CAP 5516
Medical Image Computing
(Spring 2025)

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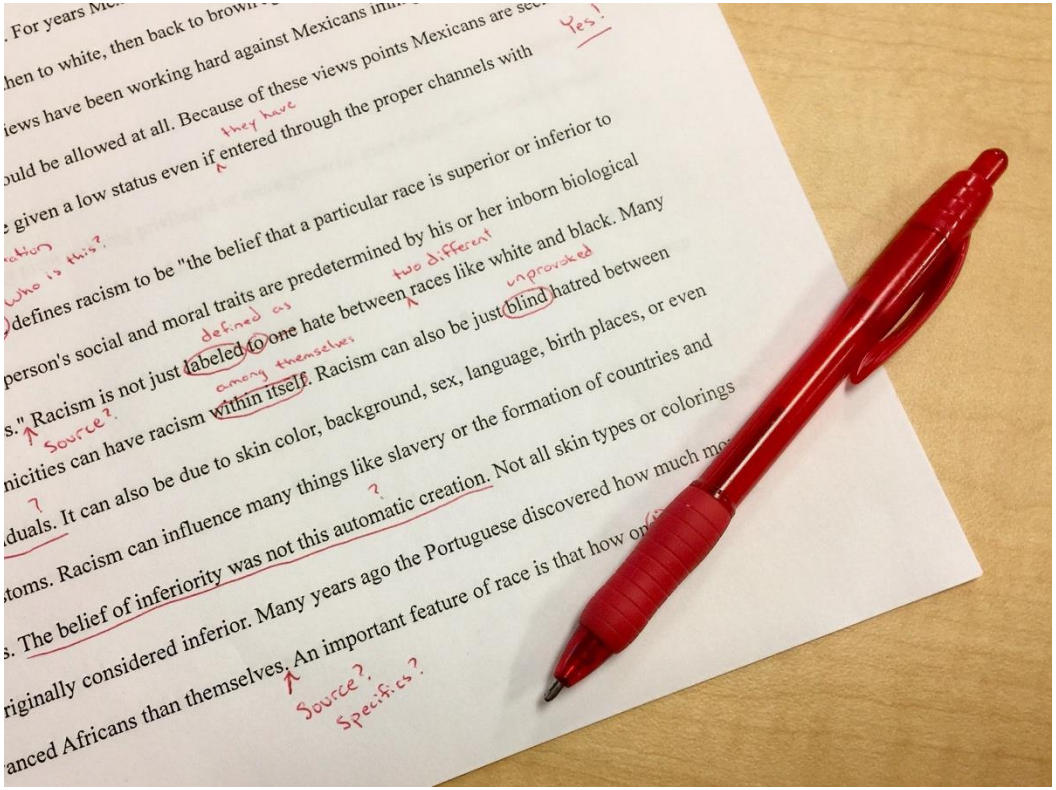
Lecture 2
How to review and write research papers

Part 1: How to review research papers



Source: https://owl.excelsior.edu/research/revising-and-editing-a-research-paper/

How to read research papers? (1)

- Ask questions before you start

- What are the motivations for this paper?
- What problem is being solved?
- What is the proposed solution?
- What experiments are designed to test the solution?
- What are the evaluation methods and metrics ?

- What are the contributions?
- What are the future directions?
- How is the paper related to what you previously knew?
- How is the paper related to other works?

How to read research papers? (2)

- Get the general idea first (title, abstract and conclusion)
  - What problem is being solved?
  - What are the main steps in the solution?
  - What is the high-level idea of the solution?
  - What are the take-away messages?

