



Oportunidades y desafíos de la Inteligencia Artificial Generativa en Salud

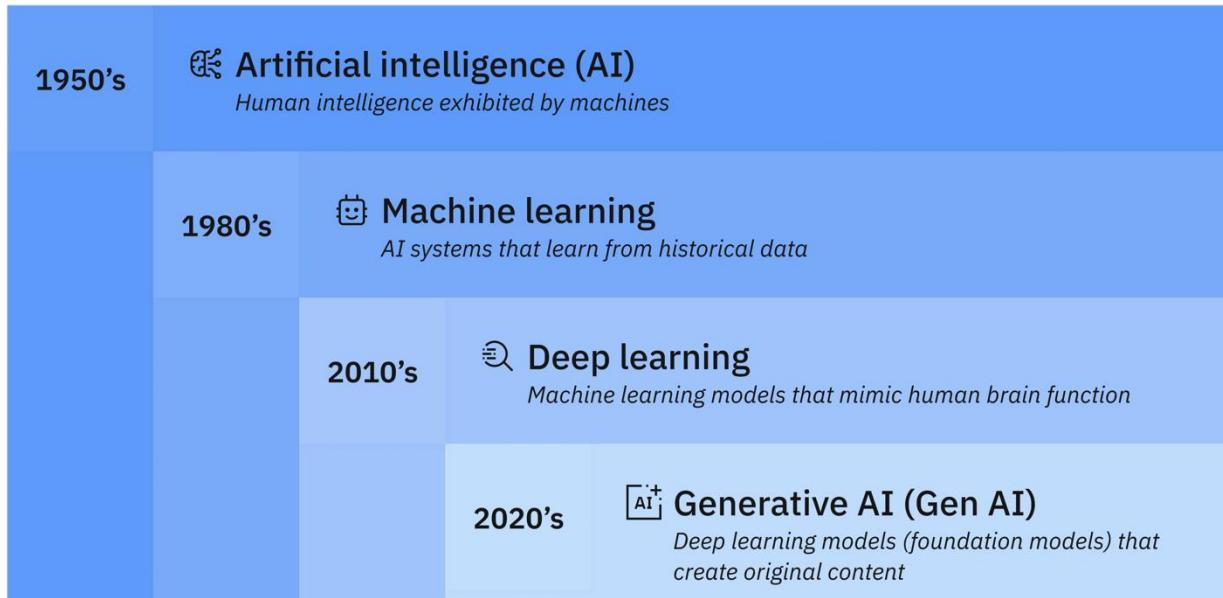
Dr. Rodrigo Salas Fuentes
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Artificial Intelligence

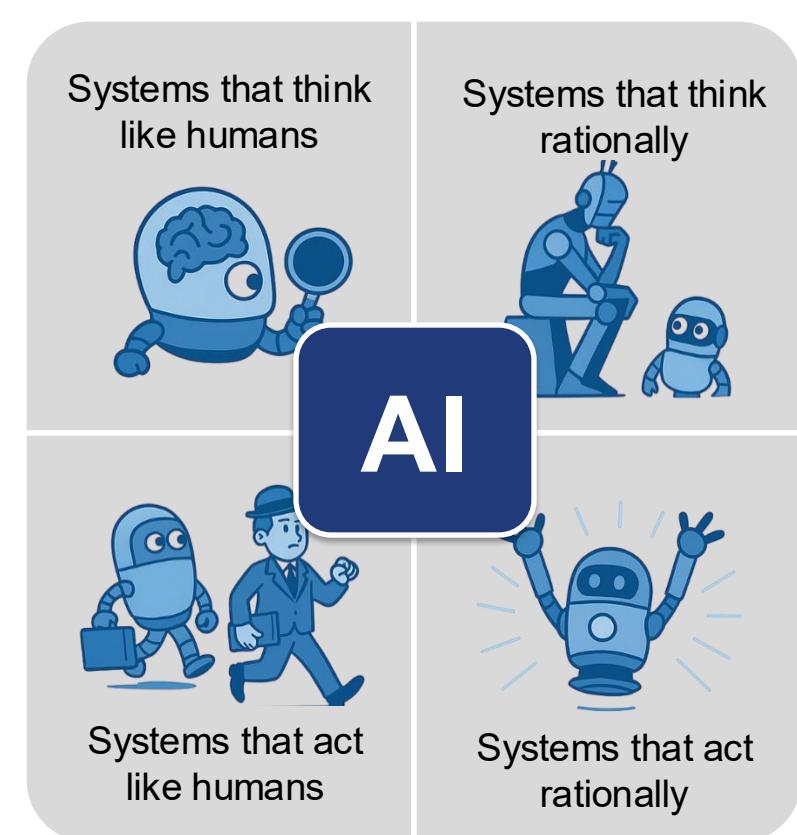
AI

What is Artificial Intelligence



<https://www.ibm.com/mx-es/think/topics/sentient-ai>

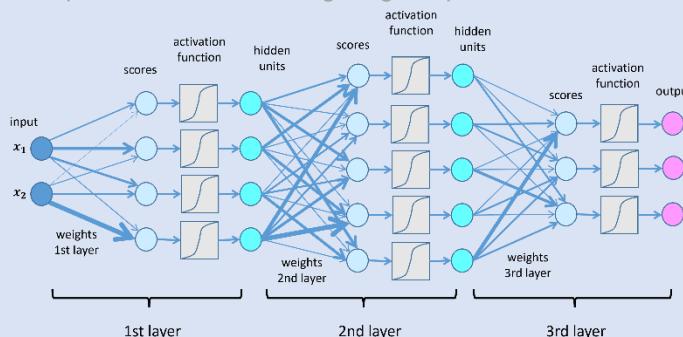
Artificial Intelligence (AI) is technology that enables computers and machines to simulate human learning, comprehension, problem solving, decision making, creativity and autonomy.



Stuart Russell y Peter Norvig, 2020

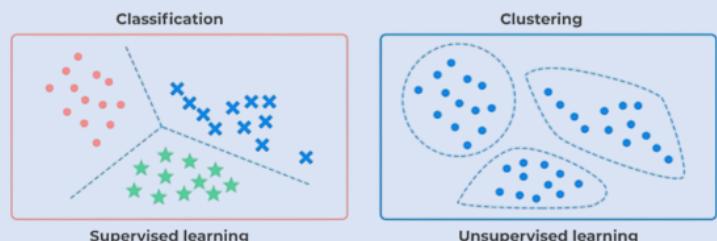
AI Methods

<https://lamarri-institute.org/blog/deep-neural-networks/>



Deep Learning

<https://www.superannotate.com/blog/image-classification-basics>



Machine Learning

<https://devopedia.org/natural-language-processing>

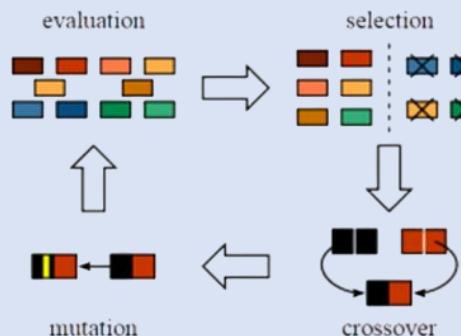
Understanding Language

 "Literally ur facebook message app is useless, you only want it to increase profit. Please fix yourself. Its sad @facebook"

- Emotion: Frustrated
- Tone: Negative, Subjective
- Organization: Facebook
- Product: Messenger App
- Adjectives: "useless", "sad"
- Language: English, Informal

