Chapter 3: Funding

Let's talk about what, for many professors, is the least favorite part of the job: making sure you have enough money to keep the lights on in the lab. Essentially, a professor applies for grants (money from the government, industry, or other charitable foundations) by writing a proposal as the Principal Investigator (PI). The funding agency reviews the proposal. If they decide to fund it, they send the money to your university. The university then takes its cut of the funding (essentially to pay for common services like buildings, admins, etc) and gives you the rest. You then spend it on your summer salary, the salaries of your students, equipment, travel, registration costs and other expenses associated with your research.

There are some nuances about the different types of funding, and how you can spend different kinds of funding. So let us get into the details. Unfortunately, these details tend to vary a lot by country, so everything I'm talking about in this chapter applies only to the US.

3.1 An example budget

Let me walk you through an example budget. Let us say you are writing a proposal for $100,000 USD (100K USD). The budget will talk about how you plan to spend this money. The following table (Table 1) shows the example budget.

Budget	
Graduate Research Assistant - 1	
Total Salary	40,000
Fringe Benefits	12,000
Total Salary and Fringe Benefits	**52,000**
Total Materials & Supplies	0
International travel to a conference	2500
Domestic travel to a conference	1481
Total Travel Costs	**3,981**
Tuition for Fall or Spring	4,746
Tuition for Summer	1,778
GRA Tuition for 1 year	**11,270**
Total Direct Costs	67,251
Modified Total Direct Cost (MTDC)	55,981
Indirect Costs 58.5% of MTDC	32,749
Total Cost (Direct + indirect costs)	**100,000**

I will explain the various parts of this example budget. I will be talking about terms such as direct costs and indirect costs as defined by the University of Texas – I believe it is similar at most other US universities, but there might be differences. Please check with your university to make sure.

Fringe. Let us say you want to support a student on this grant. In addition to paying for the student's salary, you also have to pay for *non-wage expenses*: things like health insurance, social security, and medicare. This is usually expressed as a percentage of the student's salary. At the University of Texas at Austin, this was 30% in 2022 (For a comparison point, it was 32% at Princeton). The stipend of a graduate research assistant (GRA) at UT is about $30K USD for the fall and spring semesters ($40K USD including summer). So salary and fringe for a GRA for a year is $52K.

You also have to pay the tuition of the GRA, and at UT, this is about $11.2K USD for a year. To keep things simple, I am using a single number for the tuition, but this depends on factors such as whether you are in-state or out-of-state, your progress in the PhD program (if you are all-but-dissertation, your tuition is lower), and whether you are a US citizen or not. It also depends on the fraction of time spent as GRA/TA: if this drops below 20 hours a week (considered full-time for students), tuition might have to be charged at the out-of-state rate. If the student is only doing 5 hours a week as GRA, it might also impact how much of their tuition can be covered by the grant; at 5 hours a week, the student might not be eligible for insurance. I highly recommend talking to your admin if you are accounting for less than 20 hours a week for your student on the project. Some schools also calculate tuition as a % of the stipend.

So the total cost for supporting a GRA for one year is $63.2K USD. While you are paying $63.2K for each student for a year, the student's take-home pay is only the stipend part (minus taxes that are withheld): $35.2K assuming a 12% tax rate.

Note that fringe also applies to you (the PI) when you pay yourself out of your grants for your summer months.

Direct costs. The direct cost part of your budget includes salaries, fringe benefits, travel, and equipment and supplies that contribute directly towards performing the proposed research. Direct costs are exclusive to each proposal: a piece of equipment can only be a direct cost on one proposal, and a GRA can be assigned only to one proposal at a given time. In our example, let us assume the only direct costs are supporting the student and paying for the student's travel (including registration, transportation, lodging, and food) for one international and one domestic conference.

Modified Total Direct Costs (MTDC). MTDC is a portion of the total direct costs used for calculating the indirect costs. It is the direct costs minus tuition, fellowships, equipment, and capital expenditures. Travel also counts as MTDC. In this budget, we are not spending anything

on materials and supplies in this budget, but if we did, it would be part of MTDC. Check with your university to determine exactly what is counted as MTDC – this can be surprisingly tricky. For example, you might expect computers to not count towards MTDC as it is "equipment", but it may be counted as a "supply" if the university is unable to amortize its cost. In the example above, total direct costs is $67.2K USD (63.2K for one GRA plus 4K for travel), but MTDC is only $56K (leaving out the $11.2K for tuition).

