

HIDDEN-RAD: Hidden Causality Inclusion in Radiology Report Generation

Key-Sun Choi[◇], Young-Gyun Hahm^{*}

J.H. Hahn[◇], S.Y. Lee[♡], Y.J. Kang^{*}

[◇]Konyang Univ., ^{*}Teddysum Inc., [♡]Konyang Univ. Hospital

NTCIR-18 Pilot Task



Hidden-RAD: Purpose with example

2

To Recover the Hidden Causality why such Impression and Findings are drawn in the Radiology Report

■ Task input
■ Task Output

Radiography (option)



Radiology report

Impression:

Pneumothorax

Finding:

The pneumothorax in this case may be attributed to a combination of factors, including trauma and anatomical location. The right pneumothorax **observed at** the T8-11 **thoracic spine level** in the right pleural space indicates a localized issue in the upper to middle region of the **right lung**.

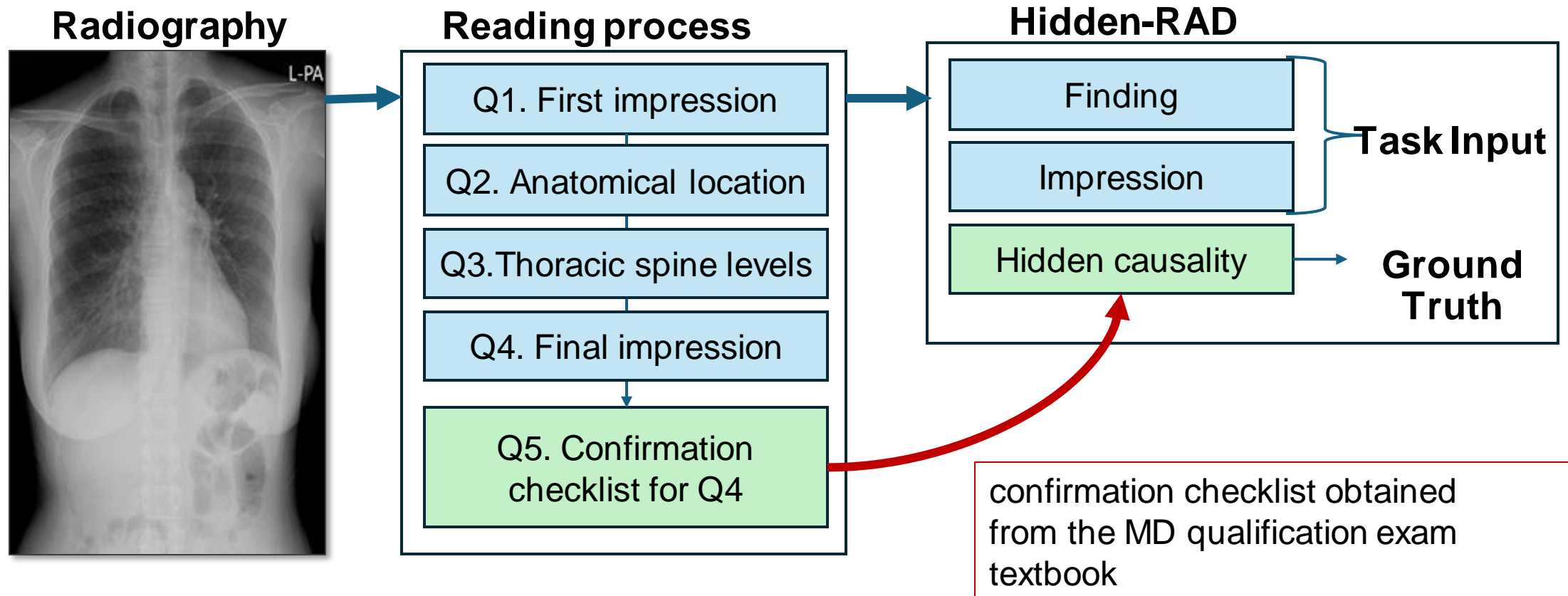
Hidden causality:

The **lack of symmetry** in the apical, upper, middle, and lower zones **suggests** an asymmetric distribution of air in the pleural space, further confirming the **presence of pneumothorax**.

