Loyola Computer Science Research Handbook

Release

CS Department

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CONTENTS

This is the *alpha* version of the research handbook for Loyola University Chicago's department of computer science. This resource is intended for faculty, students, administrators, alumni, companies, and donors to find out more about the exciting research we do in the department.

CHAPTER

ONE

WHY RESEARCH IN CS AT LUC?

The reasons for performing research are as diverse as the projects, but there are often a number of advantages student describe beyond their typical undergraduate curriculum.

- **Develop** a project beyond what you started as a course project
- **Impact** in the the scientific and technical community in small, focused pursuits or through expansive reviews of existing approaches
- **More in-depth advising** through a closer, mutually beneficial relationship with faculty
- **Building practical skills** through more substantial, hands-on training
- **Demonstrate** your abilities to future employers or programs with a significant, completed project representing your skills and efforts
- **Engage in collaborative efforts** necessary to forward goals that can only be done with long-term sustained group efforts

Computer science is a unique field where a simple idea can become a start-up reality or a popular online open source project through focussed, sustained effort alone. Your time at Loyola is a valuable opportunity to pursue these projects through guidance by faculty and collaboration with other enthusiastic students. You have resources available at Loyola that you would not have without significant upfront investment later - take the opportunity while you can.

CHAPTER

TWO

LOYOLA CS RESEARCH OPPORTUNITIES

Projects are the bread and butter of the CS experience. Beyond the learning experience and credit you receive they are often uniquely fun and rewarding. And don't forget, we always celebrate projects at the end of each semester with quick presentations after the end-of-semester party.

2.1 COMP 398/490: Independent Study

See COMP 398/490: in the Course Handbook for details.

If you want to pursue a project outside the scope of a class, this is the most likely route to receiving credit toward graduation. It's also the simplest way to receive significant advising, as many projects are collaborations with faculty who also maintain related resources.

You sign up for a COMP 398 (undergrad) or 490 (grad) after discussion with the faculty member you will partner with - criteria for working on these differ slightly among faculty by design, but here's a helpful orientation, since independent study typically comes in two flavors. Some faculty will only take independent study students who are interested in contributing to long-term research efforts, generally aimed at producing results available to the wider academic community - often team efforts requiring more than a semester from start to finish so your efforts will often be a piece of a larger project. Another common option is developing an independent study for a personal project or independent learning experience, however note that often these efforts must be independent efforts with less faculty involvement, so establishing clear goals and criteria for completion are the student's responsibility.

To pursue an independent study project, first consider if you have the required experience to pursue a project of interest - often it is best to do independent study projects after foundational courses are out of the way. Second, if you have an idea of your project goals, contact the relevant faculty member. Once you have mutually agreeable goals, you will be enrolled through an email send to the department.

Note: There are also the occasional COMP 388/488 research courses (always with "Research" in the title) which serve a similar purpose to research-based independent study COMP 398/490 courses. Contact the instructor of these courses for how they may or may not differ from typical COMP 398/490's if you are interested.

2.2 COMP 388-X: Research Methods in CS (1 credit hour)

The spring research seminar supplements the CS department seminar (currently on alternate fridays at 12:30pm) by specifically aiming at students who will directly engage in research and to facilitate their contributions in their ongoing projects. This course is designed to emphasize the tools and techniques in research collaboration, analysis, and presentation to help project groups outside the course to focus on content. Progress is encouraged and tracked in projects outside the course through milestones such as abstracts, small fellowship-style proposals, informal updates, and outcome-oriented goal setting where appropriate.

2.3 COMP 390: Computer Science Seminar

See COMP 399: for details.

The CS seminar is an opportunity to engage with other students as well as the various speakers and events supported by the CS department, usually on Fridays at 12:30pm. Past seminars include internal faculty speakers and external speakers focusing on Big Data analytics, spatial statistics, and STEM outreach opportunities. Every semester the seminar supports a local competition, recently with a Loyola hackathon competition in the Fall and a Datafest analytics competition in the Spring. Requirements include reasonable attendance expectations and brief writeups about your experiences.

