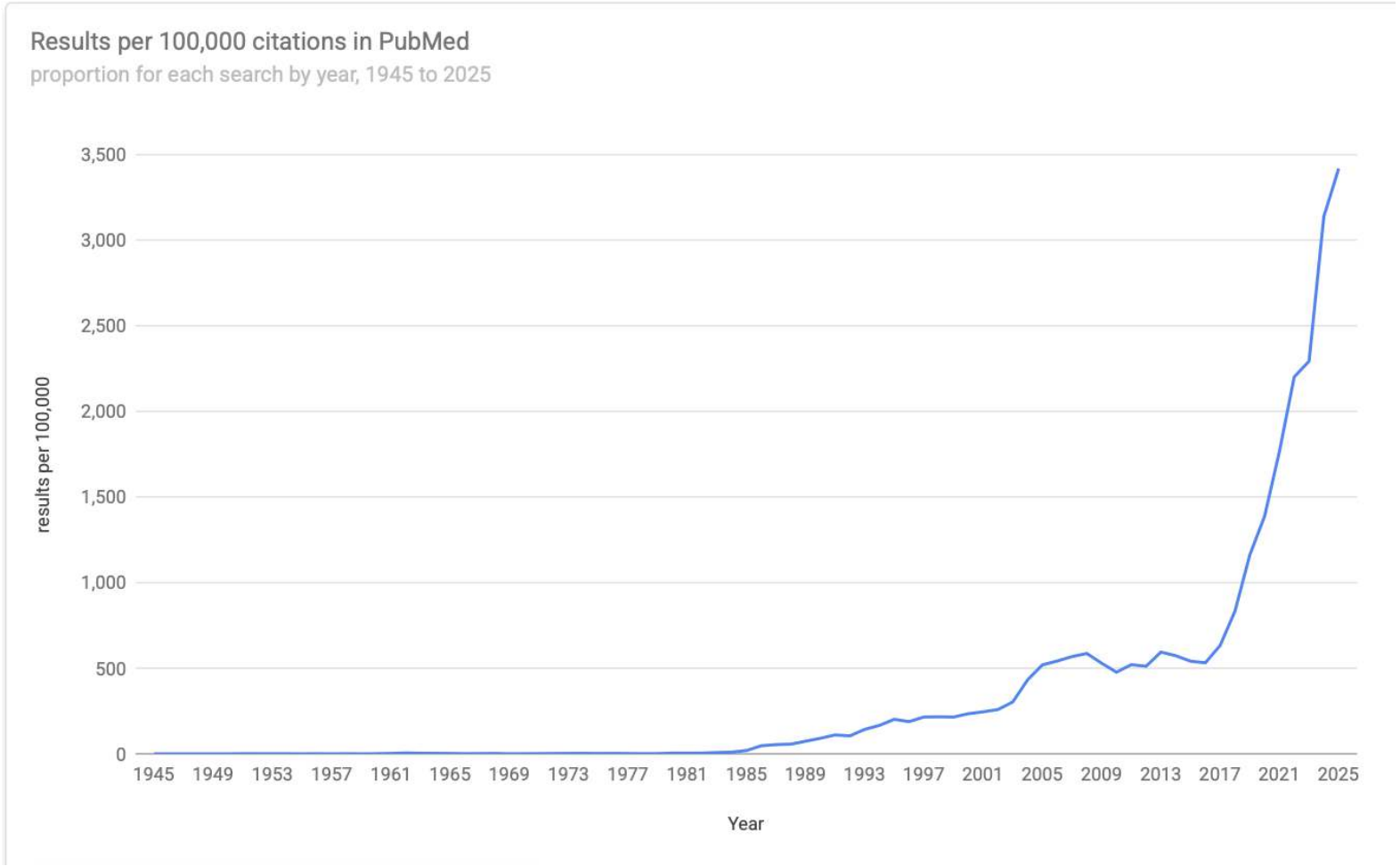
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Centre for Digital Transformation of Health

CONNECTING DIGITAL INNOVATION TO HEALTH

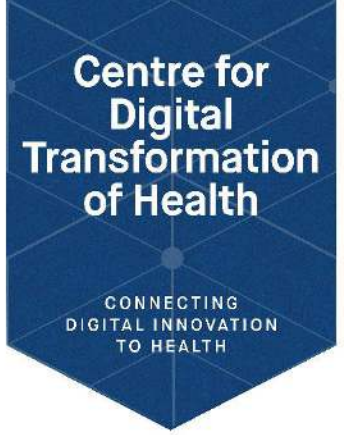
The (future) Role of Clinical Artificial Intelligence

A/Prof Daniel Capurro, MD, PhD, FRACP
School of Computing and Information Systems
Centre for the Digital Transformation of Health
Department of Medicine
University of Melbourne – Royal Melbourne Hospital



Source: PubMed





Overwhelmingly, what we call supervised learning



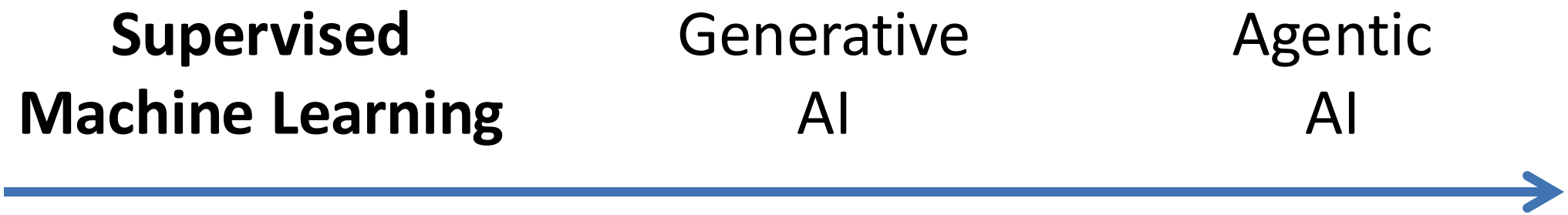


Photo source: wikimedia commons



Chihuahua vs Muffin?

https://medium.com/free-code-camp/chihuahua-or-muffin-my-search-for-the-best-computer-vision-api-cbda4d6b425d


Supervised Machine Learning
Generative AI
Agentic AI

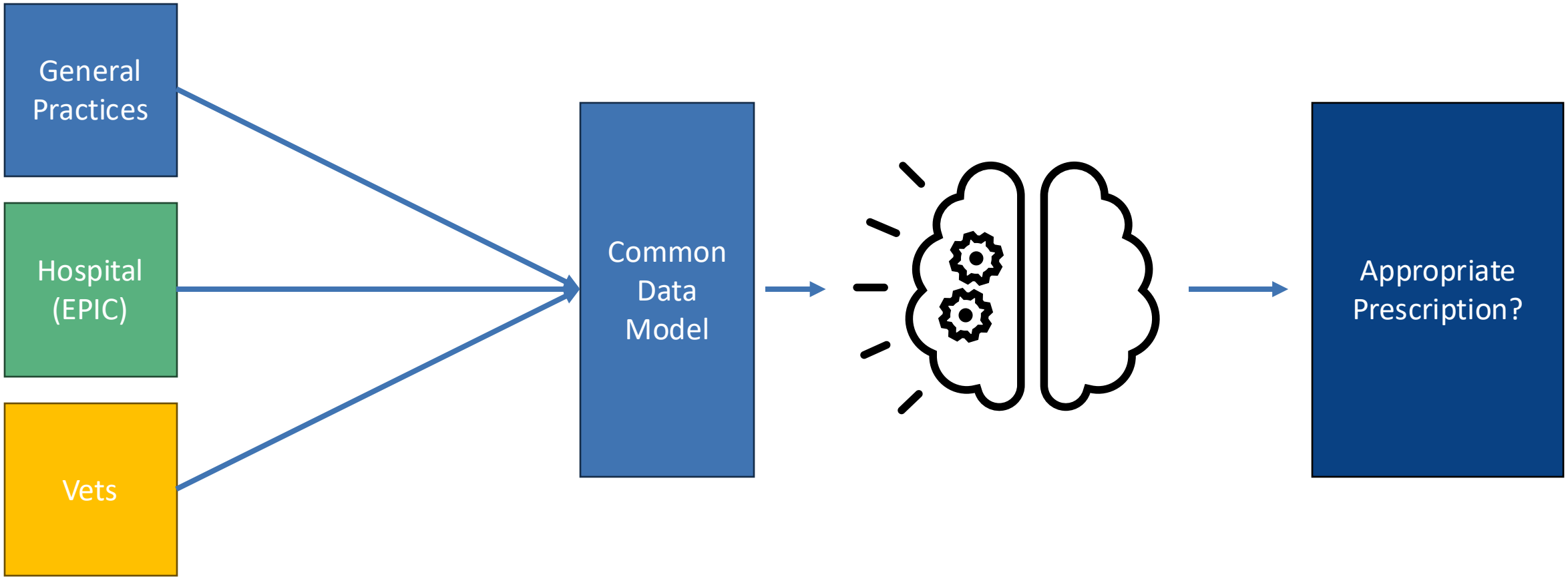
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Let’s look at an example…

