A Lightweight Approach to Academic Research Group Management Using Online Tools: Spend More Time on Research and Less on Management

Eric Eaton
University of Pennsylvania
Department of Computer and Information Science
eeaton@seas.upenn.edu

Abstract

After years of taking a trial-and-error approach to managing a moderate-size academic research group, I settled on using a set of online tools and protocols that seem effective, require relatively little effort to use and maintain, and are inexpensive. This paper discusses this approach to communication, project management, document and code management, and logistics. It is my hope that other researchers, especially new faculty and research scientists, might find this set of tools and protocols useful when determining how to manage their own research group. This paper is targeted toward research groups based in mathematics and engineering, although faculty in other disciplines may find inspiration in some of these ideas.

Introduction

Although doctoral and postdoctoral programs are effective preparation for how to *do* research, they do not necessarily include training on how to *manage* research across multiple projects and staff. When I first started as a new faculty member and was faced with managing a small research group, I adopted approaches similar to those used by my former advisors. As my research group grew and I acquired more funded and unfunded projects, I took a trial-and-error approach to improving the management process. Some ideas were quickly discarded, while others consumed extensive time only to provide little or no additional benefit. The tools and protocols that lasted were those that were effective and lightweight, requiring little of my own effort to set up and maintain. I suspect that my experience is not unique, and that many new faculty members can recount similar experiences as they learned how to manage their research group and the multitude of current and future projects within it.

This paper describes the set of online tools and management protocols that I use to manage my research group. This group is of moderate size in the computer science department at a large research university, consisting of 10–15 members depending on the semester (e.g., 1–2 postdocs, 4–5 PhD students, 4–5 Master's students, and a few undergraduates). This approach would fit smaller research groups, and could be scaled to manage much larger projects—I use a variant of it to manage a project-driven robotics course that could be viewed as a large (e.g., 25-person) semester-long group project (Eaton 2017).

The selection of tools and protocols were driven by the following goals:

- **Ease of use:** All research management tools should be easy to use and maintain, requiring little effort both on the part of the research advisor (who has little free time) and research assistants (who will fight against using these tools if they consume much time or are cumbersome).
- **Awareness of the status of all ongoing research:** At any time, there are multiple projects and papers that are being developed in parallel within the group. More senior members of the group, especially the principal investigator, should have a complete picture of current efforts and their status. Junior members should also be aware of the various ongoing projects, allowing them to seek out assistance and forge collaborations across projects.
- **Ensure the quality and longevity of all research:** Individual research papers will be easier to develop, edit, and build upon if everyone in the group follows similar conventions and uses similar development tools. Additionally, great effort goes into writing research code, and other members of the group and (eventually) the scientific community should benefit from these efforts.
- **Promote communication within the group:** Unless we are careful, it is quite easy to duplicate effort or waste time attempting problems that other group members know how to solve. Frequent communication can help alleviate this, leading everyone to be more productive and efficient.
- **Ease the transition of new group members:** Academic research groups have frequent turnover, and so new members should be able to quickly adopt the tools and procedures to contribute effectively with minimal guidance.
- **Coordination of shared resources:** Research groups often maintain computational servers and other resources that must be shared effectively across projects.

In addition to these criteria, all tools described in this paper are either free or have relatively low cost, making this combination especially affordable to academic groups. Finally, this set of tools allows for redundant backups of all critical data, although in some cases the backup might require a manual process to export the data.

Overview of the Research Management Approach

In order to minimize setup and maintenance while ensuring easy access, I chose to focus on using online services for project management. I previously explored the use of other local installations and tools, as described in the later section *Techniques that Did Not Work*, but found that these online services provided equivalent benefit with far less maintenance. These tools interoperate nicely, and are used in combination with set protocols to provide a lightweight yet complete solution to academic research management.

