1 Executive Summary

The Informatics and Computing Program (ICP) is proposing the creation of a research-intensive, Ph.D.-focused training program that will help NAU build new research capacity. This program will maximize the return-on-investment for the ICP initiative, support existing University areas of strength, and establish bridges with informatics-enabled research and education in disciplines across the institution. These are strategically important means through which this degree proposal supports increases in critical Arizona Higher Education Enterprise Plan research productivity metrics for Northern Arizona University (NAU).

The program structure we propose is the first of its type among Arizona universities and distinguishes itself from regional degree programs by combining depth in core informatics expertise with breadth in strategically selected emphasis areas emphasizing research in (a) Health and Bioinformatics, (b) Ecological and Environmental Informatics, and (c) Cyber and Software Systems. These strategically chosen emphasis areas will reinforce interdisciplinary collaboration at NAU between ICP and a broad range of entities, including the Center for Bioengineering Innovation, Center for Microbial Genetics and Genomics, Center for Ecosystem Science and Society, School of Earth Sciences and Environmental Sustainability, Merriam-Powell Center for Environmental Research, Department of Biological Sciences, Department of Physics and Astronomy, and Department of Mathematics and Statistics.

Important characteristics of the proposed degree program include:

• An emphasis on collaborative and interdisciplinary research, with a tightly-focused core of informatics foundation and professional development courses that is complemented by research-and project-intensive seminars and existing interdisciplinary coursework (Section 8.3);
• A flexible structure that easily allows for the future inclusion of emerging research areas as additional degree emphases, enabling agile development of collaborations across the university (Section 8.3);
• A streamlined and research-centric five-year path to completion (Section 8.4);
• A high degree of inclusiveness of the broader community by explicitly welcoming NAU researchers in informatics areas from any academic unit as Affiliates, allowing them to serve as advisors and dissertation committee chairs and members (Section 8.2);
• A focus on industry and government collaborations with entities such as Translational Genomics Research Institute, Northern Arizona Healthcare, U.S. Geological Survey, and Northern Arizona Planetary Science Alliance (Section 8.5).
2 Degree Program Information

This proposal addresses the creation of a graduate degree program in Informatics and Computing at the Ph.D. level with an integrated M.S. degree. This new academic plan will be supported through ICP in the College of Engineering, Forestry, and Natural Sciences, and we are aiming for the plan to become effective beginning in Fall 2016.

3 Evaluation of Program

The proposed graduate training program will provide credible and robust support to institutional and ABOR goals, while also supporting benefits for the State and Nation.

3.1 Contributions to Institutional and ABOR Goals

Our initial emphasis areas within the proposed degree program are strategically chosen to build on University areas of research strength and distinctiveness, such as environmental science and biotechnology, while also providing a framework that will support novel expansions of university research capacity in informatics, computing, and cybersystems. The envisioned graduate-level training program in Informatics and Computing will make important contributions to the University’s strategic goal of developing “nationally recognized research excellence.” This program embodies two specific strategies for supporting research excellence, namely “emphasize and reward high productivity and impact” and “provide cutting-edge training and learning opportunities to students.”

The first of these strategies will be supported through the work of doctoral students who will increase ICP research productivity as part of their doctoral work. They will also form a cohesive network of collaborators as they transition to faculty or industry researcher positions after they graduate, promoting long-term success for this program.

The second strategy is embodied in the targeting of emphasis areas that fall within what is being referred to as the “fourth paradigm” of scientific inquiry, a disruptive mode of scientific investigation relying on massive datasets and advanced hardware, software, and statistical techniques upon which to base future scientific and engineering advances. Furthermore, our proposed program includes training elements that depart from conventional graduate training structures, such as the inclusion of diverse collaborators across departmental silos and research rotations that give students immediate hands-on exposure with a variety of research groups. These program characteristics directly target “cutting edge training and learning opportunities” in content and learning modalities.