AI for Antimicrobial Stewardship



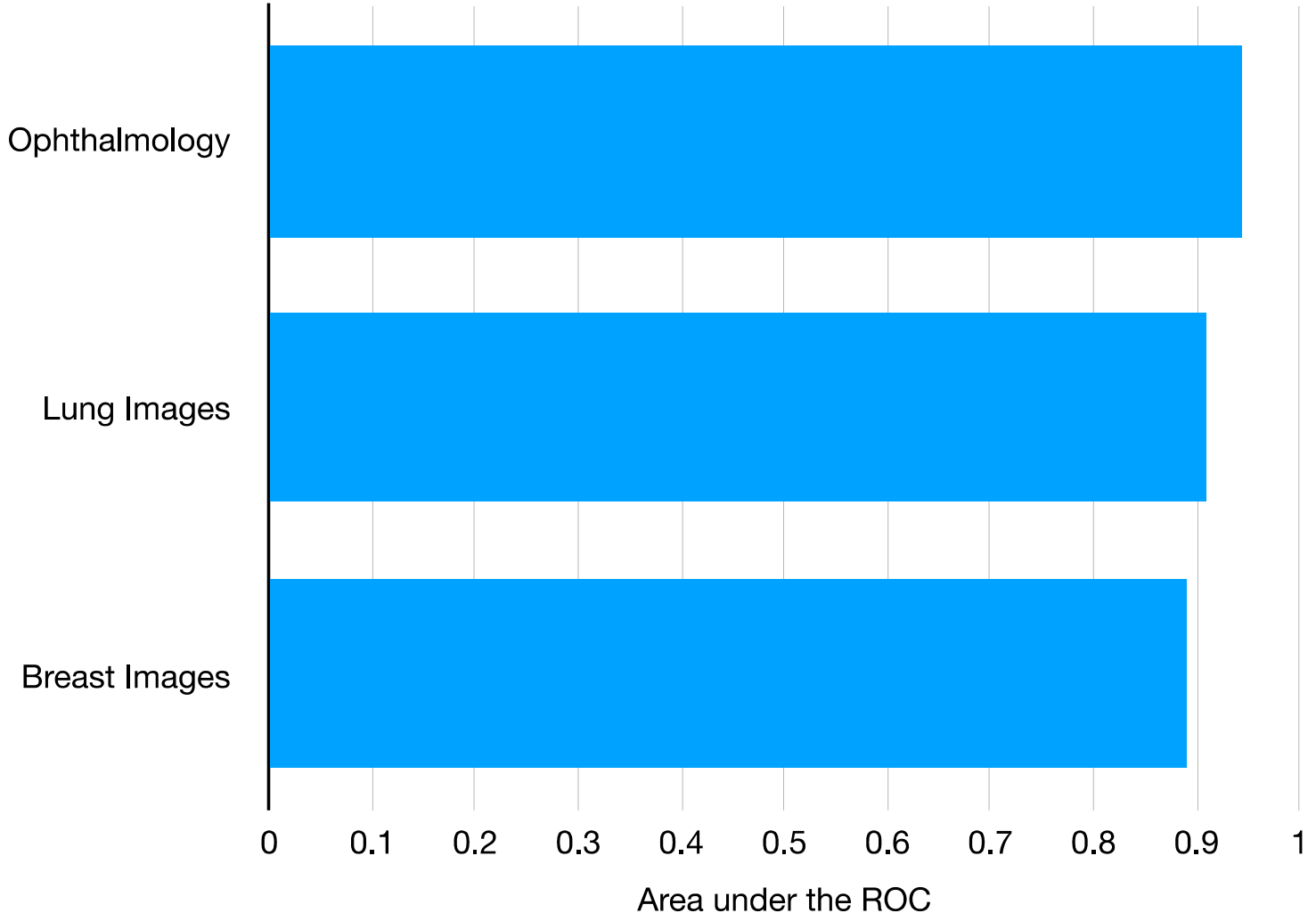
Supervised Machine Learning

Drug	Dose	Freq	Duration	Reason	Pregnancy	Allergy	eGFR	Appropriate
Amoxicillin	500mg	8h	7 days	CAP	No	No	68	
Flucloxacillin	500mg	6h	7 days	Cellulitis	No	Yes - Severe	78	
Trimethoprim	200mg	12h	3 days	UTI	No	No	UNK	
Ciprofloxacin	500mg	12h	5 days	UTI	Yes	No	UNK	



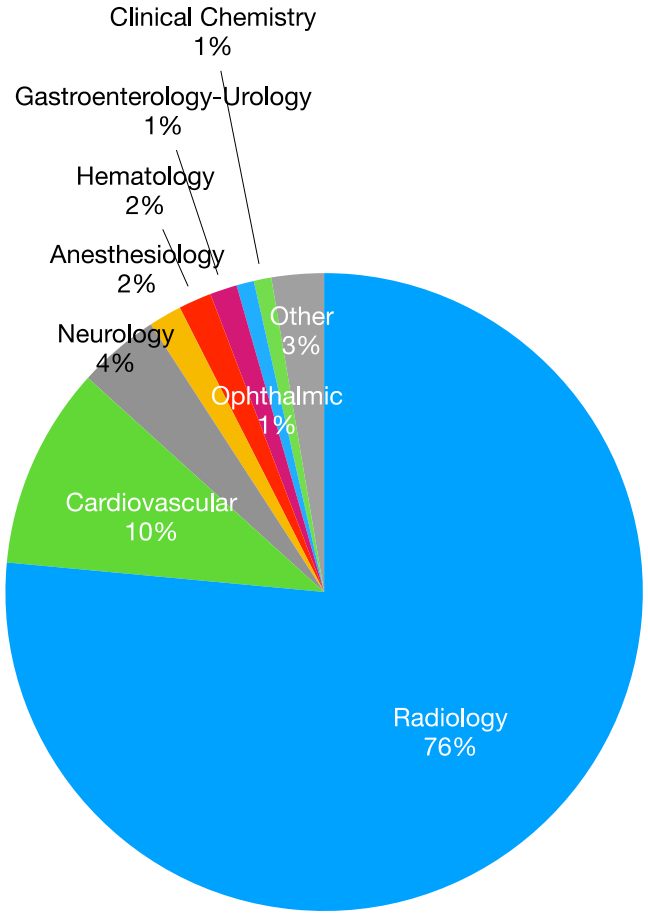
Drug	Dose	Freq	Duration	Reason	Pregnancy	Allergy	eGFR
Amoxicillin	500mg	8h	7 days	CAP	No	No	68

Does AI work?



Aggarwal, R., Sounderajah, V., Martin, G. *et al.* Diagnostic accuracy of deep learning in medical imaging: a systematic review and meta-analysis. *npj Digit. Med.* **4**, 65 (2021).

FDA Approved AI-based SaMD (N=1016)



https://www.fda.gov/medical-devices/software-medical-device-samd/artificial-intelligence-and-machine-learning-aiml-enabled-medical-devices

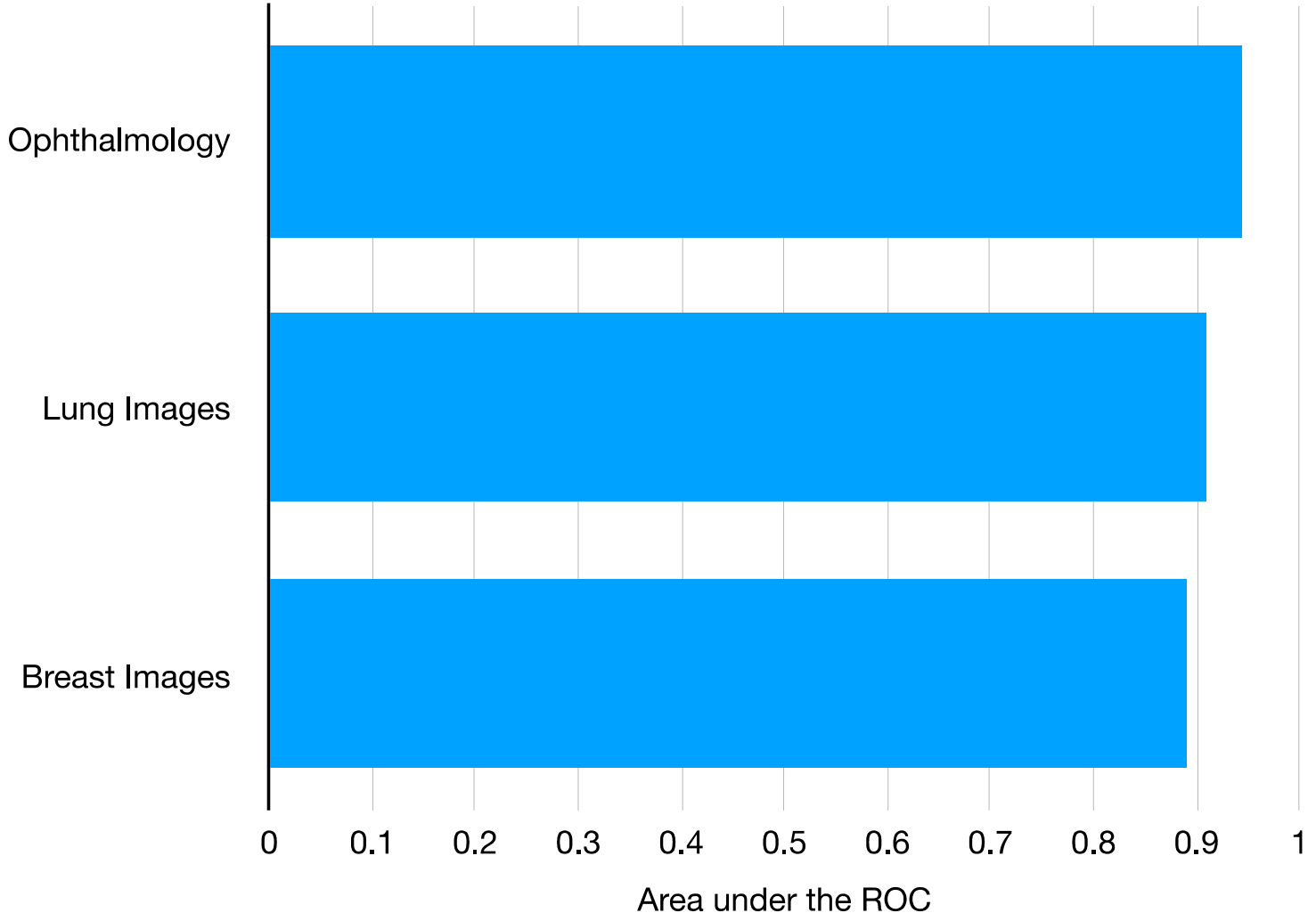
Perspectives

Why clinical artificial intelligence is (almost) non-existent in Australian hospitals and how to fix it

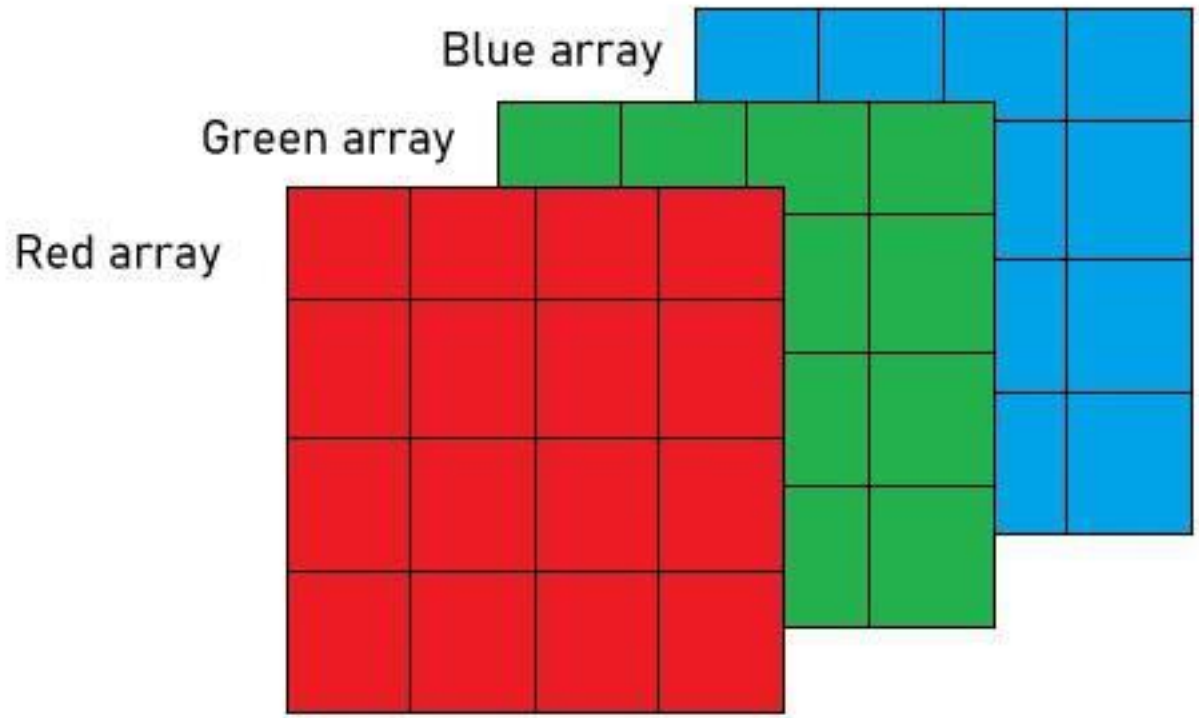
In-hospital clinical artificial intelligence (AI) encompasses learning algorithms that use real-time electronic medical record (EMR) data to support clinicians in making treatment, prognostic or diagnostic decisions. In the United States, the AI in clinical settings including, among others, prediction models for stroke, hypertension, venous thromboembolism and appendicitis.[1] Of these, 82% were implemented in the US and none in Australia.

van Der Vegt A, Campbell V, Zuccon G. Why clinical artificial intelligence is (almost) non-existent in Australian hospitals and how to fix it. Medical Journal of Australia. 2024 Mar 1;220(4).