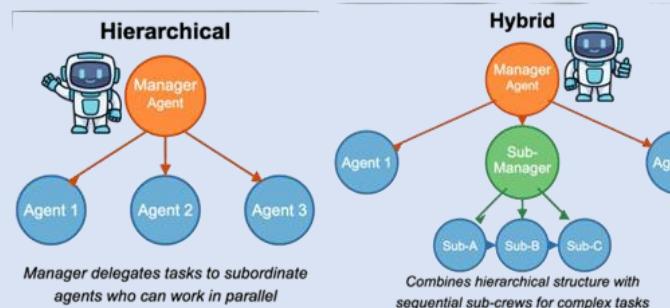
Natural Language Processing

<https://doi.org/10.1145/3446132.3446142>



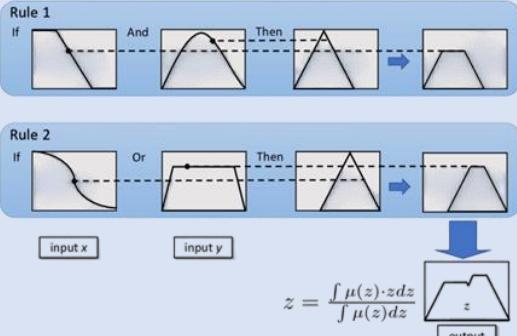
Metaheuristics

<https://l1nq.com/at8FT>



Multi-Agent Systems

<http://dx.doi.org/10.1016/j.ins.2018.09.005>



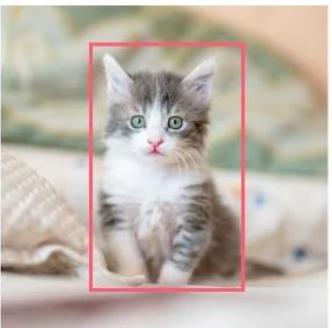
Fuzzy Inference Systems

Types of Visual Tasks

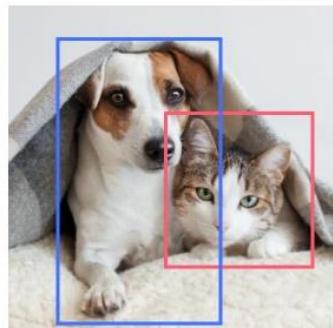
Classification



Classification + Localization



Object Detection



Instance Segmentation



Cat

Cat

Cat, Dog

Cat, Dog

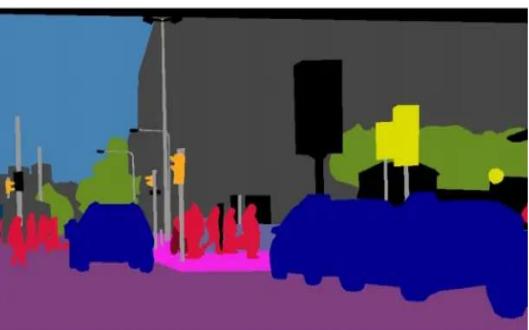
Single object

Multiple objects

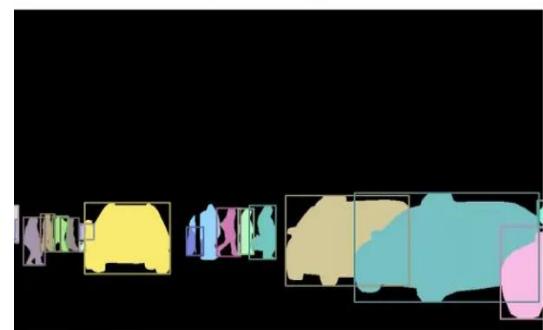
<https://www.superannotate.com/blog/image-segmentation-for-machine-learning>



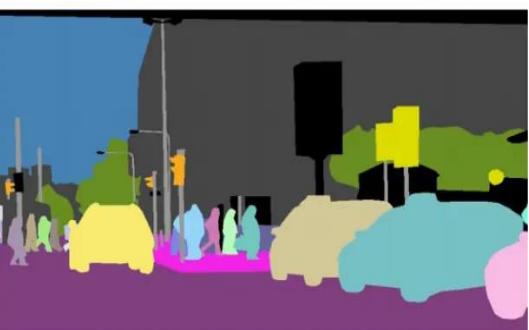
(a) image



(b) semantic segmentation



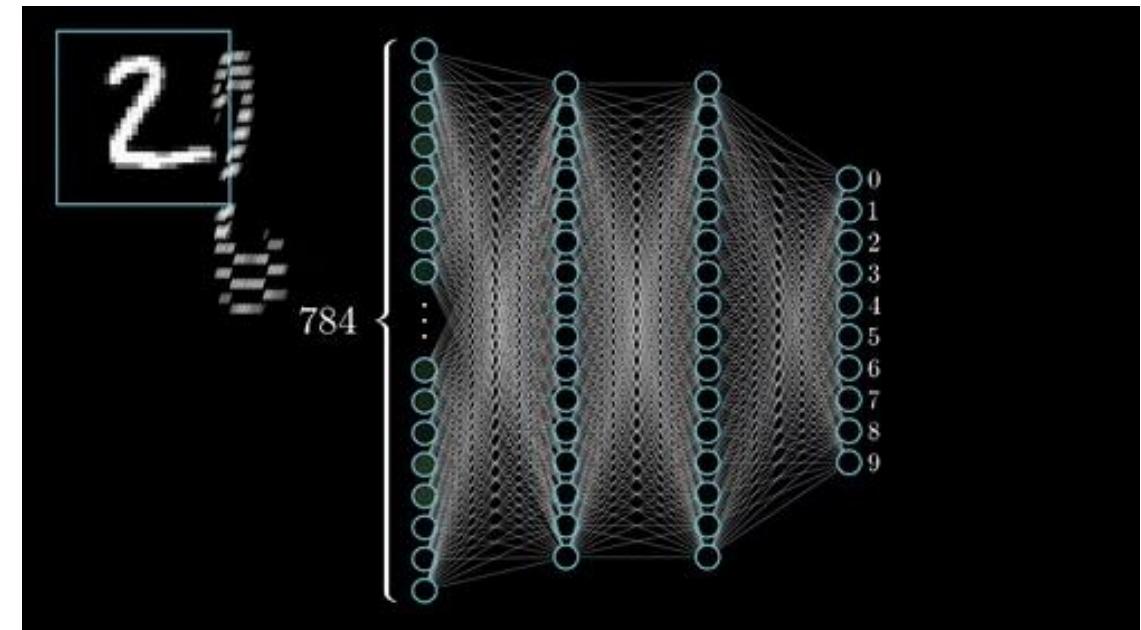
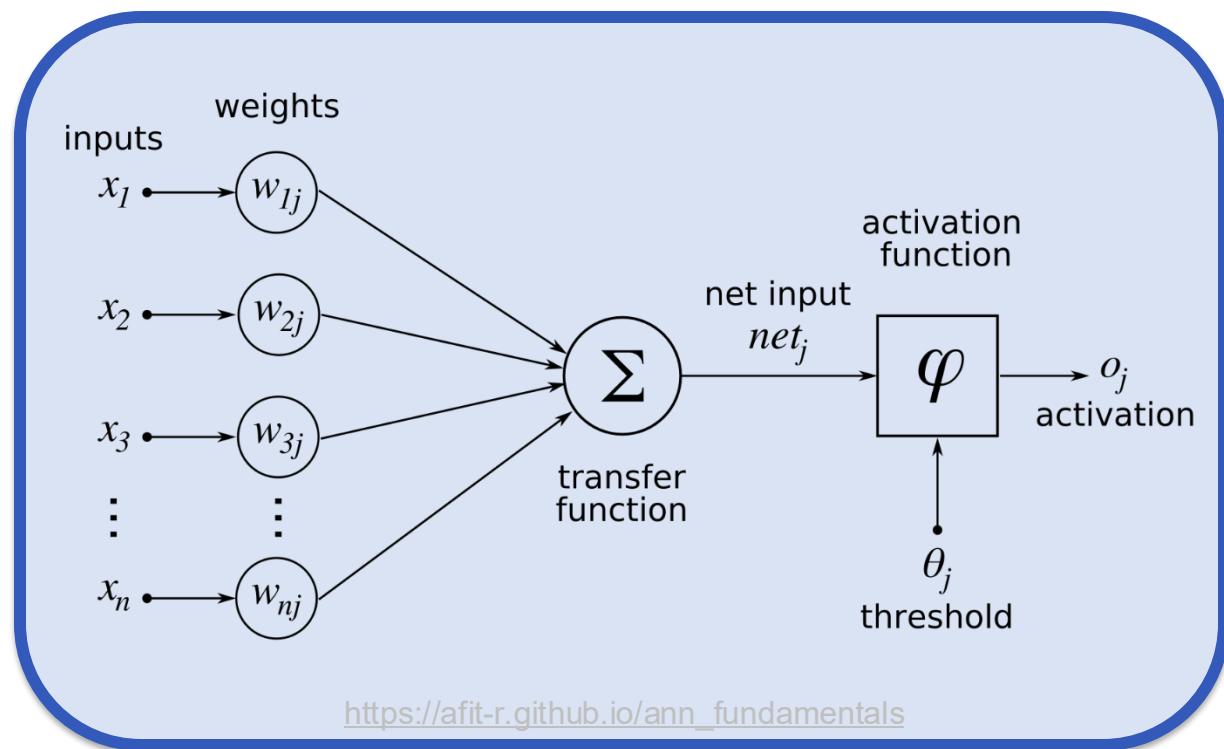
(c) instance segmentation