This approach includes the following aspects and corresponding online services:

- **Communication:** Slack (paid plan)
- **Project Management:** Trello (free)
- **Resource Coordination:** Trello (free)
- **Code and Document Version Control:** GitHub (free with an educational discount)
- **Publication Writing:** Overleaf v2 (free), with each paper linked to a GitHub repository
- **Scheduling:** Shared Google calendars (free).

In addition, all members of the research group are provided with the following shared working documents that outline protocols to be used in the research group:

- ***Research Group Policies and Procedures*:** This document includes "getting started" instructions for new members, describes the use of pre-meeting agendas and post-meeting summaries, and outlines procedures and conventions for using the above tools during the research process.
- ***Best Practices for Writing Papers & Presentations*:** This document outlines a set of conventions for writing publications in LaTeX, including mathematical formatting, the use of macros for typesetting variables, BibTeX usages, etc. It also includes templates for presentations, and procedures for archiving final versions.
- ***Git Organization*:** This document outlines procedures for structuring git repositories for long-term organization.

Critically, my research group members have been quick to adopt this approach, with unexpectedly little push-back from either new or more senior members. The remainder of this paper describes each of these tools and protocols in turn, and my rationale behind their use.

Communication via Slack

Instead of email, my research group communicates entirely through Slack[1]. Besides other benefits, this separates out research-related communication from most email, making it much easier to manage and ensure prompt responses.

Slack supports organization-wide, group, and private channels. We configure it so that each project or research topic has its own channel that reaches everyone working on that project, and members of the research group can subscribe to any channels related to their work. Slack has website-based, desktop, and mobile apps, and can be configured to send email or display a pop-up notification upon receiving a message, allowing each person to set their own notification preferences. I do require each person in my research group to configure their preferences so that they receive prompt notification of all messages during work hours.

Slack is the one paid service that we use, in order to ensure that an unlimited number of messages are searchable. Currently, this corresponds to the "standard plan" tier of service, but there is a free tier that limits the number of searchable messages. Slack currently provides an educational discount through their "Slack for Education" program, which reduces the cost to a nominal amount each year for my entire research group. Slack allows channel message histories to be exported, facilitating backups or transitions to other services.

Project and Resource Management via Trello

Trello[2] is an online project management tool that represents each project as a *board* that contains a set of *cards* organized into *lists*. Each card corresponds to a specific item or objective, and can have an associated due date, checklist of steps, and set of people assigned to it. Trello also integrates with Slack, including linking Slack conversations to specific cards, and permits members of the Slack team to join the associated Trello team.

Since Trello boards are highly general, my group uses several boards for different purposes:

- **Overview:** Our *Overview* board presents a high-level view of all projects and papers in the group. The board is organized into lists that correspond to broad research topics (e.g., multi-task learning, service robots, etc.), and each card under those lists corresponds to a specific project, sub-project, or publication related to that topic. These cards are color-coded with their status: yellow for early-stage efforts, orange for efforts approaching publication, green for ready or submitted papers, red for rejected papers under revision, and blue for ideas. Submitted and revised papers are also tagged with their intended venue and any relevant dates. In addition, this board contains a list of group members who are scheduled to present their work at our weekly group meetings.
- **Project-Specific Board:** Each project has its own Trello board, organized with detailed to-do items. There are various ways to organize this board (e.g., the Scrum agile development method (Schwaber 2004)), and the chosen organizational method may depend upon how each project is run and how many researchers are working on it.
- **Resources:** We use the *Resources* board to record who is currently using each computational server and major shared resource, allowing easy online coordination.
- **Contact Information:** The *Contacts* board contains contact information for everyone in the group and their desk or office location. Using a Trello board makes it especially easy to add or remove people from the group.

[1] https://slack.com

[2] https://trello.com/

Note that none of these boards are available out-of-the-box with Trello, but are ones we have made using Trello.

All researchers in my group are responsible for keeping their project-specific board and the general Overview board updated at all times. Although it is a slight bit of redundant effort to update both boards for each project, updates to the Overview board are relatively infrequent (since it contains only high-level information) while the project-specific boards are updated continually every few days.

