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LABORATORY MANUAL

COMPUTATIONAL MEMORY LABORATORY, OUR SCHOOL

PUBLISHED BY COMPUTATIONAL MEMORY LABORATORY, OUR SCHOOL

http://www.princeton.edu/manning3

First printing, March 2015

Contents

Introduction

This lab manual is intended to serve two purposes. First, the manual provides a comprehensive overview of official lab policies, expectations, facilities, and personnel. Second, it provides a set of general tutorials and a list of relevant links, pointers, and/or references related to the techniques we employ in our research.

Who is this lab manual for? Every new lab member should read the latest version of this lab manual in detail and reference it later as needed. Periodically throughout the document, you will see margin notes with listed `TASK` items. Completing your read through entails both reading the contents of the manual and completing the relevant `TASK` items.

`TASK`: Upon reading through this lab manual for the first time, please make at least one edit. You could correct a typo, clarify something that's unclear, add a comment, etc. Focus your edits or additions on sections that are most relevant to the work you want to do. Importantly, be sure to push your edits to the manual's github repository so that everyone can benefit.

What should you do if you don't understand something? If you don't understand something you read in this manual, it is important that you *ask another lab member for help*. Every member of the lab brings their own unique knowledge base, training, life experiences, and perspectives. Respecting and celebrating those differences drives the science we do. If you're new to the lab or new to a particular technique, you might feel like a newbie today— but chances are good that if you stick around for a bit someone else will be seeking your expert opinion before you know it. In addition to learning, there's another good reason for asking for help: if you don't understand something you read in this manual, there's a reasonable chance that you've discovered a mistake!

`TASK`: If you don't understand something, ask another lab member for help!

Why is it worth my time to read through the manual? Aside from pursuing your own curiosity, a major reason that you've decided to join an academic research lab is probably because you want to gain training or career-advancing experiences. This manual summarizes the collective wisdom of past and present lab members in a way that we think will best allow you to achieve your objectives. *Learn from it*, *challenge it*, and *add to it*.

Official lab policies

Our lab's policies are intended to provide a framework for *maximizing efficiency*. Achieving our peak efficiency as a lab means we are being as scientifically productive as possible, in terms of knowledge discovery (learning new stuff) and disemination (papers, talks, conference presentations, publicly released datasets, software, etc.). It also means that our fellow lab members are achieving their training and career objectives. To achieve peak efficiency we need to succeed on two fronts:

- **Communication.** We want to foster an environment where everyone feels comfortable contributing to the collective dialogue. Our lab meets regularly to discuss logistical (e.g. temporal, financial, sociological) and technical issues. We also use a variety of software packages to synchronize and facilitate communication within our lab and between our lab and the broader scientific community.
- **Resource allocation.** Our lab resources (e.g. equipment, time, money, attention) are finite. We want to foster an environment where lab resources are used as efficiently as possible to achieve our collective goals.

Your job as a contributing lab member is to help us to achieve our collective peak efficiency (as a lab) while also maximizing your own training and career potential.

The lab hierarchy

Our lab is organized in a roughly hierarchical structure. Importantly, the lab hierarchy does *not* serve an excuse for disrespecting or discounting the opinions of lab members at similar or different levels of the hierarchy. The hierarchy is an organizational tool that helps to define lab policies and expectations. Each lab member's position in this hierarchy is determined by two factors: the lab member's job title and the amount of time they have worked in the lab. Moving "up" in the hierarchy generally entails working in the lab for some amount of time, gaining experience by working in other labs, and/or earning academic degrees. The lab hierarchy is intended to serve as a general framework for estimating what is expected of each lab member (e.g. in terms of research, supervising and mentoring, training roles, and other lab responsibilities). The hierarchy also serves as a general framework for determining lab member salaries and benefits. There are two branches of the lab hierarchy; although personnel on different branches may have overlapping responsibilities, the first branch is primarly concerned with directly carrying out lab research and the second branch is primariy concerned with supporting or managing the lab's research objectives. The research-focused levels of the lab hierarchy are defined as follows:

R1-*x*: **Undergraduate research assistants.** This category includes undergraduate students (currently enrolled at OUR SCHOOL) who are pursing an active undergraduate research program in the lab. An active undergraduate research program may include for-credit projects (such as an independent study or an honors thesis project) or not-for-credit projects.

R2-*x*: **Postbaccalaureate research assistants.** This category includes lab members who have already earned an undergraduate degree (e.g. BA, BS) but who have not earned a graduate degree, and who are not currently enrolled in a degree-granting graduate program.