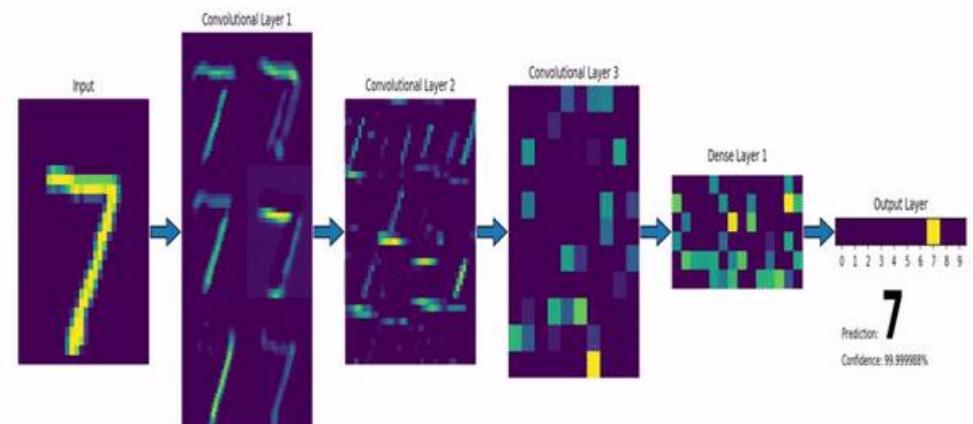
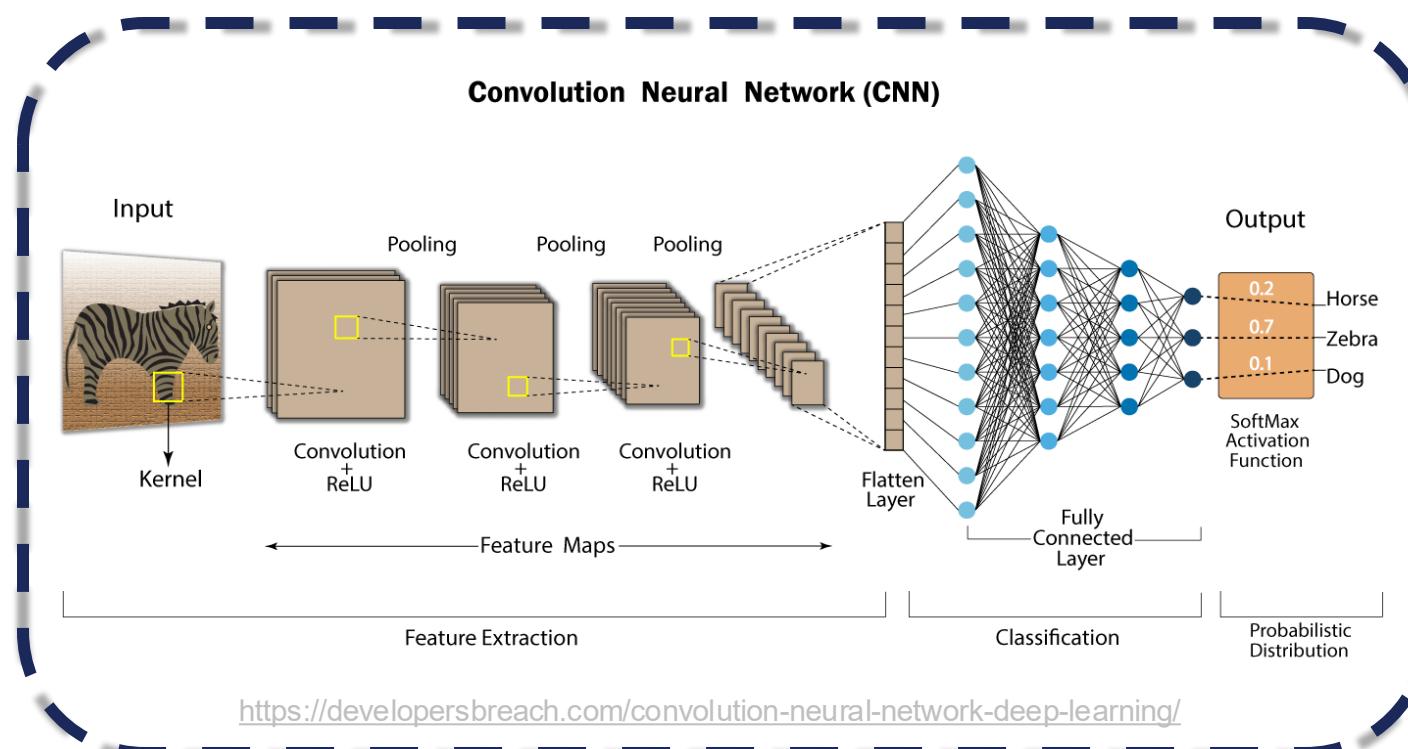
(d) panoptic segmentation

<https://www.labellerr.com/blog/semantic-vs-instance-vs-panoptic-which-image-segmentation-technique-to-choose/>

Artificial Neural Network



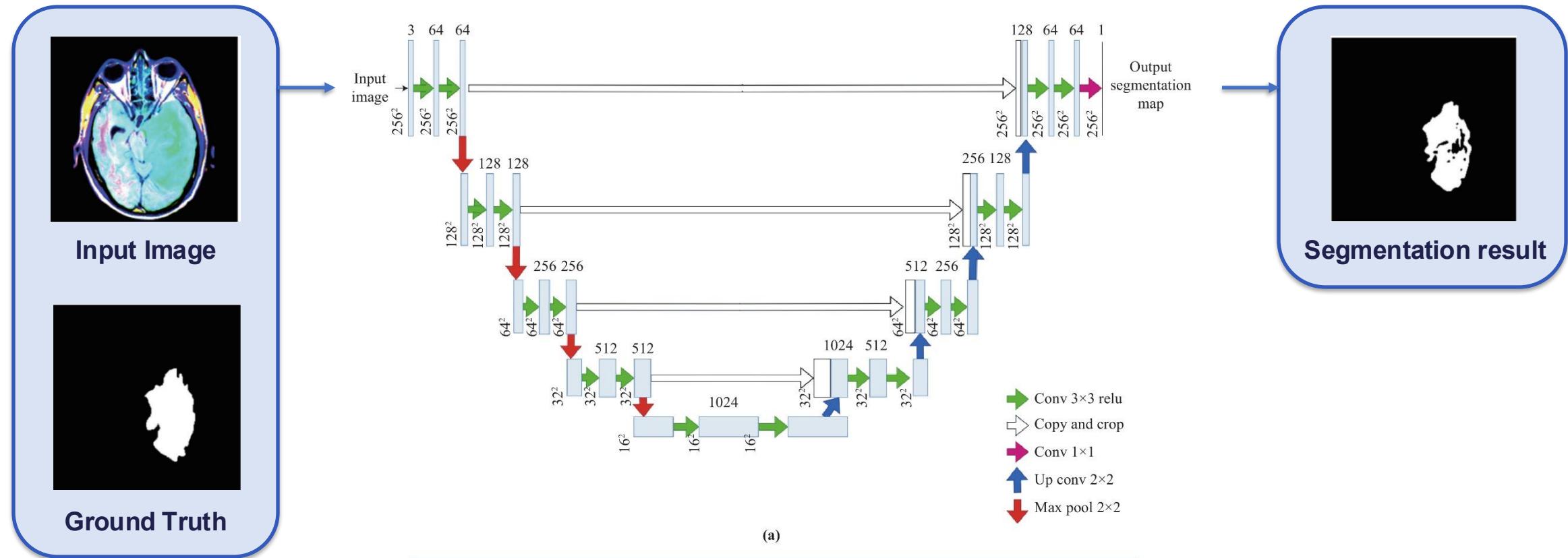
Convolutional Neural Network



<https://www.louisbouchard.ai/densenet-explained/>

<https://developersbreach.com/convolution-neural-network-deep-learning/>

U-Net: Convolutional Networks for Biomedical Image Segmentation



The Black Box Problem of Artificial Intelligence



The Black Box Problem in Artificial Intelligence



Lack of Transparency

No clear explanation of how predictions are made.



Limited Trust from Clinicians

Difficult for medical professionals to rely on outputs they cannot understand.



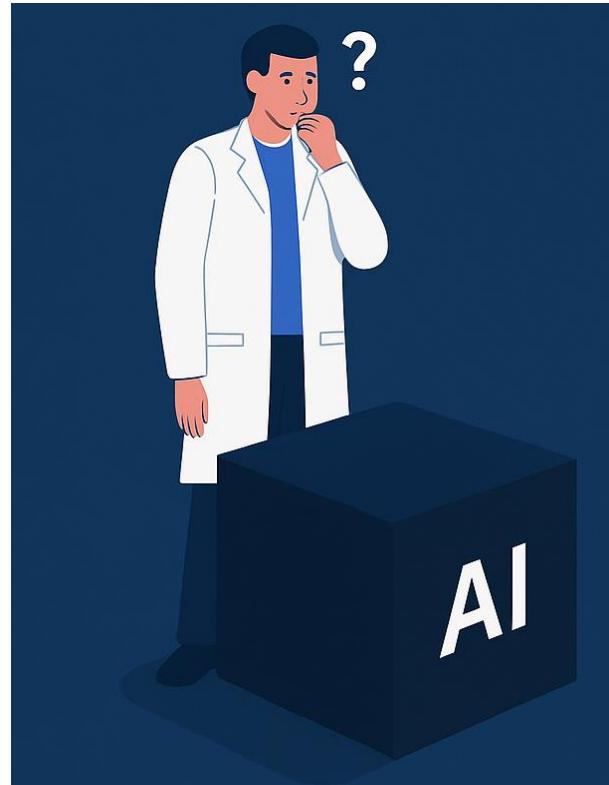
Bias and Hidden Errors

Potentially dangerous if incorrect decisions go undetected.



