Cognition X Project

Welcome!

The CognitionX Project is a cross-disciplinary research lab focused on data and digitalisation-driven project cognition and system resilience for infrastructure and buildings in the built environment.

Lab website: https://cognitionx-lab.github.io/

Location: SDE2, Department of the Built Environment (DBE), College of Design and Engineering (CDE), NUS.

1. Introduction

It looks like you recently joined the CognitionX Project lab in the Department of the Built Environment at National University of Singapore. Welcome! We're really glad to have you here and will do what we can to make your time in the lab amazing. We hope you'll learn a lot about data science, digital technologies, systems engineering, and built environment sustainability, develop new skills (coding, data analysis, writing, giving talks), make new friends, and have a great deal of fun throughout the whole process.

When you join the lab, you're expected to read this manual[1]. You're also highly encouraged to read it while deciding if you want to join the lab in the first place. You should always feel free to talk to Jinying to clarify anything in the lab manual and let her know if she isn't following through on some of her promises! This lab manual is intended to be a starting point for a positive mentor-mentee and lab experience — but, ultimately, positive experiences will also require active investment in, and refinement of, our one-on-one interactions over time.

First of all, I would like to let you know the kind of professor I want to be:

- Work hard, but also play hard, appreciate work-life balance.
- Lead by example.
- Never pretend to have all the answers, open to learning from my students and colleagues.
- Give credits to others as they deserve.
- Identify and respect each student's interests and strengths.
- Provide clear instructions, guidance, and rules, as well as individualised support and impartial advice.
- Help others to build their network.

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[1] This lab manual was inspired by several others, and borrows heavily from them (e.g., this one and this one). It's also a work in progress. If you have ideas about things to add, or what to clarify, talk to me (Jinying, the PI).

- Show passion for helping with scientific problems as well as non-scientific ones.
- Be empathetic, understand other people's concerns without making them feel embarrassed and inadequate.

2. Mission, Scope, and Core Values

- **Mission**: Design, build, and evaluate data-centric cognitive systems (the "project brain") that perceive, learn, and actuate in complex project and infrastructure environments to improve efficiency, safety, sustainability, and resilience.
- **Scope**: Infrastructure projects (roads, coastal, utilities) and buildings; applications include digital twins, IoT-driven monitoring, project cognition, lean delivery, and sustainability assessment.
- **Core values**:
    - Innovation: Invent and rigorously test novel methods and systems.
    - Collaboration: Work across disciplines, collaborate with team members, other groups, and industry/government partners with respect and open mind and open communication.
    - Excellence: Hold ourselves to high standards of rigor, integrity, and impact with professionalism.

We respect Critical Thinking, Creative Thinking, Systems Thinking, and also make our ideas happening.

We ask the **MOST Important Research Questions** even they are challenging!

3. Roles and Expectations Applicable to All Members

PI, postdocs, PhD students, visiting scholars/PhDs, graduate/undergraduate research assistants

- Be positive, to yourself, to others, to work, to life, and to the world.
- Respect your colleagues; foster a supportive, inclusive environment.
- Be proactive, reliable, and communicative.
- Document your work comprehensively.
- Uphold research integrity, reproducibility, and open science.
- Manage time responsibly, efficiency is more encouraged than long hours.
- Seek help early to me, your family/friends, or professionals when necessary.
- Take care of lab spaces and shared resources; leave things you would like to find them.

PI (Lab Director)

- Maintain lab vision, fundraising, partnerships, and strategic direction.
- Provide regular advising (weekly or biweekly) and mentorship tailored to each member's goals.

- Ensure resources, training, and professional development opportunities.
- Uphold culture of innovation, collaboration, excellence.

Research Fellow, Postdocs

- Develop an independent research direction aligned with lab mission.
- Lead projects; mentor students; co-author proposals and papers.
- Apply for fellowships/grants (e.g., Eric and Wendy Schmidt AI in Science Postdoctoral Fellowship).
- Target job market readiness by year 2–3.

PhD Students

- Build a coherent dissertation topic with 3+ publishable studies.
- Follow NUS PhD milestones (see Section 11).
- Publish consistently; lead systems/study work; practice open science.
- Mentor RAs; contribute to lab service (documentation, demos, reviews).