Hidden-RAD: dataset overview

3

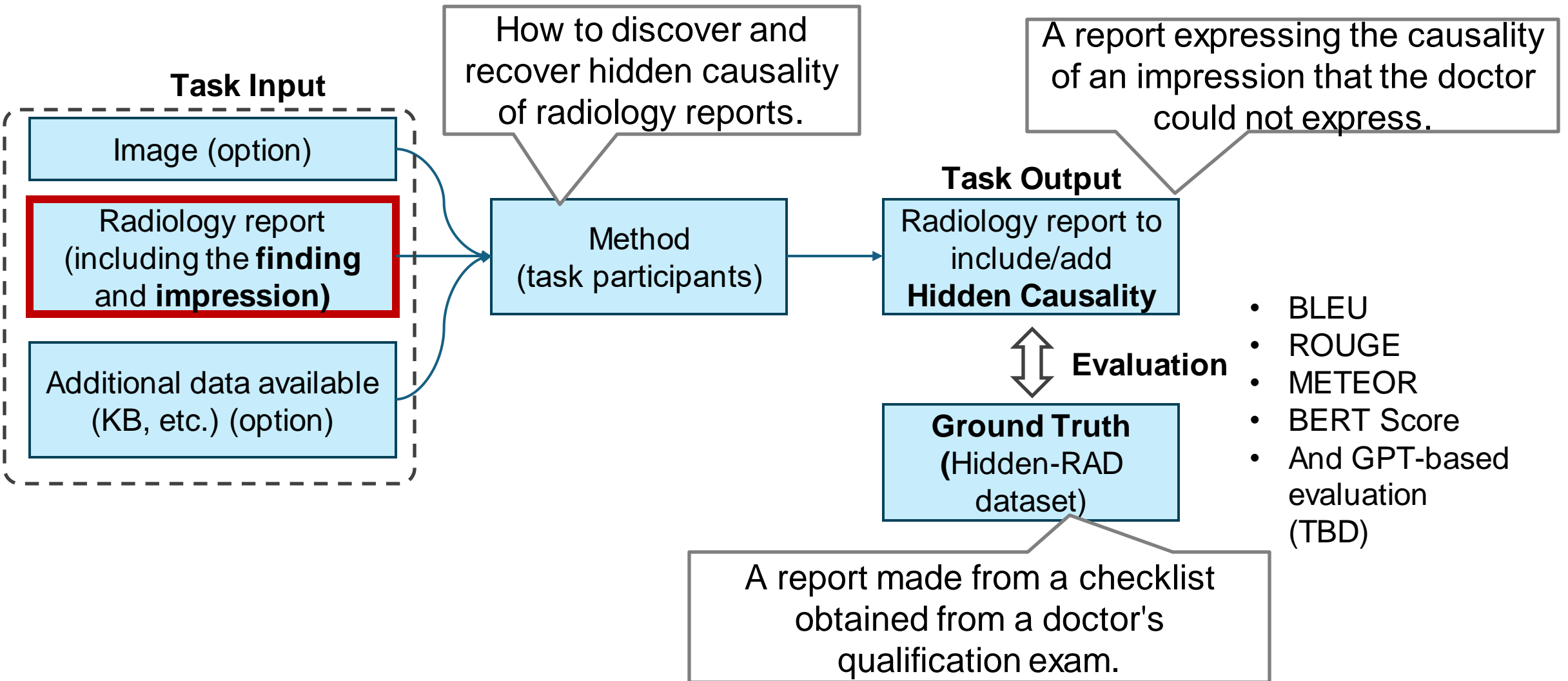
- **Data collection: Decision of Steps in Reading Process of real doctors.**
- **Hidden-RAD dataset: generated report from the collected data**



The reading process was annotated with questions and answers to reduce costs, and GPT-4 was used to generate the dataset into a report format.

Task Definition

Recovering report by discovering hidden (missing) causality in radiology reports.



Confirmation checklist: ABCDE approach

5

- 32 checklists,
- **Chest x-ray review** is a key competency for medical students, junior doctors and other allied health professionals.
- Using A, B, C, D, E is a helpful and systematic method for **chest x-ray review**:

- **A: airways – 5 checklist**
- **B: breathing (the lungs and pleural spaces) - 11 checklist**
- **C: circulation (cardiomediastinal contour) - 5 checklist**
- **D: disability (bones - especially fractures) - 6 checklist**
- **E: everything else, e.g. pneumoperitoneum - 5 checklist**

Terminology and Definition 1/2

- **Radiology Report**

- **A detailed report that describes the results of an imaging test.**
- A radiology report includes information about the type of imaging test that was done and how it was done. (A brief medical history of the person having the test, including any symptoms or known diseases and why the test was needed)

- **Interpretation (or “reading”)**

- Radiologic interpretation is based upon the **understanding of disease processes and the behaviour of diseases** in a specific **anatomic region**.
- Combined with knowledge of the specific **radiological characteristics of various lesions**, the main features of the lesion can be identified and contribute substantially to the diagnosis.

