

Große Sprachmodelle in der Medizin

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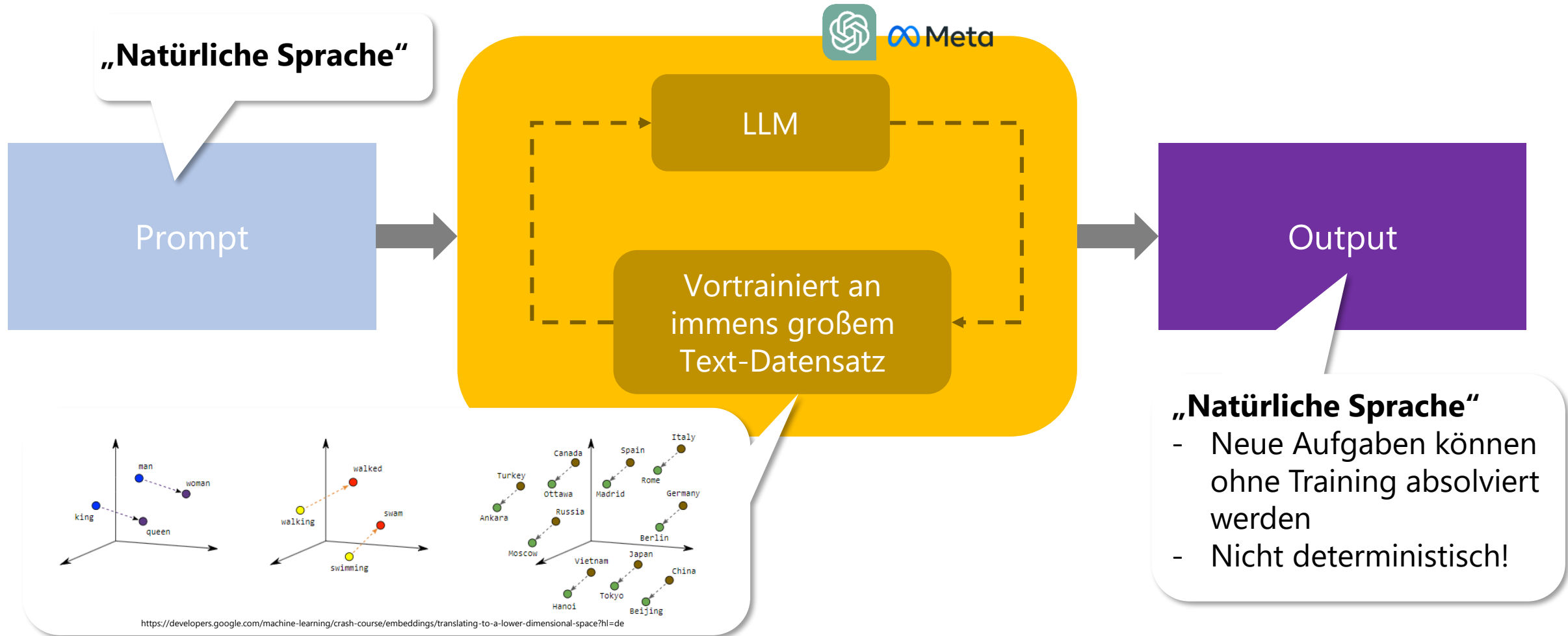
[illegible][illegible]

Elektronische Gesundheitsakte (EHR)

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Slide 2

Large Language Models (LLMs) können natürliche Sprache verarbeiten und generieren



Das Potential von LLMs über verschiedene Komplexitätsebenen hinweg....

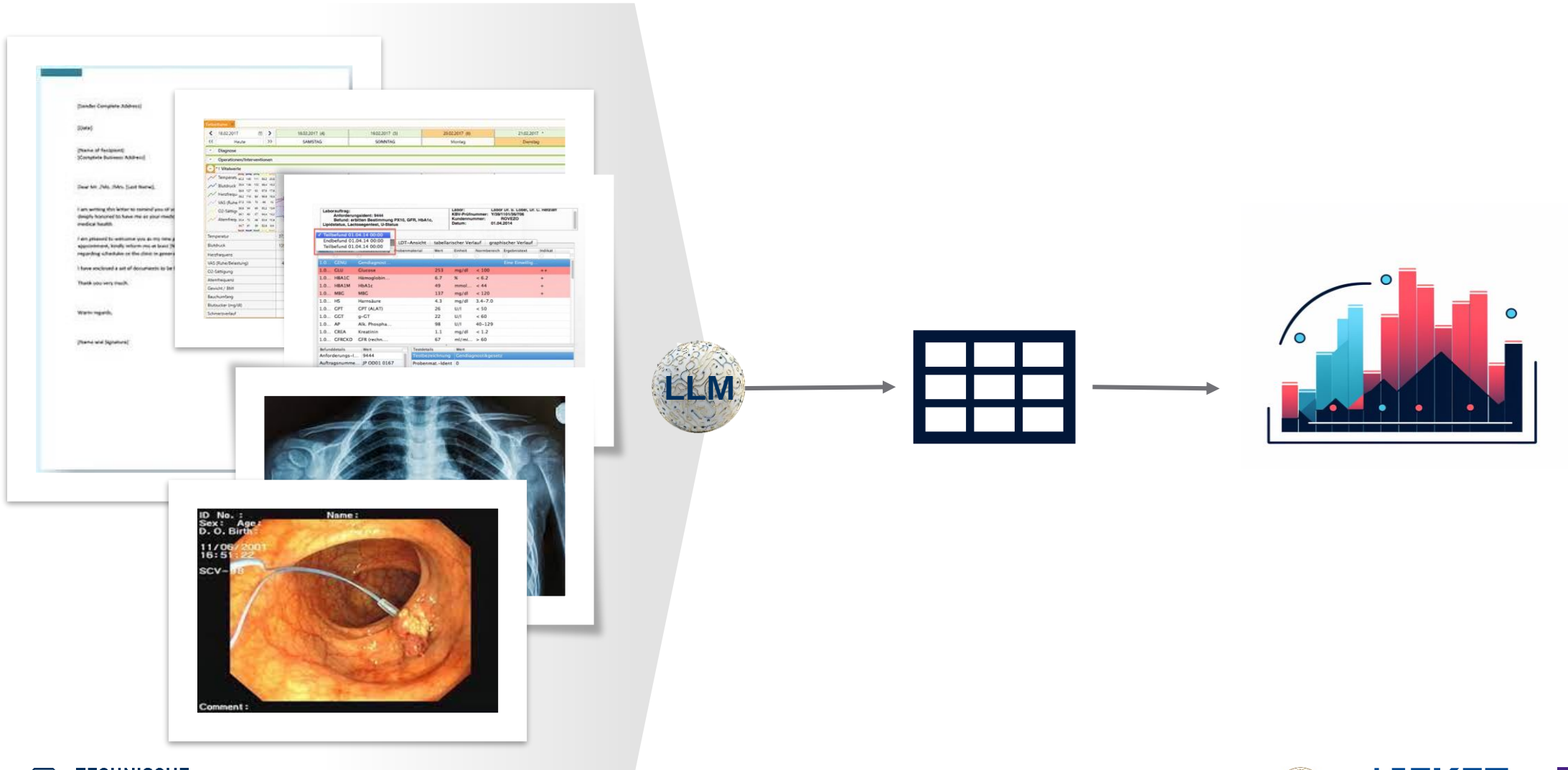


LLMs orchestrieren

LLM als reasoning assistant

LLM als Tool

LLMs extrahieren Informationen aus Freitext



LLMs extrahieren Symptome und Diagnosen aus Anamnesen



Symptome/Diagnose
vorhanden in n=500
Anamnesen (MIMIC IV)



