WRITING GRANT PROPOSALS: RAISING GENRE AWARENESS

Grant proposals are challenging to graduate students, who often have little or no experience with this genre. The first step to a winning proposal is thus to learn some key points about the genre.

Purpose: proposals should *pitch* a research project that is innovative, important and feasible. (What this means will depend on your field and program.) Remember: "don't *report—propose*!"

Perspective: proposals are about what *you plan to do*, so they tend to use more

- first person, esp. singular (I, me, my), because this is about *your own project* (even if it's part of a collaboration)
- future tense, because granting agencies want to fund *research that isn't yet done*

Audience: proposals are usually read by specialists *and* generalists—and your challenge is to satisfy specialists without alienating generalists. How can you do this?

- Give the Big Picture
- State rationales for your topic, focus and approach
- Avoid needless detail (and jargon, and acronyms), and explain technical terms you must use

Narrative: Proposals tell a story, which should be foregrounded throughout the proposal. There is no "right" way to tell your research story, but the most common narrative is like a martini glass: wide (or general) at the top and bottom, narrower in the middle. A proposal in which the components below are missing, insufficiently signaled to the reader, or arranged in counterintuitive ways or sequences is more likely not to be reader-friendly.

- **Survey the Territory: What is known** in your area of research?
- ***Identify the Research Opportuntiy*:** What **specific problem or discovery** *needs* attention?
- **Take the Opportunity:** How and why will **you** address the above? What are **your goals, hypotheses and/or main question(s)?**

WHAT & WHY

- **HOW:** How will you fulfill your objectives? How will you divide the overall task into parts? What is your Research Plan? How will you find your evidence, and why in that particular way?
- **SO WHAT:** What is the **significance** of your proposed research? What are possible implications for theory and/or practice?

The introductory section of the proposal (What & Why) can take multiple forms, but introductions should include certain predictable features. See overleaf for more on introductions. The middle section (How) is more variable, but see the last page for a simple principle that can help you make the most of this section.

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Creating a Research Space (CaRS) to "Motivate" Your Proposed Project

Adapted from http://libguides.usc.edu/writingguide/CARS. Developed by John Swales, the CaRS model describes how introductions (to an article, grant proposal, dissertation, dissertation chapter, section within a chapter, conference abstract, etc) function, how they create a research space which your research, whether proposed or completed, can now fill. See next pages for more on CaRS and its uses.

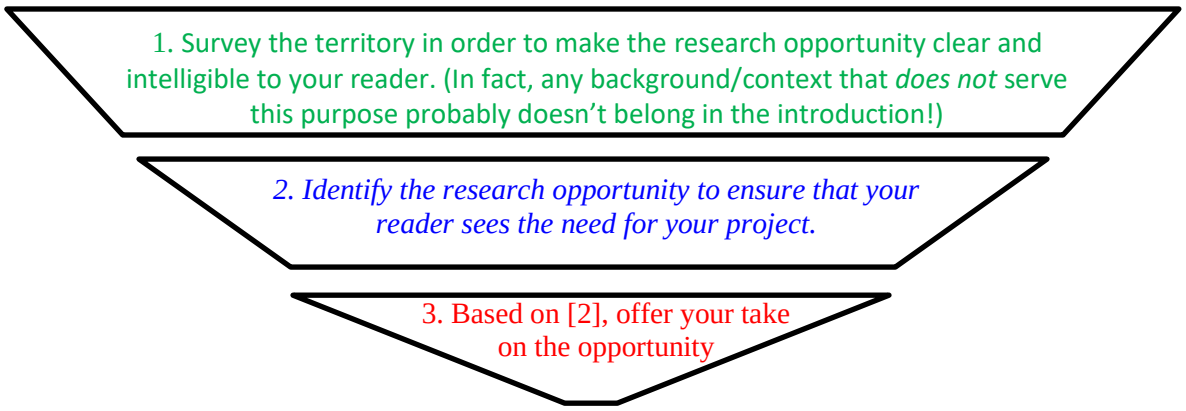
The CaRS model involves three rhetorical "moves:"

1. **Survey the Territory** (i.e. "Fuel" your contribution or intervention in the field by providing bigger-picture context, situating it within a larger area of enquiry or debate)

2. ***Identify a Research Opportunity*** (i.e. "Power Up" your contribution or intervention by identifying a gap, debate, disagreement, new discovery, etc);

3. **Take the Opportunity** (i.e. "Launch" your contribution or intervention, based *directly* on the Opportunity identified in *[2]*)

The three moves are typically made in this order, though variations are not rare (see page 5). The typical order has a certain logic, for it progressively narrows the discussion from Big Picture to the specific topic of the document at hand.