R3-*x*: **Postgraduate research assistants.** This category includes lab members who have already earned a non-doctorate graduate degree (e.g. MA, MS) but who are not currently enrolled in a degree-granting graduate program.

R4-*x*: **Graduate students.** This category includes lab memebers who are currently enrolled in a degree-granting graduate program (generally working towards a master's degree or doctorate).

R5-*x*: **Postdoctoral researchers.** This category includes lab members who have earned a doctorate degree and are not currently enrolled in a degree-granting program.

R6-x: **Principle investigator.** This category includes lab members who have successfully obtained external funding for an independent research or training project, and whose funding is currently active.

Note that the x's above should be replaced with the time elapsed since you joined the lab, in years. The supporting and manageareal roles in the lab are:

S1-x: **Administrative support staff.** This category includes lab members whose primary roles, regardless of their academic degree, are to provide administrative assistance (e.g. assisting with grant or paper submissions, registration, scheduling, coordination) to facilitate scientific research in the lab.

S2-x: **Specialists.** This category includes lab members who, regardless of their academic degree, bring a specific special scientific skill to the lab (e.g. programmers, graphic artists). However, unlike research-focused positions, the primary role of specialist lab members is to provide research *expertise* rather than determine research *direction*.

S3-x: **Project managers.** This category includes lab members whose primary role is to provide managerial support to the lab by helping to direct and organize personnel and lab resources. Generally project managers will have earned a graduate degree.

In addition to the above components of the lab hierarchy, there's one more lab position that plays an important role:

J1: **Lab director.** "*There can be only one...*" Becoming the lab director entails convincing a search committee at this or another department/university that you have what it takes to be a Supreme Ruler of Laboratory Science. Note: this position may or may not come with tenure and/or additional people to report to (e.g. senior colleagues, funding agencies, deans, provosts, presidents, etc.). This position is both research-focused and support-focused, hence its own designation.

Project hierarchies

Lab members at any level in the lab hierarchy may play different roles on different projects. The role you play on a given project determines (for that project) your research and administrative responsibilities, your supervisory responsibilities, your role in decision making or strategizing, and your authorship position in papers or conference presentations about the project. The project roles are:

The mapping between people and project roles is many-to-many: one person may play multiple project roles, and one project role may be shared by multiple people.

P1: **Project assistant.** This is a minor "non-authorship" role (generally project assitants will be listed in manuscript acknowledgements). This role is assumed by all project participants who do not satisfy the criteria for paper authorship, but who directly participant in the project's conceptual or scientific development. An example might be an undergraduate research assistant who helps to run participants but who does not contribute to any analyses or to the itellectual development of the project.

P2: **Junior co-author.** This role is generally assumed by junior lab members (e.g. research assistants, junior grad students). Junior co-authors assist with all aspects of carrying out the research (e.g. helping to write code, run participants, generate graphics, review communications, etc.). The primary difference from a senior co-author role is that junior co-authors provde less conceptual guidance than senior co-authors. Junior co-authors will generally hold "middle author" positions on communications related to the project.

P3: **Senior co-author.** This role is generally assumed by senior lab members (e.g. postdocs, senior grad students). Senior co-authors provide conceptual guidance, research assistance (though to a lesser extent than a project lead), experimental assistance (though to a lesser extant than a project lead), and writing assistance (e.g. providing comments on manuscript drafts, posters, and/or slides). Senior co-authors will generally hold "middle author" positions on communications related to the project.

P4: **Project lead.** This person is responsible for overseeing day-to-day operations for the project, and reports to the PI (or co-PI). This person's responsibilities include: writing and running experiments (or directly overseeing these processes), coding and running analyses (or directly overseeing these processes), writing the first complete draft of the manuscript(s), editing the manuscript(s), submitting the manuscript(s), designing conference posters, and putting together slides for talks (which may be presented by the project lead or lab director). The project lead is also responsible

Authorship on project communications requires meeting ALL of the following criteria:

- Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of the data
- Drafting the work or revising it critically for important intellectual content
- Final approval of the version to be published
- Agreement to be accountable for all apsects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

If a project collaborator does not meet all of the above criteria (but meets some of them), they may be listed in the "acknowledgements" section at the discresion of the lab director.

for scheduling project meetings and organizing all materials (code, data, etc.) related to the project. The project lead will generally be the first author on communications (manuscripts, abstracts, posters, talks) related to the project.