As outlined in the [Arizona Board of Regents 2020 Vision](http://azregents.asu.edu/rrc/DocumentLibrary/2020-Vision.pdf) and [Arizona Higher Education Enterprise Plan](http://azregents.asu.edu/boardbook/board%20agenda%20books/2010-09-meeting/item%2036-strategic%20realignment%20handout.pdf) strategic plans, this degree program will support improvements in several key metrics in the broad area of increasing research productivity. These metrics are also key in ensuring

---

1. Redmond, WA: Microsoft Research, 2009
that NAU maintains, or improves, its current Carnegie Classification\(^6\). Specific metrics supported include:

- **Number of doctoral degrees awarded**: Adding a program that is fundamentally focused on earning a research-intensive doctoral degree directly supports improvements in this metric. Important in this context is that the research areas of our proposed program fall within one of the fastest growing research and professional areas (see Section 3.2), strongly indicating that this program will also be attractive to prospective graduate students;

- **Research and development expenditures**: Having a doctoral degree program within ICP will be a key factor in recruiting high-quality faculty. This program will allow faculty to be more competitive in grant-seeking efforts, with graduate students providing the long-term commitment needed to establish and develop novel research directions and follow-through on commitments to funding agencies. A successful graduate training program will encourage a greater diversity of collaborations and joint grants as graduates establish themselves after their graduation;

- **Number of invention disclosures transacted**: Our focus on including partnerships with industry and government entities will help us identify mutually beneficial research projects for students. Faculty and students engaged in cutting-edge and applied research areas will produce advances in science and technologies that merit intellectual property protections.

### 3.2 Contributions to the State and Nation

The importance of developing informatics training programs such as the one we envision will continue to grow as the data-intensive research paradigm becomes increasingly pivotal in engineering and scientific innovation. Informatics and its associated sub-disciplines are already clearly identified as critical areas of national need, signaling that this program has the potential to make substantive contributions to both the State’s and the Nation’s workforce demands\(^7\)\(^-\)\(^8\). We posit that training programs such as the one we propose are also important elements of ongoing efforts to diversify Arizona’s economy. By focusing on graduate training elements with the inclusion of industry collaborators, we aim to create technically capable and innovative leaders for academia as well as private industry in informatics-enabled domains, which are areas that bodies such as the *Arizona Commerce Authority*\(^9\) and the *Arizona Technology Council*\(^10\) have identified as critical to the State’s future.

### 4 Program Need

Our vision for this proposed program is centered on fundamental informatics skills in research methods and areas, software development methods and tools, large-scale data management, and data mining and machine learning—this core is complemented by three emphasis areas in specific disciplinary applications of informatics:

\(^7\)Lacey, T., and Wright, B. Occupational employment projections to 2018. Monthly Labor Review 132, 11 (2009), 82–123
\(^8\)President’s Council of Advisors on Science and Technology. Engage to excel: Producing one million additional college graduates with degrees in science, technology, engineering, and mathematics. Tech. rep., Feb. 2012
\(^9\)www.azcommerce.com/industries/technology-innovation
\(^10\)http://www.aztechcouncil.org/serving-arizona/aztc-foundation
Health and Bioinformatics: Expertise supporting the application of informatics in genetic and genomic analysis and population health and disease transmission;

Ecological and Environmental Informatics: Expertise in applying informatics through remote sensing and ecological and environmental analysis; and

Cyber and Software Systems: Expertise in the application of informatics to the design and development of cyber-physical and large-scale software systems.

Bioengineering Informatics: focusing on data analysis and control in bioengineering applications.

Based on our research, the degree program we envision will be unique among other state and regional universities at the Ph.D. level. This provides an important, timely, and achievable opportunity to establish NAU as an innovative leader in informatics and informatics-enabled research.

Both ASU and UA offer graduate-level degrees that are somewhat related but smaller in scope and breadth than our proposal, providing an important opportunity for NAU to emerge as a statewide leader in the field of informatics and computing. While there is a much larger set of related degree offerings in California, they are substantively different from our proposed program in their scope with a dominating focus on biological applications of informatics. Related Colorado offerings focus on information science in digital media. Utah programs focus on biological applications of informatics. Nevada and New Mexico do not offer comparable graduate programs. Our analysis of related programs appears in the following sections—while we engaged in a broad inventory of informatics-related educational programs, we focus this discussion on graduate-level training programs that include the Ph.D. and M.S. degrees rather than including the much more common set of degrees that target informatics at the undergraduate level.