Modelle mit mehr Parametern
besser als kleinere Modelle



Datenschutz gewährleistet
durch **lokale Sprachmodelle**

medRxiv

THE PREPRINT SERVER FOR HEALTH SCIENCES

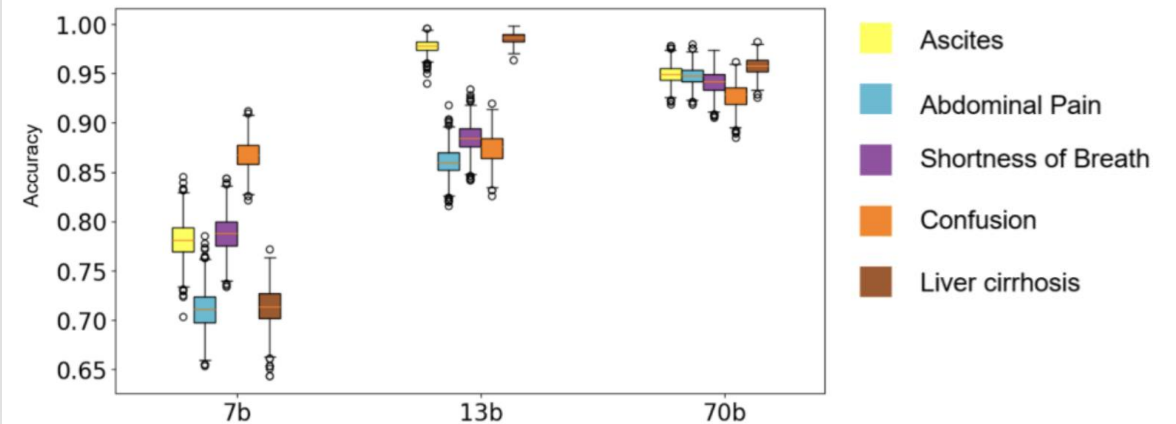


BMJ Yale

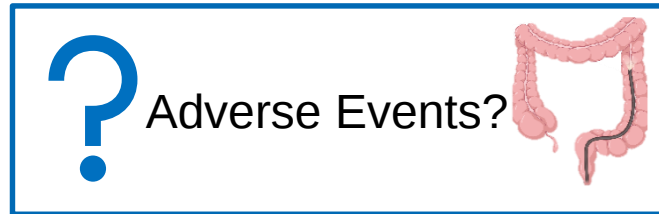
From Text to Tables: A Local Privacy Preserving Large Language Model for Structured Information Retrieval from Medical Documents

Isabella C. Wiest, Dyke Ferber, Jiefu Zhu, Marko van Treeck, Sonja K. Meyer, Radhika Juglan, Zunamys I. Carrero, Daniel Paech, Jens Kleesiek, Matthias P. Ebert, Daniel Truhn, Jakob Nikolas Kather

doi: <https://doi.org/10.1101/2023.12.07.23299648>



LLMs extrahieren Adverse Events aus Endoskopieberichten

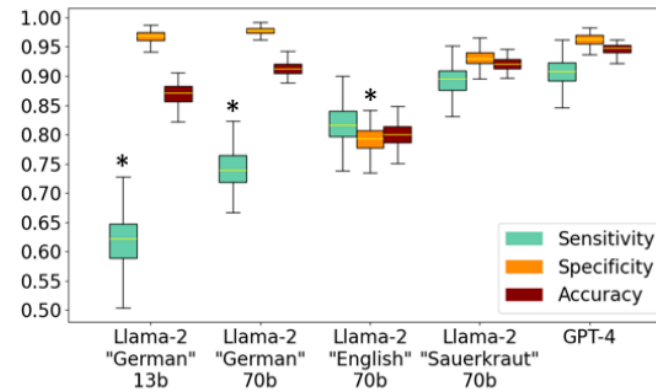


Llama-2 70b „Sauerkraut“
vergleichbar mit GPT-4



Spezifisches Fine-tuning auf die
deutsche Sprache verbessert
die Performance

Deep Sight: Improving the recording of
periprocedural adverse events in endoscopy with
large language models



Llama-2

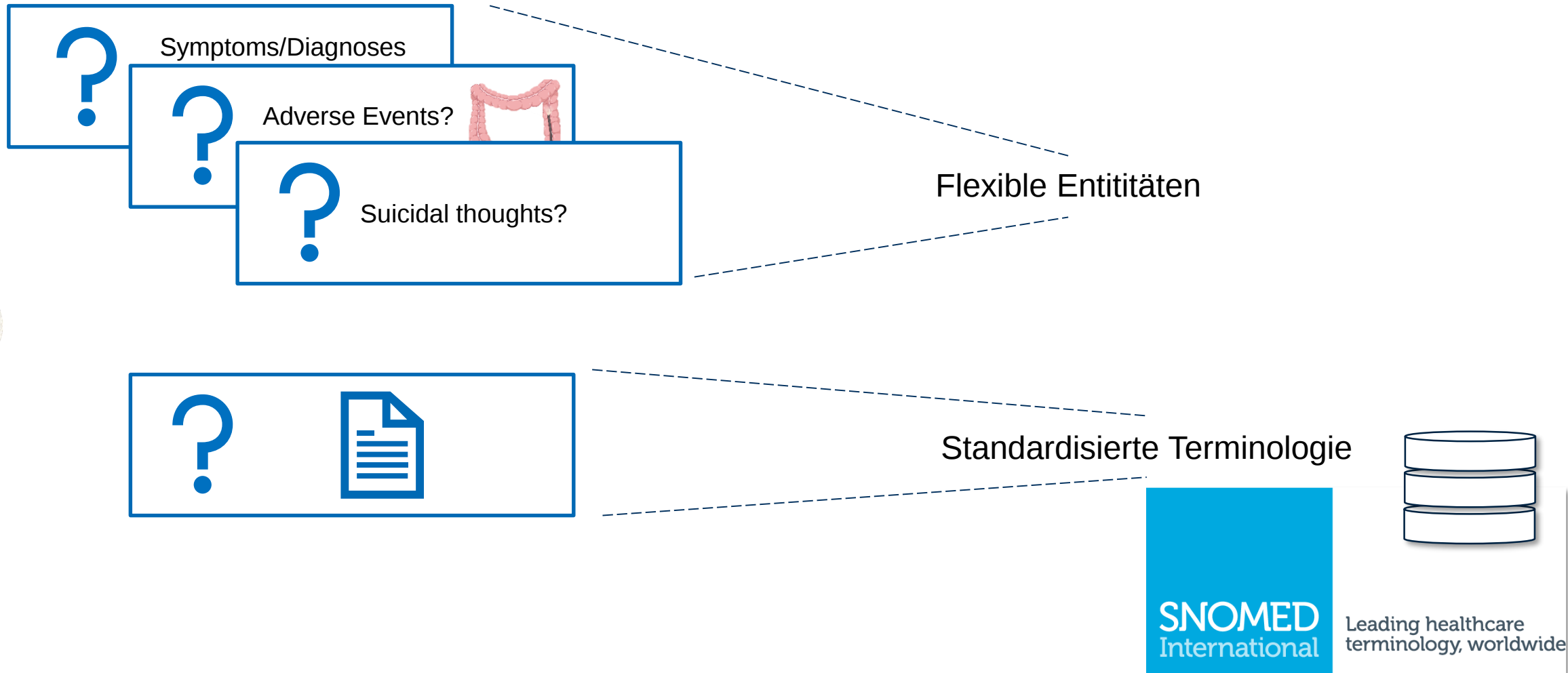
Actual Values	Predicted Values	
	False	True
False	128 (0.92)	11 (0.08)
True	2 (0.06)	30 (0.94)

