

Research Seminar - Grow Your Knowledge

A Roadmap for Your First Research Adventure

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Research Interests:

- Medical Image Analysis
- Computer Vision
- Deep Learning



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- 1 Idea & Problem Formulation
- 2 Research Conduction & Experimentation
- 3 Paper Writing
- 4 Publication and Dissemination

Background and Motivation

- The goal of academic research is to generate **novel and actionable knowledge**.
- **Motivation:** Addressing significant **real-world needs** or critical gaps in current theory/technology.
- In technical fields (e.g., AI/CV), motivation often stems from **SOTA limitations** (e.g., lack of robustness, high latency, ethical bias).
- A strong foundation is the **most crucial step**—defining a problem that is both important and solvable.

The Research Lifecycle: An Overview

- **Phase 1: Ideation & Formulation:** Identifying the gap, defining the question, forming a hypothesis.
- **Phase 2: Experiment Design:** Setting up baselines, choosing metrics, and designing test protocols.
- **Phase 3: Implementation & Validation:** Coding the solution, running experiments, analyzing results, and iterating.
- **Phase 4: Dissemination:** Writing the paper, presenting the work, and releasing code/data.

1 Idea & Problem Formulation

Idea Generation

Literature Review

How did I generate my papers Idea?

Summary

2 Research Conduction & Experimentation

3 Paper Writing

4 Publication and Dissemination

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Where Do Ideas Come Come From?

- **Critiquing Assumptions:** Questioning the core foundational beliefs of current SOTA methods.
- **External Drivers:** Industry partnerships, open challenges, or societal needs (e.g., climate tech).
- **Identifying Trade-offs:** Exploiting a common compromise (e.g., speed vs. accuracy).
- **Domain Transfer:** Applying a successful concept from one field (eg., NLP) to another (e.g., CV).

Analyzing the State-of-the-Art (SOTA)

- Identify the **current best performing solutions** on relevant benchmarks.
- **Deconstruct SOTA Architectures:** Understand their core components, loss functions, and training strategies.
- **Critique:** Focus on **why** and **where** the SOTA methods fail (e.g., generalization ability, specific data types).
- SOTA sets the **bar** for performance—your solution must surpass it in a meaningful way.

Finding the Research Gap

- The gap is the **unmet need** or **unaddressed limitation** in the SOTA.
- The gap must be **significant** enough to justify a full research project.
- Look for missing pieces: a lack of data, a failure mode (e.g., sensitivity to noise), or an efficiency bottleneck.
- *The research gap is the foundation for your **core novelty**.*

Defining the Core Novelty

- The novelty is your **unique intellectual contribution** to bridge the identified gap.
- It must be clearly stated: a new algorithm, a novel application of existing techniques, or a new theoretical insight.
- **Test:** If you remove your proposed contribution, does the problem revert?

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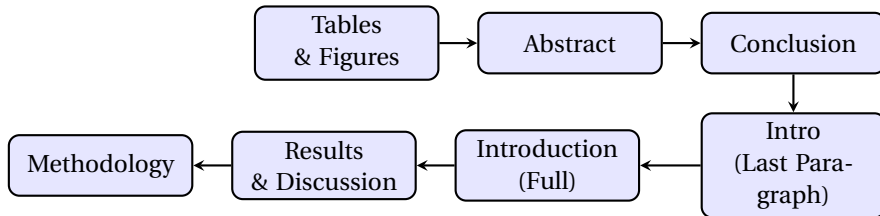
Paper Selection

- Should be top venue (CVPR, ICCV, ECCV, WACV, TPAMI, TMI, TIP, MIA, ISBI, MIDL, MICCAI)
- Must be reproducible (Source code open, dataset open)
- Keep in mind your experimental resource constrains

Source of paper

- Most of the case available in arxiv or Open Access
- Contact authors or in your community.
- Some popular sites are available.

Paper Reading Sequence



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BASNet

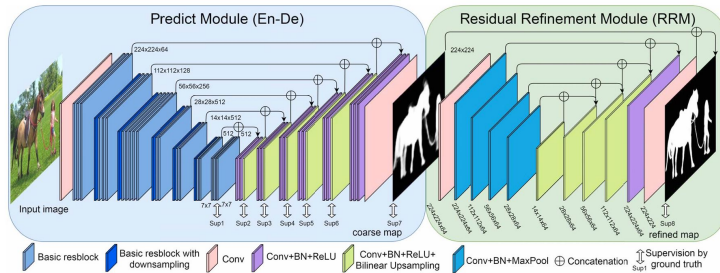


Figure 1: BASNet: Boundary-Aware Salient Object Detection ¹

¹X. Qin, Z. Zhang, C. Huang, C. Gao, M. Dehghan and M. Jagersand, "BASNet: Boundary-Aware Salient Object Detection," 2019 IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR), Long Beach, CA, USA, 2019, pp. 7471-7481, doi: 10.1109/CVPR.2019.00766.

