**Cognitive and Information Sciences Ph.D.**

**University of California, Merced**

**Annual PLO Assessment Report**

**August 5, 2014**

**Abstract**

For this round of assessment we focused on PLO 5, "Expertise in a specific scientific domain." Direct evidence includes a semantic analysis of papers from 4 students who recently completed their integrative-review papers (IR papers), and represent advanced PhD status that reveal qualities expressed in PLO 5. Indirect evidence includes an e-survey delivered to these 4 students. Three responded anonymously and provided feedback about the integrative-review papers described in PLO 5. Some helpful feedback was provided regarding making the requirements more flexible, allowing increased topical diversity in the focus areas of the IR papers.

**I. Introduction**

Cognitive Science is an interdisciplinary field that combines theories and methods from computer science, linguistics, philosophy, psychology, and neurobiology. The aim of cognitive science is to understand how cognitive processes and intelligent behaviors emerge in both individuals and groups of biological organisms, as well as artificial systems. A variety of methods are used by cognitive scientists, including neurobiological and behavioral experiments, computational and robotic modeling, and linguistic, philosophical, and statistical analyses. We, the CIS program, have five Program Learning Outcomes (PLOs):

1. Understanding foundational concepts in cognitive and information sciences.
2. Skillful use of foundational methods in cognitive and information sciences.
3. Scientific communication skills.
4. Ability to integrate knowledge across the disciplines that compose cognitive and information sciences.
5. **Expertise in a specific scientific domain.**

***PLO******5****: Expertise in a specific scientific domain. Expertise in the student's chosen specific field of study is initially assessed, at an introductory level, through the Integrative Review Papers. More advanced expertise is assessed in the Thesis Proposal and performance on the Candidacy Examination. Mastery is necessary for successful completion of the Dissertation and Thesis Defense.*

This is our third year of conducting program assessment, and we chose to focus on PLO 5 because we have a growing number of students reaching status of experts in some scientific domain. In particular, we chose 4 advanced PhD students to serve as loose "case studies" for this assessment. Their progress represents completion of milestones in the PhD program, including the completion of the IR papers, which are mentioned as crucial for PLO 5. These circumstances make PLO 5 a timely program characteristic to evaluate, and we **specifically targeted the IR papers** as a cornerstone of this specialization process. These 4 students were chosen because they had *just* completed their IR papers, and memories are likely more fresh about this process. The IR papers are intended to be qualifying exams for our program, and represent intensive literature review and writing that advance students to a point of specialization. The students we chose had just moved beyond this juncture point.

Like last year's assessment, we sought both a source of direct and indirect evidence. Similar to last year, we conducted a quantitative analysis of the content of very recently published works by these 4 students. If these students are achieving expert status in a particular domain, then we would expect our quantitative analysis to show that they are pursuing relatively unique work that is starting to relate to subdomains of the cognitive sciences. In addition, we solicited their opinion on the IR paper process.

**II. Assessment and Results**

**Direct Evidence**

It is easy to peruse student products and ascertain, intuitively, that they are pursuing *unique* projects that help them develop an individual identity as an expert *in a particular domain*. We sought direct quantitative evidence of this fact, with the general hypothesis that if we compared the products of students to each other, then they should show a diversity that is also reflected in the broader field – the students are developing uniqueness and expertise in our program by the time they reach their final years.

For the past few years, UC Merced has been in the top 5 schools represented at the *Annual Meeting of the Cognitive Science Conference*, our premiere meeting. In 2013, all 4 of the chosen PhD students (Szary, St. Clair, Kerster, Winter) presented full papers. We took the abstracts of their works along with the abstracts of the other 1,000 submissions to the conference (from hundreds of institutions). By using an R script located here:

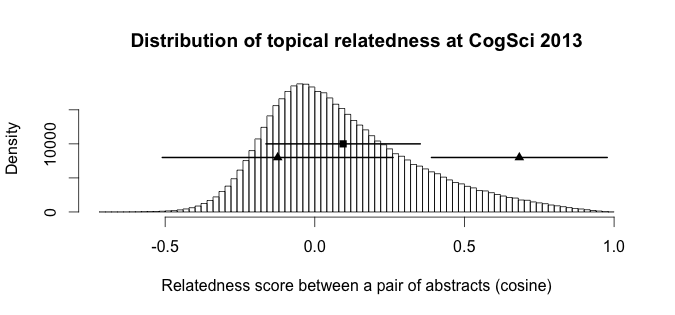
https://github.com/racdale/plo-5-evaluation-with-lsa-model