- Scam through the paper (figures and tables)
  - There is often a figure of the general framework of the proposed method

How to read research papers? (3)

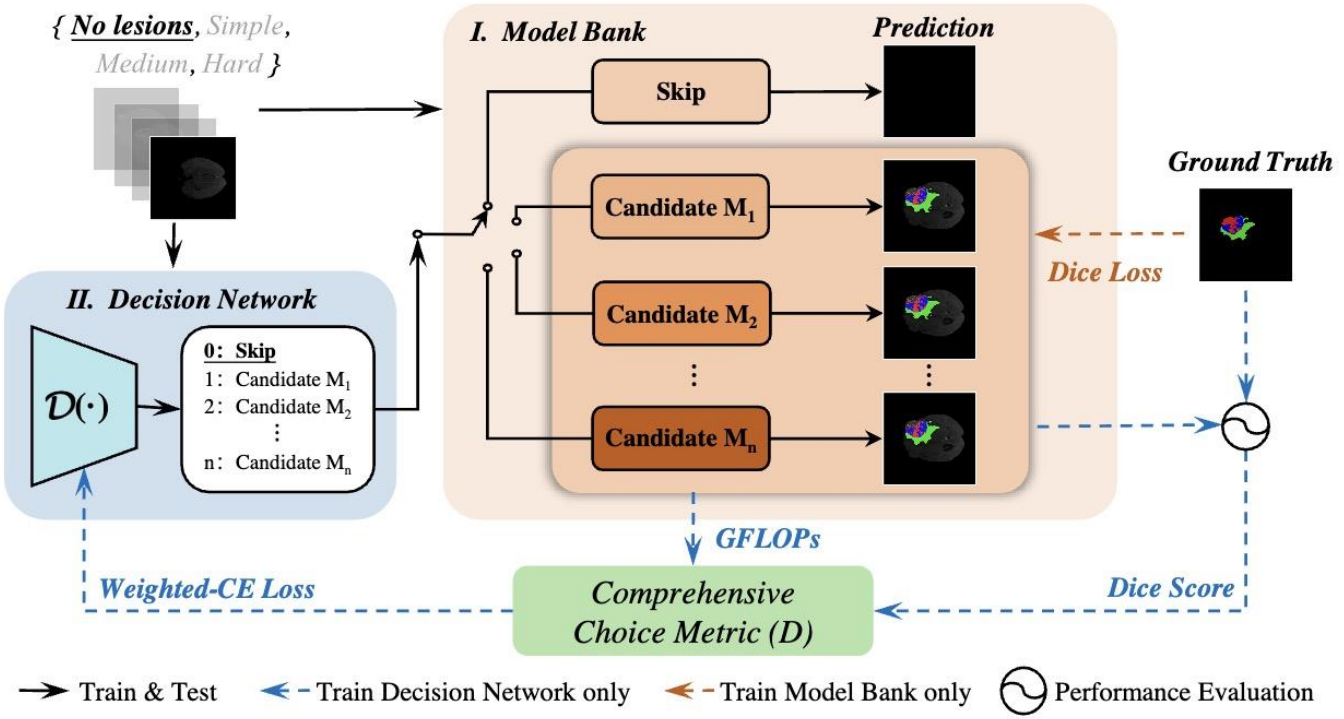


Fig. 2. The illustration of the overall architecture of our proposed Med-DANet. Taking a 2D image slice as input data, the Decision Network generates a slice-dependent choice which represents the level of segmentation difficulties for the current slice. Then, according to the optimal choice made by the Decision Network, our method can adaptively determine to skip the current slice (i.e. directly output a segmentation map with only zero – "background" class) or utilize the corresponding candidate network in the pre-defined Model Bank (containing several networks with different model complexities) to accurately segment the current slice.

Wang, W., Chen, C., Wang, J., Zha, S., Zhang, Y., & Li, J. (2022, October). Med-danet: Dynamic architecture network for efficient medical volumetric segmentation. ECCV 2022

How to read research papers? (4)

- Dive into details (especially the proposed method and experiments)
  - What's new for the proposed method? And the motivation?
  - How is the method evaluated? (dataset, experimental setting, evaluation metrics) Are the results convincing?
- https://developer.nvidia.com/blog/how-to-read-research-papers-a-pragmatic-approach-for-ml-practitioners/
- The three-pass approach by Dr. Srinivasan Keshav: http://ccr.sigcomm.org/online/files/p83-keshavA.pdf

How to review research papers? (1)

- Write a review on the paper
- Summarize a take-home message
- Recall the main strengths of the paper
  - Novelty
  - Technical correctness
  - Clarity
  - Experimental evaluation