Visiting Scholars / Visiting PhD Students

- Define scope, deliverables, and timeline prior to arrival.
- Integrate with ongoing lab projects and contribute unique expertise.
- Observe NUS DBE policies; align publications/authorship early.

Graduate Research Assistants (Masters/RAs)

- Support core projects (data collection, coding, analysis, documentation).
- Maintain weekly progress; escalate blockers; uphold reproducibility.

Undergraduate Research Students

- Assist with data, code, literature reviews, experiments.
- Keep regular hours; learn version control and research compendium basics.
- Earn course credit or hourly pay (subject to availability and policy).

4. Key documents

Research Proposal

When you write a research proposal for Postdoc Fellowship or PhD scholarships, bear in mind that you need to have **a clear and significant research question** backed by thorough literature review and theoretical and/or practical challenges. You need to have a **detailed research plan** with progressive research objectives, sensible research methodology, available data sources, data analysis methods, expected outcomes, **contributions to knowledge** (theoretical, methodological, practical) potential risks and mitigation plan, and a reasonable timeline. The research plan needs to be updated or adjusted during your research project, but to think it through first will help you have a plan to follow. Also, you need to have a roadmap of success and impact to measure your progress. I am always happy to discuss!

Elements for the research proposal

- Title and Abstract (150–250 words; problem, approach, expected impact).

- Problem Statement and Research Questions: Start with big picture, context, and significance; narrow down with specific problems and questions; discuss the reasons behind; and formulate a solid research question or a few dependent research questions.
- Literature Review: Focused synthesis, not a list; identify gaps and how your work addresses them.
- Theoretical/Conceptual Framework: Explicit constructs, hypotheses (if relevant), or propositions.
- Methodology: Study design(s), data pipeline, instruments/sensors/models, validation strategy, uncertainty analysis, ethics/IRB if applicable.
- Data: Sources, access, schemas, quality, licensing, and data governance (sensitive data handling).
- Analysis Plan: Algorithms/statistics/models; evaluation metrics; baselines; ablation/robustness checks.
- Expected Outcomes: Theoretical, methodological, practical knowledge contributions; KPIs; target venues or stakeholders.
- Risks and Mitigations: Top 5 risks (data access, model validity, field constraints, etc.) and concrete mitigations.
- Timeline: Quarter-by-quarter plan aligned to milestones and deliverables (tie to Gantt).
- Roadmap of Success and Impact: Milestones to paper/prototype/pilot; impact pathways (academic, industry/policy short term, mid-term, and long term).
- Reproducibility: Code/data artifact plan, version control, licensing, preregistration if relevant.

Project Gantt Chart

In line with your research plan, make a project Gantt chart with the key work stages/ packages and milestones, keep track and monitor your process against your plan. If there is a major change needed, update with a new version.

How it works

- Work Packages (WPs): 5–10 coherent WPs (e.g., WP1 Literature & Scoping; WP2 Methods/Models; WP3 Data collection; WP4 Field/Pilot; WP5 Data Analysis/Validation; WP6 Writing & Dissemination).
- Milestones: Key stages and deliverables (e.g., literature review finished, IRB approval, dataset v1, model v1/v2, pilot complete, paper submissions).
- Review cadence: Baseline at project start; quick check monthly; re-baseline after major scope changes.

Work Tracker

To keep track your work with fine-grained task history and reduce meeting time spent on recall, supports accountability and consistent actions, each of you should keep a work tracker and shall with me. It will help you and me keep track of the streams of work, what we discussed, what the actions and results, which tasks are completed, and which are ongoing.

How it works

- Structure (columns/fields):
    - Task/Objective (link to issue/ticket)
    - Context/Notes (what was tried, references)
    - Outcome/Result (metrics, artifacts) with date
    - Next Action(s) with owner and due date
    - Blockers/Risks
    - Links (PRs, commits, notebooks, data)
- Review cadence: weekly/bi-weekly or as work status changes; ensure updates before meetings.

CV Exercise

This exercise helps you design what you would like your CV looks when you finish your programme. Specifically, it aligns publications, teaching/service, skills, and awards/fellowships to a coherent career narrative.