Does AI work?

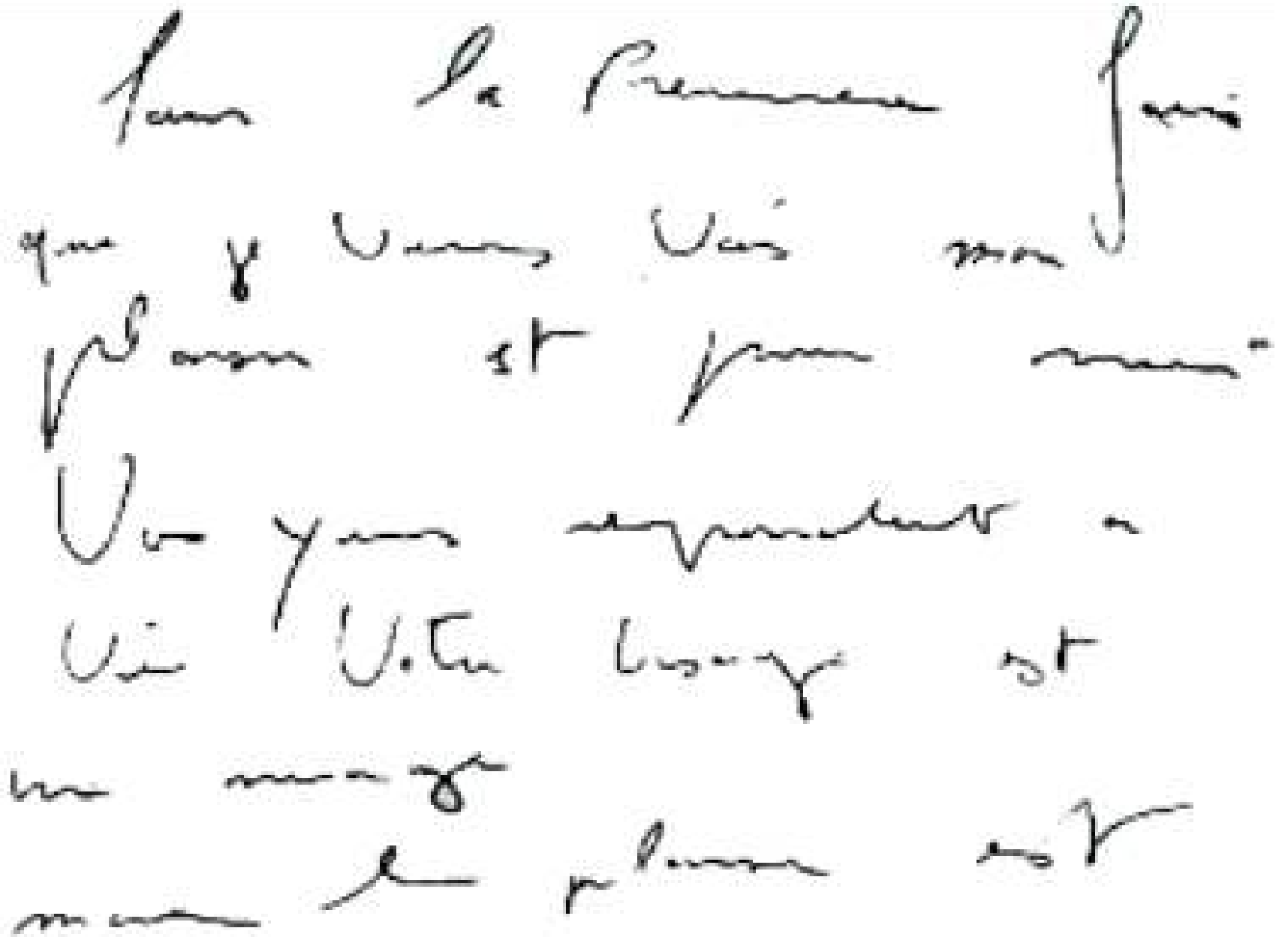


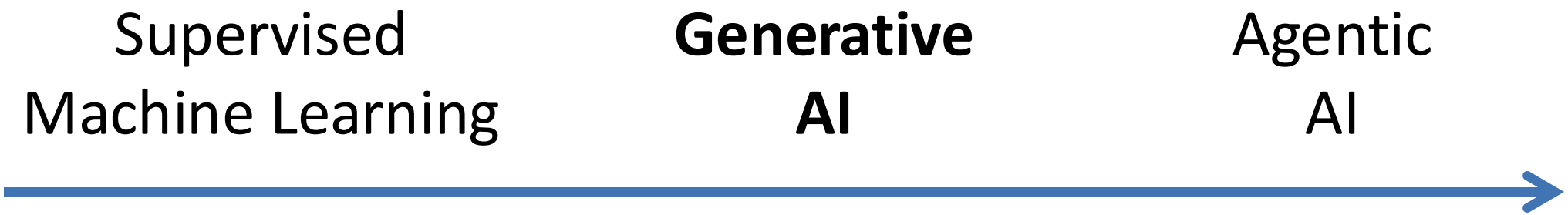
Aggarwal, R., Sounderajah, V., Martin, G. *et al.* Diagnostic accuracy of deep learning in medical imaging: a systematic review and meta-analysis. *npj Digit. Med.* **4**, 65 (2021).



Arrrays stacked over each other
to form a Digital Image.

https://www.geeksforgeeks.org/matlab-rgb-image-representation/




Supervised
Machine Learning
Generative
AI
Agentic
AI

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Generative AI: What do they do and how they do it?

Predict the next [ ]…

Prompt	Output sentence	Probability (%)
Infectious disease doctors are great at…	diagnosing complex illnesses	25.0
	managing outbreaks and epidemics	20.0
	researching new treatments and vaccines	15.0
	educating the public about disease prevention	10.0
	collaborating with global health organizations	8.0

Predict the next [ ]…

Prompt	Output sentence	Probability (%)
Infectious disease doctors are great at…	engaging in professional culinary studies to understand nutritional impacts on health	0.004
	practicing and teaching martial arts for mental and physical wellness	0.003
	participating in extreme sports to fundraise for medical research	0.002
	studying ancient languages to better understand historical medical texts	0.0015
	performing stand-up comedy to promote mental health in the medical profession	0.001

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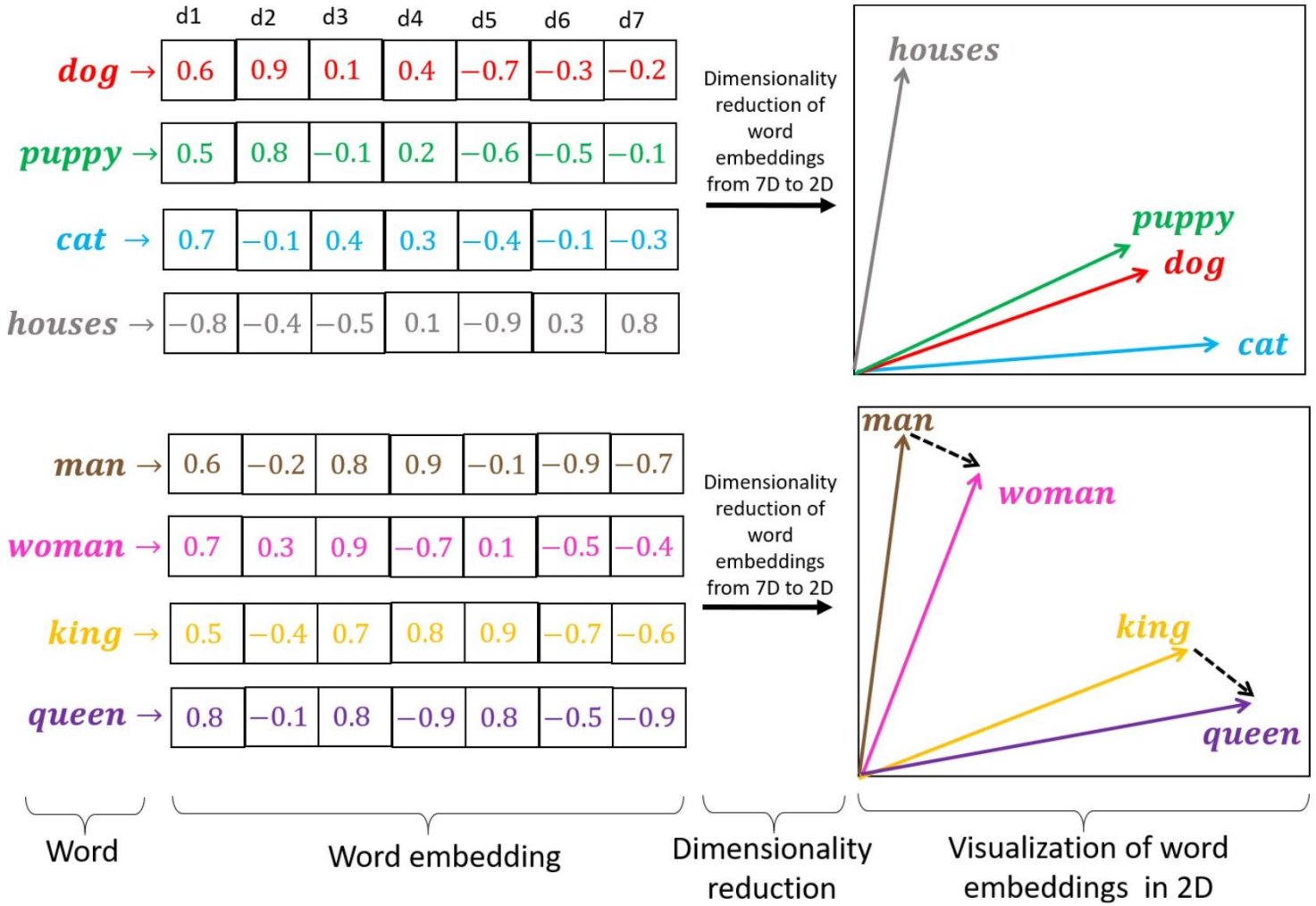
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How do they do it?