2.4 Engaged Learning Courses

These are courses specifically with a project-oriented or applied learning focus, satisfying the engaged learning requirement for undergrads at Loyola. Here are the typical engaged learning courses in CS.

The following courses (with their course handbook links) are all Engaged Learning courses that encourage capstone projects as an outcome:

- *COMP 398/490: Independent Study* Independent Study. This is standard for these courses.
- *COMP 312/412: Open Souce Practicum* Open Source Software - available Fall and Spring.
- *COMP 390: Brodeaning Participation in STEM* Broadening participation in STEM - available in the Fall.
- *COMP 391/499*: Internship - available year round
- UNIV 102-X: Intro to CS research for freshmen - FYRE program (Spring)

This course will introduce students to the project-focused environment that is part of a typical undergraduate student experience in computer science. In CS, interesting projects are performed as group projects in courses, independent study research experiences with faculty, or in collaboration with industry partners. By selectively coordinating with the biweekly Loyola CS seminar (COMP 399) and the concurrent research methods course (COMP 388), students will have a chance to both observe interesting work and learn some of the tools used in performing those projects.

2.5 LUROP (Undergraduate Research)

LUROP began as the umbrella under which several undergraduate research programs at Loyola were promoted, supported, and administered. There are currently thirteen different LUROP fellowship programs that offer undergraduates an opportunity to conduct research under a mentor, who may be a faculty member, a graduate student, or a community partner, depending on the program. These fellowships also offer excellent opportunities for faculty members and others to mentor young researchers, which is the heart of the LUROP experience. Many of these fellowships predate LUROP, and twelve are directly administered by their own centers, departments, or directors. Together, they are centrally coordinated by the Center for Experiential Learning in the Sullivan Center at the Lake Shore Campus, which also directly manages the Provost Fellowship. For more information, and directions for applying, see the page for the LUROP Fellowships.

We *encourage* our students to apply for the LUROP programs. We are routinely contacted to ensure that our students know about this program and apply. Our students often do well when competing for these awards, and this is a great way to get support for working with your CS department profesors.

CHAPTER

THREE

FACULTY RESEARCH INTERESTS

Please refer to the full-time faculty page for contact information or these faculty research bios (from Spring 2015) for further information, this list below is a much abbreviated summary of research and project interest.

Table 3.1: Faculty Research Interests and Links

Faculty Member	Keywords	Web Page	Developer Page(s)
Mark V. Albert	machine learning, healthcare analytics, wearables, computational neuroscience	mva.me	
Peter L. Dordal	computer networks, social implications of technology	pld.cs.luc.edu	
Stephen Doty	programming languages, computer algebra systems, automata theory, algorithms, cryptography	doty.math.luc.edu	
Ronald Greenberg	STEM outreach, algorithms, parallel computing	rig.cs.luc.edu/~rig	
Andrew N. Harrington	Interactive learning, algorithms, programming competitions and engagement	anh.cs.luc.edu	
Nicholas Hayward	digital humanities, open source development	Nicholas Hayward sketch	
Konstantin Läufer	programming languages, software architecture, distributed systems, mobile/pervasive computing	laufer.cs.luc.edu	GitHub
Channah Naiman	data mining, information technology	Channa Naiman sketch	
Catherine Putonti	bioinformatics, computational biology	putonti-lab.com	
Chandra Sekharan	network optimization, parallel algorithms, databases, performance engineering	csekha-ran.com	
George K. Thiru-vathukal	high performance computing, operating systems, distributed systems, storage and I/O, programming languages, scientific computing, digital humanities, music	thiru-vathukal.com	GitHub
Robert Yacobellis	software engineering, mobile computing, data-driven software development and design	Bob Yacobellis sketch	

CHAPTER

FOUR

REPRESENTATIVE PROJECTS

Every semester, we gather students after the end of semester party to present projects they have done in courses, as part of independent study courses, or jointly a research projects. To see an array of projects pursued by students, you are encouraged to read through these project descriptions below. Note, we include both early and late-stage students in these presentations.

