JEREMY R. MANNING, PH.D.

# LAB MANUAL

CONTEXTUAL DYNAMICS LAB, DARTMOUTH COLLEGE

PUBLISHED BY THE CONTEXTUAL DYNAMICS LAB, DARTMOUTH COLLEGE

http://www.context-lab.com

*First printing, May 2016*

# *Contents*

# *Introduction*

This lab manual is intended to provide a crash course in doing research in the Contextual Dynamics Lab. It introduces our general research approach and some basic lab policies.

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. Importantly, be sure to push your edits to the manual's Bitbucket 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, there's a reasonable chance that you've discovered a mistake or a logical inconsistency!

TIP: 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 briefly 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*.

WHAT "ISN'T" THIS LAB MANUAL? This lab manual is *not* intended to provide a comprehensive overview of everything you need to know

to do your research projects. As described next, you may not even *know* what you need to know to do your projects! Nevertheless, you need somewhere to start, and this is that place.

# *Official lab practices and policies*

Our lab's practices and 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 dissemination (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 three 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. scheduling, 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. We also want to foster sustainable use of resources by regularly pursuing research funding opportunities.
- **Adaptability.** The whole point of *research* is that we don't already know the answer to the questions we're exploring or how to make the tools we're working on. That means that we won't necessarily be able to plan out everything in advance. We often need to be focused and efficient *without knowing the end goal*!

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. To do this, the Contextual Dynamics Lab practices **agile science**, as described in the next section.

## *Doing agile research*

TASK: Watch the Scrum Training Series videos and answer the quiz questions. (Note: "Scrum" is an implementation of the agile process.) In the lab we'll adapt this approach somewhat, but we will try to preserve the core ideas. For example, you can mentally replace "software" with "software, papers, and posters." Also, the meeting and team structures we use in the lab will be different from those used in a software development environment. Again, we'll try to preserve the core principles.

The agile approach to research we use in the Contextual Dynamics Lab is inspired by the Agile Movement in the software development world. The idea is to create learning, adaptable teams to work on very small bite-sized tasks. Specifically, project teams are designed to respond to unpredictability in research through incremental, iterative work "sprints." Each sprint lasts approximately 1–2 weeks, and results in a demonstrable research product (e.g. a draft of a paper, a draft of a grant, a completed analysis or figure, a poster, a software tool, etc.).

This is different from traditional approaches that you may have encountered in other labs or work environments, where a research team might try to plan out every part of a project in advance in a series of small steps. We still try to break projects into tiny bite-sized chunks, but the key insight of the agile approach is that we only need to know what the *next* chunk is. Although it's helpful to have a general (if vague) sense of where things are going, we never actually need to know where the project will ultimately end up. The goals and process are constantly evolving. Perhaps the best justification for this approach is that **the first day of a new research project is when you're the most clueless about what you'll find**. So how could that possibly be the ideal time to plan out the entire project?

NOTE: Our adapted approach also draws inspiration from this blog.

Our agile science manifesto has three key tenets:

1. Value **individuals and interactions** over *processes and tools*.
2. Value **working tools and research products** over *comprehensive documentation*.
3. Value **responding to change** over *following a plan*.

While there is value to the *italicized* items, we value **bolded** items more. There are twelve principles we use to achieve these tenets:

1. Our highest priority is to benefit the research community through the early and continuous delivery of documentation (papers, presentations) and tools (software and devices).
2. Welcome changing requirements, even late in development. Agile processes harness change to gain a competitive advantage.
3. Deliver working software and papers frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.
4. Researchers in different roles must work together daily throughout the project.

5. Build projects around motivated individuals. Give them the environment and support they need and trust them to get the job done.

6. The most effective and efficient method of conveying information to and within a research team is face-to-face conversation.

7. The product itself (software, paper, poster, presentation, grant) is the primary measure of progress.

8. Agile science promotes sustainable research. Researchers should be able to maintain a constant pace indefinitely.

9. Continuous attention to technical excellence and good design enhances agility.

10. Simplicity—the art of maximizing the amount of work not done—is essential.

11. The best architectures, requirements, and designs emerge from self-organizing teams.

12. At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.

*Projects roles*

Every project has four possible roles. You will play one or more of these roles on your project:

1. **Project Owner.** This is the person responsible for maximizing "return on investment" of the project effort:

   (a) Responsible for project vision

   (b) Constantly re-prioritizes the research backlog, adjusting any long-term expectations such as publication and release plans