- Word embeddings
- Attention

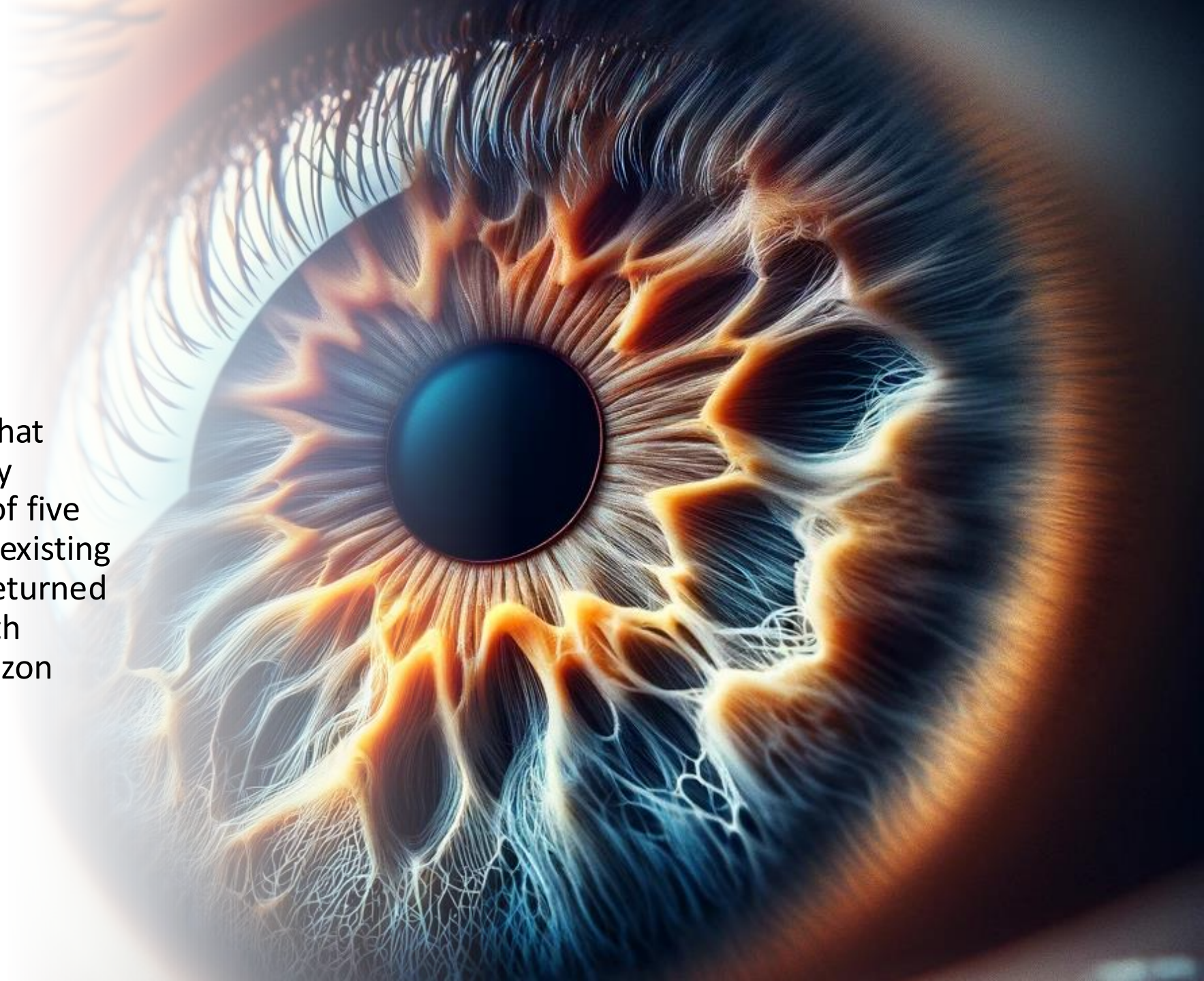
Word Embeddings



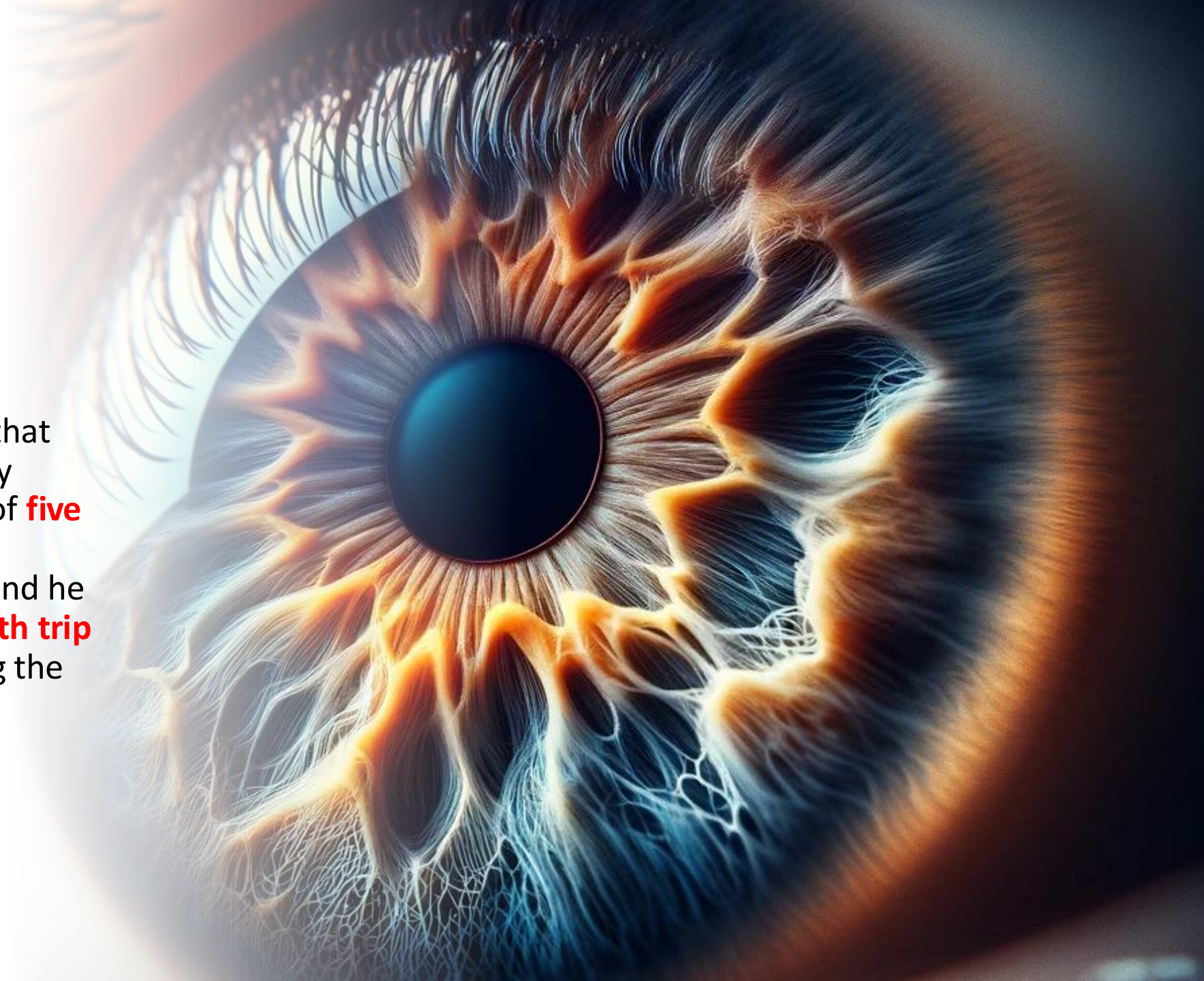
Rozado D (2020) Wide range screening of algorithmic bias in word embedding models using large sentiment lexicons reveals underreported bias types. PLoS ONE 15(4): e0231189. https://doi. org/10.1371/journal.pone.0231189

Attention

- DT is a 78 year old male that presented to the emergency department with a history of five days of fever. He has no preexisting comorbidities and he just returned from a 3-month trip to South America, including the Amazon rainforest.



Attention



- DT is a 78-year-old male that presented to the emergency department with a history of **five days of fever**. He has **no preexisting comorbidities** and he just returned from a **3-month trip to South America**, including the Amazon rainforest.

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CONNECTING DIGITAL INNOVATION TO HEALTH

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Diam ut venenatis tellus in metus. Accumsan in nisl nisi scelerisque eu. Amet porttitor eget dolor morbi non. Tellus in hac habitasse platea dictumst vestibulum. Egestas integer eget aliquet nibh. Amet consectetur adipiscing elit ut aliquam. Dictum non consectetur a erat nam at lectus. Porttitor massa id neque aliquam vestibulum morbi blandit cursus risus. Ultricies integer quis auctor elit. Imperdiet sed euismod nisi porta. Senectus et netus et malesuada fames ac. Metus dictum at tempor commodo ullamcorper a lacus vestibulum. Pharetra magna ac placerat vestibulum lectus. Viverra adipiscing at in tellus integer.

Result: take longer/complex inputs and generate longer/complex outputs

Generative AI (i.e. Large Language Models)

"I am a physician admitting a patient to the ward. The patient is a 78 year old female from home with her husband and daughter, normally independent for all her activities. She presents with a history of three days of feeling tired and today the patient woke up confused, the husband called the ambulance who brought her to the ED. There is no history of respiratory or urinary symptoms. The patient has a background of type 2 diabetes treated with metformin and hypertension treated with metoprolol.

The patient looks tired and is disoriented. Her vital signs are normal, with no fever. Physical examination is unremarkable. Initial screen shows a normal chest x-ray, elevated leucocytes, elevated neutrophils, normal kidney function, mild hyponatremia. Blood cultures and urine MCS were obtained. Urine shows nitrites ++, negative leucocytes. Cultures are pending. I think that the patient has a urinary infection and I prescribe oral amoxicillin for 7 days"

Generative AI: November 2023

“Based on this scenario, while the diagnosis of a UTI seems appropriate given the patient's presentation and lab findings, the choice of amoxicillin as the first-line treatment might not align perfectly with current Australian guidelines, especially if local resistance patterns are not favorable for amoxicillin.

The duration of treatment appears reasonable for a presumed uncomplicated UTI, but this may need to be adjusted based on the culture results and the patient's clinical response.”

Generative AI: February 2025

“From an Australian Therapeutic Guidelines perspective, oral amoxicillin by itself is *not* generally recommended as first-line empirical therapy for most uncomplicated urinary tract infections (UTIs). Here’s why:

High Rates of Resistance: Many common urinary pathogens—especially *E. coli*—have developed significant resistance to amoxicillin. As a result, amoxicillin monotherapy often provides suboptimal cover.

Generative AI: February 2025, continued…

Recommended First-Line Options

According to Australian guidelines (e.g. **Therapeutic Guidelines: Antibiotic**), the usual first-line oral agents for uncomplicated UTIs in adults include:

Trimethoprim (e.g. 300 mg daily for 3–5 days),

Nitrofurantoin (e.g. 100 mg six-hourly for 5 days),

Cephalexin (e.g. 500 mg twice daily for 5 days), or

Trimethoprim–sulfamethoxazole (in some settings, if local resistance patterns are favourable).