Ethical Concerns

Patients and doctors need understandable reasoning behind critical decisions.



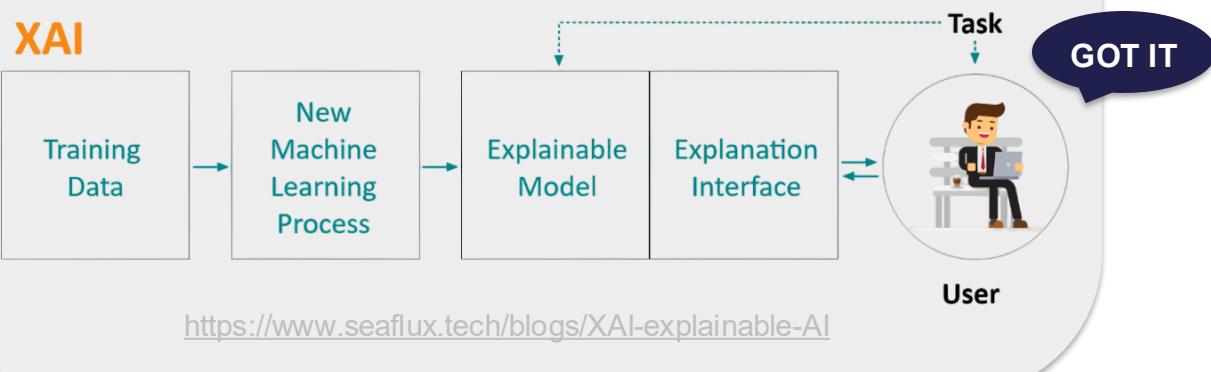
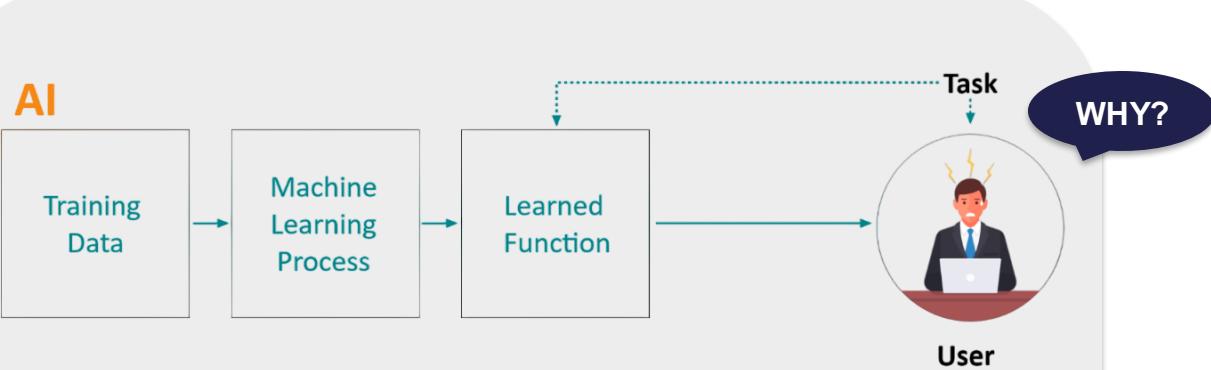


¡Open the Black Box!



eXplainable Artificial Intelligence **XAI**

What is Explainable Artificial Intelligence



Benefits of Explainable AI

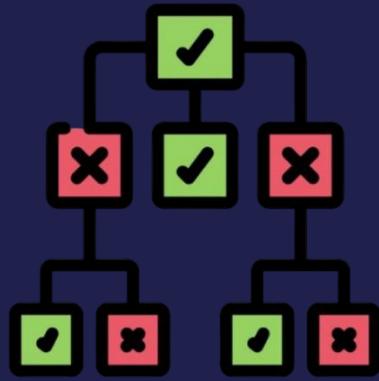
- Enables the deployment of trustworthy and understandable AI models.
- Enables continuous evaluation for faster AI outcomes.
- Reduces risk, bias, and auditing costs in AI systems.

Explainable Artificial Intelligence(XAI) is a set of processes and methods that allows human users to comprehend and trust the results and output created by AI algorithms.

<https://www.seaflux.tech/blogs/XAI-explainable-AI>

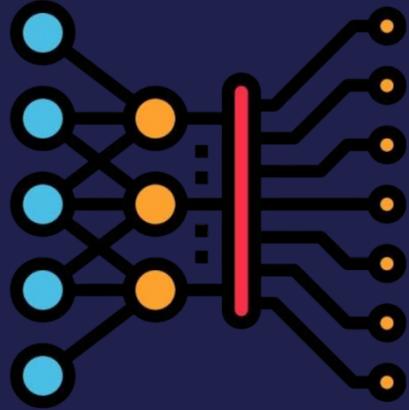
Interpretability vs Explainability

INTERPRETABILITY



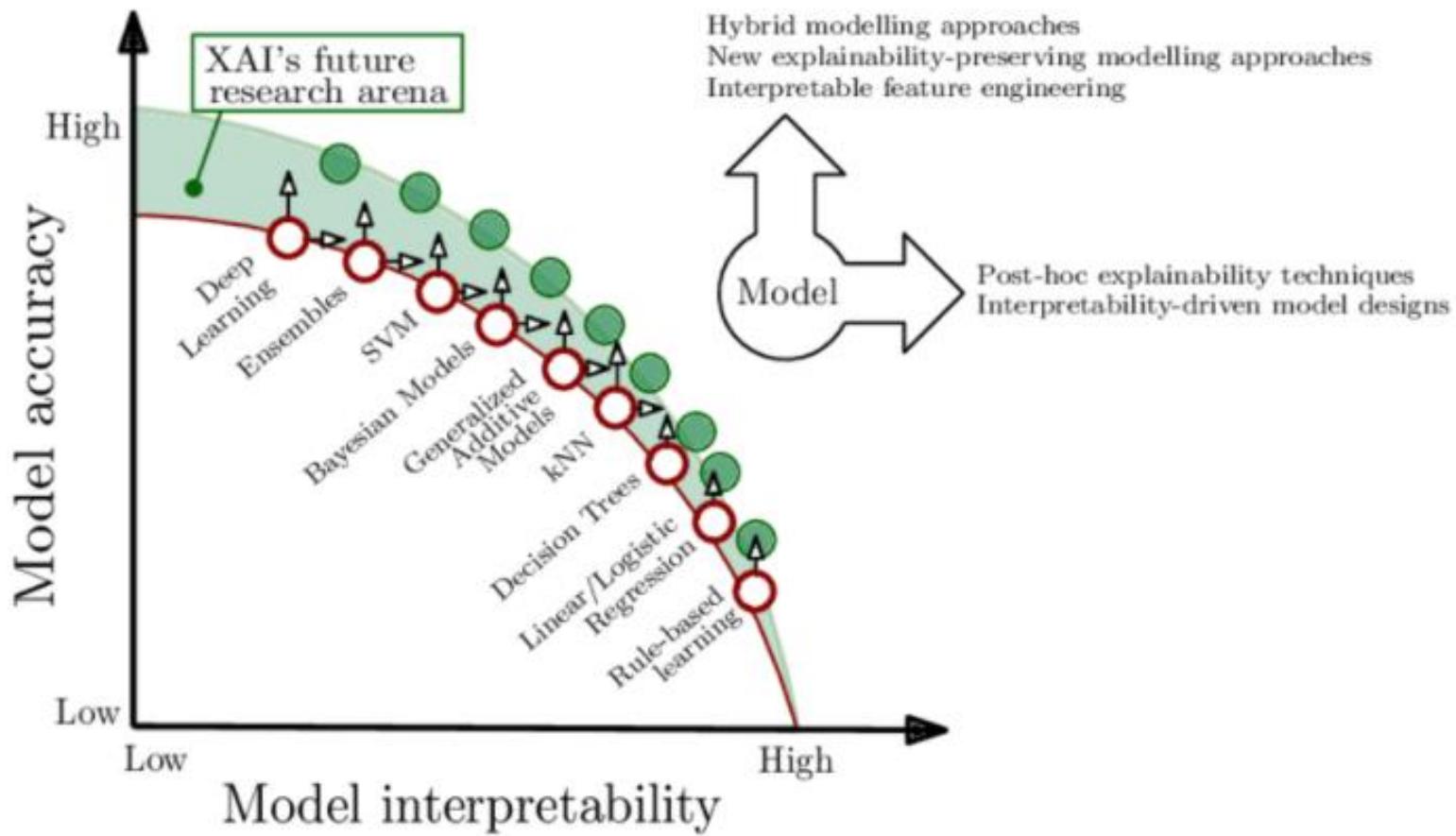
Describes *how* the model works internally, from the **developer's perspective**.

EXPLAINABILITY



Explains *why* the model made a decision, from the **user's perspective**.