We developed a latent semantic analysis (LSA) model. This model projects each abstract of the conference into a vector space that lets us compare them; we can ascertain "topical relatedness" between each pair of abstracts at the conference. For example, here are two very closely/distantly related abstracts at the '13 conference:

|  |  |
| --- | --- |
| Examples of two very unrelated abstracts (**relatedness = -.40**) | |
| "Languages around the world share a number of commonalities known as language universals. We investigate whether the existence of some recurrent patterns can be explained by the learner’s preference to balance the amount of information provided by the cues to sentence meaning. In an artificial language learning paradigm, we expose learners to two languages with optional case-marking – one with fixed and one with flexible word order. We find that learners of the flexible word order language, where word order is uninformative of sentence meaning, ..." | "This paper studies how visual perception of a scene is affected by cognitive processes beyond the scene's bottom-up saliency. The game of SET is taken as an example where contrast-based salient parts of a scene are ignored in favor of a larger group of similar elements. Using results from a laboratory experiment and a model simulation we explain how three cognitive mechanisms, differential acuity, visual iconic memory and declarative retrieval, considered together help to explain player's visual perception in SET ..." |
| Examples of two very related abstracts (**relatedness = .92**) | |
| "Languages around the world share a number of commonalities known as language universals. We investigate whether the existence of some recurrent patterns can be explained by the learner’s preference to balance the amount of information provided by the cues to sentence meaning. In an artificial language learning paradigm, we expose learners to two languages with optional case-marking – one with fixed and one with flexible word order. We find that learners of the flexible word order language, where word order is uninformative of sentence meaning, ..." | "Languages exhibit statistical regularities concerning the frequencies and co-occurrences of words. Language users learn from such patterns without being consciously aware of them. We investigated statistical properties of the language used on television news in discussing politicians. We compiled corpora consisting of language used on four networks (MSNBC, ABCNews, CNN, FOXNews) from 2007-2012. We analyzed the frequencies with which 500 affectively-valenced words co-occurred with politicians' names (Obama, McCain, Romney) during the run-ups …" |

We performed pairwise comparisons of all abstracts, giving us thousands of relatedness scores. This allows us to plot a histogram of the characteristic relatedness seen across abstracts at this conference. We next compared *our own students' abstracts*, and took the average relatedness score. This is presented in the histogram below with the square dot, and the lines (representing standard deviation of the 4 choose 2 = 6 relatedness scores for our students' abstracts). Though this falls rightward on the distribution, in general we see that the topical relatedness is what we would expect at about chance; in fact, one would hope not for radical disparity in topics among our students, since they collaborate and speak with each other during their training. However, the results do suggest, with countless caveats of tentativeness, that the students are neither too different nor especially related.

In addition, we took the maximum and minimum relatedness scores for our students' papers *with others* at the conference. These are shown in triangles. The higher cosine relatedness score at the maximum end (rightmost triangle) suggests that students are indeed distinct from each other *but achieving relatedness to subdomains in cognitive science*. In other words, they are finding their niche in the field, and some more related submissions can be found from other institutions to which our students' work relates. We give an example for one student below.



**Figure**: x-axis represents relatedness scores *across all abstracts*. The **square dot (lines = standard deviation)** represents the average relatedness *of our students to each other*. This is much lower than the maximum relationship to some other abstract (**rightmost triangle**). In other words, each student has a much more closely related topic published by another group at the conference; they are finding domains of expertise, to put it loosely.