Generative AI: February 2025, continued…

Bottom Line

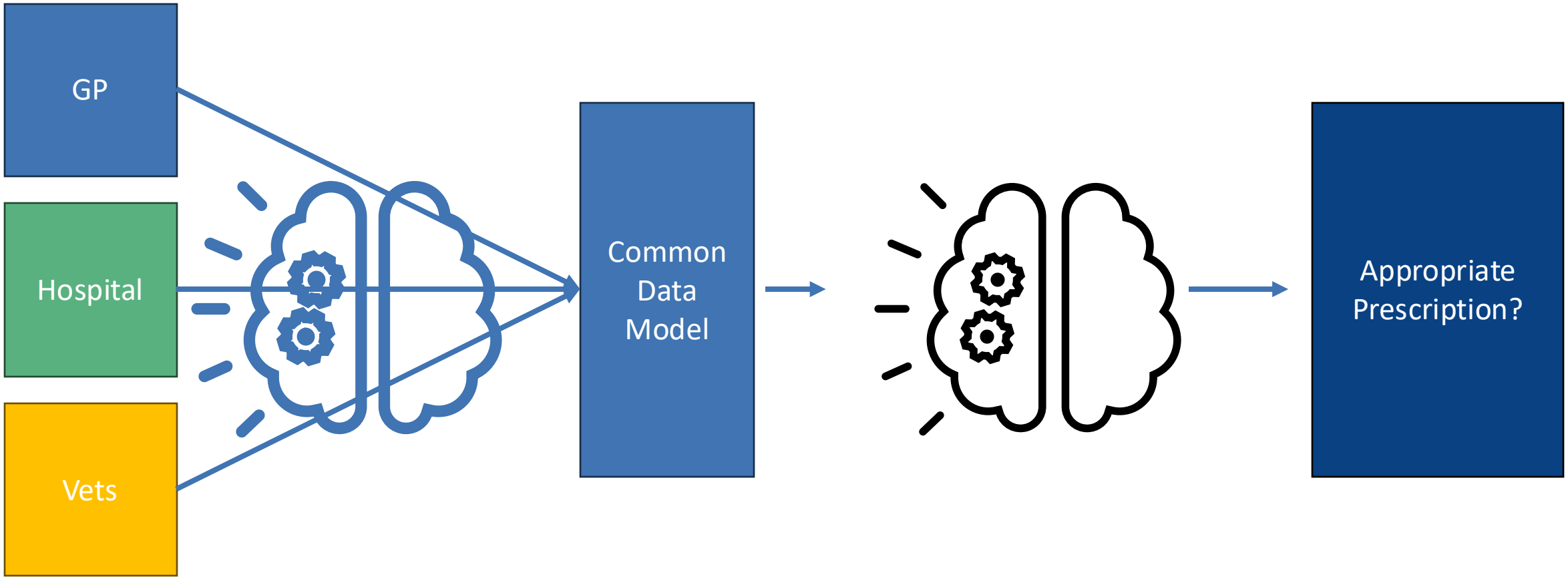
No, prescribing oral amoxicillin alone for 7 days is **not** considered first-line and does **not** align with standard Australian guidelines for empiric treatment of uncomplicated UTIs. A more guideline-compliant choice (in the absence of contraindications) would be trimethoprim, nitrofurantoin, or cephalexin while awaiting culture and sensitivity results.”

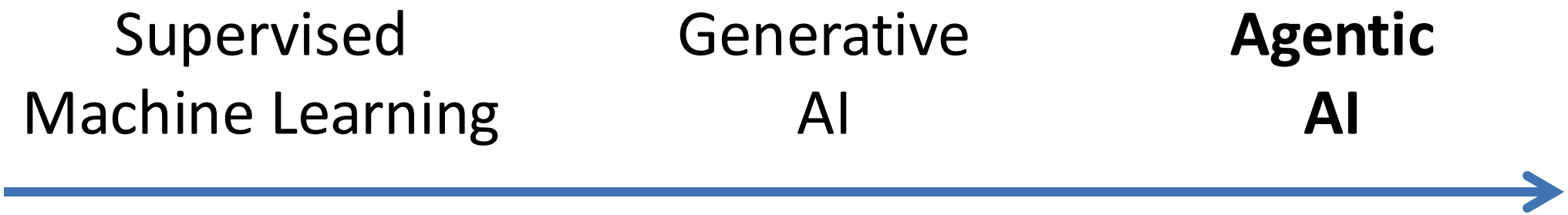
Generative AI

- More open ended than supervised ML
- Usually single-step task
- Requires prompting, which can dramatically change the results



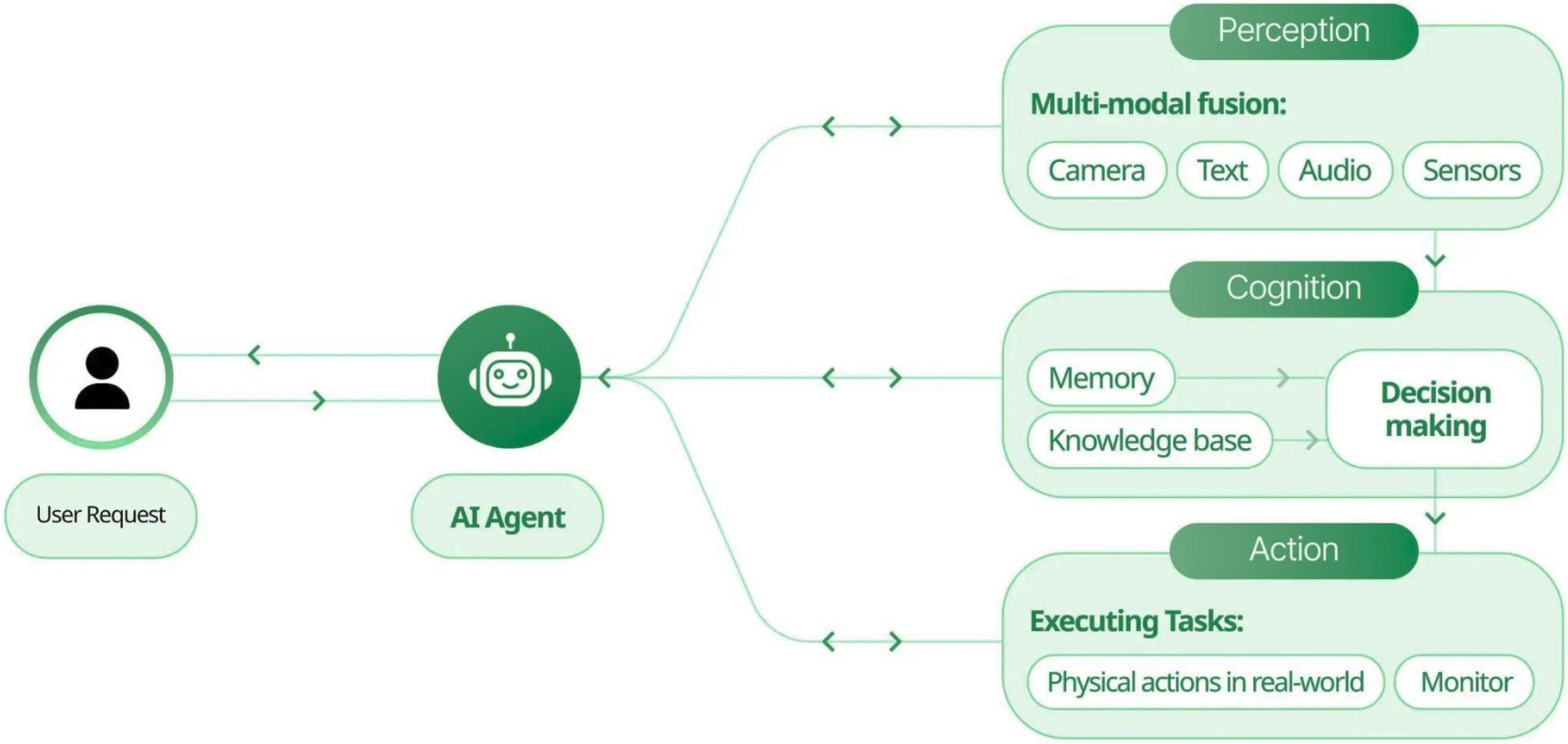
AI for Antimicrobial Stewardship



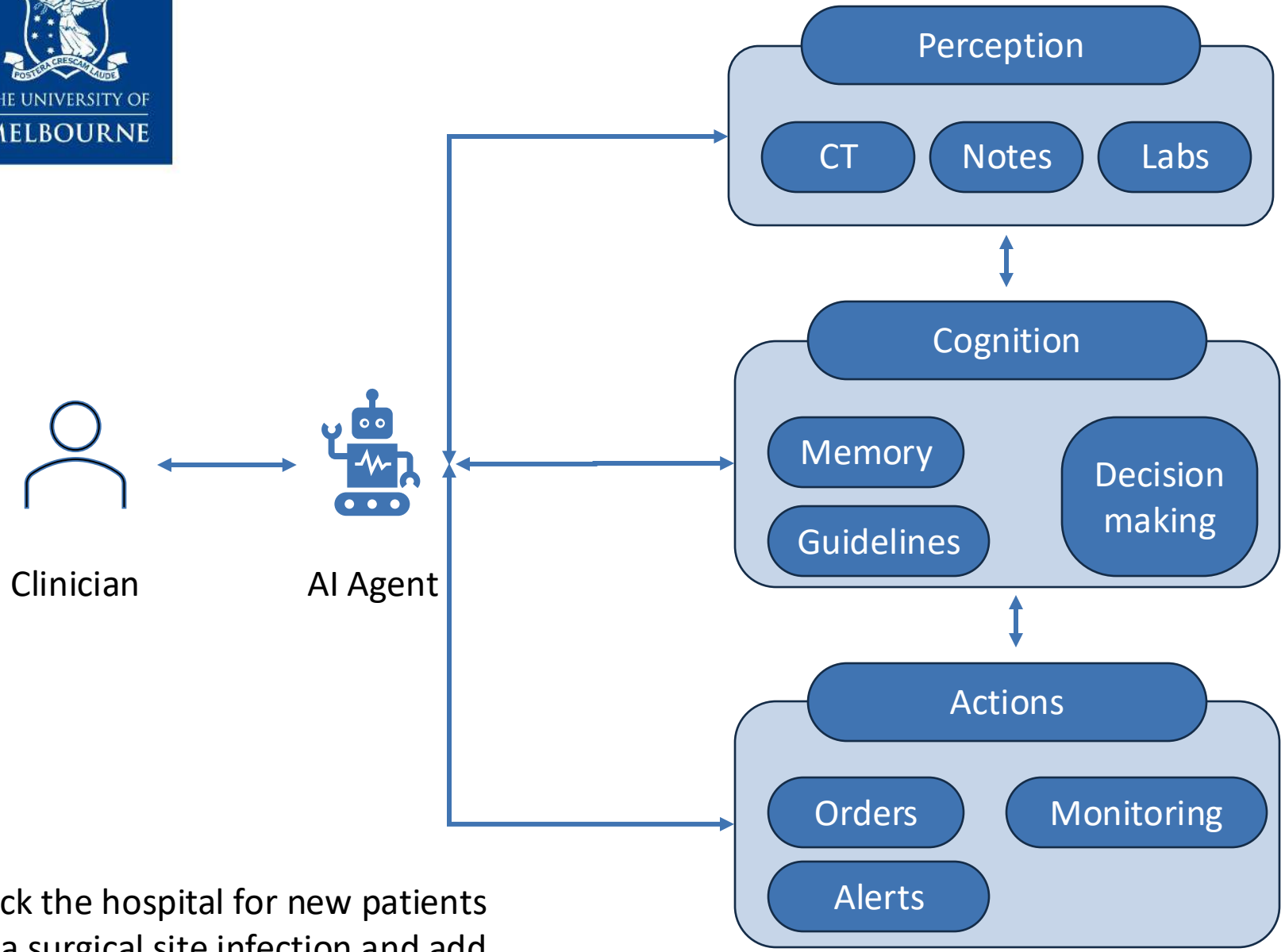

Supervised
Machine Learning
Generative
AI
**Agentic
AI**

Agentic AI?

