

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

1 Idea & Problem Formulation

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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?

① Idea & Problem Formulation

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Paper Selection

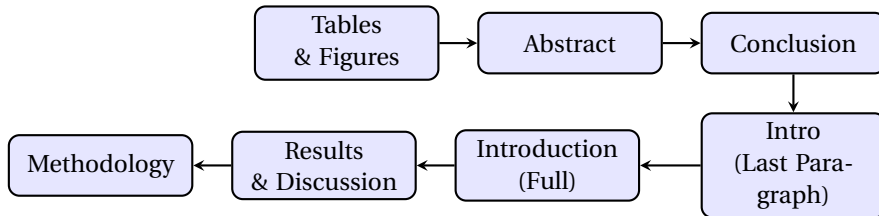
- Should be top venue (CVPR, ICCV, ECCV, WACV, TPAMI, TMI, TIP, MIA, ISBI, MIDL, MICCAI)
- Must be reproducible (Source code open, dataset open)
- Keep in mind your experimental resource constrains

Source of paper

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

Sequence of Reading Papers

Paper Reading Sequence



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BASNet

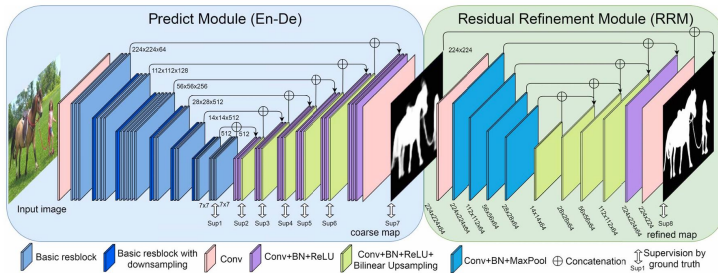


Figure 1: BASNet: Boundary-Aware Salient Object Detection¹

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

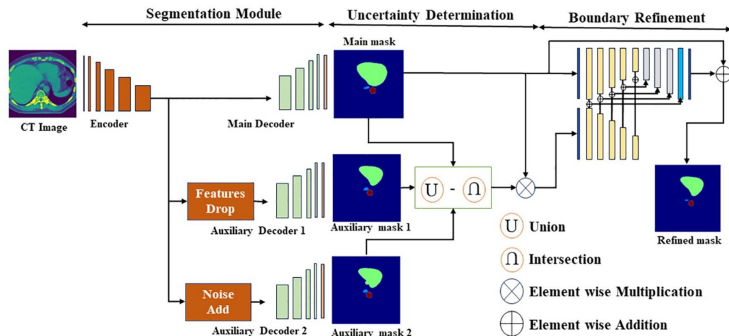


Figure 2: UDBRNet: A novel uncertainty driven boundary refined network for organ at risk segmentation²

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>.

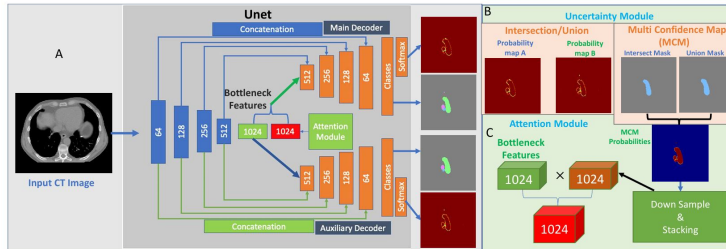


Figure 3: Uncertainty Driven Bottleneck Attention U-Net For Organ at Risk Segmentation³

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

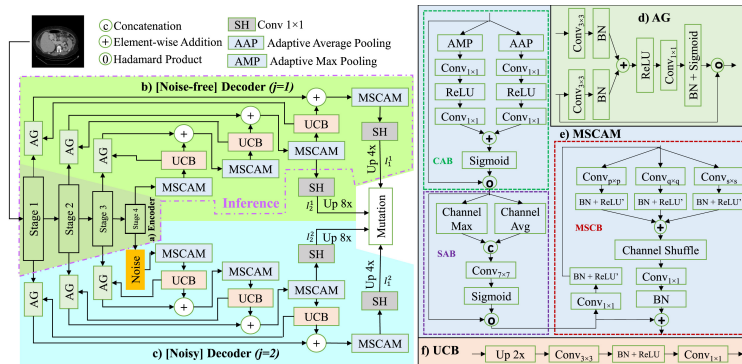


Figure 4: An efficient dual-line decoder network with multi-scale convolutional attention for multi-organ segmentation ⁴

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

① Idea & Problem Formulation

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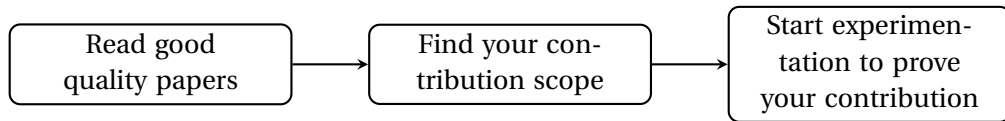
② Research Conduction & Experimentation

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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

4 Publication and Dissemination

1 Idea & Problem Formulation

② Research Conduction & Experimentation

Before Staring Code

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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?

1 Idea & Problem Formulation

② Research Conduction & Experimentation

Before Staring Code

Requirements for coding

Summary

③ Paper Writing

4 Publication and Dissemination

- 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

1 Idea & Problem Formulation

2 Research Conduction & Experimentation

③ Paper Writing

Abstract

Introduction

Literature Review

Methodology

Result and Discussion

Conclusion

Tools

4 Publication and Dissemination

Which question ans should be found in abstract?

- **What?**
- **Why?**
- **How?**
- **So what?**
- **Any impact?**

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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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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4 Publication and Dissemination

- 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

Tool

LATEX

- 1 Idea & Problem Formulation
- 2 Research Conduction & Experimentation
- 3 Paper Writing
- 4 **Publication and Dissemination**
 - Journal and Conference selection
 - Social Presence

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Build a Product

Build a MVP for end user

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

- University website
- Department website
- Your lab website
- **Your personal website**
- Linkedin
- X