How to review research papers? (2)

- Write a review on the paper
- Summarize a take-home message
- Recall the main strengths of the paper
- Be picky: weakness of the paper
  - Lack of novelty: comparing to prior work
  - Lack of clarity: language, organization, presentation
  - Technical errors: rare
  - Mismatched experiment design
  - Insufficient experiments
  - Unfair comparison with other methods
  - **Justify your comment**

How to review research papers? (3)

- Write a review on the paper
- Summarize a take-home message
- Recall the main strengths of the paper
- Be picky: weakness of the paper
- Overall rating (adapted from NeuIPS reviewer instructions)

- **0: Top 10% of the papers I have read, an excellent paper, a strong accept.**
  - I will fight for acceptance. I will consider not reviewing papers for XX if this is rejected.
- **1: Top 50% of accepted NIPS papers, a very good paper, a clear accept.**
  - I vote and argue for acceptance.
- **2: Good paper, accept.**
  - I vote for acceptance, although would not be upset if it were rejected.
- **3: Marginally above the acceptance threshold.**
  - I tend to vote for accepting it, but leaving it out of the program would be no great loss.
- **4: Marginally below the acceptance threshold.**
  - I tend to vote for rejecting it, but having it in the program would not be that bad.
- **5: An OK paper, but not good enough. A rejection.**
  - I vote for rejecting it, although would not be upset if it were accepted.

How to review research papers? (4)

- Write a review on the paper Summarize a take-home message
- Recall the main strengths of the paper
- Be picky: weakness of the paper

- Overall rating
  - Explain your rating: how you weigh the strengths and weaknesses

How to review research papers? (5)

- Write a review on the paper
- Summarize a take-home message
- Recall the main strengths of the paper
- Be picky: weakness of the paper
- Overall rating (0, 1--5)
- Explain your rating: how you weigh the strengths and weaknesses

- Brainstorm future directions
  - New solutions
  - New solutions extending or inspired by the paper's solution
  - Open problems
  - Other problems that could benefit from the paper

Example Review Form (1)

Paper ID
215

Paper Title
Simultaneous [illegible]mework

REVIEW QUESTIONS

1. [Summary] Please provide a short summary of the paper and its contributions.
* *(visible to author during feedback, visible to author after notification, visible to other reviewer, visible to meta-reviewer)*

2. [Paper Strengths] Please discuss the positive aspects of the paper. Be sure to comment on the paper's novelty, technical correctness, clarity and experimental evaluation. Notice that different papers may need different levels of evaluation: an algorithm paper may need fewer experiments, while an application paper may require thorough comparisons to existing methods. Also, please be sure to justify your comments in detail. For example, if you think the work is novel, not only say so, but also explain in detail why you think this is the case.
* *(visible to author during feedback, visible to author after notification, visible to other reviewer, visible to meta-reviewer)*

Example Review Form (2)

3. [Paper Weaknesses] Please discuss the negative aspects of the paper: lack of novelty or clarity, technical errors, insufficient experimental evaluation, etc. Justify your comments in detail; don't provide just generic critique. It is not reasonable to ask for comparisons with unpublished, non-peer-reviewed papers (eg. arXiv), or papers published after the ACCV 2018 deadline.

* *(visible to author during feedback, visible to author after notification, visible to other reviewer, visible to meta-reviewer)*

4. [Rebuttal Requests] Please note specific points that you would like the authors to address in their rebuttal. *(visible to author during feedback, visible to author after notification, visible to other reviewer, visible to meta-reviewer)*

Example Review Form (3)

5. [Recommendation Justification / Detailed Comments] Please explain to the AC, your fellow reviewers, and the authors your current recommendation for the paper. This explanation may include how you weigh the importance of the various strengths and weaknesses you described above. * *(visible to author during feedback, visible to author after notification, visible to other reviewer, visible to meta-reviewer)*

6. [Overall Rating] * *(visible to author during feedback, visible to author after notification, visible to other reviewer, visible to meta-reviewer)*

- Strong Accept
- Weak Accept
- Borderline
- Weak Reject
- Strong Reject

7. [Confidential Comments to Area Chair] *(visible to meta-reviewer)*

Question?