- An extension of Gen AI models – many models talking to each other
- Models have a ‘longer range of action’, can ‘remember’
- Models take actions autonomously



https://k21academy.com/ai-ml/what-is-agentic-ai/



"Check the hospital for new patients with a surgical site infection and add them to the quality dashboard"

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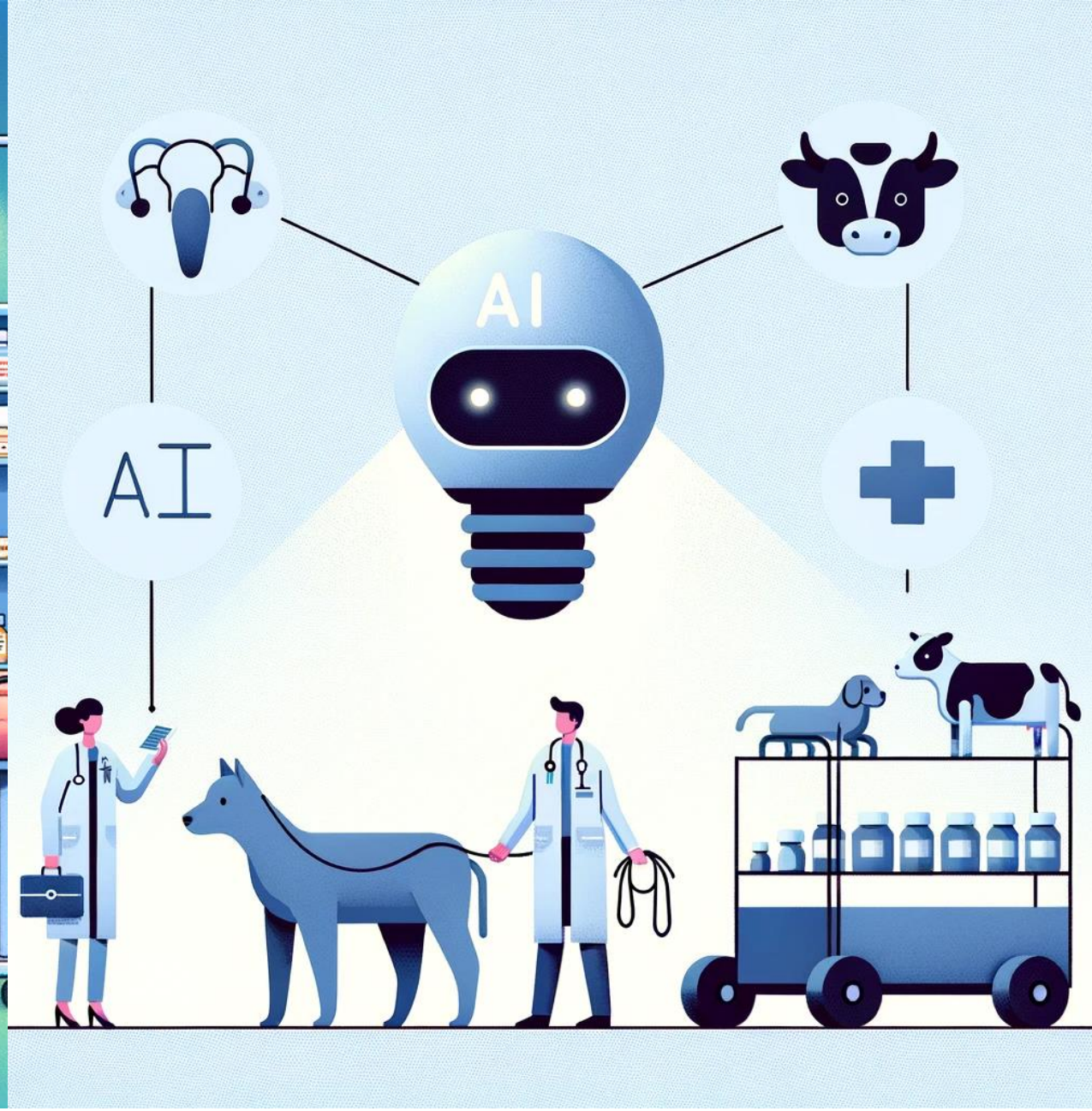
Centre for Digital Transformation of Health

CONNECTING DIGITAL INNOVATION TO HEALTH

Are we there yet?


Not Yet


AI dstoog we poyagpe anitonics
soudidatiins siroumnere doctors
spreciibing to humans pənl and pets


AI
AI

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Thanks!

dcapurro@unimelb.edu.au

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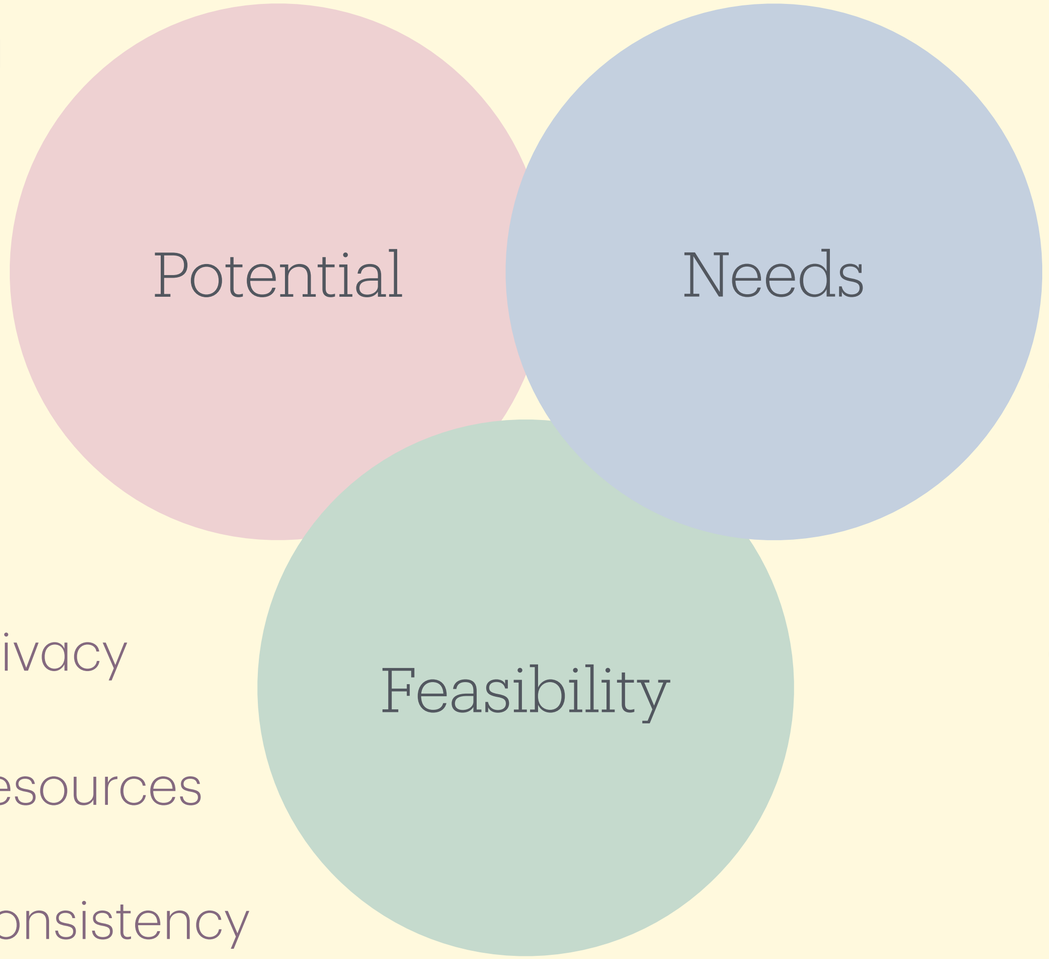
AI in Healthcare

A balancing act between tremendous potential, technical feasibility, and user needs

Vlada Rozova, PhD

AI in Healthcare

- Large amounts of data
- Pattern recognition
- Knowledge transfer



- Transparency
- Usability
- Closing gaps

- Privacy
- Resources
- Consistency

A platform for fungal infection surveillance

INVASIVE FUNGAL INFECTION SURVEILLANCE

Vlada Rozova, PhD

Why

Fungal infection surveillance

- Fungal infections can lead to serious complications in immunocompromised patients
- There is no simple diagnostic test; need to review microbiology, histology, imaging results, take into account host factors and anti-fungal therapy
- High-risk patients are treated preventatively but retrospective surveillance helps track rates of infection, identify emerging risks, benchmark facilities
- Manual surveillance is time- and labour-intensive

What

Invasive Fungal Infection Surveillance (IFIS) tool

- A platform for hospital surveillance of invasive fungal infections
- User-centred, feasible, addressing the real gaps in clinical practice
- To help clinicians monitor infection trends over time and assist with patient management
- Leveraging electronic health records, machine learning and natural language processing

High-level monitoring

Vlada Rozova, PhD

INVASIVE FUNGAL INFECTION SURVEILLANCE

Monitoring | Patients | Definitions

Graham, Barbarella

Filters

Year: All years

Organism (2): All organisms

Site of Infection (1): All sites of infection

IFI Diagnosis Classification: All classifications

IFI Diagnosis Clinical Review Status: All clinical review statuses

Treatment Response: All treatment responses

Breakthrough Status: All breakthrough statuses

Facility: All facilities

Unit: Clinical Haematology

Tumor Stream: All tumor streams

Immune Compromising Condition: All immune compromising conditions

Immunosuppressive Therapy: All immunosuppressive therapies

Antifungal Prophylaxis: All antifungal prophylaxis

Monitoring

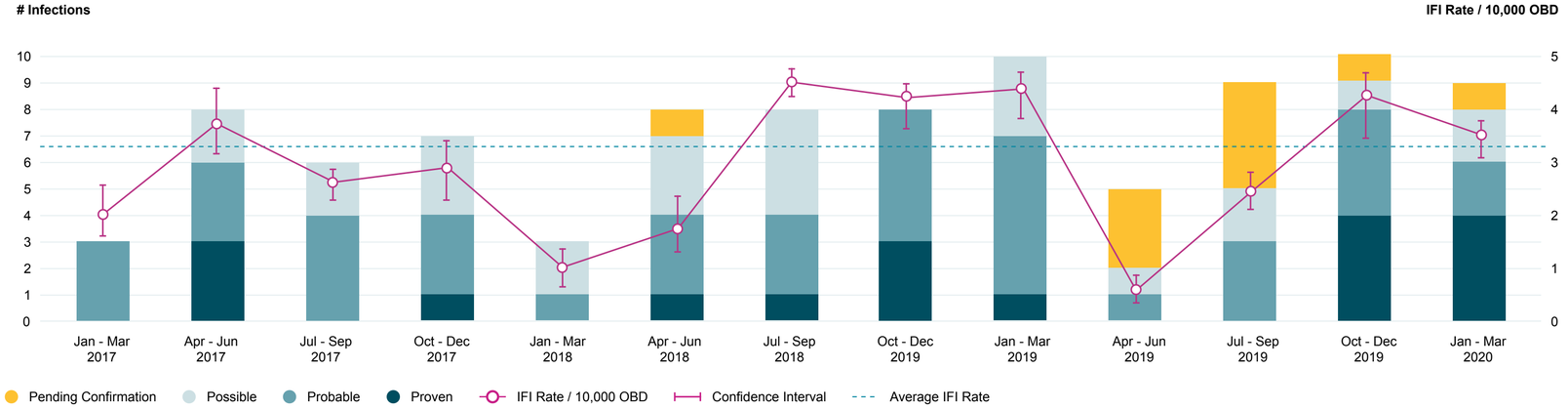
Download Report | Share Report | Manage Sentinel Events