UDBRNet

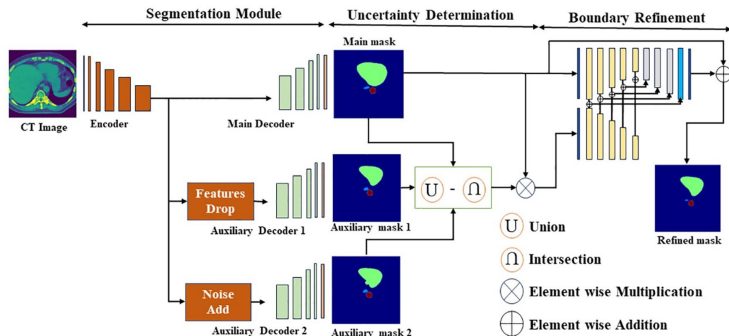


Figure 2: UDBRNet: A novel uncertainty driven boundary refined network for organ at risk segmentation²

²**R. Hassan**, M. R. H. Mondal, and S. I. Ahamed, “UDBRNet: A novel uncertainty driven boundary refined network for organ at risk segmentation,” PLOS ONE, vol. 19, no. 6, p. e0304771, Jun. 2024, doi: <https://doi.org/10.1371/journal.pone.0304771>.

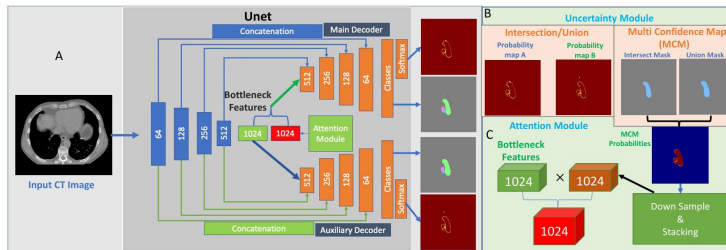


Figure 3: Uncertainty Driven Bottleneck Attention U-Net For Organ at Risk Segmentation³

³A. Nazib, **R. Hassan**, Z. Islam, and C. Fookes, “Uncertainty Driven Bottleneck Attention U-Net For Organ at Risk Segmentation,” 2024 IEEE International Symposium on Biomedical Imaging (ISBI), pp. 1–5, May 2024, doi: <https://doi.org/10.1109/isbi56570.2024.10635587>.

EDLDNet

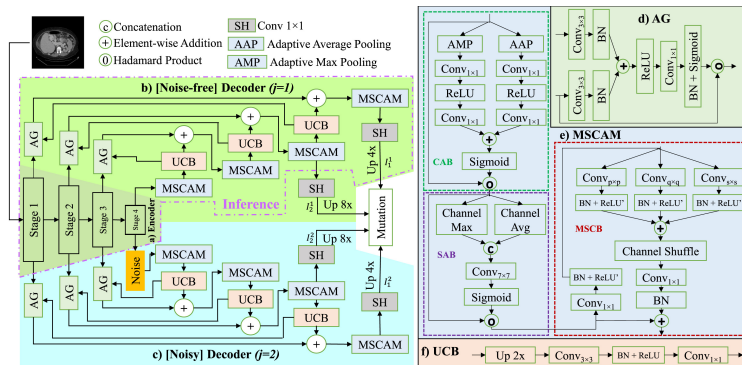


Figure 4: An efficient dual-line decoder network with multi-scale convolutional attention for multi-organ segmentation ⁴

⁴**R. Hassan**, M. R. H. Mondal, S. I. Ahamed, F. Mostafa, and M. M. Rahman, “An efficient dual-line decoder network with multi-scale convolutional attention for multi-organ segmentation,” Biomedical

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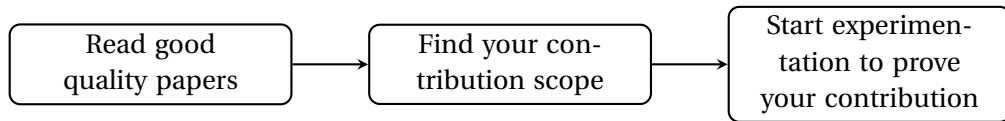
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Summary: Idea & Problem Formulation

Research Workflow



1 Idea & Problem Formulation

2 Research Conduction & Experimentation

Before Staring Code

Requirements for coding

Summary

③ Paper Writing

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Explore Dataset

- Open data and observe with your eyes
- Explore the meta values
- Finds the significance of every values

Learn the underlying technology

- Learn the basic of ML, DL
- Learn the basic of Image Processing.....
- Learn the basic of Convolution before CNN

How much need to know before?
When I can start conducting research?