4.1 Arizona

The directly relevant offerings from Arizona State University (ASU) are a Ph.D. and M.S. program in Biomedical Informatics (alongside undergraduate B.S. programs in Biomedical Informatics and Informatics). These graduate degrees focus on the intersection of the biological sciences and computing, with an emphasis on techniques in imaging, clinical applications, and population health. This degree program overlaps with parts of our degree proposal—namely the emphasis in Health and Bioinformatics—but reflects a narrower focus that does not address the important areas of study captured in our other two emphases. ASU also offers a graduate certificate in Policy Informatics, as part of its Master’s offering in Public Policy—this offering is distinct from our program and does not address the key research areas we are proposing.

University of Arizona’s Graduate Interdisciplinary Programs offer a Ph.D. in Statistical Informatics, which focuses on general data extraction, analysis, and interpretation techniques. This program focuses on core statistical foundations, rather than the broad emphases of our proposed program that cover the application of these foundational skills to concrete science and engineering applications in biology and population health, ecology and the environment, and cyber systems.

4.2 California

In the University of California (UC) system, a number of campuses offer graduate training programs in biology-oriented informatics: Los Angeles offers a degree in Bioinformatics, San Diego in Bioinformatics and Systems Biology, San Francisco in Biological and Medical Informatics, Riverside in Genetics, Genomics, and Bioinformatics, and Davis in Biostatistics. These programs overlap with our emphasis in health and bioinformatics, but do not address ecological and environmental informatics or cyber and software systems. The Irvine offering in Informatics departs from the
biology-oriented theme of other UC offerings with a focus on social aspects of technology, computing infrastructures, and human-computer interaction. Our proposed degree plan intersects with aspects of this offering, particularly in the area of computing infrastructure captured in our cyber and software systems emphasis, but remains distinct in its broad consideration of informatics systems and application areas. The California State University system does not offer Ph.D. degrees, and so its offerings are outside of the scope of this discussion.

4.3 Nevada

In Nevada, the only somewhat relevant offering is a now-defunct Ph.D. program in Informatics offered through the Howard R. Hughes College of Engineering of the University of Nevada (UN), Las Vegas. The program was very open-ended without supporting specific emphases as our proposed program does, and appears to be no longer active as of 2010 (indicators point to the program being cut as part of UN budget reductions\textsuperscript{11}).

4.4 Utah

University of Utah, Salt Lake City offers a Ph.D. degree in Biomedical Informatics with integrated thesis and non-thesis options for the M.S. degree. As with other previously discussed programs, this offering is substantially different in its breadth than our proposed program and does not address important informatics foundational and application areas.

4.5 Colorado

University of Colorado, Boulder will begin offering a Ph.D. degree in Information Science with a focus on human-data interactions and the analysis of large-scale digital media datasets. This area intersects with our focus on cyber and software systems, but does not address the important areas captured in our other emphases. University of Colorado, Denver offers a Ph.D. degree in Biostatistics, focusing on the mathematical and statistical foundations of informatics-driven inquiry, particularly in the context of health and biology. This program does not have the breadth of the application areas we consider and does not include important foundational cyber and software development skills.

5 Impact on Other Programs

We expect the impact of this interdisciplinary program to be overwhelmingly positive and foster collaborations with a wide variety of academic units at NAU (potential industry and government collaborations are discussed in Section 8.5).

Our curricular plan includes coursework (STA570, STA571, and STA572) offered through the Department of Mathematics and Statistics. These course offerings are well supported, offered frequently, and are a core part of many other graduate programs on campus. As our proposed cohorts range from eight to ten students annually, we expect that the impact of our program on this unit will be minimal. We have already received informal support from the Department of Mathematics and Statistics (see Appendix A), with a formal letter of support from that unit currently under preparation.