1. [NCI Dictionary, National Cancer Institution (NCI) in National Institution of Health (NIH), <https://www.cancer.gov/publications/dictionaries/cancer-terms/def/radiology-report>]
2. [Hartung, M. P., Bickle, I. C., Gaillard, F., & Kanne, J. P. (2020). How to create a great radiology report. *Radiographics*, 40(6), 1658-1670.]
3. [Reiner, B. I., Knight, N., & Siegel, E. L. (2007). Radiology reporting, past, present, and future: the radiologist's perspective. *Journal of the American College of Radiology*, 4(5), 313-319.]
4. [Koong, Bernard. "The basic principles of radiological interpretation." *Australian dental journal* 57 Suppl 1 (2012): 33-9 .]
5. [Baines, Elizabeth A. and Andrew Holloway. "Principles of radiological interpretation." (2013).]

Terminology and Definition 2/2

- **CAD (Computer-aided diagnosis)**
 - CAD is a system that assist doctors in interpreting medical images produce a lot of information that needs to be analyzed and evaluated in a short time.
- **“Hidden Causality”**
 - **In this task, Required conditions for the final impression as determined by the doctor**
 - In this study, hidden causality was limited to **28 checks** in the chest radiography interpretation procedure and does not imply all causal relationships in the interpretation.
 - The hidden causality was **manually annotated by doctors.**

Task summary

Task background

- If the hidden cause is not sufficiently included in the report, **it may cause errors that would worsen the patient's illness.**
- Errors according to :
 - Limitations of the perceptual capacity of the human eye and brain to perform interpretation
 - Differences in the scope and quality of background knowledge

Task Definition

- **Recovering report by discovering hidden (missing) causality in radiology reports.**
- Extraction of mechanical features from images to resolve perceptual errors and learning of qualification test lists to resolve knowledge gaps.

Dataset (Hidden-RAD dataset)

- **“Hidden-RAD dataset”** is a set of radiology reports including Findings, Impressions, and Hidden causality.
- The current data was augmented based on MIMIC-CXR and automatically generated in report format through GPT-4.

1. Waite, S., Scott, J., Gale, B., Fuchs, T., Kolla, S., & Reede, D. (2017). Interpretive error in radiology. *American Journal of Roentgenology*, 208(4), 739-749.
2. Brady, A. P. (2017). Error and discrepancy in radiology: inevitable or avoidable?. *Insights into imaging*, 8, 171-182.
3. Pow, R. E., Mello-Thoms, C., & Brennan, P. (2016). Evaluation of the effect of double reporting on test accuracy in screening and diagnostic imaging studies: a review of the evidence. *Journal of medical imaging and radiation oncology*, 60(3), 306-314.

Comparison

- No dataset containing hidden causality for lesions.
- This dataset was augmented based on MIMIC-CXR.

Dataset name	Release year	Size	Resource			
			X-Ray	Report	Impression	Hidden causality
Hidden-RAD dataset (Our)	2024	300	O	O	O	O
PadChest	2020	206,222	O	O	O	X
MIMIC-CXR	2019	371,920	O	O	O	X
CheXpert	2019	224,316	O	X	O	X
National Institutes of Health Repository	2017	112,120	O	X	O	X
PLCO	2012	185,421	O	X	O	X

X-Ray: Chest radiography, Report: A doctor's report on chest radiographs, Impression: classification of patients written by doctors in text form, Hidden causality: Interpretation of reading procedures in radiological images.

Expected result (Contribution)