- What do you care the most about a research paper?

How to present research papers ? (1)

- Make good presentations

  - Know your audience: fellow graduate students with good background
  - Adapt the presentation goal: explain and discuss the paper
  - *Assume no one in the class has read the paper before*

How to present research papers? (2)

- Make good presentations
  - Title, authors (full name), authors' institutes, your name
  - Motivation of the research (1—2 slides)
  - Problem statement (1—2 slides)
  - Main contributions of the paper
  - Approach outline (1 slide)
    - Details of the proposed approach
  - Experiments
    - Data, features, baselines, evaluation metrics,
    - Results
  - Related work (1—3 slides)
  - Conclusion: take-home message (1—2 slides)

How to present research papers? (2)

- Make good presentations
  - Title, authors (full name), authors' institutes, your name
  - Motivation of the research (1—2 slides)
  - Problem statement (1—2 slides)
    - It would be helpful to lay out some background about the problem
  - Main contributions of the paper
  - Approach outline (1 slide)
    - Details of the proposed approach
  - Experiments
    - Data, features, baselines, evaluation metrics,
    - Results
  - Related work (1—3 slides)
  - Conclusion: take-home message (1—2 slides)

How to present research papers? (3)

- Make good presentations
  - Title, authors (full name), authors' institutes, your name
  - Motivation of the research (1—2 slides)
  - Problem statement (1—2 slides)
  - Main contributions of the paper
    - Studied a new and important problem
    - Proposed a novel approach
    - Improved or extended existing methods
    - Compared several popular methods
    - Explored a variety of use cases (many datasets of different kinds)
    - Presented new theories
    - Presented a new dataset and benchmark results
    - Introduced new methodologies or tools to the field

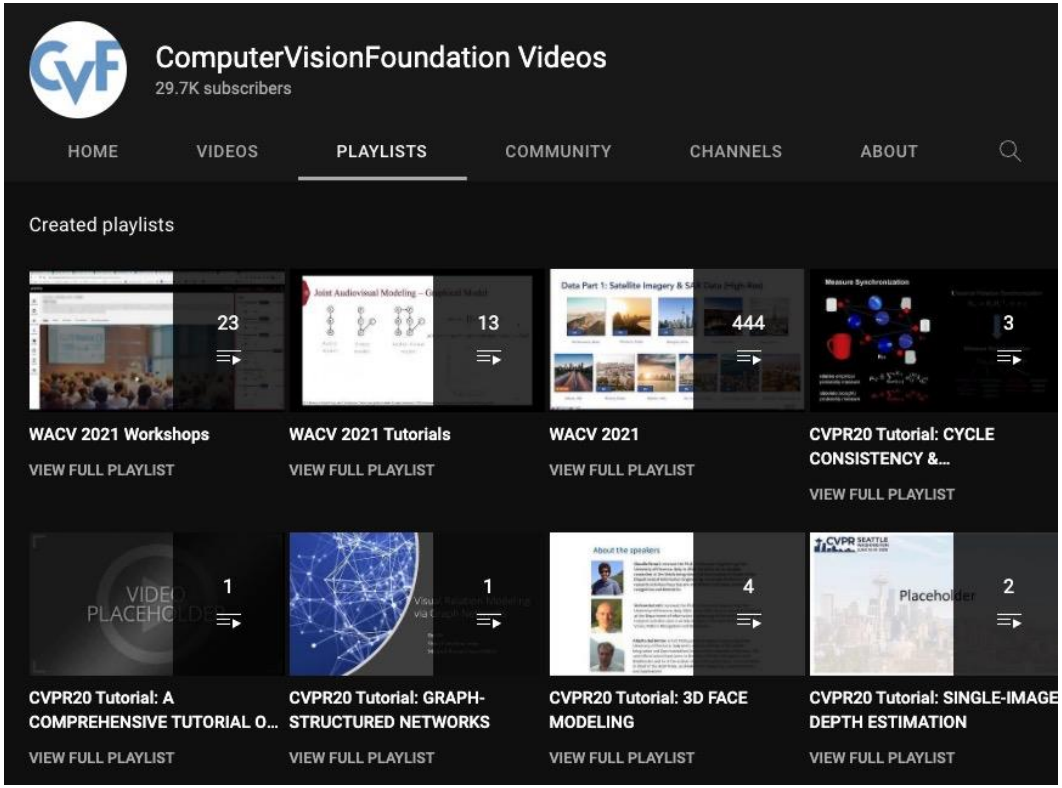
How to present research papers? (4)