- Spring 2017 projects
- Spring 2016 projects
- Fall 2015 projects
- Spring 2015 projects
- Fall 2014 projects
- Spring 2014 projects

For more information on courses focused on research, projects, and/or engaged learning, see the following:

1. Independent Study (COMP 398/490)
2. Research methods in Computer Science (1 credit hour, COMP 397 spring semester)
3. Computer Science Seminar (1 credit hour, COMP 399)
4. Engaged learning courses (COMP 312/412, 390, 392, 391/499, 398/490)
5. UNIV 102: Intro to CS projects and research (for freshmen)

Projects are the bread and butter of the CS experience. Beyond the learning experience and credit you receive they are often uniquely fun and rewarding. And don't forget, we always celebrate projects at the end of each semester with quick presentations after the end-of-semester party.

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1. COMP 398/490: Independent Study

If you want to pursue a project outside the scope of a class, this is the most general route to receiving credit toward graduation. It's also the simplest way to receive significant advising, as many projects are collaborations with faculty who also maintain related resources.

You sign up for a COMP 398 (undergrad) or 490 (grad) after discussion with the faculty member you will partner with - criteria for working on these differ slightly among faculty by design, but here's a helpful orientation, since independent study typically comes in two flavors. Some faculty will only take independent study students who are interested in contributing to long-term research efforts, generally aimed at producing results available to the wider academic community - often team efforts requiring more than a semester from start to finish so your efforts will often be a piece of a larger project. Another common option is developing an independent study for a personal project or independent learning experience; note, however, that often these efforts must be independent efforts with less faculty involvement, so establishing clear goals and criteria for completion are the student's responsibility.

To pursue an independent study project, first consider if you have the required experience to pursue a project of interest - often it is best to do independent study projects after foundational courses are out of the way. Second, if you have an idea of your project goals, contact the relevant faculty member. Once you have mutually agreeable goals, you will be enrolled through an email send to the department.

Note that pursuing an independent study course is not intended to be a substitute for performing well in traditional courses. Faculty may wish to look at your record before agreeing to supervise an independent study project, and students should anticipate that faculty may insist students have at least a 3.0 GPA.

2. COMP 397: Research Methods in Computer Science (1 credit hour)

The spring research seminar supplements the CS Seminar by specifically aiming at students who will directly engage in research and to facilitate their contributions in their ongoing projects. This course is designed to emphasize the tools and techniques in research collaboration, analysis, and presentation to help project groups outside the course to focus on content. Progress is encouraged and tracked in projects outside the course through milestones such as abstracts, small fellowship-style proposals, informal updates, and outcome-oriented goal setting where appropriate.

3. COMP 399: CS Seminar (1 credit hour)

The CS seminar is an opportunity to engage with other students as well as the various speakers and events supported by the CS department. Past seminars have include internal faculty speakers and external speakers focusing on such topics as Big Data analytics, spatial statistics, STEM outreach, game design, and digital music. The seminar also supports local competitions such as a recent Loyola hackathon competition in the Fall and a Datafest analytics competition in the Spring. Requirements include reasonable attendance expectations and brief write-ups about your experiences.

4. Engaged learning courses

These are courses specifically with a project-oriented or applied learning focus, satisfying the Engaged Learning Core requirement for undergrads at Loyola. These engaged learning courses can be used towards the "Practicum" requirement applicable to most computing majors.

- COMP 398/490: Independent Study. See further information at the link here and as described above.
- COMP 312/412: Open Source Computing. See further information at the link here. Usually runs Fall, Spring, and Summer.
- COMP 390: Broadening participation in STEM (Computing, Math & Science) . See further information at the link here. Usually runs in Fall, and students generally have an opportunity to find a placement after the start of the term.
- COMP 391/499: Internship. See further information at the link here. Available year round, but you must find a placement and register by the usual deadline for the term.
- COMP 392: Metagenomics. See further information at the link here. Of particular interest to Bioinformatics students. Usually runs in Fall.

5. UNIV 102-X: Intro to CS research for freshmen - FYRE program (Spring)

This course will introduce students to the project-focused environment that is part of a typical undergraduate student experience in computer science. In CS, interesting projects are performed as group projects in courses, independent study research experiences with faculty, or in collaboration with industry partners. The course may also selectively coordinate with COMP 397/399 for opportunities to observe interesting work and learn some of the tools used in performing those projects.

