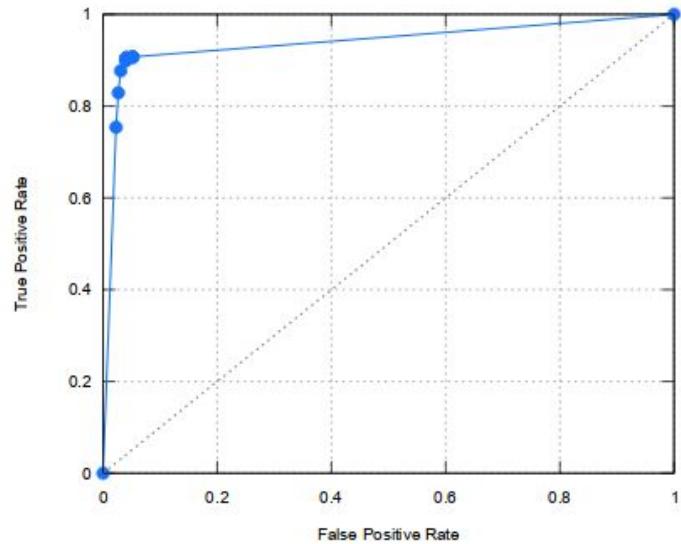


Figure 1 – Empirical ROC curve for Table 8 (AUC = 0.938).

Table 5 – Varying condition start periods.

Criteria \ (years)	2003-2013	2000-2013	2000-2016
Initial		778,015	
Dx, 18+, M/F		303,847	
CVD	45,710	49,942	63,656
People	39,498	43,293	54,126

Table 6 – Varying 2nd visit event start after index.

Criteria \ (days)	All	365	180	90
Initial		778,015		
Dx, 18+, M/F		303,847		
CVD	45,710	44,228	43,950	43,667
People	39,498	35,457	32,767	29,414

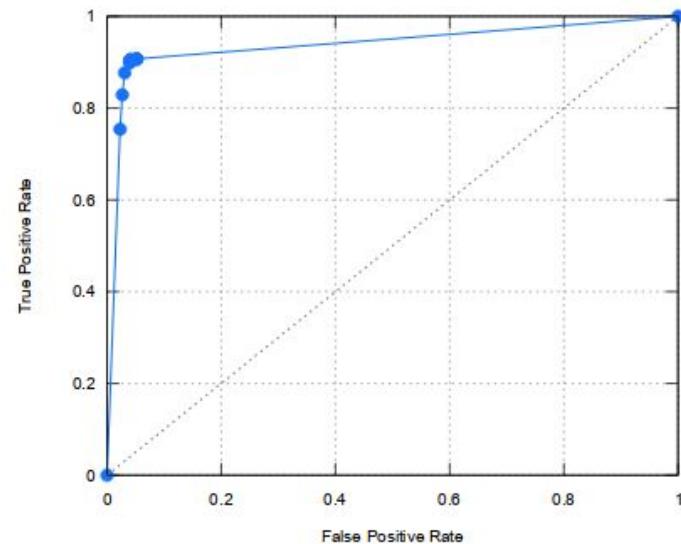


Figure 1 – Empirical ROC curve for Table 8 (AUC = 0.938).