In addition, everyone in the group is encouraged to post high-level project ideas to the Overview board, placing them at the end of the appropriate topic list and coloring the cards blue. Besides encouraging active research idea generation across projects, this process provides a list of potential project ideas and collaborations for when new students are looking to work on a research project with my group.

One benefit and potential downside to Trello is that everyone in the research group has access to all projects, allowing easy collaboration yet limiting the ability to restrict access. This is not an issue in most academic research groups, but may be a problem for using this technique to manage industrial research groups. We use the free tier of Trello, which we have found to be adequate. Trello does have the ability to export each board for backup, but it is a manual process.

Version Control of Code and Documents via GitHub

Each project has an associated private git repository to store all relevant code and documents for that project, using Git Large File Storage (LFS) for large binary files like presentation slides and images. These git repositories can also be linked directly to the associated Trello cards for the project. When it comes time to publicly release the code for a project or publication, using GitHub[3] makes it easy to move code from a private to a public repository.

These repositories are all stored under a single GitHub Organization for the research group, which includes unlimited private repositories for free after an educational discount. Under this organization, I have multiple different user groups corresponding to different levels of research assistants (e.g., postdocs, PhD students), making it easy to grant multiple students full access to projects. GitHub also supports user-level access controls, including support for external collaborators to access the repositories.

In order to keep the repositories organized in the long term, we use a shared set of guidelines across all projects that are described in a brief *Git Organization* document. Git repositories are also used for shared BibTeX bibliography files, and to store final versions of all publications and presentations.

Collaborative Writing via Overleaf

We write all publications and documents in Overleaf[4], an online LaTeX editor that provides for simultaneous online writing with a history of edits. Each Overleaf project can also be associated with a corresponding GitHub repository, facilitating version control and redundant backups.

Currently, Overleaf unlocks features as you invite new users, so faculty members can quickly unlock unlimited collaborators and other benefits for their account by inviting everyone in their research group. These benefits are only available for projects created from the faculty member's account, but it is a simple process to clone a project created by a research assistant and have everyone switch to using the faculty-owned Overleaf project instead.

To ensure some consistency in how publications and presentations are written, we maintain a working document on *Best Practices for Writing Papers & Presentations* that is used by all members of the research group. These practices for LaTeX documents include, for example, techniques for proper math formatting, using `\newcommand` to create macros for frequent variables (making them easily to globally edit later in the paper), code snippets for formatting figures, and organization conventions for Overleaf projects.

We also use a common slide template for all presentations and create those presentations in Microsoft PowerPoint. This makes it easy to combine slides from different projects together, and satisfy requests from various Government funding agencies for PowerPoint slides. Any equations used in the slides are rendered to PDF images, with the LaTeX source for the equations placed in the corresponding slide comments to facilitate future editing.

Research Group Policies

In addition to using these online tools for communication and research management, I have instituted a few policies in an effort to help my research group function effectively.

All group members are expected to be on campus and available during a set of core working hours each weekday (currently 10:00 a.m. – 4:00 p.m.); undergraduates and part-time research assistants are excused from the core hours. Class times are also an exception for everyone, but people are asked not to schedule optional activities (e.g., homework meetings) during the core hours. These core hours are soft and gently enforced, but ensure that everyone in the group is working around the same time. This helps facilitate ad hoc discussions and collaborations, and makes it much easier to schedule meetings.

When working off-campus, group members are expected to mark their off-campus work on a shared Google calendar and still be available for ad hoc videoconferences during that time. This shared calendar also marks when group members are taking time off from work.

Like most research group leaders, I meet individually with every member every 1–2 weeks. Prior to each research meeting, each member is expected to send me a brief private message on Slack that includes 1) recent goals they had planned to accomplish from the previous meeting, 2) a list of their actual accomplishments, 3) an agenda for the meeting, and 4) their intended next steps. This helps keep the meeting on track, and serves as a log for that meeting. After the meeting, I ask the researcher to send me a brief message with their new goals for the next meeting, which can then serve as the #1 item above for the next time we meet.