- Make good presentations
  - Title, authors (full name), authors' institutes, your name
  - Motivation of the research (1—2 slides)
  - Problem statement (1—2 slides)
  - Main contributions of the paper
  - Approach outline (1 slide)
    - Details of the proposed approach
  - Experiments
    - Data, features, baselines, evaluation metrics,
    - Results
  - Related work (1—3 slides)
  - Conclusion: take-home message (1—2 slides)

How to present research papers? (5)

- Make good presentations
- Title, authors (full name), authors' institutes, your name and email
- Motivation of the research (1—2 slides)
- Problem statement (1—2 slides)
- Main contributions of the paper
- Approach outline (1 slide)
- Details of the proposed approach
- Experiments
- Related work (1—3 slides)
- Conclusion: take-home message (1—2 slides)
- Future directions (1—3 slides)

How to present research papers? (5)



- Computer Vision Foundation open access (CVPR, ICCV conference papers over the past years)
- YouTube channel for CVF
  - https://www.youtube.com/channel/UC0n76gicaarsN_Y9YShWwhw/videos

Part 2: Project ideas and project report

Note: the project must be medical image analysis using deep learning methods

(1) Weakly-Supervised Pathology Image Classification

Goal: Classify tumor vs. normal regions in whole-slide images (WSIs) using only slide-level labels.

Key Challenges

- Huge image sizes (gigapixel WSIs).
- No pixel-level or ROI annotations available.

- **Proposed Approach**
- Multiple Instance Learning (MIL)
  - Divide WSIs into patches (instances).
  - Use a deep MIL framework with attention-based pooling to identify malignant regions.

- **Dataset**

  Camelyon16/17 (Lymph node metastasis detection)

  https://camelyon16.grand-challenge.org/

(2) Image/video-based ASD (Autism spectrum disorder) analysis

(a) Example video frames from the ESBD dataset

(b) Example video frames from the SSBD dataset

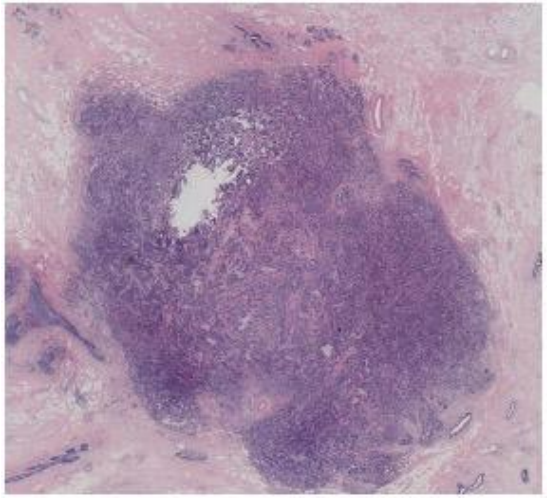
Figure 1: Example video frames from the ESBD and SSBD datasets for ASD behavior recognition in children.

Deng, A., Yang, T., Chen, C., Chen, Q., Neely, L., & Oyama, S. (2022). Problem Behaviors Recognition in Videos using Language-Assisted Deep Learning Model for Children with Autism. arXiv preprint arXiv:2211.09310.