   (c) Final arbiter of requirements questions

   (d) Accepts or rejects each project increment

   (e) Decides whether to publish/ship the project

   (f) Decides whether to continue development

   (g) Considers interests of funding bodies (e.g. NIH, NSF, DARPA, private organizations) and the scientific community

   (h) May contribute as a team member

   (i) Has a leadership role

   (j) Usually the project owner will be Jeremy

2. **Team Member.** Team members are responsible for carrying out the project work. Team members are:

   (a) Cross-functional: includes members with development skills (write code or papers/grants), testing skills (e.g. test software, proofread papers/grants), and/or domain expertise (e.g. knowledge or interest in a relevant research area)

   (b) Self-organizing and self-managing without externally assigned roles

   (c) Negotiates commitments with the Project Owner, one "sprint" at a time

   (d) Has autonomy regarding how to reach commitments

   (e) Intensely collaborative

   (f) (Ideally) located in one team room (usually this will be the lab)

   (g) (Ideally) committed to long-term, full-time lab membership

   (h) (Ideally) members of a single team/project

   (i) Has a leadership role

3. **Project Coordinator.** The Project Coordinator facilitates the agile science process by:

   (a) Helping to resolve impediments

   (b) Creating an environment conducive to team self-organization

   (c) Capturing empirical data to adjust forecasts

   (d) Shielding the team from external interference and distraction to keep it "in the zone"

   (e) Enforcing timelines

   (f) Having no management authority over the team (anyone with authority over the team is by definition not its Project Coordinator)

   (g) Having a leadership role

   (h) Usually the Lab Coordinator will also be the Project Coordinator

NOTE: we do not currently have a dedicated Lab Coordinator, so Jeremy is playing that role. Therefore the Project Coordinator role is less "pure" than in a traditional agile approach. The intended role description is outlined here, but in practice the Project Coordinator role may have management authority until we have a dedicated Lab Coordinator.

4. **Collaborator.** Collaborators are not formally part of the project team, and generally will not attend regular meetings as part of the team. Collaborators do not have a leadership role in the project. They may carry out one or more of the following roles:

   (a) Provide data or share equipment

   (b) Provide occasional consulting services

   (c) Provide occasional feedback on project results

(d) Carry out minor analyses

(e) Proofread documents

(f) Help with administrative tasks such as scheduling

(g) Help with information technology tasks such as computer maintenance

(h) A project may never be held up by a collaborator. If the collaborator fails to provide a promised service, the project team must adapt. If the collaborator fails to meet a non-critical deadline, the project will proceed without that component of the project. Involvement as a collaborator is fluid.

By definition, collaborators play a minor role in the project, and they are not responsible for managing any aspect of the project. They may become Team Members if their involvement increases. Generally collaborators will be included in a paper's acknowledgement section, but collaborators are not normally co-authors.

*Project meetings*

Effective lab communication requires forums for communicating. As described below, we use Slack to facilitate non-in-person communications, but Slack cannot replace in-person meetings. In fact, our approach is set up to encourage in-person interactions as often as possible– ideally at least once per day. We'll have the following regularly scheduled meetings:

1. **Lab meeting.** We will have, as a lab, a regular weekly 2 hour meeting where we discuss current progress, impediments to progress, and plans for the upcoming week. We will also use the meeting time to prioritize the research backlog and plan sprints for that week. (In Scrum terminology, lab meeting will combine the notions of the Backlog Refinement Meeting and the Sprint Planning Meeting.) Attendees: everyone in the lab.

2. **Daily team meeting.** You and your fellow project members will meet at least once daily, for 15 minutes. You'll schedule this meeting as a group based on what's most convenient. The idea is to discuss:

   (a) What each team member did since yesterday

   (b) What each team member plans to do today

   (c) Any impediments to progress

   Because of the content of this meeting, it's ideal to schedule the meetings for early in the day. This meeting is based on the notion

of a Daily Scrum Meeting. Attendees: all team members (except the Project Owner and Project Coordinator).

3. **Weekly team meeting.** Each team will meet for 1 hour each week to do live demonstrations of working products for the Project Owner and any external collaborators. This could be in the form of a software demonstration, a couple of slides demonstrating a figure, a poster (e.g. for a conference), or a draft of a document or section of a document. The meeting is based on the notion of a Sprint Review Meeting. Attendees: all team members (Project Coordinator attendance is optional).