The interdisciplinary nature of our proposed degree program opens the door to scholarly collaborations between ICP and a wide range of NAU academic units. These collaborations will

\textsuperscript{11}http://www.reviewjournal.com/news/unlv-budget-axe-could-cut-entire-programs
strengthen NAU as a whole and enable the wide participation of graduate and undergraduate students in our research. As part of the research pursued within this proposed degree program, we envision interdisciplinary research teams forming between ICP faculty and faculty from other NAU units.

Our proposed degree structure supports the formalization of these collaborations, as they grow and mature, into appropriate additional emphases. While we fully intend to explore new connections across the university, immediate collaborations will likely be formed with:

- **Department of Biological Sciences**: Interdisciplinary research including, but not limited to informatics-enabled ecological and genes-by-environment modeling, computational cell biology, microbial genetics and genomics, infectious diseases, epidemiology, exercise science, and human health;
- **Center for Bioengineering Innovation**: Focusing on applications of computing and data analysis to the design and refinement of prosthetics, strengthened by an explicit collaborative emphasis in Bioengineering Informatics;
- **Center for Microbial Genetics and Genomics**: Working on high-performance computing and large-scale data processing for pathogen detection, transmission, and circulation analyses in the context of population health, food security, and biodefense;
- **Center for Ecosystem Science and Society**: Focusing on data synthesis and statistical analysis for ecological and environmental processes and systems;
- **Department of Electrical Engineering and Computer Science** (part of the upcoming School of Informatics, Computing, and Cyber Systems unit): Focusing on the application of computing to the design and implementation of cyber-physical and large-scale software systems;
- **School of Earth Sciences and Environmental Sustainability**: Focusing on the application of remote sensing and geospatial analysis to inform environmental resource management;
- **Merriam-Powell Center for Environmental Research**: Applications of distributed computing and large-scale geospatial and sensor data management and analysis to environmental research questions;
- **Department of Physics and Astronomy**: Working in applications of high-performance computing, data mining, and image processing to knowledge extraction from massive astronomical observation data sets;
- **Department of Psychological Sciences**: Applications of data collection and analysis technologies to studying the impact of behavior on specific diseases and health;
- **School of Forestry**: Supporting outreach and conservation efforts on the Colorado Plateau and beyond;
- **Department of Mathematics and Statistics**: Collaborating in applications of statistics to data analysis across the entire spectrum of our research activities.

6 Workforce Needs and Enrollment Projection

As discussed in Section 3.2, this proposed program addresses critical workforce needs in the informatics area with positive employment growth projections. Our five year projected enrollment appears in Table 1. This enrollment model is based on the following:

- The model includes a 20% loss in the second year to account for a variety of factors that might pull students out of our program, such as family or health challenges and possible repeated lack of success in the qualifying exam. Barring these exigent and unforeseen circumstances
Table 1: Projected total enrollment for the first five years of our proposed program, with a steady-state enrollment of 44 students.

<table>
<thead>
<tr>
<th>Students</th>
<th>Academic Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AY16-17</td>
</tr>
<tr>
<td>Admitted</td>
<td>5</td>
</tr>
<tr>
<td>2nd year</td>
<td>-</td>
</tr>
<tr>
<td>3rd year</td>
<td>-</td>
</tr>
<tr>
<td>4th year</td>
<td>-</td>
</tr>
<tr>
<td>5th year/graduates</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total enrollment</strong></td>
<td>5</td>
</tr>
</tbody>
</table>

and with careful scrutiny during admission and effective mentoring, our goal is to ensure that all students are successful in the program.

- The model is based on admitting and funding students using the requested graduate teaching assistant (GTA) support for two-year terms, and then transitioning these students to grant-supported assistantships for the remainder of their term of study. Requested GTA levels of support would allow us to admit five students per year into the program through these means.

- The model’s estimated ranges are based on admitting students in addition to the five that our requested levels of GTA support would allow beginning in AY17-18. These students would be admitted through means such as available grant funding and the use of some existing GTA positions.