Note that this narrowing structure corresponds to the "cup" in our martini-glass model (see p 2).

These three moves be present *somewhere* in the proposal's introduction, if not necessarily in the order above. The three moves should also be clearly identifiable by the reader. Proposal writers should therefore consider giving their readers unambiguous signals of where Move # 1 becomes *Move # 2*, and where *Move # 2* becomes Move # 3.

The shift from Move #1 to *Move # 2* is often signaled with a word or phrase equivalent to "however," "but," "yet," "what remains unknown is …" and so on. The shift from *Move #2* to Move #3 is often marked by the introduction to the first person or equivalent ("In this essay, I argue that…" or "This article proposes….") and/or some causal linker like "for this reason" or "therefore."

The pages that follow show CaRS in action in abstracts (I use this genre because abstracts are short).

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Illustration of the CaRS model #1: The Canonical Structure

The example below, an abstract for the 2019 Joint Statistics Meeting, exemplifies the Martini-glass structure and the CaRS model. It's a conference abstract, not a grant proposal, but structurally and rhetorically the two genres are similar (and the abstract has the advantage of brevity). The field in this case is statistics, but the field is beside the point: CaRS is trans-disciplinary and trans-generic. CaRS is extremely flexible, equally amenable to empirical, theoretical and/or applied scientific research proposals.

Here and in the pages that follow, the three rhetorical "moves" from CaRS are identified typographically as such:

Move # 1 (survey the territory): Standard type (sans serif)

Move # 2 (identify an opportunity): Italic type

Move # 3 (take the opportunity): standard type (serif)

After the Introductory part of the abstract, the writing reverts to black type.

The order above is conventional, but it is neither required nor necessarily preferable. Proposals beginning with Move # 3, then taking a step back to Moves # 1 and 2 are not rare, for example. More important than the exact way it's done here is the presence of the three moves and the clear signaling that tells readers when one move shifts to another (marked in **bold**).

Black-Box Inference: Efficient, Scalable, Model-Free Tests for Variable Importance

In the supervised learning context, black-box learning methods are often viewed as sacrificing interpretability for predictive accuracy. The complex forms of the model estimates preclude many traditional approaches to statistical inference. ***While*** *heuristic approaches have been developed for tasks like measuring variable importance, these are ad hoc, lack statistical justification, and can produce quite misleading results.* **In this work, we begin** to bridge this gap by developing provably valid hypothesis tests for comparing models trained on different inputs. This allows for testing a model trained on the original covariates against one trained on a randomized subset in order to formally test importance. While closed-form distributional results are newly available for particular models like random forests, practical implementation is limited by exceptionally difficult parameter estimation problems. We thus demonstrate how a permutation test approach circumvents these challenges, producing valid inference with high power with orders of magnitude less computational overhead.

—Timothy Coleman and Lucas Mentch, JSM 2019 (Denver)

Note, by the way, how well this abstract as a whole corresponds to the martini-glass model from page 1. The text in black (everything after the introduction) can be divided into the HOW (first black sentence) and the SO WHAT (second black sentence).

Illustration of the CARS model #2: A Variation

The examples below, from the International Global Atmospheric Chemistry (2018) and Evolution Society conferences (2017) respectively, demonstrate two of many possible variations on the structure of introductions. They both show how CaRS still applies with good introductions that deviate from the "canonical" pattern. Not as "neat" as the canonical structure on the previous page, this arrangement of the three "moves" still strikes me as logical and effective—in this case anyway. But unusually arrangement can serve to flag less effective introduction.