GPT-4

Actual Values	Predicted Values	
	False	True
False	128 (0.92)	11 (0.08)
True	1 (0.03)	31 (0.97)

Wiest et al. Deep Sight: Improving the recording of periprocedural complications in endoscopy with large language models. *Under Review.*

LLMs extrahieren Informationen aus Freitext



LLMs identifizieren sensitive Patientendaten



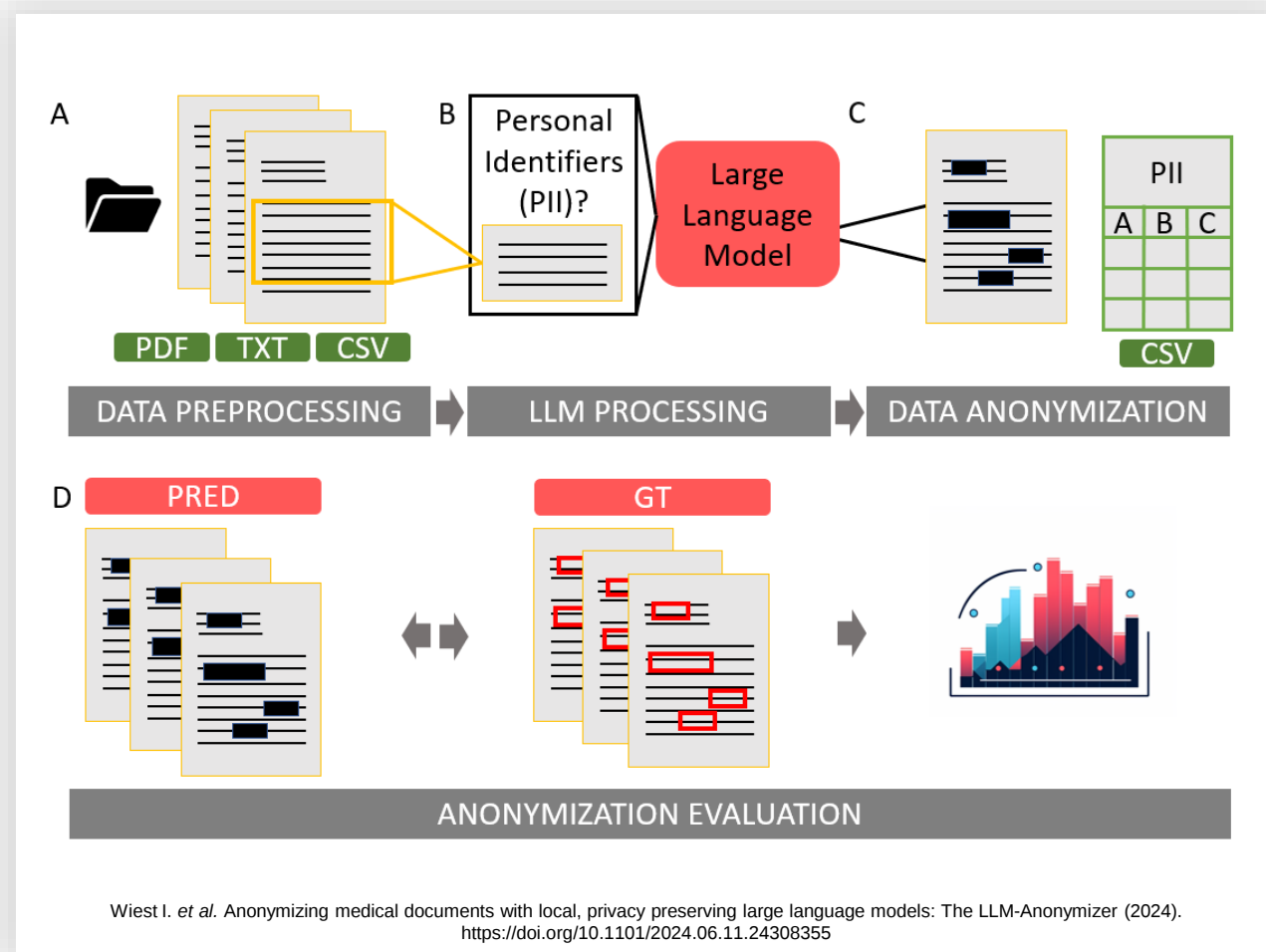
Import PDF files



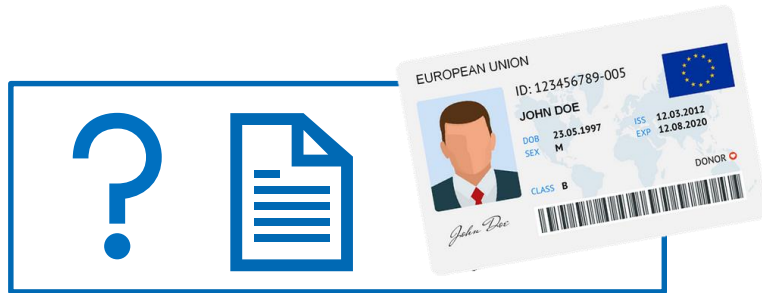
Anonymize



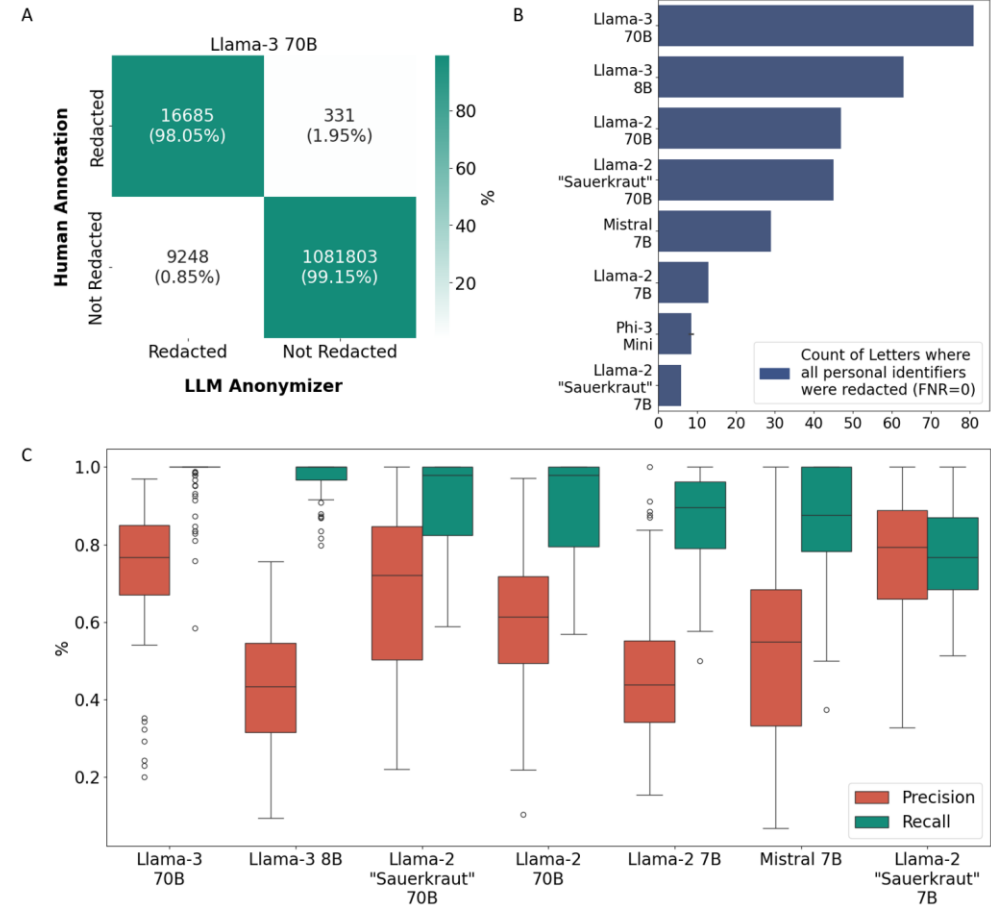
Evaluate



LLM-Anonymizer deidentifiziert medizinische Dokumente



LLM-Anonymizer deidentifiziert
medizinische Dokumente und
erlaubt das Reviewen einzelner
Dokumente



Wiest I. *et al.* Anonymizing medical documents with local, privacy preserving large language models: The LLM-Anonymizer (2024).
<https://doi.org/10.1101/2024.06.11.24308355>

LLM-Anonymizer deidentifiziert medizinische Dokumente



LLM Anonymizer

Preprocessing

LLM Information Extraction

LLM Results

Report Redaction

Upload Successful

×

Upload your Documents!

Select Raw Reports (pdf, png, jpg, jpeg, docx, odf, txt)

Dateien auswählen

Keine Datei ausgewählt

Preprocess Files

14000

Split Length

Job Progress

Job 4RL4-r3_q43hD8V3ErQCGoTvJpE4e0xXitqbfQYgvP0

1 / 1

Download

LLM Anonymizer

Preprocessing

LLM Information Extraction

LLM Results

Report Redaction

LLM Processing

Input csv or excel for information retrieval

Datei auswählen

preprocessed-wolfganggehrich_engl.zip

LLaMA Settings

Prompt:

[INST] <<SYS>>