CHAPTER

FIVE

RESEARCH GROUPS

Active research groups

- *Putonti Lab*
- *Emerging Technologies Laboratory (ETL)*‘ <http://home.etl.luc.edu/>‘__
- *Pervasive and Ambient Computing (PAC) Lab*
- *Center for Textual Studies and Digital Humanities* -

Please visit the *faculty research interests* page for individual faculty

CHAPTER

SIX

PUBLICATIONS

6.1 Digital Archives

Most recent faculty publications can be retrieved from the Loyola University Chicago eCommons.

6.2 Faculty Collections

Mark Albert - Google Scholar, - Lab

Peter Dordal - TBD

Stephen Doty - Google Scholar

Ronald Greenberg - Google Scholar

Andrew Harrington - Google Scholar

Nicholas Hayward - TBD

William Honig - Google Scholar

Konstantin Laufer - Google Scholar

Channah Naiman

Catherine Putonti - Google Scholar - PubMed - Lab

Chandra Sekaran - Google Scholar

George K. Thiruvathukal - Google Scholar

Robert Yacobellis - Google Scholar

CHAPTER

SEVEN

FREE AND OPEN SOURCE SOFTWARE

The department is active in free/open source software, both in terms of using and developing it.

We maintain several organizations within GitHub:

- Department Resources and Handbooks, LoyolaChicagoCS
- Books and Lecture Notes, LoyolaChicagoBooks
- Code Examples and Research Prototypes, LoyolaChicagoCode

For individual faculty activity on GitHub, see the faculty interests pages.

CHAPTER

EIGHT

FUNDING

Research Grants

- Ronald I. Greenberg, George K. Thiruvathukal, *Collaborative Research: Chicago Alliance For Equity in Computer Science (CAFECS)*, National Science Foundation CNS-1738691, $72,497 Loyola portion within a $2,011,529 collaboration, October 2017 – September 2021.
- Catherine Putonti, *Collaborative Research: Deciphering the Genetic Diversity of Viruses through Gene Networks*, National Science Foundation, $676,340, May 2017 – April 2020.
- Ronald I. Greenberg, Steven McGee (Learning Partnership), and Brenda Wilkerson (CPS), *What Features of the Exploring Computer Science Course Equitably Inspire Students to Pursue Further Computer Science Coursework*, National Science Foundation, $599,986, October 2015 – September 2018.
- Ronald I. Greenberg, Lucia Dettori (DePaul), Dale Reed (UIC), Don Yanek (CPS), Brenda Wilkerson (CPS), *Accelerate ECS4ALL*, National Science Foundation, $999,438, October 2015 – September 2018.
- George K. Thiruvathukal, *EAGER: Collaborative Research: Making Software Engineering Work for Computational Science and Engineering: An Integrated Approach*, National Science Foundation, ACI-1445347, $109,549, August 2014 – July 2018.
- Ronald I. Greenberg, *Collaborative Research: Type I: A Taste of Computing: Adding a CS Entree to the Education Choices in a Large Urban School District*, National Science Foundation, September 2011 – August 2015, $176,149 Loyola portion within a $1,093,455 collaboration
- Catherine Putonti, *CAREER: How do phage drive bacterial diversity in Lake Michigan near-shore waters? A bioinformatics perspective*, National Science Foundation, $706,540, June 2012 – May 2017.
- Ronald I. Greenberg, William Honig, Konstantin Läufer, Catherine Putonti, and George K. Thiruvathukal, *Collaborative Research: BPC-A: Improving Metropolitan Participation to Accelerate Computing Throughput and Success*, National Science Foundation, $141,711 for Loyola as lead institution on a $300,000 project, December 2008 – May 2011.
- Ronald I. Greenberg, Howard M. Laten, Kenneth W. Olsen, Carol Scheidenhelm, and Chandra N. Sekharan, *ExCEL: Excellence in Computing at Every Level*, National Science Foundation, $600,000, February 2008 – February 2013.
- William Honig, Konstantin Läufer, and George K. Thiruvathukal *Learning the Wonders of Computing with Wireless Collaboration*, Hewlett-Packard, $68,000, June 2007 – June 2009.
- *Howard Laten, George K. Thiruvathukal, and Timothy O'Brien,*REU Site: Integrated Cross-disciplinary Summer Program in Bioinformatics*, National Science Foundation, $282,747, June 2006 – May 2009.
- Nancy C. Tuchman, Chandra N. Sekharan, et al., *High Performance Computing in Bioinformatics*, Defense Advanced Research Projects Agency, $4,500,000, 2003 – 2005.