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Before Staring Code

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- Version Controlling
- Practice OOP during coding
- Python
 - TensoBoard
 - wandb
 - Matplotlib
 - Pandas
 - OpenCV
 -
 - CSV
- PyTorch



Figure 5: Pytorch logo

What type of coding style should I follow?

- ① Jupiter Notebook
- ② Single file python code
- ③ Modular

What type of coding style should I follow?

- ① Jupiter Notebook [For learning]
- ② Single file python code [For prototyping]
- ③ Modular

Define Project Structure

```
project_root/
├── configs/
├── data/
├── datasets/
├── models/
├── losses/
├── utils/
├── train.py
├── evaluate.py
├── requirements.txt
└── README.md
```

YAML config files for experiments

Scripts to handle data

Custom Dataset classes

Model definitions

Custom loss functions

Helper functions

Main training script

Main evaluation script

Dependencies

IDE

- ① VS Code - Free⁵
- ② Pycharm - Community version (Free), Professional version (free for students)

⁵Not IDE, Need to configure everything

Version Controlling



- Use git for version Control
- Commit properly to track your code
- For experimenting multiple ideas, use different brunch

Result Storage

- Must store your result in permanent storage (i.e., CSV)
- Keep logs of results with experimental configuration
- Store the necessary weights with all parameters (Best and last)
- Every file name should be meaningful
- *TensoBoard* can be used for visualization

Life is easy, but when?

If you find a **GOOD** paper and reproduce with their given dataset, source code, weights

How?

- They follow good coding style.
- They already have comparing table with previous comparing methods

Summary: Research Conduction & Experimentation

- Find a paper where source code, preprocessed dataset, weights are available
- Run the code successfully and reproduce the claimed result
- Implement your idea within the code

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③ Paper Writing

Abstract

Introduction

Literature Review

Methodology

Result and Discussion

Conclusion

Tools

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What we write in abstract?

- **Work:** Define your work with broad use case. *[1 sentence]*
- **Problem:** Initiate with current solution the research gap or challenge. *[2-3 Sentences]*
- **Method:** Briefly describe your approach. *[2-4 Sentences]*
- **Results:** Include key quantitative findings. *[2 Sentences]*
- **Impact:** State the significance of your work. *[1 Sentence]*

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Structure Your Introduction

- 1 **Start broad:** Establish the research field *[1st paragraph]*
- 2 **Narrow down:** Focus on specific problem *[1st paragraph]*
- 3 **Identify gap:** What's missing in current research? *[2nd paragraph]*
- 4 **Your solution:** Describe how you mitigate the gap. *[3rd paragraph]*
- 5 **State contributions:** What does your paper add? *[with bullate points]*
- 6 **Preview structure:** How is the paper organized? *[Last paragraph]*

Your paper may be desk rejected, if not

- Properly explain the research gap with logic
- Clearly present your idea
- **Very careful regarding contribution. Need to prove your contribution with experimental results.**

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Literature Review

- Need a story in sequential order
- Try to categorize if possible

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Methodology

- Discuss in technical words what you have done to solve research question
- If possible, give mathematical formulation of your work
- Do not describe much what is not your contribution

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Result and Discussion

- Must be a table to present comparative analysis with SOTA
- In text, you should describe the results and must give the **logic** why your results are good

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Conclusion

- Avoid technical words
- Give problem, your solution, your result
- Focus on use case
- Give one or two limitation for future work

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Tool

LATEX

- 1 Idea & Problem Formulation
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- 4 **Publication and Dissemination**
 - Journal and Conference selection
 - Social Presence

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Research fund is a major issue in our country

- Try to select top venue of conference, if registration and attending fund is available.
- Try for top journals (Not open access). For open access journal APC is huge.
- If all authors are form low income country like Bangladesh, you can publish your article freely in Elsevier's open access journal (Not included in GEO list) with bangladeshi university affiliation.

You can publish in Arxiv without going through review process. It will not consider as your peer reviewed publication.

Build a Product

Build a MVP for end user

- ① Idea & Problem Formulation
- ② Research Conduction & Experimentation
- ③ Paper Writing
- ④ Publication and Dissemination**
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