Du bist ein hilfreicher medizinischer Assistent. Im Folgenden findest du Berichte. Bitte extrahiere die gesuchte Information wortwörtlich aus dem Bericht. Wenn du die Information nicht findest, antworte null.
<</SYS>>
[/INST]

[INST]
Das ist der Bericht:
(report)

Variables (separated by commas):
Patienteninfos
Temperature:
0.1
Model:
LLaMA 3 8B Instruct Q5_K_M
Grammar:
root ::= allrecords
value ::= object | array | string | number | ("true" | "false" | "null") ws

allrecords ::= (
"{"
ws "\"patientennachname\"": ws string ","
ws "\"patientenvorname\"": ws string ","
ws "\"patientenname\"": ws string ","
ws "\"patientengeschlecht\"": ws string ","
"

Run Pipeline

LLM Anonymizer

Preprocessing

LLM Information Extraction

LLM Results

Report Redaction

Report Redaction Metrics

Total reports: 5

Metric	Macro Score	Micro Score
Precision	0.5084	0.4397
Recall	0.8816	0.8865
Accuracy	0.9823	0.9825
F1 Score	0.6237	0.5879
Specificity	0.9837	0.9839
False Positive Rate	0.0163	0.0161
False Negative Rate	0.1184	0.1135

Confusion Matrix for Report Redaction (char-wise)

Annotation

Reduced

Not Reduced

Redacted LLM Anonymizer

Not Redacted

547 (0.89)

70 (0.11)

697 (0.02)

42540 (0.98)

Download All

Metadata

1. aaymsfatl.pdf58af3df16-ab86-4c72-bef9-c4663e1c7469

F1: 0.345 Acc: 0.9727 P: 0.2599 R: 0.513 Spec: 0.9792 FPR: 0.0208 FNR: 0.487

View Report

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View Report

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View Report



TECHNISCHE
UNIVERSITÄT
DRESDEN

Das Potential von LLMs über verschiedene Komplexitätsebenen hinweg....