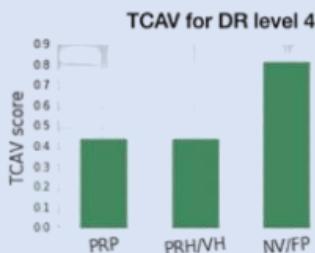
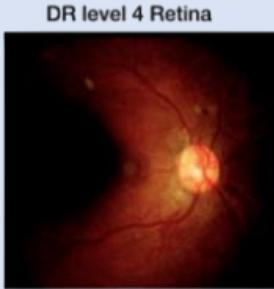
Open the Black Box



<https://doi.org/10.1016/j.colec.2024.101629>

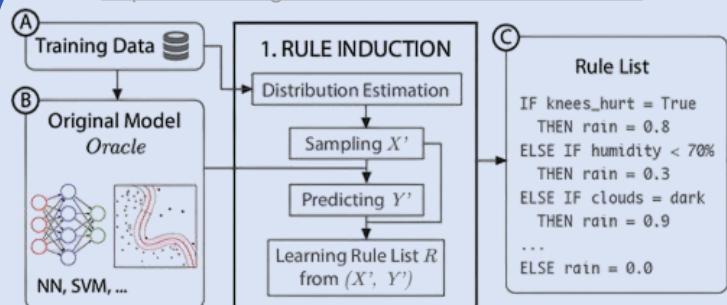
iii Open the Black Box!!!

<https://doi.org/10.48550/arXiv.1711.11279>



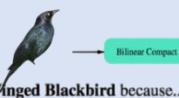
Numeric Explanations

<http://dx.doi.org/10.1109/TVCG.2018.2864812>

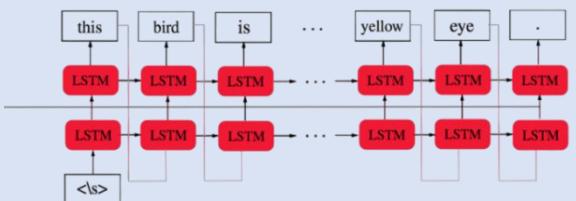


Rule-Based Explanations

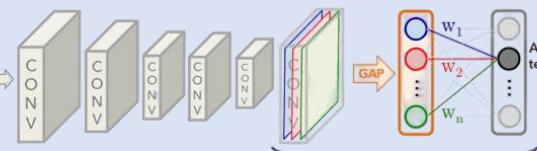
<https://doi.org/10.3390/make3030032>



This is an image of a Red Winged Blackbird because...



Textual Explanations



Visual Explanations

<https://doi.org/10.48550/arXiv.1512.04150>

Q: Is this a healthy meal?

Textual Justification

Visual Pointing



A: No

...because it
is a hot dog
with a lot of
toppings.



A: Yes

...because it
contains a
variety of
vegetables on
the table.



Mixed Explanations

<https://doi.org/10.3390/make3040048>

Applications of XAI in Medicine and Health. “Made in LATAM”



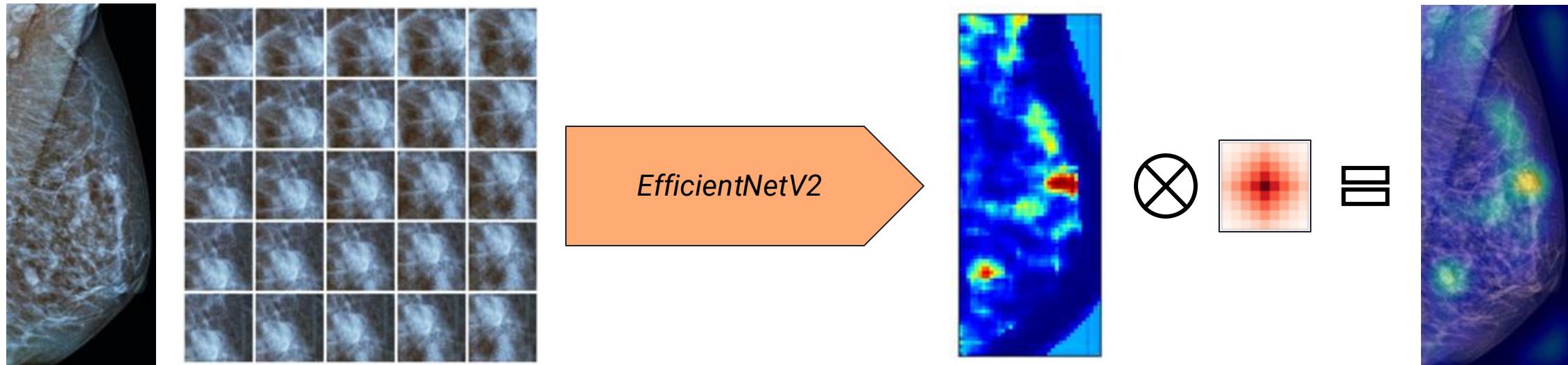
MAMAI: Sistema de Inteligencia Artificial para el apoyo al diagnóstico en mamografía



FONDEF IDEA 20i10332: Sistema de inteligencia artificial para el apoyo en el diagnóstico y priorización de exámenes mamográficos

FONDEF IDEA I+D 2021 IT23i0040: Cuantificación automática de densidad mamaria usando inteligencia artificial, como herramienta de apoyo en la pesquisa de cáncer mamario: mamAI-dens

Sliding Windows for local classification

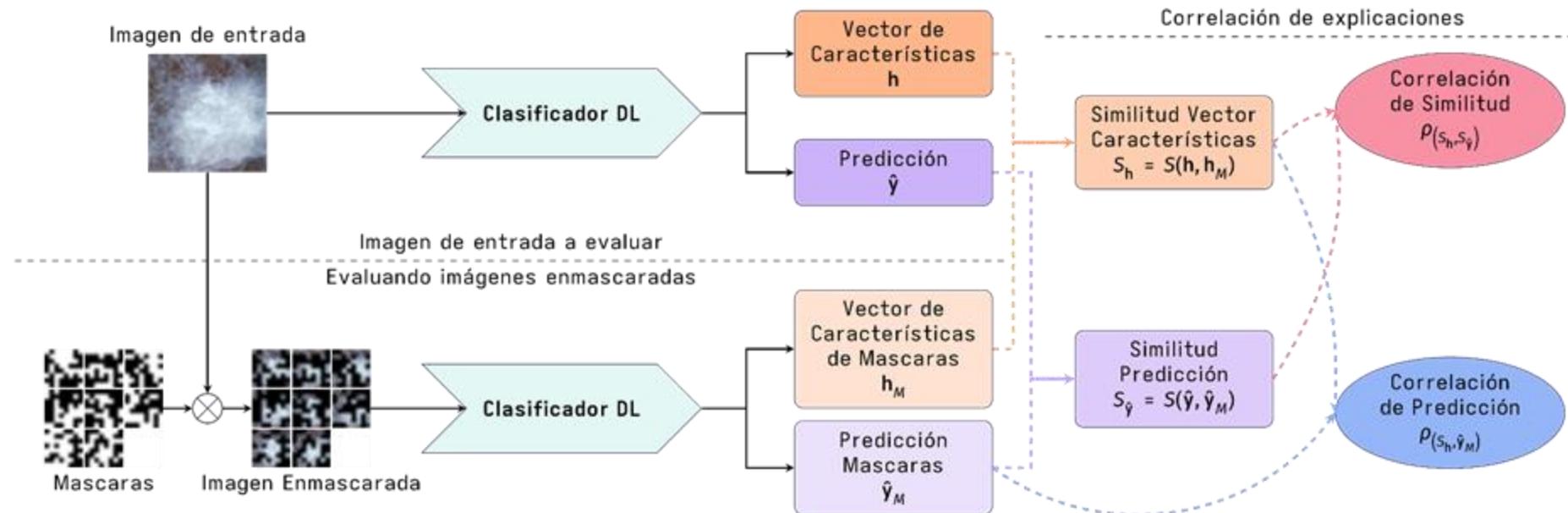


Detection of pathological findings using sliding window evaluation of local areas within mammography images.

Global prediction reconstruction using adjacency kernel



CorRELAX – Correlation of local representations as explanations.