Indirect costs. The university takes a portion of all the money you receive, to pay for centralized functions such as building costs, utilities, admin, and libraries. This is termed as the "indirect" cost, usually expressed as a percentage of the MTDC. At most universities in the US, indirect costs are more than 50% of the MTDC. At UT, it is 58.5% (Mike Freedman reports it is 63% at Princeton). Thus, in our budget, we would have .585 * 56K = $32.7K added as indirect costs. As a result, it would cost 67.2 + 32.7 = $100K USD for supporting a single GRA and some travel on this grant. Note that even though the 58.5% number is scary, you are only paying 33% of your budget for indirect costs; in other words, you don't lose 58.5% of the *total* budget to indirect costs.

As you can see from the preceding table, the $100K USD budget only covers one student for one year. At some universities, a GRA costs more, requiring more funding.

This should give you a picture of how expensive it is to maintain large groups! If you had ten students, you would need to pull in a million dollars each year to fund your students.

It is useful to think of your budget in terms of student-years. $400K is simply two students for two years. A dissertation, roughly five student years, is $500K. If you get the NSF CAREER grant, you would typically be able to support one dissertation. This helps determine the scope of your proposal: if you need five students to work on it for two years, a grant that provides $250K will not be a good match.

Summer months in your budget. PIs at most R1 universities in the US are expected to fund themselves via grants in the summer. When you are drawing up your budget, you are expected to estimate how much of your summer months you will dedicate to this project. This is taken as an indication of PI commitment at the funding agency – you don't want to write a budget where your estimated time involvement is zero. So if you have one NSF grant where you estimate your time commitment to be one month, you can only put in one more month for another NSF grant proposal (since NSF limits total PI compensation to be two months per year across all NSF grants).

3.2 Types of grants

Broadly speaking, there are four different kinds of grants or funding, each with different restrictions on how you can use the money. The differences come down to **what you can spend the money on, how long you can keep the money,** and **what the overhead is.**

We can term the four kinds of funding as *grants, contracts, university funding, and gift funding.* Let me go over each type of funding.

Grants. The National Science Foundation (NSF), the Defense Advanced Research Projects Agency (DARPA), the Army, the Navy, and the Air Force all fund research related to computer science. These grants are competitive – NSF has a 25% acceptance rate (though this varies by the directorate), and I imagine the other programs are similar.

This money can typically only be used for funding students, yourself, travel, and equipment purchases that you had already put in the budget. For example, if you suddenly want to purchase equipment not in the original budget, it needs to be approved by the Office of Sponsored Research at your university (which makes sure you are spending the money in the right way). You cannot use government funding to pay for things like a meal with your students during the semester (meals during travel is allowed).

Government funding has strict timelines by which the money has to be spent. Typically, the money is released on a yearly basis. You have to show that you have used the previous installment to get the next round of funding. This sometimes results in professors making last minute purchases to exhaust their grant!

In some cases, you can ask your funding program manager for a *no-cost* extension to your grant. This typically means that you don't need extra money, but you want extra time to use the money. This is usually considered on a case-by-case basis, and I would not recommend counting on getting a no-cost extension.

Indirect costs are levied on government funding (more generally, on all funding that goes through the Office of Sponsored Research). The example budget I showed in the previous section assumes funding is via sponsored research.

Grant proposals typically have reporting requirements (for example, you have to submit a report once a year for an NSF grant). However, grants typically do not expect any concrete deliverables to be provided at the end of the funding period. Essentially, the grant allows you to carry out the proposed research: the act of publishing itself is the desired outcome. As a result, grants have a strong alignment between the PIs and the funding agency: they both just want to get research done.

Contracts. The second kind of funding is via contracts. Contract funding comes with an explicit contract you must fulfill to keep and obtain more funding. For example, there may be quarterly or monthly reports, or on-site visits by the sponsor. Contract funding typically also has deliverables that are expected at regular intervals during the funding period. One example of contract funding is DARPA funding, which comes with a number of deliverables and reporting requirements. Contract funding is less aligned with the PIs than grant funding: apart from doing the core research, the PI's students will have to spend time on creating the deliverables, and the PI herself has to spend a significant amount of time on reports and meetings.