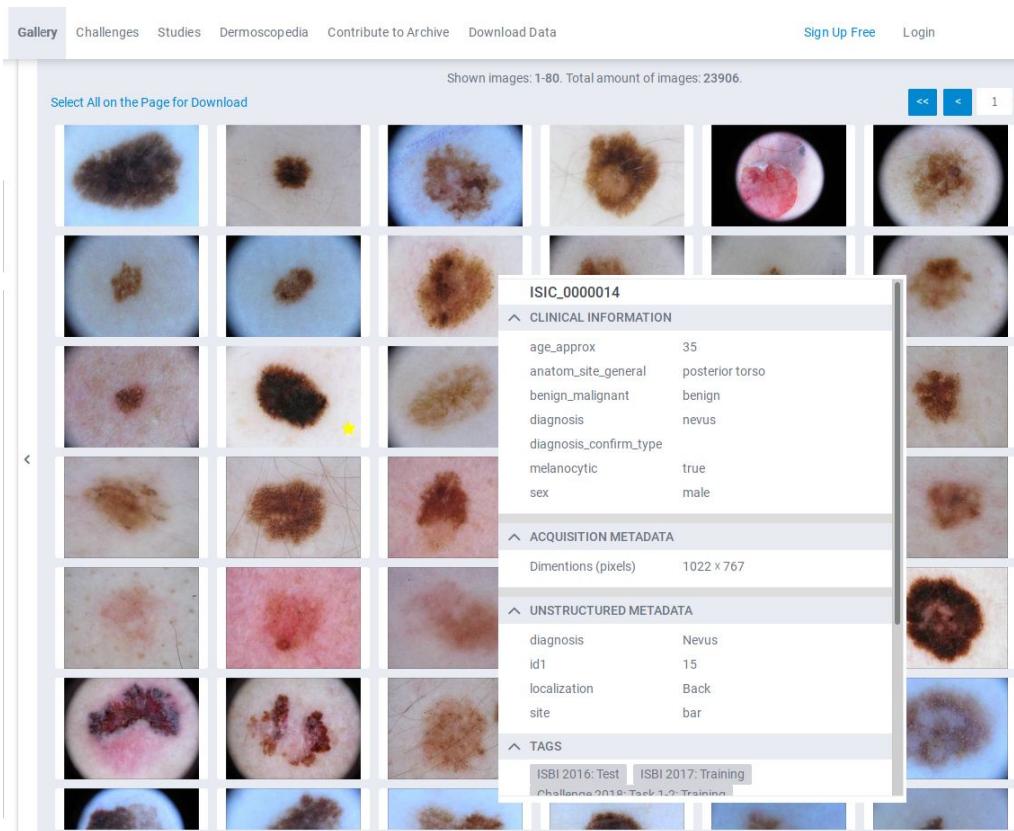
DermaDL

Objetivos:

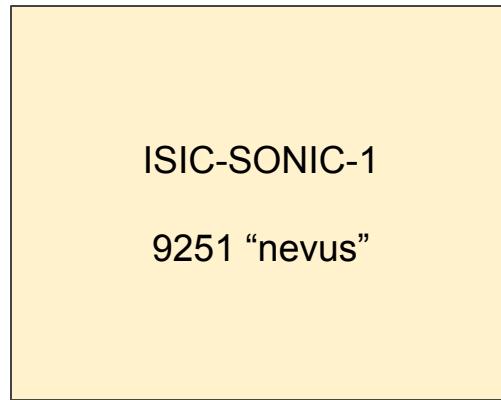
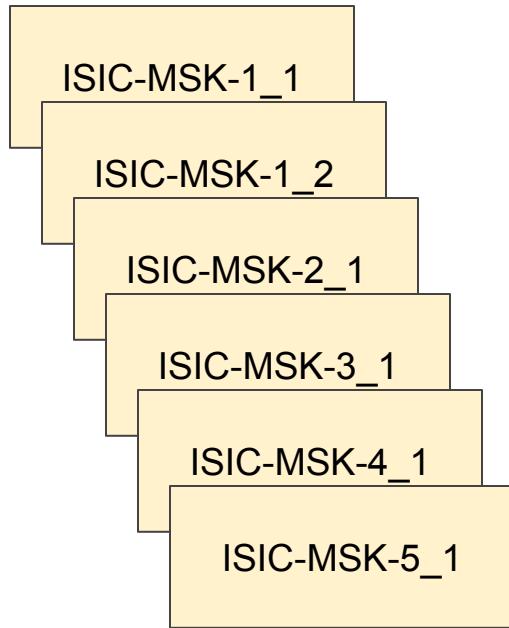
- Avaliar DL na detecção de câncer de pele (melanoma)
- App mobile

Dataset: ISIC-Archive (13.7k)

Método: Transfer Learning
Inception-v3 / MobileNet



ISIC

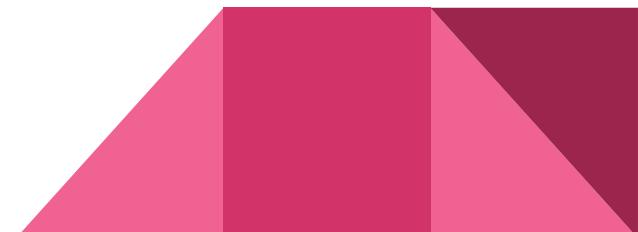


ISIC-MSK-*

2202	Nevus
826	Melanoma
413	Seborrheic keratosis
242	<NULL>
71	Lentigo NOS
57	Solar lentigo
30	Basal cell carcinoma
27	Lentigo simplex
50	*