This level of enrollment would support two Ph.D. students for each projected faculty member in ICP, and does not include additional students that may join the program advised by other NAU faculty, which may result in even higher enrollments in this program. This body of graduate students would support significantly increased research productivity yet remain manageable for our requested level of faculty and teaching assistant support.

7 Student Learning Outcomes and Assessment

Our curricular design is aimed at preparing students for meaningful and fulfilling careers as leaders in industry research labs, research scientists and faculty members in academia, or entrepreneurs innovating in informatics areas.

7.1 Program Learning Outcomes

Graduates of this training program will demonstrate the following advanced competencies:

LO1 Explain the major theories, research methods, and technical approaches driving informatics-driven science and engineering and the impact of these elements on society.

LO2 Identify, explain, synthesize, and apply the fundamental concepts of informatics, including large-scale data representation and organization, various types of programming languages, software development methods, data processing, information extraction and machine learning, and statistical analysis.

LO3 Identify, explain, synthesize, and apply the interdisciplinary combination of core informatics and in-depth disciplinary expertise defining one of the following emphasis areas:
- Health and Bioinformatics, focusing genetic and genomic analysis, population health, and disease transmission;
- Ecological and Environmental Informatics, focusing on ecological and environmental analyses and remote sensing;
- Cyber and Software Systems, focusing on the design and implementation of cyber-physical and large-scale software systems;
- Bioengineering Informatics, focusing on data analysis and control in bioengineering applications.

LO4 Identify, survey, analyze, organize, and critically distill information from the scientific literature within an informatics emphasis area and creatively identify open research questions.

LO5 Independently apply appropriate expertise, methods, and tools to the creative design, execution, and assessment of an investigation that addresses original informatics research questions.

LO6 Compose and engage in highly effective written and oral communication in informatics areas; demonstrate clear argumentation and logical cohesion in a variety of written and oral communications, including scholarly dissemination, funding requests, industry, and lay communication.

7.2 Assessment and Program Quality

An initial assessment plan appears in Table 2, referring to the program learning outcomes (PLOs) presented in Section 7.1, coursework appearing in Section 8.3, and milestones appearing in Section 8.4. Program assessment will be conducted by our proposed program’s Graduate Assessment Committee, consisting of ICP faculty and chaired by ICP’s Associate Director. This group will coordinate with the Director, the NAU Graduate College, other NAU faculty, student advisory and dissertation committees, and other university entities to assess our program, meeting once per semester and preparing an annual assessment report that captures the group’s assessment for each PLO. Individual student achievement metrics will focus on gathering qualitative data for the percentage of students scoring within specific score brackets (>= 70%, >= 80%, and >= 90%) on the specific rubric instrument, irrespective of their achievement on the associated assessment instrument or examination. Metrics of success will include target percentages of students achieving specific benchmarks of success for each rubric associated with this assessment plan, to be determined as the Graduate Assessment Committee completes its work over the coming months. The Scholarly Rigor and Placement rubrics will target scholarly output and metrics regarding student job placement immediately before graduation respectively.

8 Proposed Curriculum

The following sections capture the curriculum for the Ph.D. degree in Informatics and Computing, including entrance requirements, curricular elements, an outline of major milestones, and a summary of new courses needed. Figure 1 provides an outline of our proposed milestones and an example progress plan—STA-prefixed courses already exist and only INF-prefixed coursework will be new.

The specific set of emphases listed in this proposed program reflect the areas that embody sufficient critical mass, as provided by existing faculty expertise and research collaborations, to merit formal inclusion into the academic program. As additional research areas emerge and mature to a similar critical mass through our interdisciplinary collaborations across NAU, it is likely that these areas will be similarly included into the academic program as explicit emphases.
Table 2: Initial assessment plan for the graduate training program in Informatics and Computing showing program learning outcomes, the means through which learning is supported in each outcome, assessment points where outcomes are assessed, and how relevant data will be collected and assessed.