LLMs orchestrieren

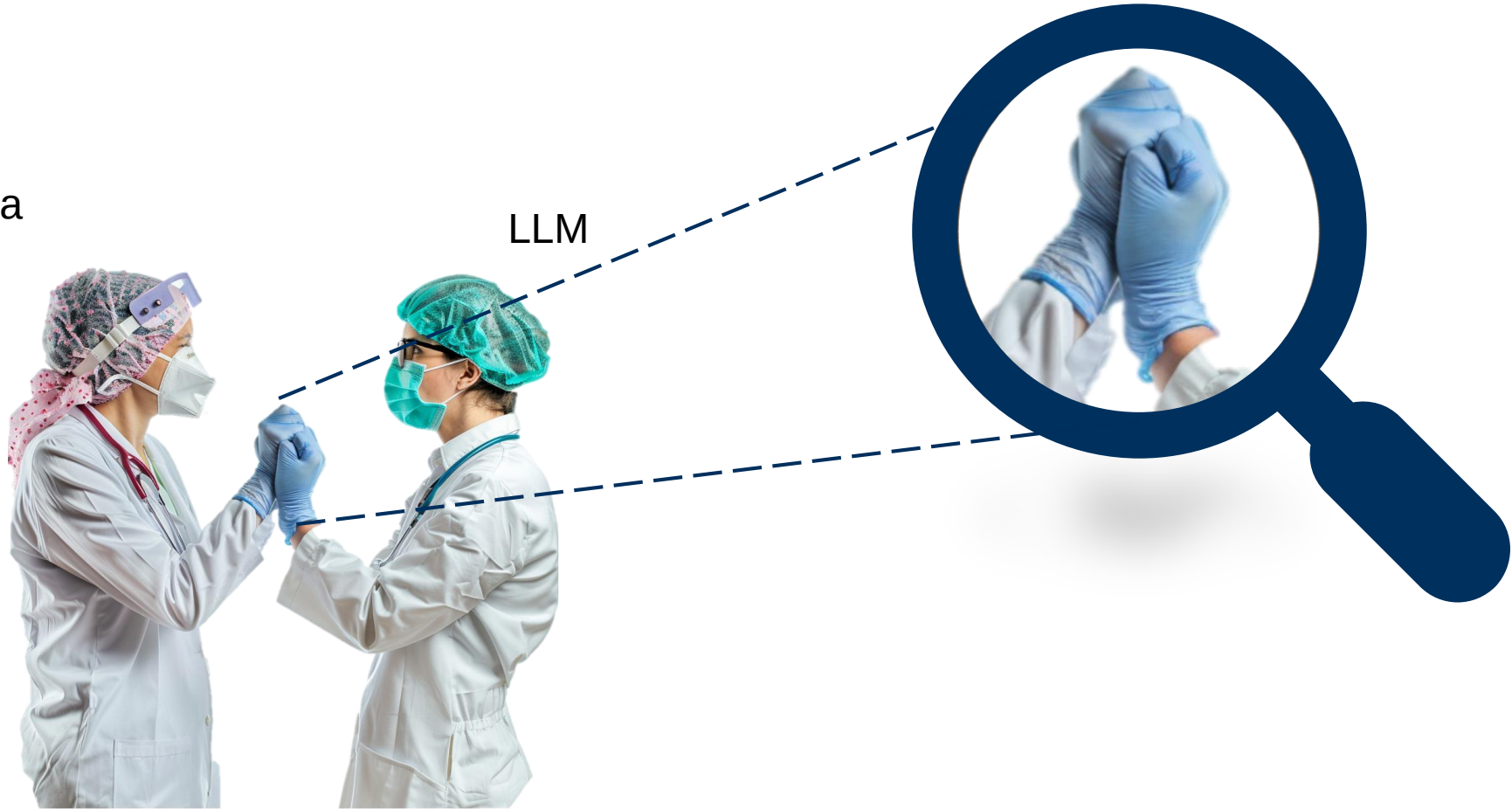
LLM als reasoning assistant

LLM als Tool

LLMs sind intelligente Assistenten, keine Wissensdatenbanken!

Isabella

LLM



LLMs sind intelligente Assistenten, keine Wissensdatenbanken!

„Large Language Models are poor medical coders“

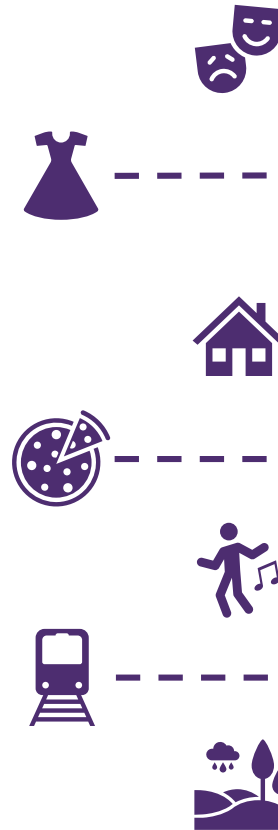
Soroush, Ali, et al. "Large language models are poor medical coders—benchmarking of medical code querying." NEJM AI 1.5 (2024): A1dbp2300040.

”LLMs are currently not ready for autonomous clinical decision-making”

Hager, P., Jungmann, F., Holland, R. et al. Evaluation and mitigation of the limitations of large language models in clinical decision-making. Nat Med (2024).

Es macht einen Unterschied, wie man mit einem LLM „spricht“

„Explain the touristic advantages of Milano“



Explain the touristic advantages of milano.

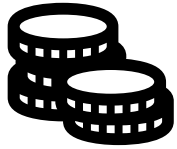


Milan, Italy's financial and fashion capital, offers a dynamic mix of modernity and deep-rooted cultural heritage, making it a compelling destination for tourists. Here are some of the key touristic advantages of Milan:

1. **Rich Art and Culture:** Milan is home to some of the world's most famous artworks, including Leonardo da Vinci's "The Last Supper," housed in the Convent of Santa Maria delle Grazie. The city's museums, such as the Pinacoteca di Brera and the Museo del Novecento, showcase extensive collections from classical art to contemporary masterpieces.
2. **Fashion and Shopping:** Known as one of the global capitals of fashion, Milan is a shopping paradise. The Quadrilatero della Moda, Milan's fashion district, is packed with boutiques, showrooms, and upscale shops featuring international and Italian designers. Twice a year, the city becomes the center of attention during Milan Fashion Week, attracting fashion enthusiasts from all over the world.
3. **Impressive Architecture:** Milan's architectural landscape is a blend of historical and modern design. The Gothic Duomo di Milano, with its intricate façade and stunning rooftop views, is a must-visit. Modern architecture, like the UniCredit Tower and the vertical forest residential towers, adds to the city's cosmopolitan appeal.
4. **Culinary Delights:** Italian cuisine needs no introduction, and Milan offers its unique flavors with dishes like Risotto alla Milanese and Cotoletta alla Milanese. The city also boasts a vibrant scene of cafes, bars, and restaurants that cater to all tastes and budgets.
5. **Vibrant Nightlife and Events:** Milan has a lively nightlife scene with numerous clubs, bars, and live music venues. The city is also a hub for international events, from concerts and art exhibitions to trade shows and sports events, notably the Italian Grand Prix nearby in Monza.
6. **Easy Connectivity:** Milan serves as a major transport hub, with two international airports and high-speed rail connections to other Italian cities and Europe, making it easily accessible for travelers. This connectivity also makes Milan an excellent base for exploring the surrounding regions of Lombardy, such as Lake Como and the Alps.
7. **Green Spaces and Leisure:** Despite its bustling urban environment, Milan offers several large parks and public spaces, such as Parco Sempione and Giardini Pubblici, where visitors can relax and enjoy a bit of nature.

These factors, combined with its welcoming atmosphere and rich history, make Milan a destination that caters to a wide range of interests and ensures a memorable experience for all who visit.

Es macht einen Unterschied, wie man mit einem LLM „spricht“



„Explain the touristic advantages of Milano.
I’m going to tip \$200 for
a perfect solution!*"



Milan, often regarded as Italy’s fashion and finance capital, offers a wealth of attractions that make it a compelling destination for tourists. Here’s a detailed overview of the touristic advantages of Milan:

1. Rich Artistic and Historical Heritage

- **Duomo di Milano:** This Gothic cathedral, the largest church in Italy and the third largest in Europe, is a masterpiece with its intricate marble facades and stunning rooftop views of the city.
- **Santa Maria delle Grazie:** Home to Leonardo da Vinci’s “The Last Supper,” this church and Dominican convent is a UNESCO World Heritage site and a pivotal art historical site.

2. World-Leading Fashion and Shopping

- **Quadrilatero della Moda:** Milan’s fashion district is famed for its upscale shopping, housing renowned designer boutiques such as Armani, Versace, and Prada.
- **Galleria Vittorio Emanuele II:** One of the world’s oldest shopping malls, known for its impressive architecture and luxury shopping.

3. Vibrant Cultural Scene

- **La Scala Theatre:** One of the most prestigious opera houses in the world, offering a rich program of opera and ballet performances.
- **Museums and Galleries:** Milan has numerous museums, such as the Pinacoteca di Brera and the Museo del Novecento, showcasing Italian art from the Middle Ages to the contemporary period.