How it works:

- Target CV (Future-State): An “aspirational CV” dated at programme end, with:
    - Publications: Target venues and tentative titles.
    - Awards/Fellowships: Targets and deadlines.
    - Teaching/TA/Service: Planned roles and outcomes.
    - Conferences/Talks/Posters: Target talks and conferences.
    - Industry/Agency Engagement: Collaborations, internships, pilots, policy briefs.
- Gap Analysis: Matrix of current vs. target with gaps and strategies to close them.
- Quarterly Plan: 2–3 outcomes per quarter that build toward the target CV (tie to Gantt milestones).
- Narrative: 1–2 paragraph personal “positioning statement” that ties your body of work to a distinct niche.
- Review cadence: Initial within first 6–8 weeks; update at semester boundary; use in annual review.

5. Code of Conduct and Inclusion

- Harassment-free environment; zero tolerance for discrimination or microaggressions.
- Professional behaviour in labs, meetings, fieldwork, and online channels.
- Confidential channels for concerns: [PI to specify departmental contact], DBE Chair/Graduate Office, NUS reporting pathways.
- Psychological safety: Speak up; ideas and concerns are welcomed.

6. Research Integrity and Open Science

- Reproducibility: Use version control (Git/GitHub), maintain READMEs, and automate pipelines (scripts/notebooks).
- Pre-analysis plans (where applicable): Register on OSF/AsPredicted; at minimum maintain internal pre-analysis documents.
- Data/code release: Aim to share code/data (de-identified or synthetic) with publications; use lab organization GitHub and appropriate licenses.
- Authorship (CRediT taxonomy):
  - No honorary authorship. All authors must contribute and approve final manuscript.
  - Authorship order discussed early and revisited if roles change.
- Conflicts of interest: Disclose in papers and proposals; follow NUS policies.

7. Data Management and Security

- Storage locations:
  - Secure institutional servers for identifiable data (if applicable) following NUS IRB/ethics rules.
  - Dropbox/One Drive (shared team drive) for documents, non-identifiable datasets, and project management.
  - GitHub for code and research compendia (no raw sensitive data).
- Folder structure (recommended):
  - Project_Name
    - 01_RawData (original datasets; de-identified where possible)
    - 02_Models (digital twin/BIM/GIS assets)
    - 03_Code (src, scripts, notebooks; with README)
    - 04_Analysis (reports, visualizations)
    - 05_Documentation (meeting notes, protocols)
    - 06_Outputs (papers, posters, presentations)
- Backups: Use institutional backups and cloud redundancy; never store sole copies locally.
- IRB/Ethics: Before human subjects or sensitive data collection, obtain required approvals. [PI to specify NUS/DBE IRB contacts and SOPs]
- Data sharing: Follow funder/journal requirements; anonymize and license appropriately.

8. Tools and Infrastructure

- Version control: Git/GitHub (https://cognitionx-lab.github.io/).
- Writing: Overleaf (LaTeX) for manuscripts; NUS provides Overleaf Pro features.
- Documentation: Google Drive shared team drive; shared agenda docs for meetings.
- Communication: Slack (primary), Email (formal), Teams/Zoom (meetings).
- Computational resources: Home - NUSIT HPC
- Software standards:
  - Python/R/Julia for analytics.
  - Data schemas/ontologies (e.g., SensorML, IFC/BIM, CityGML) where appropriate.

9. Meetings and Communication

- Lab meetings: Biweekly (subject to review when team grows); project updates, tutorials, paper reviews, practice talks.
- One-on-one meetings: every two weeks, 30-45 minutes; agenda sent beforehand; track action items in Work Tracker.
- Project meetings: Weekly/biweekly; led by project lead; pre-circulate agenda and artifacts.
- Status updates: Concise notes before meetings (links to code, figures).
- Responsiveness: During working hours, aim to reply within a few hours to direct requests; asynchronous communication preferred over interruptions.

10. Work Policy and Well-Being

- Hybrid presence: Be in lab on campus at least 3 days/week, 10am–4pm, unless otherwise agreed.
- Participate in bi-weekly group meeting is compulsory, preferably in-person, otherwise should join online, otherwise written records to the team lead.
- Respect working hours and boundaries; no expectation to respond outside working hours.
- Sick leave: Do not come to lab ill; update Slack status; reschedule participants/meetings.
- Vacation/time off: Plan in advance; note on lab calendar.
- Safety: Follow NUS safety protocols in lab and field deployments.