ISIC-UDA-*

408	Nevus
193	Melanoma
6	Seborrheic keratosis
3	Basal cell carcinoma
2	<NULL>
2	dermatofibroma
2	angioma
1	Lichenoid keratosis



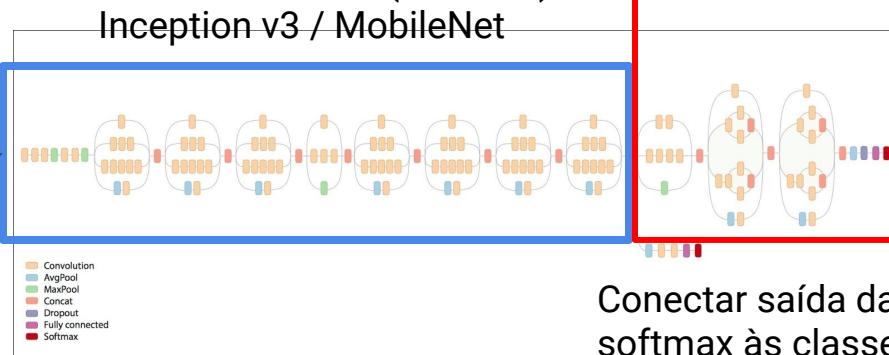


resize 1000px
auto-curves
crop /mask ROI



zoom
rotate
color variations
resize 300px

Parâmetros fixados (FROZEN) Inception v3 / MobileNet



Coneectar saída da
softmax às classes
do ISIC e retomar
treinamento

- actinic keratoses (329)
- angiofibroma or fibrous papule (1)
- atypical melanocytic proliferation (13)
- basal cell carcinoma (586)
- dermatofibroma (122)
- lentigo NOS (71)
- lentigo simplex (27)
- lichenoid keratosis (1)
- melanoma (2169)
- nevus (18566)
- other (10)
- scar (1)
- seborrheic keratosis (419)
- solar lentigo (57)
- squamous cell carcinoma (29)
- unknown (249)

Resultados iniciais

Tabela 10: Execuções e parâmetros. A instância sc-n5 obteve acurácia geral $f_acc = 91\%$

	sc-n1	sc-n2	sc-n3	sc-n4	sc-n5	sn-n1	sn-n2	sn-n3	sn-n4	sn-n5	sn-n6
input	all	all	M	M+S	M+S	M	M+S	M	M	M	M
test_%	25	20	10	10	10	10	10	10	10	10	10
vali_%	25	20	10	10	10	10	10	10	10	10	10
flip_lr	1	1	1	1	1	1	1	1	1	1	1
r_crop	20	10	20	20	20	50	50	50	40	50	50
r_scale	20	10	20	20	20	50	50	50	30	30	30
r brig	20	10	20	20	20	20	20	20	20	20	20
steps	4000	8000	8000	32000	32000	20000	4000	4000	4000	4000	4000
f_acc					.910	.827	.814	.531	.458	.485	.501

Avaliando acurácia por cada classe, a instância sc-n5 detectou 87.4% dos 159 melanomas do conjunto ISIC-UDA-1_1.

Conclusão

Conclusão

- InCor-CDM permite seleção de coortes para pesquisa clínica, mas qualidade do dataset pode (e deve) ser melhorada
 - Concordância com Abrahao et al 2012:
 - precisão = 62~75%
 - revocação = 75~91%
 - F1 = 74~80%
 - AUC = 0,938
- Os resultados do transfer learning da Inception-v3 para imagens dermatológicas sugere potencial para triagem de pacientes com câncer de pele, e.g. áreas remotas
 - 91% de acurácia geral
 - 87% de precisão na detecção da classe “melanoma”

Trabalhos futuros

Finalizar experimentos do DermaDL e lançar app móvel

Adicionar dados complexos (PACS) ao InCor-CDM

Desenvolver aplicações de outras técnicas de DL (GANs, LSTMs)

A photograph of a deep, narrow canyon with layered rock walls. The rock is dark grey on the left and light brown on the right, showing clear horizontal sedimentary layers. A small river flows through the bottom of the canyon, its water reflecting the surrounding rock. Sunlight filters down from the top, creating bright highlights on the rock faces and casting deep shadows in the crevices.

Obrigado

Imagen: Cânion do rio Poti

Este projeto foi apoiado pela CAPES, CNPq e pelo processo FAPESP número 2018/11424-0.