P5: **Principle investigator (PI).** This is the person listed as the PI (or co-PI) on the grant that's funding the project. (This role may be shared, e.g. in the case of a co-PI.) Generally the (co-)PI will also be the project lead and/or will be the lab director. The PI is responsible for overseeing the project's budget (in collaboration with the lab director) and ensuring that the project timeline is adhered to (in collaboration with the lab director). The PI should discuss "order of authorship" on project communications with the lab director and ensure that all project members are informed of their order in the author sequence at the start of the project. Prior to the project starting, the PI is also responsible for drafting and submitting the grant application (in collaboration with the lab director).

P6: **Lab director.** This is the most senior person on the project. Generally this will be the lab director of the computational memory lab (Jeremy Manning). For collaborative projects, the lab director role may fall to another faculty-level collaborator.

Starting a new project

Our lab uses a number of project management tools and policies to promote continuity across projects and lab members. When you start a new project as a project lead, here are the steps you should take:

JEREMY TO DO: create a "Getting started checklist" and add it to the lab manual.

1. Come up with a project name to uniquely identify your project (e.g. "EEG mind decoder"). Keep lab naming conventions consistent; the project will be referred to using this name from now on.

2. Create a RedBooth project and add all team members. See *Task management using Redbooth* for detailed instructions on how to organize the new Redbooth project.

TASK: Create a RedBooth account if you don't already have one.

3. Create a Bitbucket repository for your project. Give all team members write access to the repository; PIs and the lab director should have administrative access. See *Code and document management using Bitbucket* for detailed instructions on how to organize the Bitbucket repository. Add a link to the Redbooth project in the project's Bitbucket wiki page. Also add a link to the Bitbucket repository in Redbooth.

TASK: Create a Bitbucket account if you don't already have one.

4. Create a proposed budget spreadsheet (in Google Docs) for project equipment purchases and subject payments. Other project costs (travel expenses, publication fees, conference registration fees, textbooks, etc.) should be added to the spreadsheet as they become known. Send a link to the spreadsheet to Jeremy and cc the project PI (if not Jeremy).

All equipment purchases or other lab charges must be approved in writing by Jeremy Manning *prior to spending lab funds*. IMPORTANT NOTE: Budget spreasheets should not be attached to the Redbooth project. All budgets are to be kept confidential within the lab.

5. Create a spreadsheet outlining all project personnel and their project roles. This should include each project member's:
   - Full name
   - Lab hierarchy code (e.g. R4-0, J1, etc.)
   - Project hierarchy codes (e.g. P4 and P5)
   - Expected project role (keep it brief– e.g. "Project management; Code experiment; Run participants; Ensure consistent levels of caffenation maintained by all project members during lab business hours.")
   - Proposed authorship order (this will apply to any project communication– manuscripts, abstracts, talks, etc.)
   - Contact information (preferred email, preferred phone number, preferred mailing address, and primary office number or address if different from mailing address)

   Add a link to the personnel spreadsheet in Redbooth.

6. Create a Google Calendar for project meetings and events.
7. Add a line to your lab snippet template for this project. (See *Lab Snippets*.)
8. Send a polite but brief email to all project personnel welcoming them to the project. Include the following information:
   - A 1-2 sentence description of the project.
   - A link to a Doodle Poll proposing some times for a first team meeting.
   - A request that all team members join the project in Redbooth and Bitbucket. If any team members are not current lab members, also include a brief description of what Redbooth and Bitbucket are. (A project management tool and version control system, respectively.)
   - A ical link to the project's Google calendar.
   - A note that you have outlined expected project roles and responsibilities in Redbooth, and that these roles and responsibilities will be discussed during the first project meeting. Ask the project members to look over what you've proposed and make note of any comments, questions, or concerns (either within Redbooth or elsewhere) prior to that first meeting.

TASK: Create a Google account if you don't already have one (or if you'd like to create a new one for lab-only use). Make sure your account is linked with the lab's Google Apps account, which will give you access to extra storage space and some other additional functionality.

Scheduling

Complex dynamic systems can be difficult to understand (e.g. describe, compute with). Fortunately for us, we do not need to start entirely from scratch with respect to attempting to organize some complex dynamic system we care about in our lab. For example, we can use tools like calendars and other software packages to organize and understand our own temporal dynamics. Our lab's scheduling policies are intended to facilitate lab member interactions between ourselves, our collaborators, and our experimental participants.