4. **Tutorial meetings.** Once every other week, we will meet for 1 hour to discuss a method or technique of general interest and relevance to the lab. Usually this will entail a student-lead discussion of a journal article, software package, or technique. The presentations may be slide-based (e.g. PowerPoint, Keynote, Beamer) or whiteboard-based. Presentations should be informal and heavily discussion oriented. Attendees: optional, but all lab members and collaborators are encouraged to attend.

## *Getting started in the lab*

TASK: Create Slack, Trello, and BitBucket accounts.

The very first thing you need to do is to create three accounts that will enable you to interact with the rest of the lab, download and use the lab's software packages, and accomplish various necessary administrative tasks:

1. **Slack.** This is where almost all not-in-person lab communications take place. It provides an interface for asking questions, storing notes, and sharing ideas. If you have an @dartmouth.edu email address, you can create an account without an invitation. Otherwise you'll need to get invited by the Lab Coordinator.

2. **Trello.** This is used to manage all projects and tasks. It provides a way of tracking progress and impediments to progress. You'll need to sign up for a free account and then have the Lab Coordinator invite you to the lab's Trello Team.

3. **BitBucket.** This is used to manage all code, papers, grants, presentations, and posters. In other words, anything where it'd be useful to track multiple versions, anything that we might ultimately want to release to the public, and/or anything that multiple lab members will be collaborating on. Each project has one or more BitBucket repositories.

Once you've created those accounts (and once you've been invited to the lab-specific team on Trello), you can start working through the Lab Setup Trello Board. You can ask any questions through Slack (use the #general channel or the channel specific your project).

### *Starting a new project*

Our lab uses a number of project management tools and policies to promote continuity across projects and lab members. First, make sure that your project doesn't already exist. If you're sure your project doesn't already exist, follow the steps here to initiate a new project.

### *Joining a project*

To join a project, simply subscribe to the project's Slack channel and update the Project Staffing & Collaborators board on Trello. All project communications should occur through Slack, whenever possible. This keeps notes searchable and visible to all team members (except direct messages, which are useful for private communications between one or more team members).

### *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. There are three basic tools the lab uses to organize and schedule events:

- Google Calendar. We use the main lab calendar to keep track of lab-wide events including lab meetings, conferences, important talks. We use the DHMC events calendar to keep track of important events and meetings at the DHMC. We use the out-of-lab calendar to keep track of known absences (e.g. illness, travel, holidays, etc.). We use the meetings calendar to keep track of scheduled meetings (regularly scheduled meetings with Jeremy or senior lab members, project meetings, etc.). When you add an event, it is important to include the following information as a comment (this does not apply to "out-of-lab" events):

TASK: ask the Lab Coordinator to send you an invite to the out-of-lab calendar so that you can add your planned absences.

  - Key contact names and contact information (email or phone)
  - Physical address (where the event will take place)
  - A brief description of the event and/or other relevant information
  - Attach any relevant documents via Google Docs
- Doodle and When2Meet. We use Doodle and When2Meet to converge on mutually good meeting times that fit (as well as possible) with everyone's busy schedules. Doodle is most useful for selecting a date from a large number of options, and When2Meet is most useful for selecting a specific time on a relatively small number of dates.

*Attendance policy*

We abide by a "common sense" attendance policy that relies on an honor system. If you cannot attend a lab event or meeting, your privacy will be respected: you do not (generally speaking) need to provide a reason for your absence (although you are honor bound not to abuse this system!)– but you are expected to responsibly manage your schedule so that you get your work done and minimize inconvenience to others to the extent possible. The one exception is that if you seem to be abusing this system (as determined by your project owner or project coordinator), you may be asked to provide additional information (in a way that does not invade your privacy– and if you are worried that this policy is overly intrusive, please bring your concerns to Jeremy or the Lab Coordinator). Here's the official lab attendance policy:

- It is your responsibility to notify anyone your absence will affect (e.g. people you're scheduled to meet with, etc.). The best way to do this is via email or Slack. We also use an "out-of-lab" calendar to keep track of things like vacations or longer planned absences.
- If you are feeling sick, *do not come into the lab*. We can arrange virtual meetings (if you are feeling well enough) or re-schedule as needed. The health and safety of the lab is the top priority.
- If you need to be out of the lab for an unexpected non-illness-related emergency, simply give as much notice and information as possible.
- You are expected to attend all lab meetings and other regularly scheduled meetings that are directly relevant to your work in the lab.

- If you are scheduled to present at a conference (i.e. you submit an abstract and the abstract is accepted as a talk or poster), you are expected to attend the conference to present your work.
- You are strongly encouraged (but never required) to attend relevant journal clubs, PBS talks, DHMC meetings and talks, thesis defenses, and other relevant lab and/or Dartmouth-affiliated events. If you are overwhelmed with other work, have a conflicting meeting, are running an experimental participant, or are out of the lab for other reasons, you do not need to provide a reason for your absence (unless you're presenting or are otherwise playing a key role).