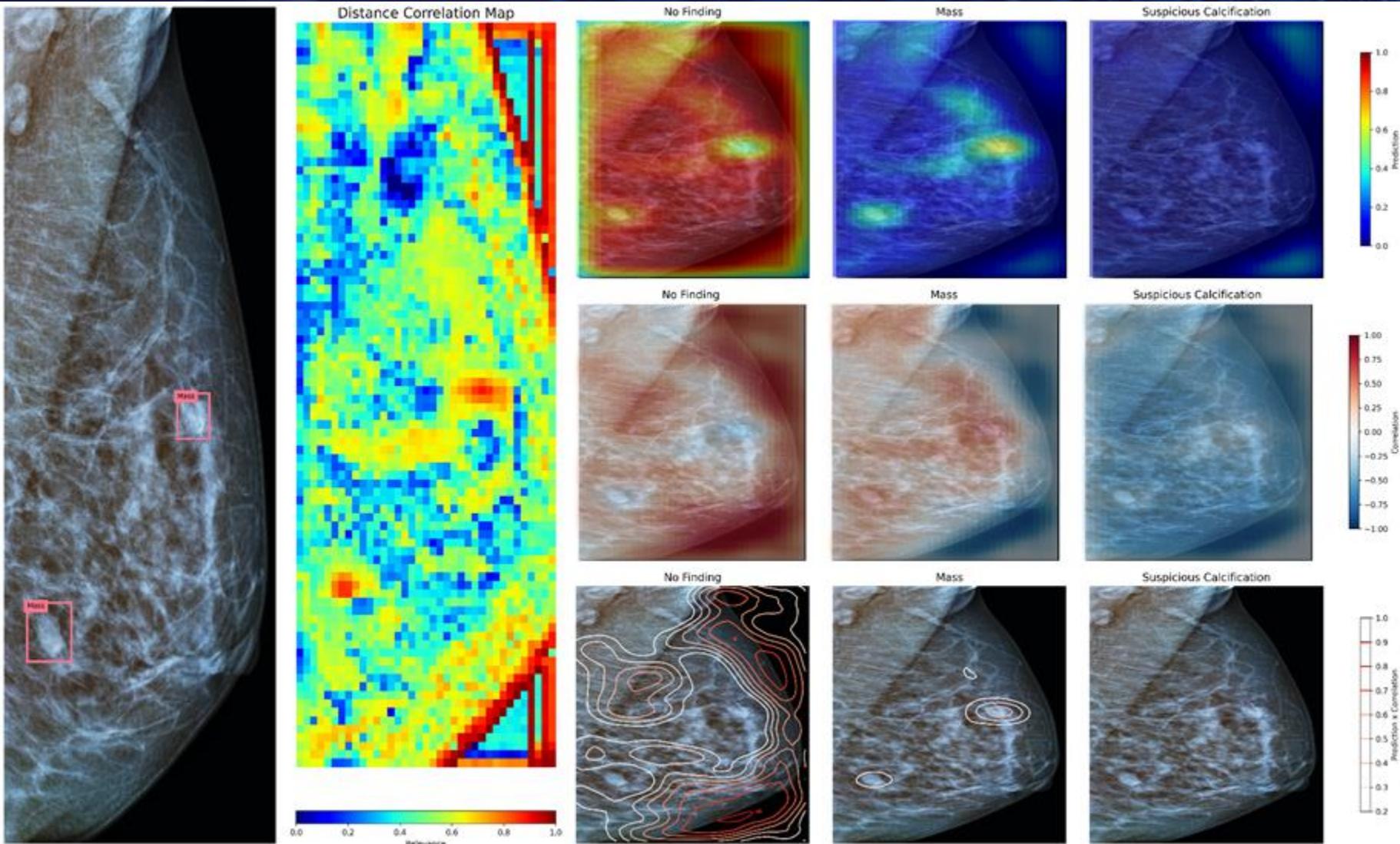


1. Feature distance measurement between images and masked versions to measure importance.
2. Correlation of similarity between features and predictions.
3. Consistency with respect to model knowledge.



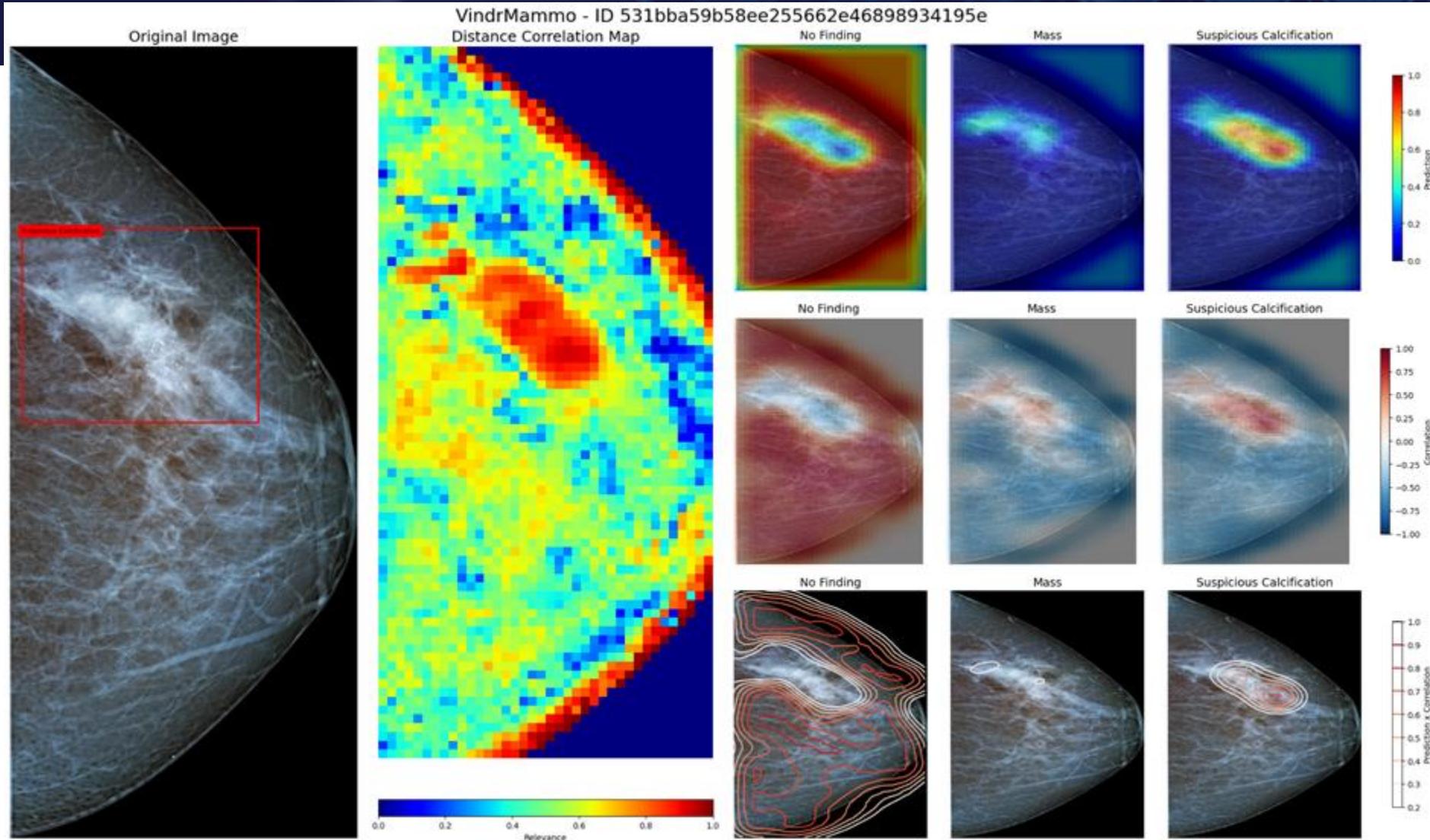
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 Diego Mellado

Correlation Maps

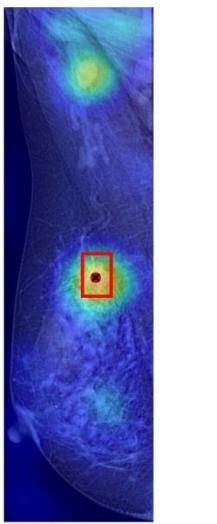


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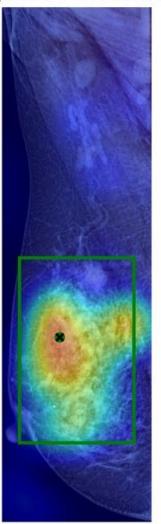
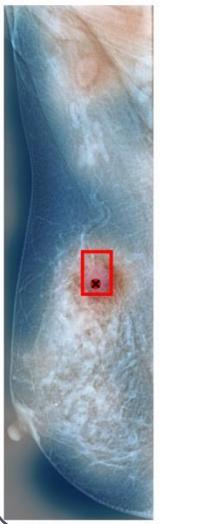
Correlation Maps



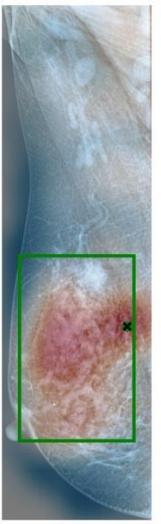
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Prediction Maps
 Suspicious Calcification


Suspicious Lymph Node


 Correlation Maps
 Suspicious Calcification


Suspicious Lymph Node



Zhang J, Lin Z, Brandt J, Shen X, Sclaroff S. Top-down Neural Attention by Excitation Backprop [Internet]. arXiv; 2016 [cited 2024 Aug 1]. Available from: <http://arxiv.org/abs/1608.00507>

Validation of precision of explanations Using Pointing Game Metric

- Pointing game metric (Zhang et al., 2016) to evaluate precision of maxima of detected region, compared to annotated bounding box.