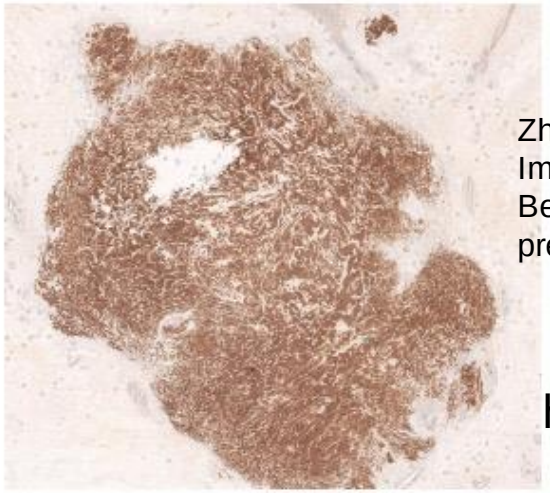
(3) Image generation/translation

- Data (e.g., image) generation/translation using diffusion models
  - Breast Cancer Immunohistochemical (IHC) Image Generation: directly generating IHC stained images from Hematoxylin and Eosin (H&E) for evaluating human epidermal growth factor receptor 2 (HER2) expression levels
  - Reduce costs associated with labor and materials

https://bupt-ai-cz.github.io/BCI_for_GrandChallenge/



(a) An example of H&E slice.



(b) An example of IHC-stained slice.

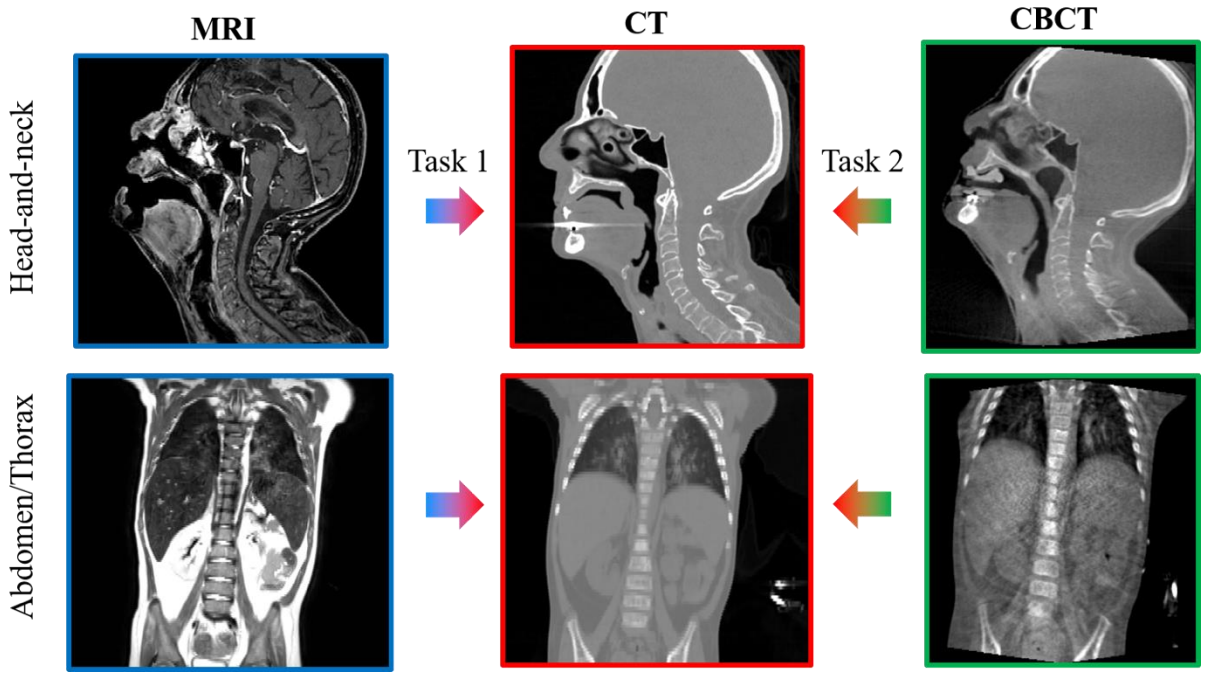
Zhu, Chuang, et al. "Breast Cancer Immunohistochemical Image Generation: a Benchmark Dataset and Challenge Review." arXiv preprint arXiv:2305.03546 (2023).

https://bupt-ai-cz.github.io/BCI/

Other Applications

- Data generation/translation
  - Different data modality translation, e.g., CT to MRI, T1 to T2, FLAIR, EEG to fMRI

https://synthrad2025.grand-challenge.org/synthrad2025/



synthetic CT (sCT)