|  |  |
| --- | --- |
| Example of a very related abstract for student Winter (**relatedness = .91**) | |
| "Research on the mental representation of numbers has focused on a horizontally aligned mental number line, but more and more findings have begun to implicate a vertical orientation as well. We investigate the relationship between these two orientations when people generate random numbers. In the horizontal condition, people generated larger numbers when they looked right as opposed to left. In the vertical condition, people generated larger numbers when they looked up as opposed to down. ..." [**Winter et al., UCM**] | "How are we able to reason about abstract concepts that lie resolutely beyond the reach of perception? One strategy is to ground understanding in space. Numbers, for instance, are known to interact with egocentric space during rapid numerical judgments. A range of experimental results have demonstrated that, among literate Western people, this “mental number-line” goes from left to right, with smaller numbers associated with left space, and larger numbers with right space. But what is the nature of this “space”? …" [**Bergen et al., UCSD**] |

In summary, our students are neither too closely related to each other, nor too distant; they exhibit relatedness characteristic of the entire distribution of the field, with perhaps a slight tendency to be more related (which would be anticipated from experiencing the same program). In addition, they are considerably *more* related to other researchers and submissions at the conference, suggesting the advanced students are finding a "niche" of sorts. Note also that the rightmost triangle is not very high, and dispersion is wide (lines = SD), so the students' work is not *too* closely related to others in the field; this does not reflect derivativeness. **In short, these results, though they can only be preliminary and imperfect, do suggest that our intuitions hold up about student products. Advanced students are individuating and achieving focused expertise**.

**Indirect Evidence**

Indirect evidence includes an e-survey administered to students to explore how well the program supports learning around PLO 5. In particular, we posed questions regarding the IR papers and how these support growing expertise.

Three of the 4 students responded anonymously. In general, the most dominant reported source of growing expertise is research activity. Students did not see the IR papers as being *the most* influential in finding a niche. They regard their expertise as having increased since arrival, moving from Introductory/Intermediate in their respective specialization, to Expert/Advanced. So, based on these few responses from advanced PhD students, they feel the research focus of our program is what drives them most towards specialization.

We did ask a series of questions about the IR papers specifically (see Appendix). All three felt that the IR papers were useful to growing expertise, and noted that there isn't much to change. However, they did offer some helpful points. Some suggested they would like more extensive written feedback on their documents, including edits on paragraphs and so on. This seems unreasonable, as faculty are not copyeditors, despite many forces in the universe often causing them to be. Students also suggested flexibility in topic selection. The IR papers currently force students to write about 6 domains: Behavioral Science, Computational Modeling, Cognitive Engineering, Linguistic Analyses, Neuroscience, Philosophical Methods. Perhaps faculty could consider introducing flexible changes given students’ needs. For example, perhaps "Educational Methods" would be suitable, or "Cognitive Development", or "Evolutionary Biology." These could be open to consideration by a student’s committee (see further reflections below). A full summary of the survey is below.

**IV. Conclusions & Recommendations**

***Student Specialization***.These direct methods of assessment may be enhanced and applied to all students. We may validate the emergence of specialization by a student by seeing an increase in uniqueness in their relatedness scores relative to their peers, and an increase in relatedness to relevant subdomains of cognitive science. In general, the pointers in our direct evidence suggest specialization is taking place. It is useful to have some quantitative support for this.

***Specialization Flexibility***.Students suggest that some topical flexibility in the IR papers would help them focus on those areas of specialization when they might not fit perfectly into the 6 categories in our requirements. The Graduate Group faculty will discuss this and consider adding provisions for introducing some flexibility.

**V. Implications of Proposed Changes (Planning / Budget)**.

There are no direct planning or budget implications of these proposed changes. If we do change the requirements on IR papers, it will require a change in our program documents that will likely need approval of GC.

**VI. Self Evaluation**

(1) Assessable Program Learning Outcomes

***Highly Developed:***

Our PLO specifically describes how students will achieve specialization. This suggests many ways of assessing outcomes, including analysis of available data, and probing the students themselves. Future means of assessing this specialization could come from analysis of students across stages of "development," of publication outlets of the students, comparative methodologies, and assessment of progress itself by considering IR papers and their contents. In fact, the contents of the abstracts which we analyzed represent the topics of the students’ IR papers, so at least by proxy we have already done this; and by conducting this analysis relative to CogSci 2013 we can determine how their relatedness or difference is situated on a broader topical distribution. Future analysis may consider some further form of qualitative or quantitative assessment of IR-paper content.