FILTERS: Aspergillus nidulans complex | Fusarium chlamydosporum complex | Pulmonary | Clear all

Diagnosed Invasive Fungal Infections / All patients

PATIENTS 78 | INFECTIONS 84

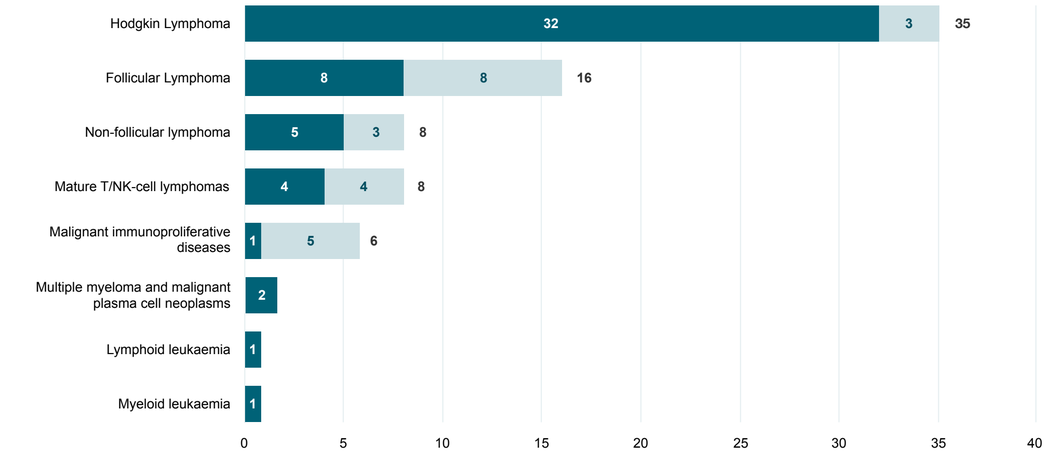
View quarterly | View by classification



Host Factors

Infection Count / IFI episodes

View broad | View by condition

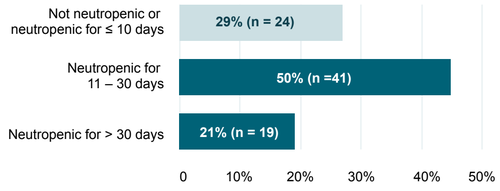


Neutropenia / IFI episodes

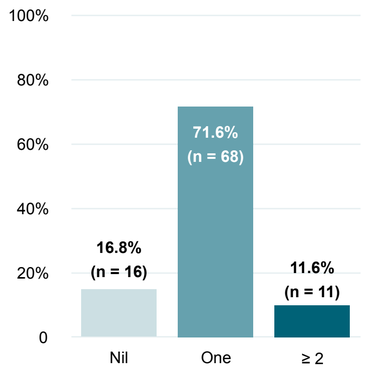


Duration of neutropenia

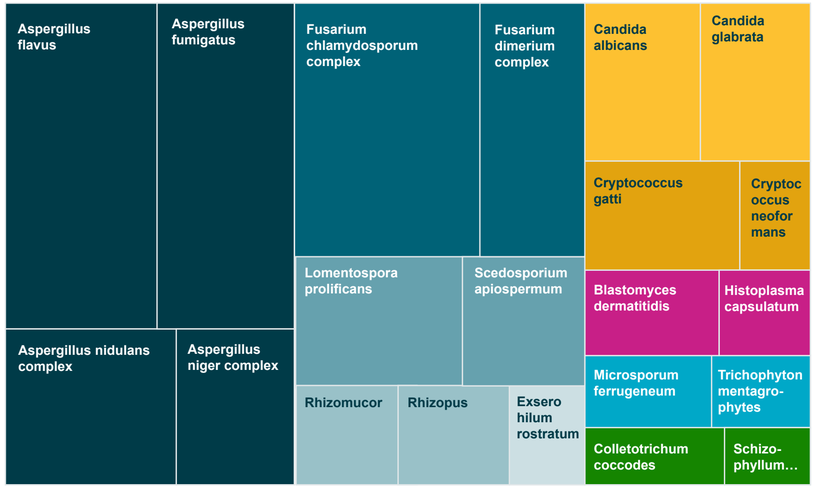
Median 22 days



Number of Isolated Organisms / IFI episodes



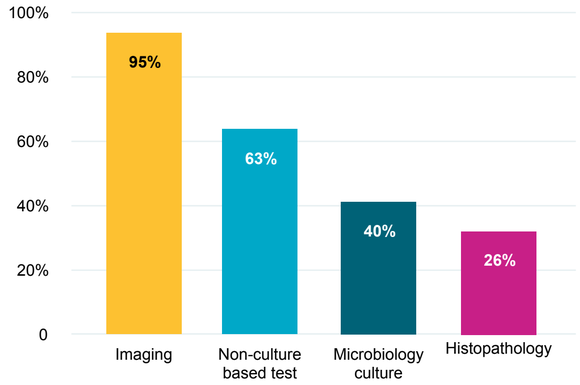
Fungal Organisms / All identified fungal organisms



Organism	No.	%
Aspergillus	52	65.8%
Fusarium	15	19%
Lomentospora / Scedosporium	15	19%
Murocales	15	19%
Other Mould	15	19%
Candida & Candida like	15	19%
Cryptococcus	15	19%
Other Yeast	15	19%
Dimorphic	15	19%
Dermatophyte	15	19%
Other	15	19%

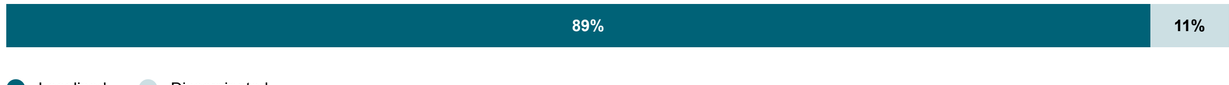
Investigations contributing to IFI Diagnosis

/ IFI episodes

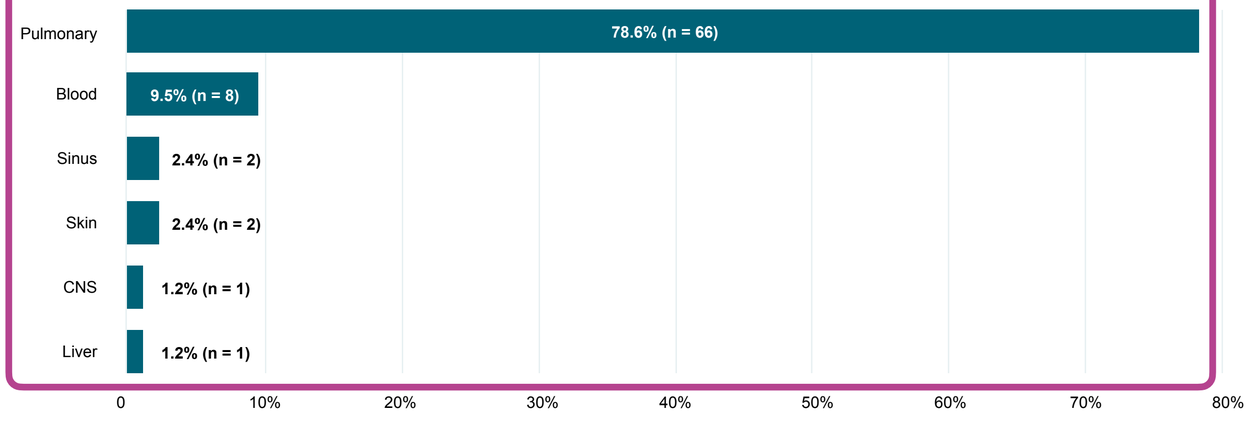


Investigation	No.	%
Culture	35	42%
Non-culture based test	86	63%
Galactomannan	25	30%
Aspergillus PCR	28	33%

Localised vs Disseminated Infections / IFI episodes



Site of Infection / All infection sites



Vlada Rozova, PhD

Individual patient management

Vlada Rozova, PhD

Allemand, Claudine | UR: 123456

Episode 1

Share Diagnosis | View Diagnosis History

Details

Patient

Name
Allemand, Claudine

UR
123456

DOB
9 February 1961

Age
61 y 1 m

Gender
Female

Location

Facility
RMH

Unit
Clinical Haematology

Tumor Stream
Lorem Ipsum

Ward
7 East

Admission

Admitted
19 November 2019

Discharged
26 February 2020

Length of Stay
92 days

Past Medical History

Host Factors — Edit

Immune Compromising Factors

Immunocompromising Condition
Acute myeloid leukaemia (AML)

Illness Factor
Primary course of disease

Immunosuppressive Therapy
Allogenic stem cell transplant

Illness Stage
Relapsed

Graft vs Host Disease (GVHD)
Yes

GVHD Treatment
Cyclosporine

Corticosteroids

Prolonged Corticosteroid Use
Yes

Neutropenia

Neutropenia
26 November 2019 - 12 December 2019
(16 days)

Antifungal Prophylaxis Prescribing

Poscanazole
19 Nov 2019 - 5 Dec 2019

Occupation

Not provided

Clinically Reviewed Invasive Fungal Infection — Edit

Diagnosis

Clinically reviewed by Leung, Min on18 May 2019, 8:08pm

ORGANISM 1	SITE OF INFECTION	DATE OF DIAGNOSIS	IFI CLASSIFICATION
Aspergillus fumigatus	Pulmonary	6 December 2019 19 days after hospital admission	Probable
ORGANISM 2	**SITE OF INFECTION**	**DATE OF DIAGNOSIS**	**IFI CLASSIFICATION**
Rhizopus microsporus	Pulmonary, Sinus	6 December 2019 19 days after hospital admission	Proven

Investigations and Results

Expand all results

From specimens taken 04 May 2019 - 18 May 2019

- Microbiology - Culture — 2 tests
- Microbiology - Non-Culture Based Tests — 6 tests
  - Galactomannan — 1 test
  - Aspergillus PCR — 1 test
  - Panfungal PCR — 4 tests
  - Cryptococcal Antigen — 0 tests
  - Meningitis PCR — 0 tests
  - BioFire — 0 tests
- Histopathology — 1 test
- Imaging — 3 tests
  - CT — 2 tests
  - PET — 1 test