Data assimilation of the cross-border transport of aerosols/PM2.5 using Himawari 8 data and NICAM-Chem model

We are making a forecasting system of air quality for human health from the distributions of aerosols including PM2.5, oxidants (tropospheric ozone), NOx, SOx and so on. A report by WHO estimated that the air pollution due to those species caused the health damage such as lung trouble and cerebrovascular disease corresponding to kill ~3.7 million people in the world during the year of 2012. In the case of Japan, about a half of the observed PM2.5 and tropospheric ozone originate outside of the country, and, especially in the western Japan, the cross-border transport of PM2.5 from the continent is significant. ***Therefore,*** *in the prediction of air pollution there, consideration of the global-scale transports of aerosols and oxidants is indispensable.* Himawari 8 observes the column distributions of aerosols covering the East Asia with very high resolutions for both time (10 minutes) and space (~5 km), and provide the open observational data sets within a day. We have derived the abundance of PM2.5 near the surface from the data sets assuming the bimodal size distribution of aerosols based on the algorithm by Higurashi and Nakajima (1999) and the vertical profile observed by CALIPSO, and assimilated the density data into the NICAM-Chem general circulation model (Goto et al. 2015). The method of assimilation is based on the optimal interpolation to be adaptable for the fast predictions with small computational resources. In the presentation we show the preliminary results of the assimilated PM2.5 distributions on Japan, and discuss the connection with the km-scale regional simulations to predict the urban air quality.

Takeshi Kuroda *et al.*

Conflict increases cooperation between microbial species

How does *community context shape the selection for inter-specific cooperation****?*** **We investigate** this question with a novel mutualism between *Escherichia coli* and a mutant *Salmonella enterica*. In lactose media *E. coli* excretes carbon byproducts required by *S. enterica*, and the *S. enterica* mutant excretes a costly amino acid that the E. coli can no longer produce. We competed mutualistic S. enterica against the non-cooperative wildtype in the presence of *E. coli* and found that the mutualist settled to 45% of the *Salmonella* population. The mutualism was then made more complex by changing the environment such that a third species, *Methylobacterium extorquens*, was required to provide nitrogen. Increasing community complexity dropped the frequency of cooperators maintained in the *S. enterica* population to 10%. Interestingly, if *M. extorquens* is switched from a mutualist to a competitor with *S. enterica* (i.e. nitrogen is made freely available), the ratio of cooperators increases to 60%, the highest observed frequency. Genome-scale metabolic modeling qualitatively recapitulates our results and suggests that a competitor increases inter-specific cooperation by reducing the benefit of cheaters. This work indicates that to understand the prevalence of mutualists it will be important to consider not only with whom each species is interacting, but also how they are interacting.

William Harcombe

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Illustration of the CaRS model: How CaRS can guide revision

Here's another conference abstract:

Structure and bonding properties of some silver and alloy nanoclusters by X-ray spectroscopy

X-ray spectroscopy is a good tool for study the structure and bonding properties of nanoclusters. Nanoclusters with an exact number of atoms have intriguing properties and can be applied in many fields. **In this presentation**, the study of some nanoclusters in terms of their structural and bonding properties by X-ray spectroscopy techniques such as X-ray absorption spectroscopy and X-ray photoelectron spectroscopy will be presented. Systems of interest include some doped and undoped atomically precise silver nanoclusters. It will be demonstrated that the structural and property changes between doping and non-doping clusters can be sensitively captured by X-ray spectroscopy techniques. The information obtained from the X-ray techniques will also be useful to more thoroughly understand the stability and structural control of those nanoclusters.

Ziyi Chen & Peng Zhang, Canadian Chemistry Conference and Exhibition 2019

This abstract exhibits the most common problem with proposal introductions: the *research opportunity* is either implied or missing. Here, it's missing. This is no big issue for conference abstracts, but it *is* for proposals: the rationale for the proposed project lies in that *research opportunity*. One benefit of using CaRS is it can help you identify such gaps in the progression of your proposal. Having identified the missed step, you have a good idea of how to improve the draft (in the case above, by adding one or more sentences identifying the *research opportunity*).

Consider the "lay abstract" below, for example. Note, first, how this mini-abstract models the martini-glass principle from page 1. Now focus on the introduction:

Growing evidence suggests that microplastics (plastic <5mm) have negative effects on aquatic species. ***However**, the impacts of microfibers from synthetic textiles are less well understood.* **Here, we examine** the growth, survival and reproduction of a benthic invertebrate exposed to polyester microfibers. Individuals fed high microfiber doses (500 /L) exhibited significantly slower growth and lower egg production compared to the control. Growth and reproductive effects in exposed individuals indicate individual- and population-level effects of microfibers.