Attendance policy

As you move up in the lab hierarchy, our policy is to afford you increasing scheduling flexibility (which, in turn, assumes increasing responsibility on your part). Increased *scheduling flexibility* comes in the form of less frequent check-ins (e.g. times you are required to meet with your supervisor) and less structured research time (e.g. your level of independence as a researcher, as determined by your supervisor). Increased *responsibility* comes in the form of increased expectations placed on you as a researcher (in terms of research effort and productivity).

Lab calendar

Mandatory lab events

Optional lab events

Scheduling participants

Task management using Redbooth

Code and document management using Bitbucket

We use Bitbucket as a means of organizing, maintaining, and sharing our code and documents. Bitbucket provides a unified framework for documenting changes over time, managing and integrating code from multiple users, and submitting bug reports or feature requests. Atlassian's SourceTree client provides a convenient and easy-to-use desktop client for OS X and Windows systems. Each project should have its own Bitbucket repository, and should be organized using the following directory structure:

The lab's standard practice is to use the Git version control system, although lab members may use Mercurial (Hg) instead at their discretion. All projects *must* be managed using either Git or Hg via Bitbucket.

- *code/main*: contains code for running experiments and analyses. When the paper is published, this folder (and/or its contents) will

be made publically available. How this folder gets organized is up to the project lead.

- *code/main/contents.txt*: a list of
- *code/main/README.txt*: quick start instructions for using the code.
- *code/dev*: contains under-development and/or half-baked code. All project-related code should start life in this folder, and should be moved to code/main after it has been debugged and after its unit tests have been written.
- *code/debug*: contains unit tests for code in code/main. Unit tests should provide example scripts for running code/main code along with specific detailed descriptions of the expected behavior or output.
- *docs/admin*: contains organizational files related to the project, including:
  - **Project vision.** A high level description of the project along with a (rough) proposed timeline for the project's phases.
  - **Personnel list.** A description of all project members and their expected roles on the project. Authorship order must be specified in this document, and changes must be approved by the lab director.
- *docs/admin/forms*: official forms and approvals related to the project. Each experiment should have its own sub-folder containing:
  - IRB approval forms
  - Participant consent forms
  - Participant exit surveys (if applicable)
  - Participant instructions
  - Participant debriefing document
  - Ammendments to any forms (e.g. IRB approval extensions)
  - A document listing budget codes for grants that fund any part of the project
- *docs/papers*: each paper should exist as a sub-folder of this directory. Each paper's sub-folder should contain the following:
  - *paper_name.tex*: main source file for document text
  - *boneyard.tex*: a source file containing pasted snippets of discarded text that might conceivably be useful at some later point (in this or other projects).

  - Other files needed to compile the main source file into a complete PDF.
  - *figs*: sub-folder containing complete PDF figures.
  - *figs/source*: sub-folder containing files relevant to constructing each manuscript figure (e.g. the images for each panel in a figure). Each figure should have its own sub-folder. For compound figures (e.g. a panel that has multiple sub-panels), each panel should have its own *source* directory that lives in its parent figure's source directory. Raw data should not be stored in these folders, but intermediate files or images that would be time consuming to regenerate (or that are useful to have in an easily accessed location) should be included. In addition, Adobe source files (e.g. .ai or .psd files) should be included in the source folders.
  - *replicate*: sub-folder containing links to the data and code relevant to the paper, along with **detailed** helpful instructions that would allow someone to download the project's Bitbucket repository and data, and reproduce figures from each paper from scratch (assuming they had the appropriate hardware to run the analyses). The instructions should also list system requirements (as applicable) and software dependencies (along with download links and installation instructions). This folder should also contain a "make_figs" script that, when run, should reproduce the basic versions of the paper's figures (e.g. before editing fonts and line styles or composing figure panels in Illustrator).

- *docs/posters*: each poster should exist as a sub-folder of this directory. Each poster's sub-folder should contain:
  - The main .ai, .pdf, or .pptx poster file.
  - A copy of the associated conference abstract or paper.
  - A README.txt file containing bibliographic information for the poster.
  - *source*: sub-folder containing all source materials linked to in the main poster file. This folder may contain other sub-folders as needed (at the discretion of the poster maker).
- *docs/slides*: sub-folder containing the .key, .pptx, or .pdf files for each presentation.
- *docs/slides/source*: sub-folder containing all source materials (figures, etc.) linked to in any presentation.