Table 4. Accuracy of “Pointing Game” evaluation of prediction and correlation maps compared to labeled bounding boxes

Finding	Prediction Map ($\geq 25\%$)	Prediction Map ($\geq 50\%$)	Correlation Map	Support
Mass	0.5205	0.2654	0.4201	219
Suspicious Calcification	0.7714	0.5714	0.7238	105
Asymmetries	0.2692	0.0384	0.3462	78
Architectural Distortion	0.0000	0.0000	0.0000	24
Suspicious Lymph Node	0.4000	0.2000	0.0000	10
Skin Thickening	0.5833	0.4166	0.4167	12
Retractions	0.0000	0.0000	0.0000	8
Weighted Mean Accuracy	0.6358	0.3613	0.5602	456



Publicación de los Resultados



A Deep Learning Classifier Using Sliding Patches For Detection of Mammographical Findings

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Identifying Clinically Relevant Findings in Breast Cancer using Deep Learning and Feature Attribution on Local Views from High-Resolution Mammography

Diego Mellado^{1, 2, 3, 4}, Leondry Mayeta^{1, 4, 3}, Julio Sotelo⁵, Marvin Querales^{6, 4}, Eduardo Godoy^{7, 4, 3},
Scarlett Lever⁸, Fabian N. Pardo^{4, 9, 10}, Steren Chabert^{8, 4, 3}, Rodrigo Salas^{8, 4, 3*}

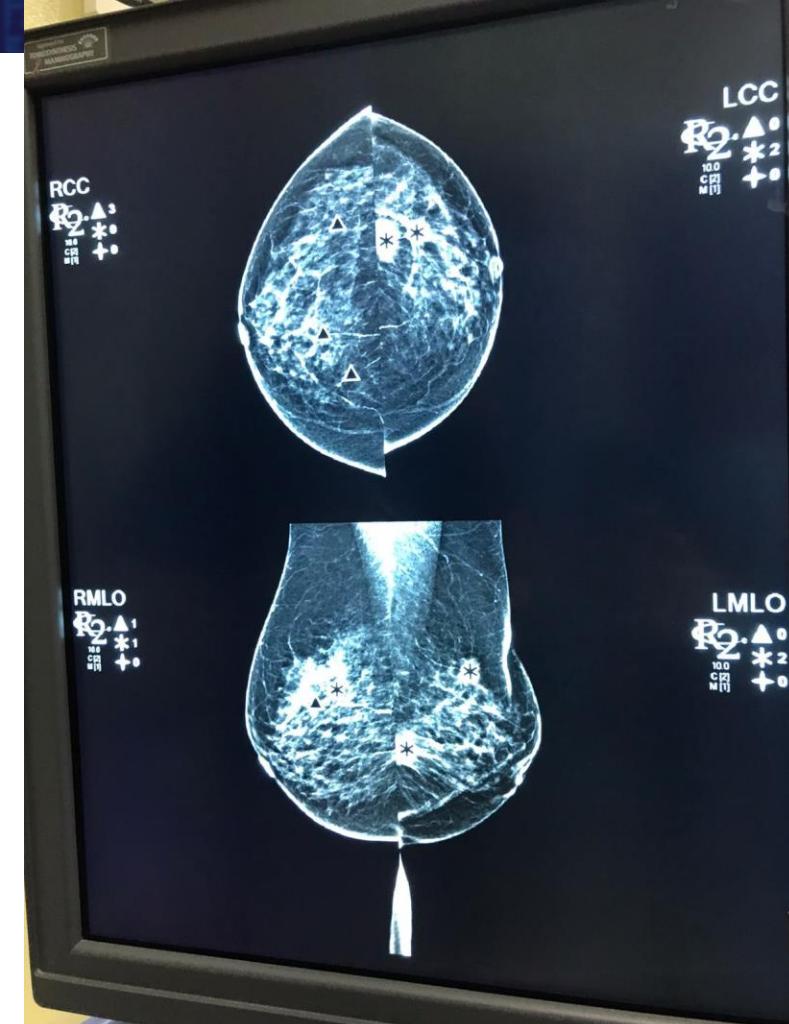
Radiological Report

MAMOGRAFIA DIGITAL BILATERAL:
(Proyecciones cráneo caudales
y oblicuo medio lateral).
Sin factores de riesgo.

Hallazgos:
Mamas constituidas por densidades
fibroglandulares dispersas.
No identifico nódulos sospechosos
ni lesiones espiculadas.
Tampoco hay microcalcificaciones
agrupadas.
Calcificación benigna a derecha.

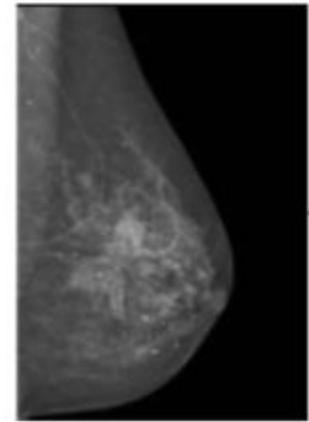
Impresión:
Mamografía sin signos sugerentes
de malignidad.
Se recomienda control mamográfico
anual.
BIRADS 2.
Atentamente,

- LATERALIDAD
- LOCALIZACION
- HALLAZGOS



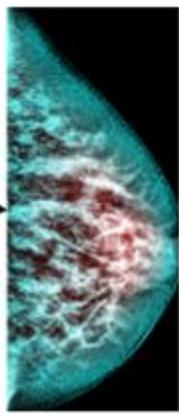
Multimodal Visual-Language Framework for Mammography

Data Processing



Pre-processing Image

- Normalization
- Crop
- Clahe



Pre-processing Report

- Tab Findings and impressions
- Create Tokenizer
- Apply NER
- Add entry to dataset

MAMOGRAFIA DIGITAL BILATERAL:
(Proyecciones cráneo caudales y oblicuo medio lateral).
Sin factores de riesgo.

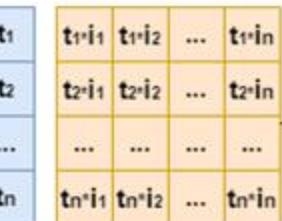
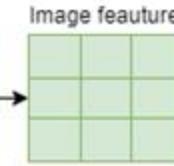
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Calcificación benigna a derecha.

Impresión:
Mamografía sin signos sugerentes de malignidad.
Se recomienda control mamográfico anual.
BIRADS 2.
Atentamente,

Training

Encoder

Feature Extraction CNN



Decoder

Clinic text output

Softmax

Add and Normalization

Feed Forward

Add and Normalization

Multi-Head Attention

Add and Normalization

Feed Forward

Add and Normalization

Multi-Head Attention

Clinic text input

Evaluation

Report

Hallazgos:
Mamas constituidas por densidades fibroglandulares dispersas.
No identifico nódulos sospechosos ni lesiones espículadas.
Tampoco hay microcalcificaciones agrupadas.
Calcificación benigna a derecha.

Apply NLP Metrics

Bleu

Meteor

Rouge

CIDEr

Results

Evaluation



Experiment Results

Table 1

Aumentation technics evaluation

FE-CNN	Image	BLEU-1	BLEU-2	BLEU-3	BLEU-4	ROUGE-L	METEOR	CIDEr
Resnet101	RAW	0.440	0.323	0.244	0.175	0.414	0.418	0.226
	CLAHE	0.382	0.317	0.270	0.228	0.495	0.449	0.817
EfficientnetB7	RAW	0.432	0.354	0.300	0.254	0.494	0.458	0.703
	CLAHE	0.413	0.344	0.295	0.253	0.504	0.464	0.792

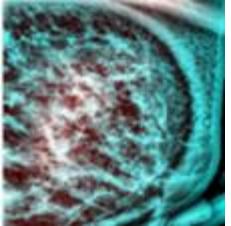
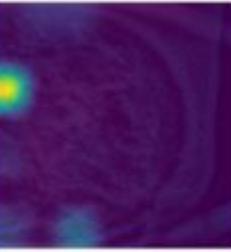
Table 2

Our framework performance compared with some models of the state of the art

Model	BLEU-1	BLEU-2	BLEU-3	BLEU-4	ROUGE-L	METEOR	CIDEr
TieNet	0.286	0.159	0.103	0.073	0.226	0.107	-
R2Gen	0.314	0.218	0.145	0.103	0.277	0.142	-
KBF	0.496	0.327	0.238	0.178	0.381	-	0.382
Our	0.413	0.344	0.295	0.253	0.504	0.464	0.792
Our Exp 01	0.412	0.344	0.296	0.255	0.507	0.464	0.831
Our Exp 02	0.383	0.314	0.263	0.218	0.484	0.445	0.648