<table>
<thead>
<tr>
<th>PLO Means</th>
<th>Assessment Points</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>LO1 INF501 Qualifying Exam</td>
<td><em>Breadth Topics</em> rubric, attached to Qualifying Exam</td>
<td></td>
</tr>
<tr>
<td>LO2 INF502, INF503, INF504, STA570, STA571, STA572 Qualifying Exam</td>
<td><em>Core Topics</em> rubric, attached to Qualifying Exam</td>
<td></td>
</tr>
<tr>
<td>LO3 INF610, INF611, INF612, INF620, INF621, INF622, INF630, INF631, INF632, INF799, emphasis courses Qualifying Exam, Advancement to Candidacy Exam</td>
<td><em>Emphasis Topics</em> rubric, attached to Qualifying Exam; <em>Emphasis Synthesis</em> rubric, attached to Advancement to Candidacy Exam</td>
<td></td>
</tr>
<tr>
<td>LO4 INF610, INF611, INF612, INF620, INF621, INF622, INF630, INF631, INF632, INF799 Advancement to Candidacy Exam</td>
<td><em>Research Synthesis</em> rubric, attached to Advancement to Candidacy Exam</td>
<td></td>
</tr>
<tr>
<td>LO5 INF684, INF799 Advancement to Candidacy Exam, Dissertation Defense</td>
<td><em>Research Execution</em> rubric, attached to the Advancement to Candidacy Exam; <em>Scholarly Rigor</em> rubric, attached to the Dissertation Defense exam and assessing scholarly output and quality</td>
<td></td>
</tr>
<tr>
<td>LO6 INF610, INF611, INF612, INF620, INF621, INF622, INF630, INF631, INF632, INF799 Advancement to Candidacy Exam, Dissertation Defense</td>
<td><em>Communication</em> rubric, attached to the Advancement to Candidacy and Dissertation Defense exams; <em>Placement</em> rubric, attached to Dissertation Defense exam and assessing individual student job placement immediately before graduation</td>
<td></td>
</tr>
</tbody>
</table>
Progress Plan
Informatics and Computing Ph.D.
(integrated M.S.)

| Year 1 | Fall | INF501 (3) | INF684 (3) | STA570 (3) |
|        | Spring | INF601 (3) | INF602 (3) | Emphasis |

| Year 2 | Fall | INF502 (3) | STA571 (3) | INF603 (1) Emphasis |
|        | Spring | INF602 (3) | INF603 (1) Emphasis |

| Year 3 | Fall | INF799 (9) | Emphasis/INF799 (6) |
|        | Spring | INF799 (9) | Emphasis/INF799 (6) |

| Year 4 | Fall | INF799 (9) | Emphasis/INF799 (6) |
|        | Spring | INF799 (9) | Emphasis/INF799 (6) |

| Year 5 | Fall | INF799 (9) | Emphasis/INF799 (6) |
|        | Spring | INF799 (9) | Emphasis/INF799 (6) |

Figure 1: An outline of major degree milestones and an example of a student progress plan.

8.1 Entrance Requirements

This program demands that students have sufficient mastery of key foundational areas in informatics to meaningfully engage in and contribute to original research in the area. These areas include core computing areas, such as programming, data structures, software development methods, and statistics, as well as areas that support specific emphases, such as biology, ecology, and cyber systems. The program and a student’s advisor may require that students admitted into the program correct any deficiencies in these areas by enrolling in undergraduate or graduate courses in relevant areas.

Other admission requirements include GRE scores, three letters of recommendation, a personal statement of interest, a resume or curriculum vitae, and official TOEFL iBT/IELTS scores taken within the last two years for international applicants.

Students who have completed relevant coursework in their undergraduate or previous graduate studies may qualify to receive up to 18 units of credit toward the degree requirements of this program based on this previous coursework, with course substitutions being approved by ICP’s Associate Director and the student’s advisor.