Lisa Erdle, University of Toronto

At first glance I though this was a perfect use of CaRS, but once colour-coded a missing step became visible, even though here all three "moves" are present. In my view, the author moves too fast from "green" to "blue." How do we get from "microplastics" to "microfibers"? (The connection may seem obvious to you, but it may not be to readers.) More problematically, the research opportunity is incomplete: although it identifies a gap, it does not really offer any hint about why the gap is one worth filling. I let these insights guide my revision, so that we get this:

Growing evidence suggests that microplastics (plastic <5mm) have negative effects on aquatic species. ***However**, microplastics come in various kinds, and it is unclear whether they all affect ecosystems similarly. One type of microplastic, microfibers from synthetic textiles, are ubiquitous **and yet** their effects remain largely unknown.* **Here, we examine** the growth, survival and reproduction of a benthic invertebrate exposed to polyester microfibers….

Middles: Foregrounding Your Proposed Research Project

A common weakness in the middle part of grant proposals (the Research Plan) is a tendency to focus on the current state of the field, what is known, important recent findings and other factual information. This is a problem because the proposal is, by definition, about **your** project.

Here's a general principle for avoiding this problem: once you've introduced your project, try starting and perhaps ending paragraphs with an explicit reference to your project. I call this the M.Y.R.S. model, by analogy with the C.a.R.S. model. Once you've **C**reated **a R**esearch **S**pace in your introduction, you now want to **M**aintain **Y**our **R**esearch **S**pace—to keep your focus firmly on your proposed research, rather than background information.

Compare the two paragraphs below, the first from an early draft, the second from a final (winning) version of a doctoral NSERC CGS-D (shared with author's permission). The paragraphs don't have quite the same content, but they are both at the same place (paragraph two, just after the introduction). What matters here is how differently the two paragraphs distribute different kinds of statements. Sentences in sans-serif green type are those that do not explicitly refer to the proposed project; sentences in red serif type indicate those that do. Note the distribution of red and green in the two passages. The first foregrounds general information because it begins and ends with it:

> One key task in QI is quantum teleportation, in which an unknown quantum state is deconstructed in one place and later reassembled in another [3]. Since quantum states cannot be copied or read-out without the loss of coherence, a teleportation protocol is going to have to act as an interface between quantum processors, thereby enabling a crucial part of distributed quantum computing and overcoming the scaling issue of quantum processors [4]. Which is why **I am currently working to further develop** self-pumped integrated sources of squeezed light [5]. These self-pump devices are a patented technology from our group that produce dynamically reconfigurable squeezing at room temperature. This unique approach removes the need off-chip alignment, making them stable and scalable, meaning that whole labs can be put on-chip, and allow a level of state control and effect that does not have an bulk optic equivalent. Now, we are seeing promising results from our integrated distributed feedback lasers as they have a much narrower linewidth then Fabry-Perrot lasers. With the addition of amplifiers to increase flux and on-going optimization of the operating conditions, unprecedented quantum state tomography results for integrated sources are expected. A source kind could bring integrated photonics to the forefront of quantum information.

The second passage more appropriately maintains the focus on the proposed research, beginning and ending with explicit references to the project. Background in green is "insulated" between red sentences:

> Therefore, **my project aims to** build a source of photons pairs with dynamically reconfigurable properties on a chip while operating at room temperature. One vital feature of this source it that it will be able to generate a two-mode squeezed vacuum (TMSV) state which exemplifies the highly entangled Einstein-Podolsky-Rosen state, and is the main resource for what is known as continuous variable (CV) quantum teleportation, as we are teleporting continuous properties of the electric field. This **will allow me to** perform the first demonstration of a CV teleportation protocol with all components on a single chip, all the while operating at room temperature, and miniaturizing a protocol which would regularly occupy an entire optics lab.

Beyond the obviously different distribution of green and red, the second passage sends more obvious "proposal-signals" to the reader. Note the strategically-placed uses of the first person singular (I, my) and future-oriented statements (aims to, will allow me to).

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