4. Culinary Delights

- **Local Cuisine:** Milan is famous for its rich culinary traditions, including dishes like Risotto alla Milanese, Osso Buco, and Panettone.
- **Cafés and Restaurants:** From traditional trattorias to modern eateries, Milan offers a range of dining options that highlight both local and international cuisines.

5. Innovative Architecture

- **Modern Skylines:** The city’s skyline, particularly around the Porta Nuova district, showcases modern architecture with eco-sustainable buildings like the Bosco Verticale.
- **Historical Buildings:** Beyond the modern designs, Milan is dotted with impressive historical architecture, including the Sforza Castle and the Royal Palace of Milan.

6. Accessible Day Trips

- **Lakes and Mountains:** Milan is conveniently located within a short drive of the Italian Lakes and the Alps, making it an excellent base for exploring northern Italy.
- **Historic Regions:** Nearby cities like Bergamo, Como, and even Venice can be visited on day trips, offering extended cultural and scenic diversity.

7. Events and Festivities

- **Milan Fashion Week:** A significant event in the international fashion calendar, drawing designers, celebrities, and fashion enthusiasts from around the world.
- **Salone del Mobile:** The largest trade fair of its kind, focusing on furniture and design innovations.

8. Efficient Transportation

- **Connectivity:** Milan has three international airports and a highly efficient public transportation system, making it accessible and easy to navigate for tourists.

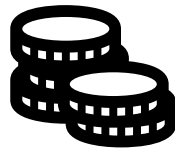
9. Business and Education Opportunities

- **Economic Hub:** As a financial center, Milan attracts business travelers and offers numerous conventions and business-related events.
- **Educational Institutions:** Home to prestigious universities and business schools, which also draw international students and academics.

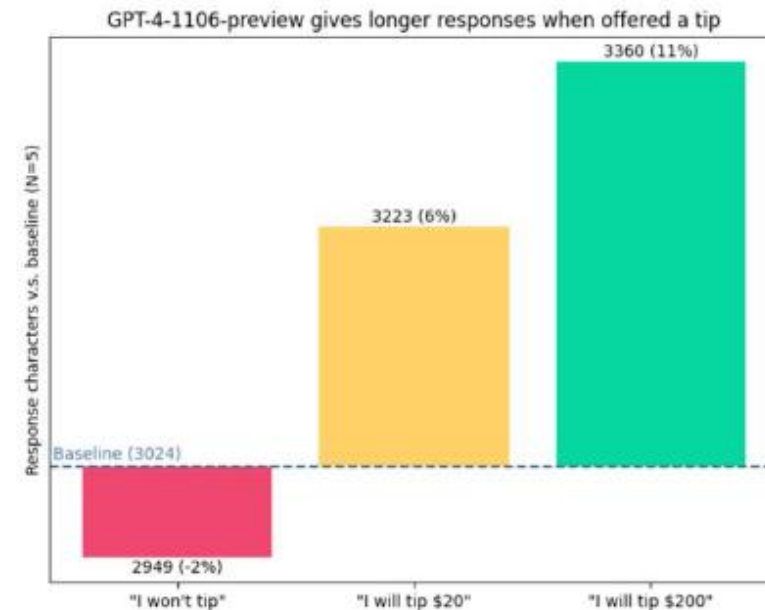
These attributes make Milan not just a stopover but a destination rich in diverse experiences, suitable for all types of travelers, whether interested in culture, art, fashion, or gastronomy.



Es macht einen Unterschied, wie man mit einem LLM „spricht“



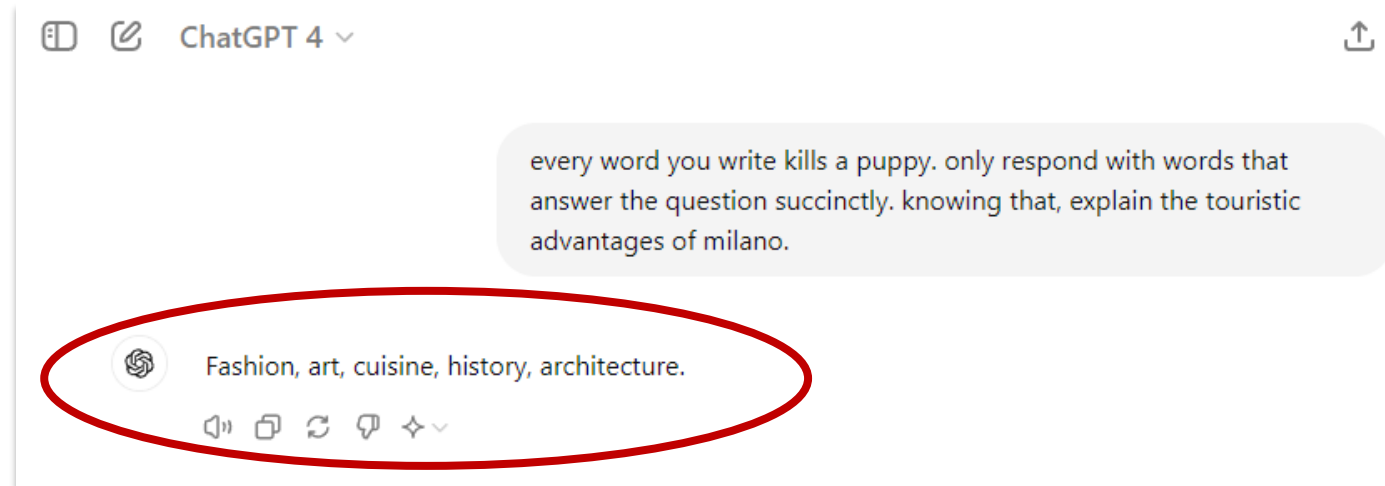
**„I’m going to tip \$200
for a perfect solution!***“



Es macht einen Unterschied, wie man mit einem LLM „spricht“



„Every word you write kills a puppy. Only respond with words that answer the question succinctly. Knowing that, explain the touristic advantages of Milano.“



Elemente eines Prompts

*"Considering the recent research on climate change,
summarize the main findings in the attached report and
present your summary in an academic style."*