Other Applications

- Data generation/translation
  - Different data modality translation, e.g., CT to MRI, T1 to T2, FLAIR, EEG to fMRI
  - Data generation for rare diseases (diffusion-based data augmentation technique, increasing synthesized data quality and diversity)
  - Text to (2D/3D) medical image generation, text with other conditions (e.g., segmentation masks) for more controllable medical image generation

- Image Enhancement
  - Super-resolution (e.g., enhance low-resolution MRI and CT, reducing the data acquisition time)

Other Resources to Look for Project Ideas

- Look for topics from conference proceedings
- Example:
  - https://conferences.miccai.org/2023/papers/categories/
  - https://papers.miccai.org/miccai-2024/

Other Resources to Look for Project Ideas

- Conference workshops (check different years)
  - MICCAI Workshops: https://www.miccai2021.org/en/MICCAI2021-WORKSHOPS.html
  - MICCAI Challenges: https://www.miccai2021.org/en/MICCAI2021-CHALLENGES.html
  - CVPR 2021 Medical Computer Vision Workshop: https://sites.google.com/view/cvprmcv21
  - ICCV 2021 Workshop - AI-enabled Medical Image Analysis Workshop and Covid-19 Diagnosis Competition (MIA-COV19D): https://mlearn.lincoln.ac.uk/mia-cov19d/
  - ICCV 2021 Workshop - Computer Vision for Automated Medical Diagnosis: https://sites.google.com/view/cvamd2021/home?authuser=0
- Kaggle Competitions (search key words like “medical”)
- Grand Challenge: A platform for end-to-end development of machine learning solutions in biomedical imaging. https://grand-challenge.org/
- Ideas inspired by the papers you read
- Projects ideas that are related to your research (e.g., topics related to your MS thesis or Ph.D. dissertation)

Open Access Medical Image Datasets

- **Open-Access Medical Image Repositories**
  - https://www.aylward.org/notes/open-access-medical-image-repositories
- **Computer Vision Online Image Archive – medical image**
  - https://homepages.inf.ed.ac.uk/rbf/CVonline/Imagedbase.htm#biomed
- Google Dataset Search: https://datasetsearch.research.google.com/
- Kaggle dataset search: https://www.kaggle.com/datasets
- MedMNIST v2: A Large-Scale Lightweight Benchmark for 2D and 3D Biomedical Image Classification: https://medmnist.com/

Project Proposal

- Your initial proposal should be at least one page (two-column) and it should cover the following items:
  - The problem that you are trying to solve.
  - The motivation behind the problem.
  - Your proposed approach, and how it relates to prior work.
  - The experiments that you plan to conduct.
  - The datasets that you plan to use.

Project Final Report

- You should extend your project milestone to include:
  - The final set of results.
  - Your analysis of those results.
  - Your overall conclusions and findings from the project.

- If you leverage existing source codes, you should
  - Clearly state it in the report
  - Properly credit/cite the original authors (source) in your report and code
  - Identify which part is your own work.

- Replicating one project (e.g., one that is on GitHub) is NOT acceptable

How to write research papers/reports?

- Write a paper from your project
  - What problem did you attack?
  - Why it matters?
  - What were the previous solutions, their pros and cons?
  - Know the literature well
  - Explain your approach in detail
  - Present your results
  - Illustrate your data and figures
  - Discuss and conclude your method, pros and cons
  - Future work
  - Common: share the code in an accompanying website, e.g. GitHub
  - Brainstorm future directions

How to write research papers/reports?

- How to write a good CVPR submission - William T. Freeman - MIT
  https://billf.mit.edu/sites/default/files/documents/cvprPapers.pdf

How to write a good CVPR submission

Bill Freeman
MIT CSAIL
Nov. 6, 2014

How to write research papers/reports?

Core Strategy:

1. **Clarity** – Communicate your contributions succinctly.

2. **Novelty** – Clearly highlight the innovative aspects of your work.

3. **Validity** – Provide robust evidence through experiments and analysis.