NSF vs DARPA. NSF is a good example of grant funding, while DARPA is a good example of contract funding. Both these agencies fund a lot of computer science research. DARPA requires deliverables and reports to be produced regularly during the grant duration. NSF only requires a report to be submitted for each year of the grant duration. You can apply for NSF funds as someone on a visa, while DARPA and other similar government funding programs might require you to be a US citizen or a permanent resident.

University funding. Your university, or your college, or your department may choose to give you funding. Typically when you start, you get a "startup" package that allows you to kickstart your research group. University funding is "internal" funding in a way, and as such has fewer restrictions than government funding. But this really depends on the specific university. I know universities where startup funding cannot be used for covering summer salary of PIs. Apart from startup funding, your university might have internal competitions to award "seed" funding (typically under 50K) that you can then use to get preliminary results and later apply for traditional grants.

University funding is also associated with timelines. For example, startup funding usually has to be spent before you get tenure. However, university funding deadlines might be a little more flexible than grant or contract funding deadlines.

University funding typically does not have associated indirect costs (as it is already university money). You still have to pay fringe support for your students and your own summer salary.

An interesting sub-category of university funding are **Research Centers.** A research center is funded by sponsors to carry out a certain mission over a span of around 5 years. The research center has a program director who is responsible for allocating the funding. PIs at the university apply for funding from the research center (a sort of internal grant), and are allocated funding. Obtaining funding in this manner is easier than competing for an external grant. Particularly for assistant professors who are just starting, research centers can provide seed funding before the first grants are obtained. Check out the ADA center at Michigan for a good example.

Gift funding or unrestricted research funding. Companies or charitable foundations may choose to fund your research in the form of "gifts" or unrestricted research grants. This is the best kind of funding, for three reasons: indirect costs are typically not levied on these gifts, there is no associated timeline by when you should spend them, and you can use them for a broader range of things than university and grant/contract funding.

Indirect costs are not levied because the gift-giver can specify that it cannot be used for indirect costs (the university has to honor this). Since it is an unrestricted gift, there are no limits on what you can spend them on, or by when you should spend them. This doesn't mean you can spend the money on personal expenses. All expenses still have to be approved by the university, and should be used for research-related expenses. But things like taking your research group out for a meal can be expensed during gift funding (but not government funding).

Indirect costs not being levied can make a huge difference. For example, in our budget from earlier, if you were using gift funding to fund the student, you don't have to pay indirect costs, and thus get over $30K back. Considering a student costs $63K, you get to sponsor the student for 1.5 years rather than 1 year!

How should you use your funding? Let us say that you are lucky enough to have all four kinds of funding. And you have an expense that could be assigned to any of these funding (note that this is often not the case: you can't use a grant on topic X to support a student working on Y if X and Y are not closely related). What should you use?

The typical rule is "*Use the most restricted funding that will expire the earliest*". Thus, you should always use the appropriate grant/contract funding first, then your university funding, and finally gift funding. Gift funding is the most flexible, so use it only when you have no other option.

Always spend your gift funding on expenses that will have overhead (if funded from grants), such as students. Do not spend it on things like equipment (be careful to ask what counts as equipment at your university) which do not have overhead even when expensed to grants.

Writing a grant with other PIs. While you could write smaller grants as the sole PI, typically for larger grants, you need to collaborate with other PIs and submit as a team. For example, you cannot submit NSF Large grants as a solo PI. One thing to remember though: all the funding is shared between the PIs. For example, imagine a grant for one million USD. It sounds amazing! However, if the grant was awarded to a team of two PIs, and the grant duration is five years, each PI can only support one student on it for the grant duration (100K * 2 * 5). Similarly, if a grant of 10 million USD was won by a team of five PIs, each PI can only support one student for four years (100K * 5 * 4). So in the end, the share of each PI is similar or lower than that of an NSF CAREER.

This is not to say you should not collaborate with other PIs to write grants. Collaboration often brings new ideas and research directions that are unlikely or impossible when working alone. And bigger grants often provide prestige: for example, landing an NSF Large grant is significant and puts you on the map. But it is useful to calculate how much you expect to receive if a grant proposal is funded.