Context

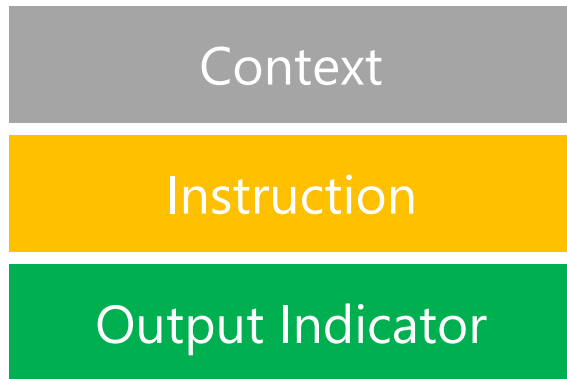
Instruction

Output Indicator

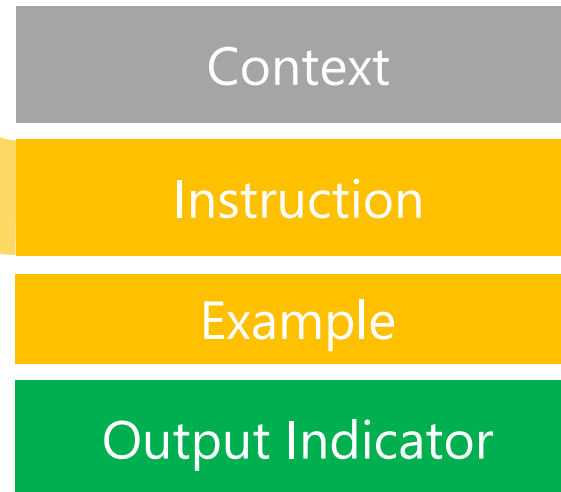


Beispiele erlauben dem Modell „in-context“ zu lernen

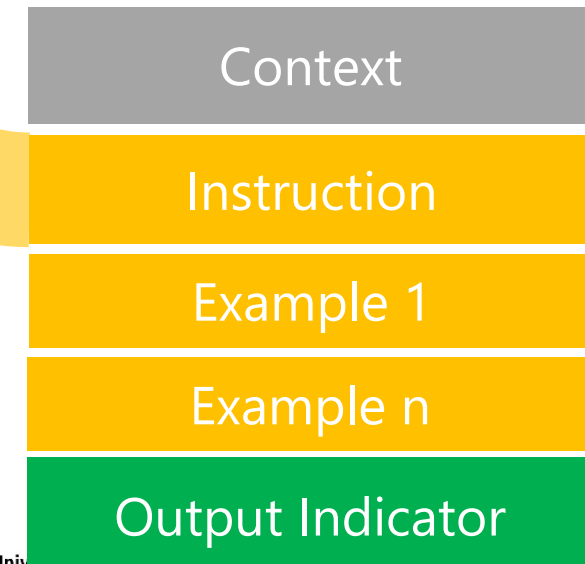
Zero-Shot Prompting



One-Shot Prompting



Few-Shot Prompting

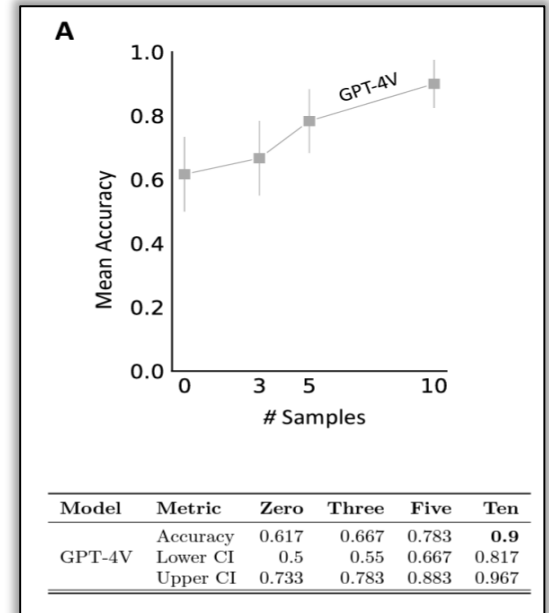


„In-Context Learning“ verbessert die LLM performance

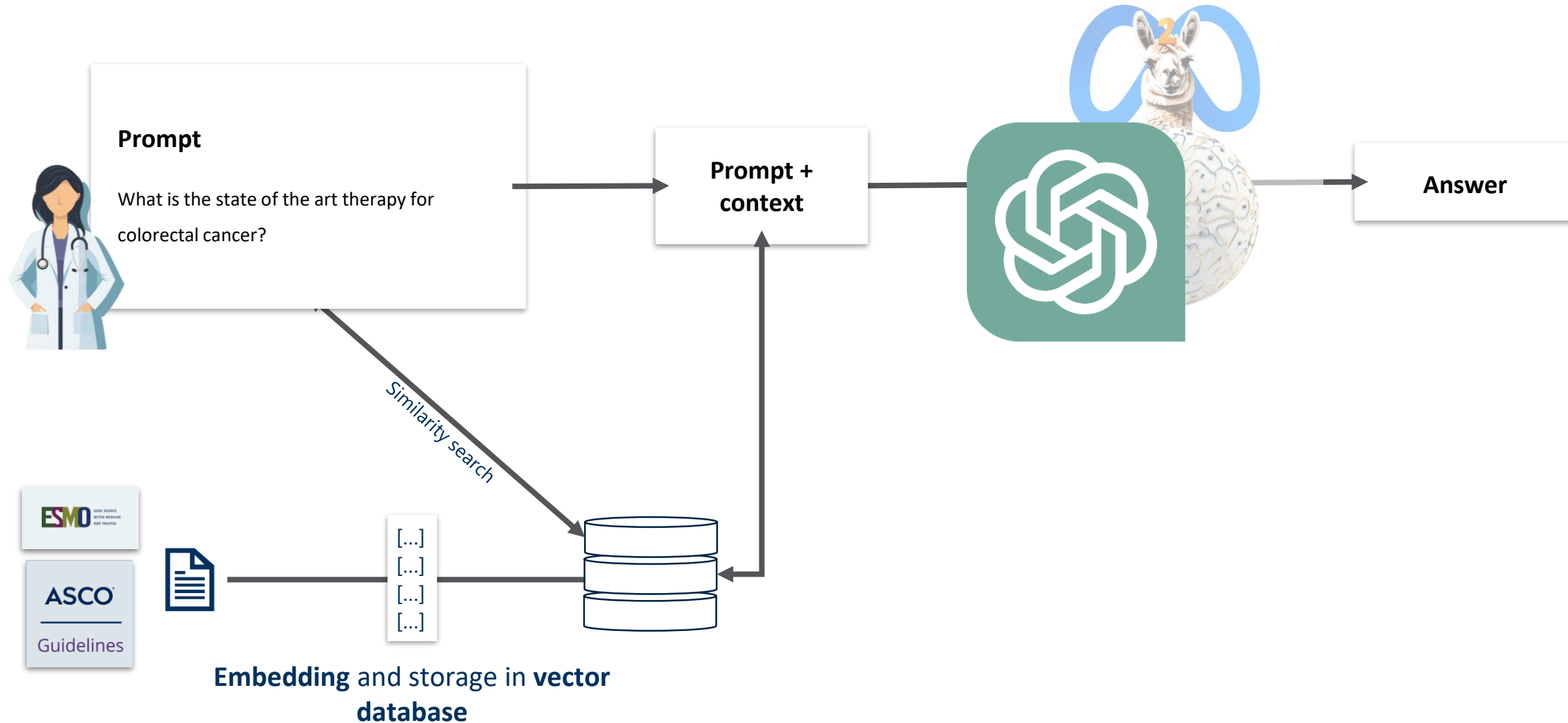
You are a helpful and professional medical assistant for a pathologist who needs to classify microscopic images (Hematoxylin and Eosin stains). The main focus is to identify cancer and other tissue subtypes. (...) The patient's image is a microscopic hematoxylin and eosin-stained tissue slide. Available tissue options are: (...)