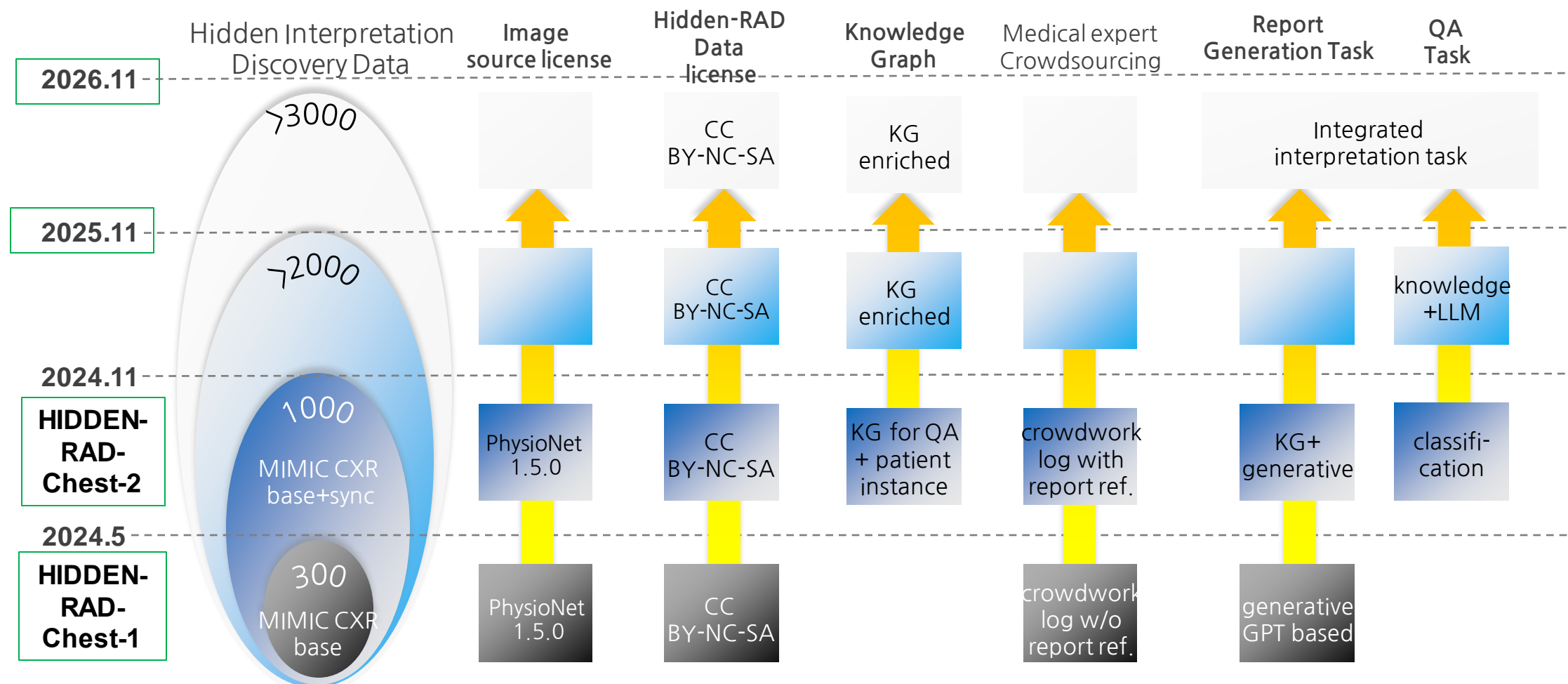
10

- Explainable CAD technology.
- Reducing diagnostic error
 - Hidden causality is included in the report through systematic interpretation of the images. This is a complete scan of the radiograph and contributes to reducing the number of diagnostic errors.

1. Kok, E. M., Jarodzka, H., de Bruin, A. B., BinAmir, H. A., Robben, S. G., & van Merriënboer, J. J. (2016). Systematic viewing in radiology: seeing more, missing less?. *Advances in Health Sciences Education*, 21, 189-205.
2. Waite, S., Scott, J., Gale, B., Fuchs, T., Kolla, S., & Reede, D. (2017). Interpretive error in radiology. *American Journal of Roentgenology*, 208(4), 739-749.
3. Brady, A. P. (2017). Error and discrepancy in radiology: inevitable or avoidable?. *Insights into imaging*, 8, 171-182.
4. Pow, R. E., Mello-Thoms, C., & Brennan, P. (2016). Evaluation of the effect of double reporting on test accuracy in screening and diagnostic imaging studies: a review of the evidence. *Journal of medical imaging and radiation oncology*, 60(3), 306-314.

Data release plan (2024-2026)

Data for User-Adaptable Explanation Report Generation of Medical Interpretation and Diagnosis



(The initial) Early experimental results

12

- Use the same input for tasks
- Perform analysis through GPT-V

Model	Metric							
	BLEU-1	BLEU-2	BLEU-3	ROUG E-1	ROUG E-2	ROUG E-I	METEOR	BERT Score
GPT-V	25.41	11.32	7.11	21.71	7.14	1.69	0.19	0.34

Important dates

- Kick-off Event: March 29, 2024
- **1st-Training Set Release: May 31, 2024 / Quantity: 300 cases**
- **2nd-Training Set Release: Jun 30, 2024 / Quantity: 300 cases**
- **Test Set Release: Dec 8, 2024 / Quantity: 400 cases**
- System Submission Deadline: Jan 8, 2025
- Evaluation Results Release: Feb 1, 2025
- Submission Due of Participant Papers (draft): March 1, 2025
- Camera-Ready Participant Paper Due: May 1, 2025
- NTCIR-18 Conference: Jun 10-13, 2025