3.3 The grant application process

So how does one go about submitting a grant? There are several steps in the process:

1. The funding agency first puts out a call for proposals. For example, check out the NSF call for CRII grants, a startup grant meant for new PIs who have not yet received a grant. Note that PIs at many R1 universities are not eligible for CRII. This was posted on May 18, 2022. Each call has a solicitation page with details about the program and how the proposal should be structured – you should read this carefully.

2. In some cases, there are webinars where the program managers explain the grant opportunity. CRII had such a webinar on Jul 13 2022. I highly recommend attending these webinars if it is your first time submitting for a particular grant opportunity.

3. In some cases, the funding agency might want you to submit a preliminary proposal. They will review the preliminary proposals and inform you if they would like you to go ahead with the full proposal. This is not the case for CRII.

4. There will be a due date by which you need to submit the proposal. For the CRII, this is Sep 19 2022. The proposal will have a number of parts, and the solicitation will clearly lay out what the proposal should look like.

5. You write the proposal, and sometime before you submit, you send it to the Office of Sponsored Research (OSP or OSR) at your university. They have to approve the proposal before you can submit, and they may request to see your proposal a week or 10 days before you submit. Please make sure you get a draft to the OSP on time!

6. Finally, you submit the proposal, and you wait. To be exact, your admin/OSP submits for you, so you want to let them know when you are done. You and your admin/OSP will be submitting a lot of proposals together; make sure you get to know the folks doing this. I only have experience with NSF proposals, but these usually take 6-8 months to be reviewed. In some cases, it might take even longer.

7. If you are lucky enough to get your proposal funded, you might get an email or a call from the NSF program manager. They might ask you to slightly modify your budget. For example, I was asked to reduce my NSF CAREER budget (and appropriately reduce the scope of my tasks as well). You will be asked to provide an abstract that will be displayed on the NSF website. For example, check out the abstract for my CAREER award.

8. Finally, you will get an official email that your grant has been awarded, it will become public on the NSF website, and you will get the first installment delivered to your university. You can then begin spending it in accordance with what you proposed.

9. In the unlucky case that your proposal is not funded, you will get back three or more reviews from NSF. These reviews tend to be short, and nowhere as detailed as paper reviews. As such, it can be hard to figure out what to do after getting a rejection. My advice is to go talk to senior faculty in your department if this happens, and they should be able to guide you in the right direction.

3.3 Writing your first grant proposal

Writing your first grant can be a stressful experience, since it is quite different from writing a research paper. There are a number of differences.

First, the audience for a grant proposal is broader than that of a research paper; it is guaranteed that non-experts in your area will be reading and evaluating your proposal (for example, if I write

a grant proposal about storage research, I can expect it to be read by someone working in systems broadly, but not necessarily someone doing storage research). As a result, it has to be much broader and more accessible than a research paper. Proposal reviewers might also have a smaller amount of time to spend on each proposal – some funding agencies ask reviewers to read a dozen proposals in around a month when you serve on their panel. You can imagine how much time each proposal would get. Thus, your proposal must be easy to skim and read, must get to the major points quickly, and must be accessible to a broad audience.

Second, in a research paper, you are reporting on something that is already done. The focus is on the technical details: how you were able to achieve the result, what are the drawbacks, etc. However, in a grant proposal, you are talking about things that *you will do in the future*. In a grant proposal, the most important thing is to be able to **inspire** the reviewer, and convince them that this is a thing worth doing (and funding). In this respect, it is much more similar to a founder pitching before an investor, than a professor talking to her peers about her research. While the details do matter to some extent, what is much more important is that you paint a big picture of how your proposed research will make the world a better place. This is quite different from writing a research paper, and takes some practice.

For writing your first grant proposal, I'd recommend two things. First, talk to folks who have gotten the grant you are submitting for, and ask if you could see their grant proposal. Many folks are happy to share privately. Some folks, like Jeff Bigham and Gillian Hayes, are publicly sharing some of their proposals. Second, write up your draft proposal, and show it to senior folks in your department. They would be able to catch errors that could cause rejection.