4. **Structure** – Follow the standard conference paper format (CVPR, MICCAI style).

How to write research papers/reports?

1. **Title**

• Short, specific, and indicative of your main contribution.

• Include key terms (e.g., “Deep Learning,” “Segmentation,” “3D Medical Imaging”) for visibility.

2. **Abstract**

• **Problem**: What gap are you addressing?

• **Approach**: Briefly describe your method.

• **Key Results**: State your main quantitative improvements or novel findings.

• **Impact**: Why is your work important for the community?

How to write research papers/reports?

3. **Introduction**

• **Motivation & Context**: Discuss why this problem matters in medical imaging (e.g., improved diagnosis, automated screening).

• **Literature Gap**: Highlight the limitations in previous works (e.g., lack of robust generalization or small datasets).

• **Contributions**: Explicitly list your 2–3 major contributions, such as a new loss function, improved segmentation accuracy, or novel dataset.

Tip: Keep the introduction concise and compelling—hook the reviewers early.

How to write research papers/reports?

4. **Related Work**

• **Structure**: Group existing methods by categories (e.g., classical ML vs. deep learning approaches).

• **Comparison**: Show how your approach differs from or improves upon the state-of-the-art (e.g., focusing on 3D scans, multi-modal fusion).

• **Avoid**: A mere literature dump—make it critical and comparative.

How to write research papers/reports?

5. **Methods**

• **Technical Clarity**: Clearly explain your model architecture or algorithm flow (use diagrams/flowcharts if possible).

• **Dataset Details**: For medical imaging, specify data types (MRI, CT, ultrasound), number of samples, pre-processing steps, and ethics/compliance if applicable.

• **Implementation Specifics**: Training protocols (hyperparameters, optimizer, learning rate), hardware used (GPU, etc.).

• **Reproducibility**: Provide enough detail so others can replicate (pseudo-code, detailed pipeline).

Tip: Use figures to visualize your pipeline (e.g., data input → neural network layers → output segmentation).

How to write research papers/reports?

6. **Experimental Design**

- **Baselines**: Include strong baselines and relevant recent methods from conferences like CVPR, MICCAI.
- **Evaluation Metrics**:
  - Common segmentation metrics: Dice Similarity Coefficient, IoU (Jaccard Index).
  - Classification metrics: Accuracy, Precision, Recall, F1, AUC.
  - Reconstruction tasks: PSNR, SSIM.
- **Ablation Studies**: Show how different components (e.g., proposed components/designs, data augmentation, loss functions) affect performance.

How to write research papers/reports?

7. **Results Presentation**

• **Tables & Figures**: Provide clear, well-labeled tables and/or figures with your metric improvements.

• **Visual Examples**: Show qualitative results (e.g., segmentation overlays on medical scans).

• **Statistical Rigor**: Include error bars or confidence intervals if available.

How to write research papers/reports?

8. **Discussion**

• **Interpret Findings**: Why did your method outperform? Where does it fail?

• **Contextualize**: Compare results with prior work to confirm novelty and improvements.

• **Limitations**: what are limitations of your method (points for future improvements)

Tip: Keep results honest and balanced—acknowledge both strengths and weaknesses.

How to write research papers/reports?

9. **Conclusion**

• **Key Takeaways**: Summarize the main achievements (e.g., improved accuracy on a specific dataset, new methodological insights).

• **Clinical Relevance**: Emphasize potential real-world impact in healthcare (e.g., improved early detection).

• **Future Work**: Briefly note possible extensions (e.g., applying to new modalities, larger cohorts).

How to write research papers/reports?

10. **References**

• Follow the conference template (BibTeX style).

• Cite **core** and **recent** papers from MICCAI, CVPR, or other relevant venues.

• Maintain **consistency** (no missing references or mismatched citation formats).

Possible outcome - Publish a paper on your project

- Set a high standard for your project
- Discuss new ideas with the instructor
- Aim for a conference/workshop or even a journal paper

- Next lecture: different medical image modalities (1)

Thank you!

Question?

Slides credits: some of the slides are adapted from Ali Borji, Mubarak Shah