11. Publications, Talks, and Conferences

- Publication quality: Prioritize rigor and impact; include reproducible code/data where feasible.
- Templates: Maintain figure style, accessible PDFs, and consistent branding.
- Practice talks: Present internally at least one week before external talks/posters.

- Conferences/travel: Funding subject to availability; be frugal; apply for travel grants; aim for 1 major conference per year per student/postdoc where feasible.

12. PhD Program Milestones (NUS DBE Guidance)

- Typical 4-year cadence (indicative; follow departmental rules and advisor guidance):
  - Sem 1: 3 core modules; integrate with lab; start literature review; pose new, feasible questions within topic
  - Sem 2: 3 core modules; draft initial paper outline(s).
  - Sem 3: Written QE; firm up thesis topic; first submission target.
  - Sem 4: Oral QE; submit and ideally publish first journal article.
  - Sem 6: Second journal article submitted/published.
  - Sem 7: Begin thesis writing; composition of results chapters.
  - Sem 8: Submit third article; submit thesis; thesis defence.
- Open science competency (required within first 2 semesters): Able to write in Overleaf and publish a GitHub research compendium.

13. Onboarding and Offboarding

- Onboarding checklist:
  - Accounts: Slack, GitHub org, Overleaf, Google Drive team drive.
  - Access: Lab spaces, equipment, data repositories, HPC (if applicable).
  - Policies: Read lab manual; confirm understanding; IRB/ethics training (CITI or NUS equivalent).
  - Project alignment: Agree scope, deliverables, timelines with PI/mentor.
- Offboarding checklist:
  - Archive datasets and code; ensure documentation and READMEs are complete.
  - Transfer ownership/access to lab repositories and Drive.
  - Outline publication plan for any outstanding work; authorship agreed.

14. Funding, Remuneration, and Reporting

- Funding sources: NUS grants, CDE internal funds, government/industry grants, philanthropic calls (e.g., CFI, NRF, PUB), etc.
- RA/TA and fellowship options: Follow NUS policies; Follow updates on website; PI will advise on opportunities.
- Annual reports: Contribute to funder reports (accomplishments, products, impacts).
- Budget expectations: Be frugal; equipment purchases require PI approval.

15. Use of AI and Computational Ethics

- Allowed and encouraged for productivity (coding, writing, data analysis) with human-in-the-loop oversight.

- Never use AI blindly; understand models and data; avoid hallucinated content.
- Declare AI usage in manuscripts/proposals where appropriate:
  - "Declaration of AI usage": Tool(s), how used, rationale.
- Data privacy: Do not upload sensitive data/code to public AI tools; follow IRB/data governance.

16. Compliance, Ethics, and Safety

- IRB/Ethics: Obtain approvals for any human-subjects or sensitive data.
- Field deployments: Risk assessment, permits, PPE, data security plans.
- Conflicts of interest/compliance training: Complete mandatory NUS modules.

17. Lab Space, Equipment, and Access

- Lab rooms and storage: TBC
- Equipment booking/usage: TBC; training required for specialized tools.
- Access: Keycards/permissions via department admin; respect shared spaces.

18. Branding and External Visibility

- Lab name and logo: Cognition X Project [PI to confirm]; brand assets repository: https://cognitionx-lab.github.io/
- Website and social media: Maintain updated project pages; amplify publications and demos.
- Open science visibility: Public GitHub repos, OSF pages, preprints as appropriate.

19. Recruitment and Visitors

- Recruitment process: Informal chats; portfolio/code review; alignment with lab culture and needs.
- Visitors: Define scope, deliverables, mentorship, and timeline; onboard to tools/policies.
- Diversity and inclusion: Seek diverse perspectives and backgrounds.

20. Appendices and Templates

- Templates included (to be added and maintained on Drive/GitHub):
  - Pre-analysis plan template
  - Project README template
  - Overleaf manuscript template (lab style)
  - Poster and slide templates (lab branding)
  - IRB/ethics SOP and data management plan
  - Weekly agenda/status template
  - Onboarding/offboarding checklist