When submitting grant proposals, do not be disheartened if it gets rejected. As far as I can tell, most proposals, even from experienced faculty, get rejected a few times before getting accepted. Grant rejections are a bit more painful because the waiting time is high, you might only get to submit to a grant opportunity once per year. But with time and repeated submissions, many grant proposals do get funded.

3.4 Serving on grant panels

Once you become a PI, you will get invited to serve on grant review committees. You can directly email program managers and say you are interested in reviewing, and they will see if they can recruit you for the next reviewing cycle. I highly recommend doing this if you can: it is really eye-opening to see how the sausage gets made! Serving on a grant review committee is educational: you will immediately pick up what you need to do to make your proposals better.

If you do volunteer for grant proposal reviewing, expect this to take up a lot of time. You will be asked to review a dozen proposals (or more) in a month or so. It will be similar to a program committee meeting, where all the proposals will be discussed. You will be expected to share your view of the paper, and argue for why it should be funded or not.

3.5 Getting funding from industry

Since I started at UT, I have been fortunate to receive funding from a number of companies: Meta, Google, VMware, and Toyota. How did I get this funding? Unlike with government agencies, there is no set process to follow in general (exception being Google with the Google Research award).

Giving talks and networking. The process is more organic: I give talks at various companies about my research, and talk to their engineers about how my group's research can impact them. This is useful to gain an understanding of how our work will play out in the real world, and to understand the problems they are facing.

Sometimes after talks like these, the company reaches out to see if they can sponsor our research. At other times, the company is looking for academic groups to invest in, and my talk puts our group on their radar. Note that you might sometimes receive funding even without doing this – good work is always noticed and rewarded (especially if close to the company's interests).

In rare cases, if you know the folks at the company really well, you can also reach out and say I am trying to achieve research goal X, is your company looking to fund anybody in this space. But you only do this after building up strong ties with the company over a long period of time. You can't start out by saying "can you give me some money".

Networking and building connections always pay out over the long term. So you shouldn't have the mindset of "I gave a talk at company X, I should get some funding from them soon". Rather, you should aim to get your group's research out there and known by companies in that space. The funding will follow later, but time spent networking and giving talks is never wasted.

3.6 Financial planning for your research group

Finally, I want to talk a little bit about financial planning for your group. As a professor, you are now a manager, and you should ensure that the students working with you are adequately funded. If you are unable to fund your graduate students, your department might be able to fund them as TAs, though the dept would need some advance notice. For postdocs, this option is not there, so you need to make sure you have funding for your postdocs.

Runway. In general, it is good practice to think six months to 1 year ahead, and make sure you have enough funding for existing students/postdocs and folks you are planning to hire. Initially, you will have your startup funding, so you start with a full tank of gas. For every student/postdoc you hire, you should check how much runway your group has: how long until your group runs out of funding. You should ensure you have a runway of 6 months to 1 year.

This means that if you have 1 year of runway, you need to write grant proposals now (since it usually takes about a year to be reviewed and funded). At the start of every semester, review your finances with your admin and make sure you have enough of a runway.

Savings. An important part of financial planning is to always have a little bit extra in your coffers than your anticipated expenses. For example, imagine that you got a paper accepted, and there is no associated grant you can expense it to. If you don't have some money left over, you would not be able to sponsor your student attending the conference and presenting the paper.

Summers. Part of this financial planning is also deciding what to do in your summers. I strongly advocate ensuring that you can both pay yourself for the summer, and pay your students. This might require being conservative in taking on students until you are sure you can pay them. There is the temptation to cut back on your own summer salary so that you can pay your students; I would recommend avoiding this. While it can be a temporary fix, it is necessary for your long-term health, and that of your group, if you maintain your own summer payment.

If you are able to work at a company for the summer, this can reduce the strain on your group's finances while also helping your research become more grounded. I spent one summer at VMware after joining UT Austin, and that time spent was useful for my research. You would probably need to reach out much earlier to set this up – the group hosting you would need to make sure they have the budget to host you for the summer.

Coordinating with admins. You want to make sure you and your admin are on the same page regarding what funding to use for each expense (sometimes it can be hard to move expenses between accounts). Most admins are experienced and get the picture quickly once you describe your overall strategy.

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