(2) Valid Evidence

***Developed:***

We collected relevant and sufficient direct and indirect evidence for demonstrating the alignment of student performance around the PLO and our expectations for that performance. Assessment instruments (i.e., the criteria) lend themselves to considering the ways that students have to date met the standards of the PLO (see p. 2). Evidence is aligned with the PLO and assessment criteria to enable meaningful results and conclusions.

(3) Reliable Results

***Developed:***

The application of the criteria (our preliminary quantification of expertise, and the assessment through student responses) can be easily geared towards the goals of the PLO. We did not need to conduct inter-rater reliability in the application of our criteria due to the way in which this assessment was carried-out – it is based on raw quantification of topical relatedness among students who have reached a high level of expertise. More students would help improve reliability.

(4) Summarizing Results

***Highly Developed:***

The results clearly delineate each line of evidence. The direct and indirect lines were designed to directly and practically inform one another. The program-specific criteria for the direct evidence did not rely on indicating various levels of achievement as conference papers are either accepted or not by the conference reviewers.

(5) Conclusions and Recommendations

This is the first assessment of PLO 5, and results suggest we are doing relatively well, and that students appreciate the IR papers and its function for assisting in specialization. The suggestions provided will make for valuable discussion among faculty about flexibility in topic.

**VII. Appendices**

1. e-Survey results summary
2. e-Survey screenshots

**Student Expertise in Specialized Areas of Cognitive and Information Science**

**Summary of Survey Data**

**July 2014**

**Respondent Information**

3 out of 4 eligible students responded to the survey request. Of those respondents, one was a third year student, one was a fourth year student, and one was a fifth year student.

**Chosen field(s) of study within CIS:**

* Cognitive linguistics, numerical cognition, and language evolution
* Human search and law behaviors
* Interactive memory foraging, interpersonal alignment and synchrony, memory processes

**The factors that most influenced students’ choice of specialization:**

* 3 of 3 respondents said faculty research projects/Interaction with faculty
* 1 of 3 respondents said the Integrative review papers
* 1 of 3 respondents said Personal interests
* 1 of 3 respondents said Conferences

**Student Perception of their Level of Expertise:**

*Students were asked to rate their level of expertise on the following scale:* ***Expert/Advanced/Intermediate/Introductory****, where Introductory equated to the level of knowledge of a Bachelor's degree recipient and Expert equated to the level of knowledge of a Post-Doctoral Scholar/Assistant Professor.*

* 2 respondents rated their current level of expertise in their specializations as **Advanced**.
* 1 respondent rated their current level of expertise in their specializations as **Expert**.
* 2 respondents rated their level of expertise upon entering the program as **Introductory**.
* 1 respondent rated their level of expertise upon entering the program as **Intermediate**.

**Questions relating to the Integrative Review Paper**

**How did the IRP help narrow your research focus?**

1. Encourages very thorough literature review.
2. Helps to contextualize the research questions within the broader field.
3. Helps to identify open questions in the literature that can be answered as part of the dissertation.
4. Helps to identify the unifying theme or “cohesive vision” across many ideas.

**Suggestions for improving the IRP process:**

All three respondents noted that the process of writing the IRP was extremely useful and that there wasn’t much they would change. Being required to look at so many approaches was useful considering the breadth of certain specializations.

Suggestions for improvement were:

1. Receiving more extensive written feedback on the paper, including specific comments and edits on paragraphs and the ideas of the paper.
2. More flexibility in topic selection.
3. Requiring (or stressing more emphatically) that the topics of the papers have to be synthesized so that the paper can compare and contrast the contributions of the different approaches.

**How did the IRP affect your level of expertise in your area of specialization?**

1. Requires an extensive amount of reading and reference checking to be able to support claims, enabling you to feel more certain about what you know.
2. Became a source for publication submissions.
3. Improved knowledge of the literature, especially competing theories.
4. Allows you to explore your own ideas in a relatively unconstrained format, rather than working in the language and form constraints of publications and conference papers.

**Are there any other activities, resources, or products that could accompany the IRP to help with specialization at this stage?**

1 respondent suggested that examples or more thoroughly documented expectations of the final product would be helpful.