- George K. Thiruvathukal, *Collaborative Proposal: Ultra-scalable System Software and Tools for Data-intensive Computing*, NSF/DARPA, $72,000, January 2005 – December 2008. (This proposal was awarded to Northwestern University as lead institution and University of Pennsylvania.)
- Konstantin Läufer and George K. Thiruvathukal, *South Asian Language Resource Center Mini-Grant*, $5,000, August 2004 – April 2000
- Jerry R. Sanders, Bryan Pickett, Chandra N. Sekharan, George K. Thiruvathukal, William A. Yost, *High Performance Network Connections: HPNC for Science Research at Loyola University Chicago*, National Science Foundation, $150,000, October 2002 – October 2005.
- George K. Thiruvathukal, Chandra Sekharan, and Linda Salchenberger (now with NWU SCS), *Information Technology Research: The Community Information Technology Enterprise Project*, National Science Foundation, $1,000,000, October 2002 – October 2005.
- Michael Goldwasser, *Maximizing Resource Utilization through Admission Control*, National Science Foundation, $134,866, September 2002 – August 2005.
- William Honig, Christine Haught, Keith Van Rhein, *TECH 37 Grant for Underprivileged High School Students*, City of Chicago, $28,000, Jan 2003 – June 2003.
- Konstantin Läufer, Vineet Gupta, and Radha Jagadeesan, *The Triveni Project*, National Science Foundation, Software Engineering and Languages program, $154,000, September 1999 – August 2002.
- Peter Dordal, Radha Jagadeesan, Konstantin Läufer, and Chandra Sekharan, *Academic Equipment Grant*, Sun Microsystems, $89,000, September 1999 – August 2000.
- Peter Dordal, Radha Jagadeesan, Konstantin Läufer, and Chandra Sekharan, *Instructional Lab Grant*, Microsoft, $70,000, September 1996 – August 1998.
- Ronald Greenberg, *General-Purpose Parallel Architectures and Routing Schemes*, National Science Foundation, $169,470, September 1994 – August 1998.
- Stephen Doty, *Representation Theory of Reductive Groups & Monoids*, National Science Foundation, $60,000, June 1994 – May 1998.
- Chandra N. Sekharan, *A Study of Outstanding Issues in the Design of Algorithms for Partial K-Trees*, National Science Foundation, $15,000, July 1993 – June 1994.
- Chandra N. Sekharan, *A Study of Outstanding Issues in the Design of Algorithms for Partial K-Trees*, National Science Foundation, $36,501, July 1991 – June 1994.

CHAPTER

NINE

ASSISTANTSHIPS

For information on TA awards, please see the Graduate Handbook at http://gradhandbook.cs.luc.edu.

Research assistantships are subject to funding (e.g. NSF, NIH, NEH, and other agency funding) and are awarded to students with exceptional merit and expertise.

Add link to Graduate Handbook standards for merit awards, which usually require GRE and a solid record of academic achievement (a.k.a grades).

CHAPTER

TEN

DOWNLOAD OTHER FORMATS

In addition to the html version on the server, http://research.cs.luc.edu, we also provide the following formats for offline reading:

- PDF for printing or desktop reading
- ePub (for e-reading devices, e.g. e-readers, tablets, or Adobe Digital Editions on desktop)

All these different formats are generated using the incredible Sphinx documentation tools from the Python community.

You can view the source text files from which all versions are derived at https://bitbucket.org/loyolachicagocs/gradhandbook. The site also shows a change log.

CHAPTER

ELEVEN

ACKNOWLEDGMENTS

To appear.

CHAPTER

TWELVE

PUBLICATIONS MAP

genindex

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