IFI Management — Edit

ID Consultation

Yes

Antifungal Treatment

Voriconazole
IV, 5 Dec 2019 - 5 Dec 2019

Voriconazole
IV, 6 Dec 2019 - 8 Dec 2019

Liposomal ampoteracin B
IV, 8 Dec 2019 - 9 Dec 2019

Liposomal ampoteracin B
IV, 10 Dec 2019 - 19 Dec 2019

Liposomal ampoteracin B
IV, 19 Dec 2019 - 24 Jan 2020

Voriconazole
Oral, 25 Jan 2020 - 26 Feb 2020

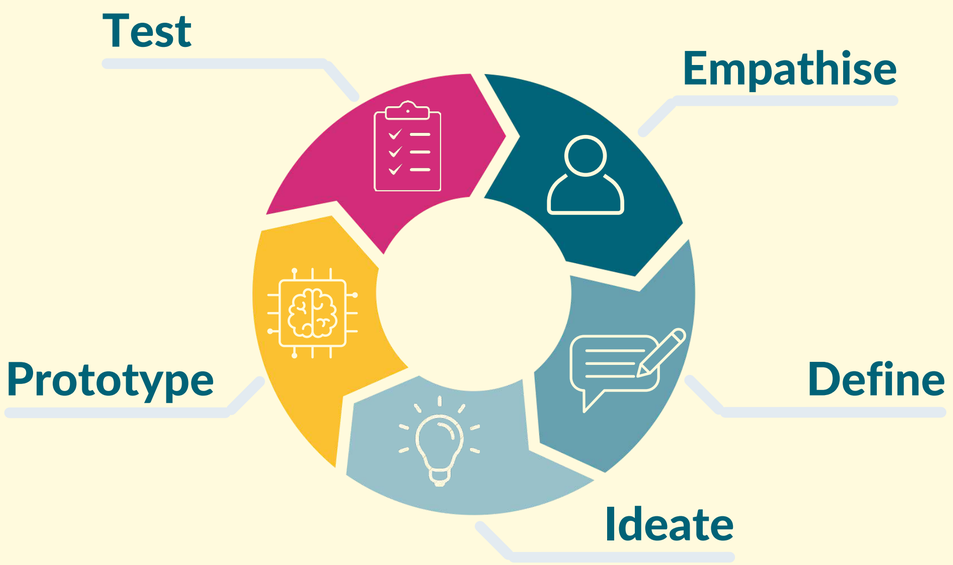
90 Day* Response to Treatment

Death

* 2 March 2019 (90 days post diagnosis)

How

Design Thinking Framework



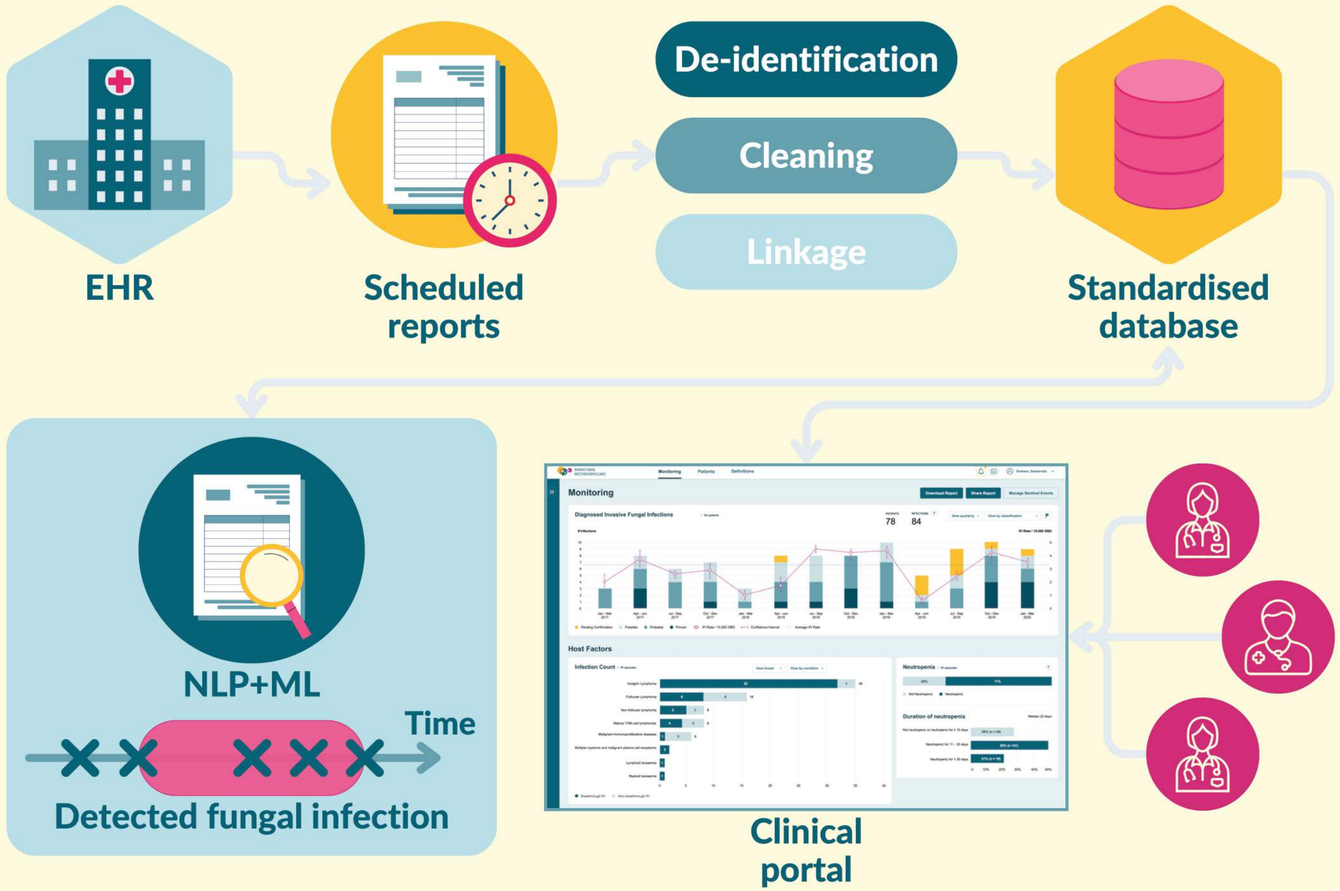
- We use the framework to guide each step of the development process:
  - Which information needs to be extracted from hospital systems
  - How data is processed, which ML/NLP tasks need to be solved
  - Which ML/NLP techniques to employ, what are the outputs of the data pipeline
  - The design, layout and functionality of the clinical portal, its access permissions
  - How to collect user feedback and to monitor performance of the system over time

Needs

How

Data pipeline

- Scheduled extracts from EPIC
- Data pre-processing
- Rule and ML-based inference (lab results, evidence of infection in free-text reports)
- Aggregation of findings into episodes of infection
- Presentation via the clinical portal



Vlada Rozova, PhD

NCAS National Centre for Antimicrobial Stewardship

The Royal Melbourne Hospital

BioGrid Connecting health information

RMIT UNIVERSITY

THE UNIVERSITY OF MELBOURNE

Automated assessment of antimicrobial prescriptions

Vlada Rozova, PhD

Why

Audit of prescriptions

- Misuse and unnecessary overuse of antimicrobials lead to proliferation of drug-resistant bacteria, viruses, fungi, etc
- Antimicrobial resistance (AMR) is a growing global threat, in humans and animals
- In Australia, at least 1/3 of antimicrobials are prescribed inappropriately:
    - Incorrect dosing or duration, no indication, contradictions, spectrum too broad
- Audit of prescriptions helps assess the quantity and quality of antimicrobial prescribing
- Audit is manual and subjective, and limited to each facility

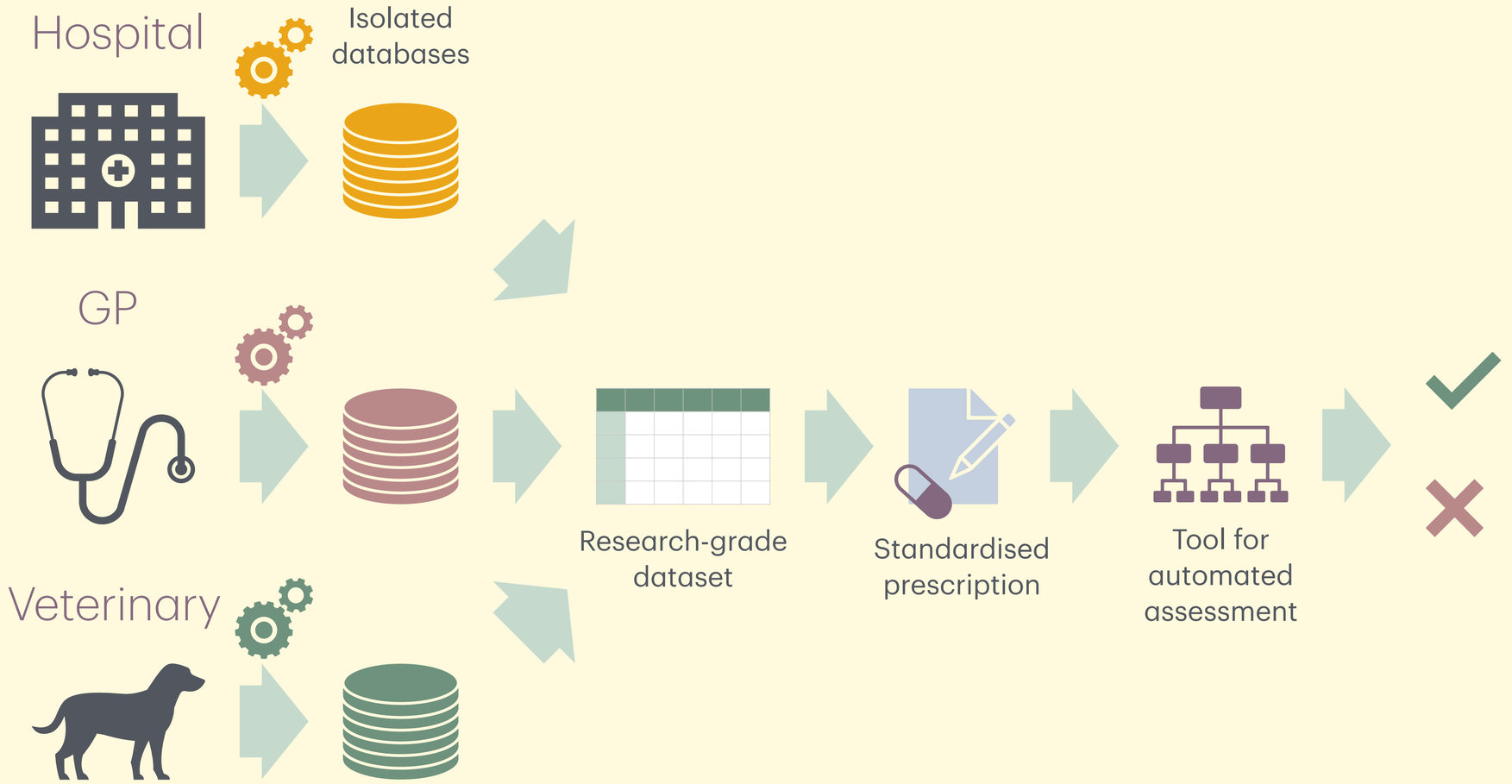
What

Assessment of antimicrobial prescriptions

- Research Data Infrastructure:
    - A research-grade dataset with relevant information
    - A tool for automated assessment of antimicrobial prescriptions
- In hospital, GP and veterinary settings
- Shared standards, data models, and indications
- Leveraging electronic health records, machine learning and natural language processing

How

Data pipeline



Key Takeaways

AI in healthcare is a balancing act

- Easy to get excited about applying AI, especially with access to large electronic datasets
- Solutions need to be technically feasible, within the available resources
- Understanding the user needs is key to designing the 'right' solution
- 'Good' clinical AI solution improves upon the current workflow:
    - Costs
    - Efficiency
    - Accuracy

Thank you!

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