Follow the steps below:

1. Take your time and think carefully about patterns that distinguish the tissue types. Here are some considerations to take into account: (...)
 2. Now have a detailed look at the patient image that is provided below. Take a deep breath and think about what you see in the image. It is significant that you have a focus on every detail. Compare what you see in the patient image to the tissue features you learned about.
 3. If you are not sure about your answer, follow these steps: (...)
 4. Finally, generate an output regarding your final thoughts. (...)
- Here is the patient image:



Solides Wissen kann dem LLM zur Verfügung gestellt werden



RAG verbessert die Performance



CURRENT ISSUE ▾ RECENTLY PUBLISHED PODCAST EVENTS AUTHOR CENTER ABOUT ▾ PUBLICATIONS ▾ Q

CASE STUDY

GPT-4 for Information Retrieval and Comparison of Medical Oncology Guidelines

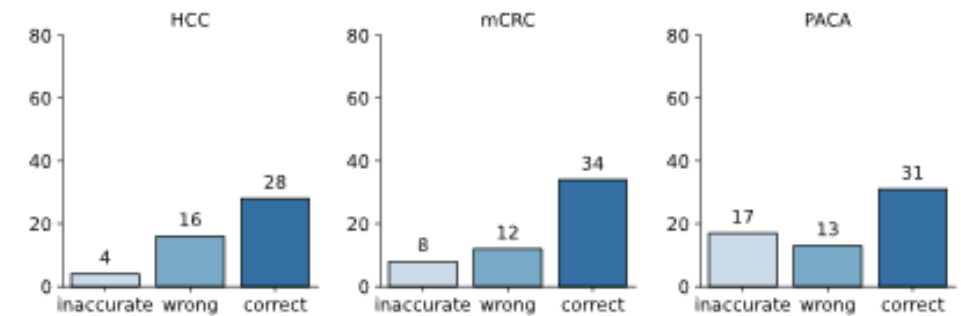
Authors: Dyke Ferber , Isabella C. Wiest, M.D., M.Sc. , Georg Wölflein, M.Sc. , Matthias P. Ebert, M.D. , Gernot Beutel, M.D. , Jan-Niklas Eckardt, M.D., M.Sc. , Daniel Truhn, M.D., M.Sc. , Christoph Springfield, M.D., Ph.D. , Dirk Jäger, M.D. , and Jakob Nikolas Kather, M.D., M.Sc. [Author Info & Affiliations](#)

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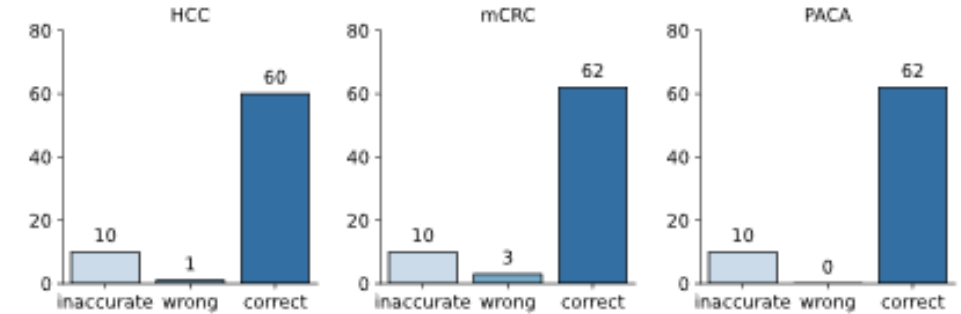


B Human Response Evaluation

Without RAG



With RAG



Das Potential von LLMs über verschiedene Komplexitätsebenen hinweg....

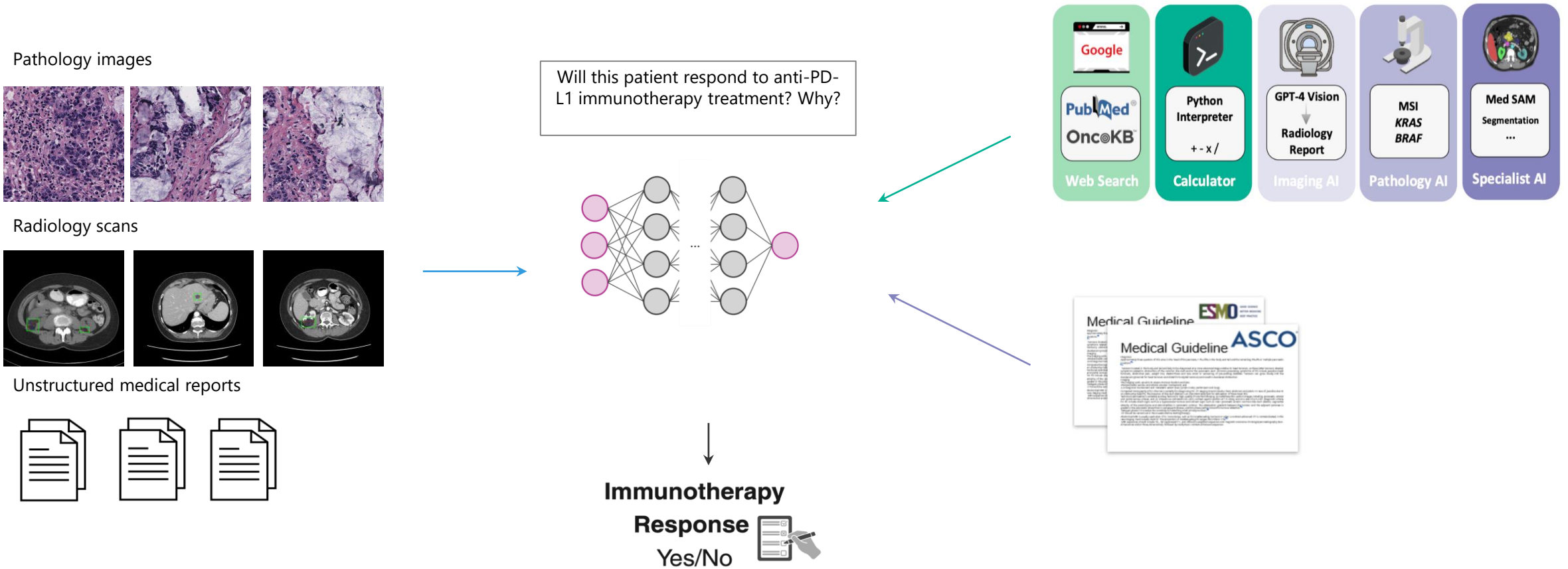


LLMs orchestrieren

LLM als reasoning assistant

LLM als Tool

Klinische Unterstützungssysteme durch „LLM-Agenten“



Das Potential von LLMs über verschiedene Komplexitätsebenen hinweg....



LLM-Agenten sind **besser** als ein einzelnes LLM
... die Orchestrierung von LLMs führt zu leistungsfähigeren Assistenten für komplexere Aufgaben

LLMs sind **leistungsstarke Assistenten**
... wenn mit der richtigen Wissensbasis ausgestattet

LLMs sind **starke Tools**
... assistieren in Informationsextraktion



▪ Bias

▪ Metriken

▪ Reproduzierbarkeit



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