### *Lab resources*

As with most academic research labs, we (sadly!) must conduct our research within a limited research budget. In practice, the important thing is to communicate with Jeremy and/or the Lab Coordinator before you spend (or commit to spending) lab funds.

Generally, the lab's financial policy is the following: we will do whatever is possible to ensure you have the equipment and resources you *need* to do your best work. If you can adequately justify an expense and sufficient funds are available, then we will spend what it takes to get the job done. If you cannot justify an expense, or if the lab does not have sufficient funds, then we will need to get creative by figuring out how to get the job done anyway on a seemingly too-small budget. Usually we'll find ourselves somewhere in the middle of this continuum, which will help us to stretch our limited budget as far as possible while not making ourselves crazy or losing too much productivity in the process.

Some of our projects are intended to be self-funded and/or to support other projects (e.g. StockProphet). Any use of project-generated funds should be discussed with Jeremy and/or the Lab Coordinator.

#### *Computers*

All lab members need a computer to get their work done. We generally prefer to use Macs, as this maximizes compatibility across lab members. Depending on your expected role in the lab and the specifics of your project, the lab may provide a computer to you, or you may be expected to use your personal computer to complete your work. Any equipment purchased by the lab, including personal computers, is the official property of the Contextual Dynamics Lab and should be treated as such. All equipment must be returned to the lab when your association with the lab is complete.

In addition to personal computers, we also maintain a lab account on Dartmouth's Discovery Supercomputing Cluster. We use Discovery for our most computationally intensive work. The Lab Setup Trello Board contains instructions for creating an account and accessing the Discovery cluster. Our suggested workflow is to do non-intensive computations and analyses on your personal desktop or laptop computer, and to offload more intensive analyses to Discovery. The lab's code repository includes sample MATLAB scripts for submitting analyses to Discovery.

### *Other research equipment*

Many research projects require specialized research equipment (e.g. for neuroimaging using fMRI, EEG, ECoG, etc.). Some of the necessary research equipment is owned by the Contextual Dynamics Lab, and other equipment is shared with other labs or with PBS. All equipment should be treated with care and respect. Any malfunctions should be reported immediately.

### *Travel policy*

A major component of doing scientific research is communicating with other scientists. The Contextual Dynamics Lab regularly presents at several international scientific conferences. If you are presenting your work (i.e., you are the presenting author for a talk or poster), then your travel expenses and conference registration fees will be guaranteed by the lab, under the assumption that you will also make reasonable efforts to seek out alternative sources of travel funding (e.g. through PBS, other internal Dartmouth sources, apply for travel awards, use personal grants like NRSAs or NSF fellowships, etc.). You are also expected to keep costs low (e.g. fly economy class, seek out cheaper tickets, stay in reasonably priced hotels, share a room with other lab members, etc.). By the same token, we also want to be cognizant of your comfort and time, and it is not always necessary to use the cheapest option. More specific travel guidelines will be given on a per-conference or per-trip basis.

If you are not presenting your work, but you are a full-time graduate student, postdoctoral researcher, or lab coordinator, then the lab will cover your travel expenses to a limited number of conferences each year. These should be discussed with Jeremy.

If you are an undergraduate research not presenting your work, the lab will generally not pay for you to attend conferences. However, if you are interested in attending a conference, and you aren't able to secure funding through non-lab sources, you should discuss your options with Jeremy.

### *Poster printing*

There are two on-campus poster printers. One is maintained through the Thayer School of Engineering. More information may be found here. This is the preferred printing method, as it is free to use. The second on-campus option is to use the Map Room through the Baker Library. More information may be found here. This is a relatively low-cost option, and is sometimes more convenient than using Thayer's printer.

### *Publication costs*

All costs related to lab publications will be fully covered by the lab. The Lab Coordinator can help facilitate these payments.

### *Subject payments*

Subject payments for lab research projects will be fully covered by the lab. Subject payment guidelines are generally found in the IRB approval documentation relevant to your project. For Mechanical Turk experiments, a subject payments budget should be approved prior to beginning the experiment.

## *Internal Review Board (IRB) approvals*

### *List of active protocols*

The lab does not currently have any active protocols. When protocols are approved, they will be added here.

### *List of inactive protocols*

The lab does not have any inactive protocols.