Unsupervised Structured Report Generation using Cycle Consistency

1. General Info

Project Title: Unsupervised Structured Report Generation using Cycle Consistency

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2. Project Abstract

Structured reporting is an important tool in radiology, as it can provide concise, standardized and complete reports. However, the development of automated systems to generate these reports is hindered by the scarcity of datasets comprising paired radiological images and corresponding structured reports. This project proposes a novel approach to circumvent the need for such paired data by harnessing unsupervised learning techniques, specifically Cycle-Consistent Adversarial Networks (CycleGANs) or similar frameworks, for the generation of coherent and contextually accurate radiological reports from unpaired data.

3. Background and Motivation

Automatic report generation in radiology can reduce radiologists' workload and improve diagnostic performance [1,2]. While there is a lot of on-going research on free-text radiology report generation, the research on structured reports is very limited [3,4,5]. However, structured reports have a lot of advantages in comparison to free-text reports. Free-text radiology reports present findings in narrative form, which can be ambiguous and inconsistent. Structured reports use a standardized format with predefined categories, ensuring clearer and more organized information. For instance, while a free-text report may describe a lung nodule in a sentence, a structured report separates details into specific fields, like size, location, and characteristics, reducing ambiguity and enhancing report quality. However, datasets comprising paired radiological images and corresponding structured reports are very limited[5]. Therefore data-efficient methods for generating structured radiology reports are of high interest.

In this project, we aim to explore the use of cycle-consistency based generation in order to learn structured report generation in an unsupervised manner. For this, the first step is to synthesize realistic structured reports via predefined rules capturing the essence of authentic radiological observations, creating a substantial corpus of unpaired synthetic reports. Leveraging the capabilities of CycleGANs or similar models, a model capable of learning domain translations from radiological images to structured text can be trained, employing the concept of cycle consistency to retain key diagnostic information.

4. Technical Prerequisites

- Good background in deep learning
- Good skills in PyTorch
- Motivation to work on a challenging research project

5. Benefits:

- Scientific contribution to the emerging field of structured radiology reporting
- Working on a novel idea
- Possible publication of results

6. Students' Tasks Description

Students' tasks would be the following:

- WP1: Researching SOTA methods for learning from unpaired data
- WP2: Pipeline for synthetic structured report generation
- WP3: Build semantic image-to-image comparison module, e.g. based on SOTA contrastive Chest-Xray models
- WP4: Define report-to-report comparison metric
- WP5: Build conditioned image generation module
- WP6: Build structured report generation module
- WP7: Create complete framework
- WP8: Documentation of the results

7. Work-packages and Time-plan:

	Description	#Students	From	To
WP1	Research unpaired data learning methods	2	Start of Nov	Mid of Nov
WP2	Synthetic structured report generation	2	Start of Nov	Mid of Nov
WP3	Image-to-image comparison module	2	Mid of Nov	Start of Dec
WP4	Report-to-report comparison metric	2	Mid of Nov	Start of Dec
M1	Intermediate Presentation	4	TBD: Mid of December?	
WP5	Image Generation Module	2	Start of Dec	Mid of Jan
WP6	Report Generation Module	2	Start of Dec	Mid of Jan
WP7	Complete Framework	2	Mid of Jan	End of Jan
WP8	Documentation	2	Start of Feb	Mid of Feb
M2	Final Presentation	4	TBD: Mid of February?	

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[2] Tanwani, A.K., Barral, J., Freedman, D.: Repsnet: Combining vision with lan- guage for automated medical reports. In: Medical Image Computing and Computer Assisted Intervention–MICCAI 2022: 25th International Conference, Singapore, September 18–22, 2022, Proceedings, Part V. pp. 714–724. Springer (2022)
[3] Keicher, M., Mullakaeva, K., Czempiel, T., Mach, K., Khakzar, A., Navab, N.: Few-shot structured radiology report generation using natural language prompts. arXiv preprint arXiv:2203.15723 (2022)
[4] Bhalodia, R., Hatamizadeh, A., Tam, L., Xu, Z., Wang, X., Turkbey, E., Xu, D.: Improving pneumonia localization via cross-attention on medical images and re- ports. In: Medical Image Computing and Computer Assisted Intervention–MICCAI 2021: 24th International Conference, Strasbourg, France, September 27–October 1, 2021, Proceedings, Part II 24. pp. 571–581. Springer (2021)
[5] Pellegrini, C., Keicher, M., Özsoy, E., & Navab, N. (2023, October). Rad-ReStruct: A Novel VQA Benchmark and Method for Structured Radiology Reporting. In International Conference on Medical Image Computing and Computer-Assisted Intervention (pp. 409-419). Cham: Springer Nature Switzerland.