[3] https://github.com/

[4] https://www.overleaf.com/

The working document *Research Group Policies and Procedures* describes these policies, along with how the tools mentioned above are used during the research process. Having all of this information in written form helps all group members to use these tools, and helps new group members quickly adopt these practices. This document also includes a "Getting Started" section for new group members with a checklist of online services to sign up for, how to link their accounts to the research group, getting on payroll, etc.

Other Considerations

This section briefly discusses two aspects that are outside the scope of these tools and protocols.

Financial Management

One aspect that is not covered by this approach to research project management is the financial aspect. Since universities already maintain their own financial accounting system, I prefer to take a high-level approach to managing project staffing and supply purchases, and then double check these items with the university's financial systems. For each funded project, I maintain a local spreadsheet with the monthly support for each staffing category (e.g., 12 months of a PhD student, 11 months of a Postdoc, etc.) and the proposed supply purchases, and then have an allocation spreadsheet that matches those items to individual group members and purchases. This spreadsheet allows me to forecast project staffing and purchasing. I then periodically check this against the university financial system to make sure that the project is on budget.

Shared Reference Management

Another aspect of research management that I have not yet mentioned is managing references, especially across a group. While software such as Mendeley[5] supports private shared paper repositories and integrates well with Overleaf, having multiple private repositories for different projects is currently rather costly. For this reason, my research group currently shares URLs of references via Slack, with each person downloading the papers into their own local reference management system. However, we do maintain a shared BibTeX bibliography file in a git repository to facilitate references in publications.

Techniques that Did Not Work

Before settling on this set of tools and management protocols, I tried a number of different setups. This section briefly describes some of these, and why they did not work.

For communication, I started with a combination of email and various email distribution lists, but found that this mechanism mixed research-based discussions with the myriad of other emails, and so threads would easily be lost. Distribution lists were difficult to maintain as the group membership changed, often requiring action from me. In contrast, Slack supports email (if that is your preferred means of notification), separates out research discussions, and allows group members to easily join or leave different channels.

For project management and coordination, we first tried an internal wiki, easily editable internal websites, and shared spreadsheets on Google Drive[6] or Dropbox[7], all of which were cumbersome to maintain. I also tried standalone project management software, such as OmniPlan[8], but found most project management software was much too complex for my group's needs and lacked easy collaborative management. Trello replaces all of these with a lightweight online tool, where the burden of updating a project's status could be distributed among its members.

As our version control system, we started with a locally hosted subversion (svn) installation, and later moved to git with gitolite extensions[9] for easy administration and access control. Git was an improvement over svn, since each checkout yields a git repository that is a backup of the original, but the effort required to maintain a local installation was costly. In addition, some collaborators found the gitolite installation difficult to use, since it required creating and maintaining public ssh keys for authentication. Moving to GitHub provided equivalent performance, easier access, easier maintenance, and was free after the educational discount.

We previous wrote all publications using local LaTeX installations, with the source files maintained in the svn or git version control system. Overleaf is more accessible, since it does not require a local LaTeX installation or public ssh key authentication, and provides the same version control benefits, since it can be linked to a git repository.

Final Remarks

I have found this combination of online tools and management policies to require relatively little effort for both me and my research assistants. It does require a bit of initial setup, and requires new group members to sign up for a bunch of individual accounts with different services. However, once those steps are completed, using this combination of tools seems effective with little effort. In retrospect, the choice of tools seems rather obvious, but hopefully knowing this combination of tools worked for another academic research group will help new faculty and research scientists when they choose how to set up their own research group.

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References

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[5] https://www.mendeley.com

[6] https://www.google.com/drive/

[7] https://www.dropbox.com

[8] https://www.omnigroup.com/omniplan

[9] http://gitolite.com/