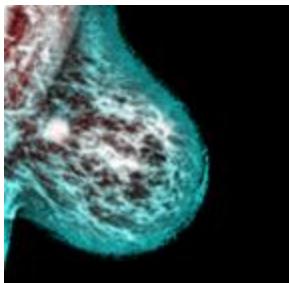
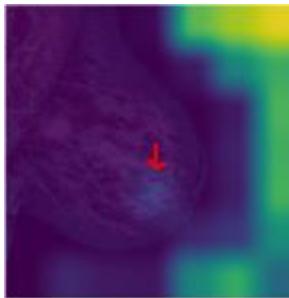


Examples

	Real Clahe	[FINDINGS] Parénquima mamario heterogéneamente denso, observando un nódulo parcialmente visible en unión cuadrantes superiores de mama izquierda de aproximadamente 8mm., de contorno anterior bien delimitado. No se observan microcalcificaciones sospechosas. [IMPRESSION] Nódulo mamario izquierdo que requiere control estricto con mamografía izquierda y compresiones localizadas en 6 meses. [BIRADS]3
	Gen-IA	[FINDINGS] Parénquima mamario heterogéneamente denso, observando un nódulo parcialmente visible en unión cuadrantes superiores de mama izquierda, de contorno anterior bien delimitado. No se observan microcalcificaciones sospechosas. [IMPRESSION] Nódulo mamario izquierdo que requiere control estricto con mamografía izquierda y compresiones localizadas en 6 meses. [BIRADS]3 [END_REPORT] [END]



Examples

	Real Clahe	<p>[FINDINGS] Mamas compuestas por densidades fibroglandulares dispersas. En región central y posterior de la mama izquierda a 11 cm del pezón, se observa un nódulo denso, ovalado, parcialmente delimitado que mide 23 x 18 mm. en sus diámetros mayores, no estaba presente en examen previo del año 2018. No se observa microcalcificaciones agrupadas sospechosas. Escasas calcificaciones aisladas benignas. Linfonodos axilares visibles de aspecto normal. Se complementó con ecografía. [IMPRESSION] Nódulo mamario izquierdo de aspecto sospechoso. Se sugiere estudio histológico a través de biopsia Core bajo ecografía. [BIRADS]4</p>
	Gen-IA	<p>[FINDINGS] Parénquima mamario heterogéneamente denso, observando en unión de cuadrantes superiores de mama izquierda un nódulo de contornos parcialmente delimitados. No se observan microcalcificaciones sospechosas. [IMPRESSION] Nódulo mamario izquierdo que requiere estudio con ecografía. [BIRADS]0 [END_REPORT]</p>



Tesis de Doctorado en Ingeniería en Informática Aplicada
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Publicación de los Resultados



Automatic detection of contextual laterality in Mammography Reports using Large Language Models

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Research Article

Hybrid framework for automated generation of mammography radiology reports

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MSc. Student
Esthefania Astorgo

Opening the Black Box: Challenges, Opportunities, and the Future

Current Challenges in Explainable AI for Medicine



Ethical and Legal Risks

Algorithmic biases can affect vulnerable populations.

Data privacy and informed consent are challenges that remain unresolved.

Who is responsible for an automated medical error?



Absence of standardized explainability metrics

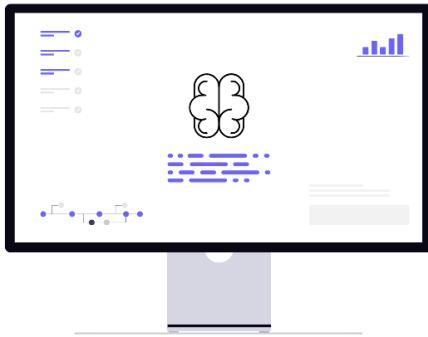
Lack of a universal metric for assessing the quality of explanations.

This prevents comparing XAI methods with each other or establishing a reliable standard.

This hinders safe adoption in medical settings.

Clinical Integration in XAI

Context-Aware Explanations



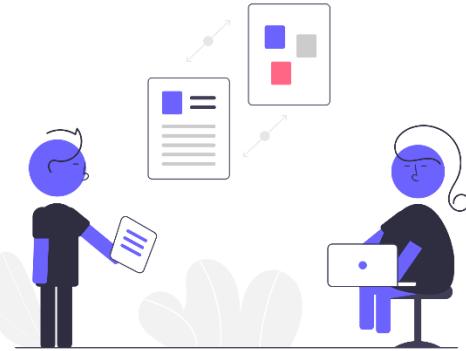
Explanations must match the user's role, adjusting language, detail, and format.

Reducing Clinical Resistance



Transparent interfaces increase trust and reduce perceived threat to expertise.

Supporting Informed Decision-Making



Explanations justify actions and help detect model errors in clinical practice.

The Future of XAI in Medicine

**It is not meant to replace the physician,
but to assist them.**

Rather than competing, it becomes a second reader or support tool.

Towards explainable, useful, and trustworthy AI

The future of medical AI lies not only in being accurate, but in being understandable.



AI will NEVER replace physicians



"It is clear to me that AI will never replace physicians — but physicians who use AI will replace those who don't"

*"If I, as a physician, am going to supervise and correct AI,
I have to know that it's there.
I have to understand the outputs it's producing.
I have to be able to step in if something happens."*

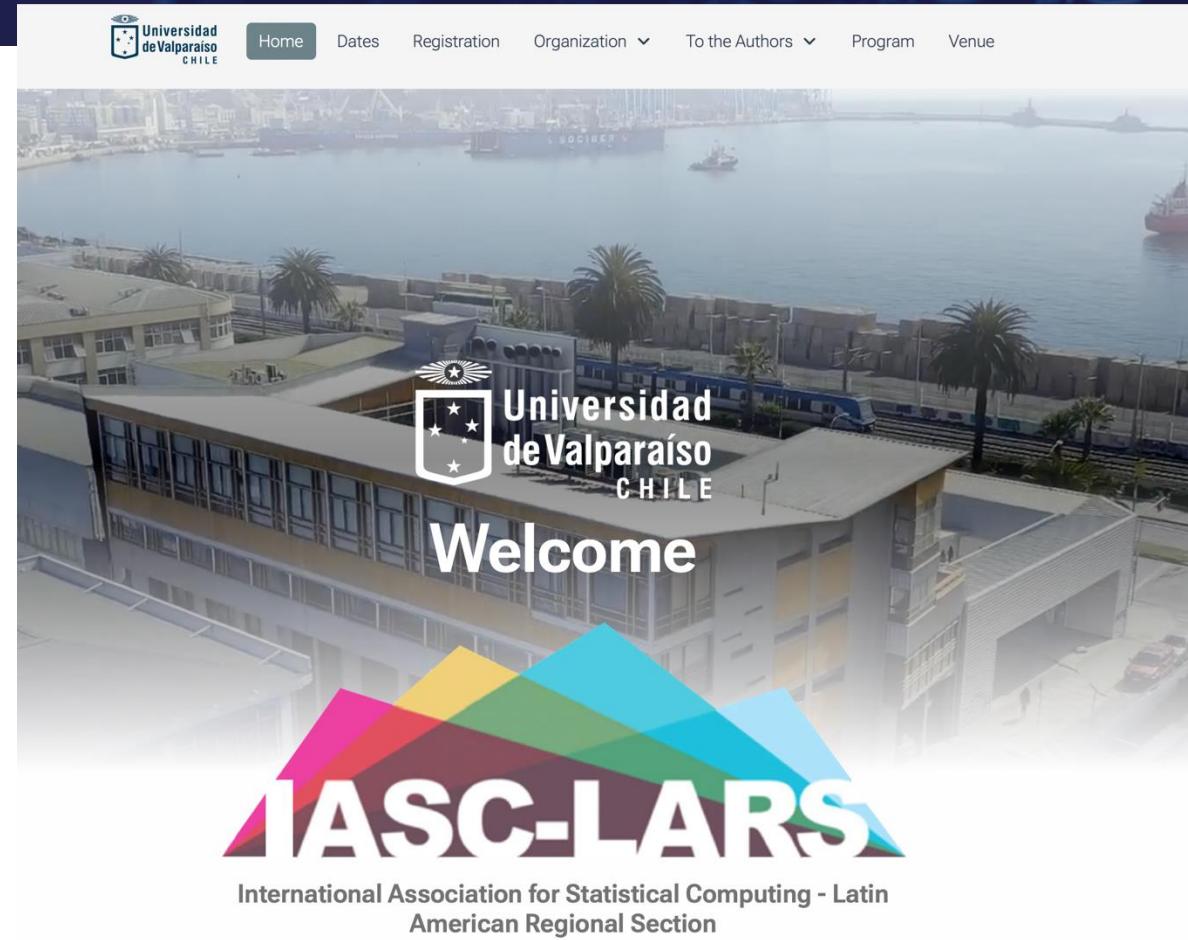
<https://www.ama-assn.org/practice-management/digital-health/ai-already-reshaping-care-heres-what-it-means-doctors>

AMA Presidente de la Asociación Médica Americana (AM) Dr. Jesse Ehrenfeld, MD

Latin American Conference on Statistical Computing LACSC2025

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Thanks for your Attention

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