Students with a previously earned M.S. degree in an area closely related to our program’s emphases may qualify to receive up to 30 units of credit toward the degree requirements of this program based on their previous coursework. These students may also qualify as having completed their qualifying exam based on previous work for emphases that require the production of scholarly manuscripts or funding proposals. Course substitutions must be approved by ICP’s Associate Director in consultation with the student’s advisor. Students with an M.S. must establish the same general competencies as other students in core computing areas, and may still be required to take additional undergraduate or graduate courses in relevant areas where their expertise falls short.

8.2 Advisor Policies and Affiliates

As an interdisciplinary program, we welcome the participation of affiliated faculty and researchers from across NAU into our proposed degree program. In consultation with faculty, ICP’s Director may grant Affiliate status to any interested NAU faculty member (with a terminal degree in their discipline) with appropriate software and application expertise and research interests. Affiliate status allows this collaborating faculty to serve as an advisor to a student in this proposed program (and, by extension, serve as chair of the student’s Dissertation Committee).
8.3 Degree Requirements

Our program leverages a combination of existing courses, primarily as elective elements in our emphases, and newly-developed courses. The curriculum of the proposed program is composed of the following elements, including courses that support each element:

- **Informatics Foundations (total of 12 units):** Foundational techniques in informatics and computing, building expertise in these common underpinnings across the program’s emphases.
  - INF 501 (3): Research Methods in Informatics and Computing
  - INF 502 (3): Software Development Methodologies
  - INF 503 (3): Large-scale Data Structures and Organization
  - INF 504 (3): Data Mining and Machine Learning

- **Professional and Communication (total of 3 units):** Meta skills that address core professional and career expertise that cross-cuts the specific expertise areas in our program.
  - INF 601 (1): Professional and Career Development
  - INF 602 (1): Professional Communication
  - INF 603 (1): Proposal and Grant Preparation

- **Statistical Methods (total of 9 units):** Advanced expertise in statistical techniques underpinning data analysis.
  - STA 570 (3): Statistical Methods I
  - STA 571 (3): Statistical Methods II
  - STA 572 (3): Multivariate Statistical Methods
  - Other statistics courses may be substituted, depending on each student’s background and previous coursework.

- **Research Rotation (total of 3 units):** Project-based learning supported by embedding students into existing research groups early in their studies.
  - INF 684 (3): Research Rotation

- **Dissertation (minimum of 15 units; possibly more):** Research and thesis development.
  - INF 799 (1-9): Dissertation

- **Emphases (minimum of 18 units; possibly more):** Specific emphases corresponding to areas of strength, with varied coursework as defined by relevant faculty, as well as interdisciplinary collaborative emphases with external partners, such as the Center for Bioengineering Innovation.
  - Informatics and Computing Emphases (minimum of 12 units of INF-prefixed seminars and 6 units of other relevant coursework)
    - **Health and Bioinformatics**
      - INF 610 (3): Topics in Bioinformatics (varying topic; may be repeated with different topic)
      - INF 611 (3): Topics in Population Health (varying topic; may be repeated with different topic)
      - INF 612 (3): Topics in Healthcare Informatics (varying topic; may be repeated with different topic)
      - Other coursework (such as from Computer Science, Biology, Psychological Sciences, or Nursing), as guided by research needs and advisor input
* Ecological and Environmental Informatics
  - INF 620 (3): *Topics in Remote Sensing* (varying topic; may be repeated with different topic); will be cross-listed with EES529/GSP529
  - INF 621 (3): *Topics in Ecological Modeling* (varying topic; may be repeated with different topic)
  - Other coursework (such as from Forestry, Environmental Sciences, Geology, and Biology), as guided by research needs and advisor input

* Cyber and Software Systems
  - INF 630 (3): *Topics in Cyber-Physical Systems* (varying topic; may be repeated with different topic)
  - INF 631 (3): *Topics in Software Engineering* (varying topic; may be repeated with different topic)
  - INF 632 (3): *Topics in Wearable Computing* (varying topic; may be repeated with different topic)
  - INF 633 (3): *Topics in Cybersecurity* (varying topic; may be repeated with different topic)
  - Other coursework (such as from Computer Science and Electrical Engineering), as guided by research needs and advisor input

- Interdisciplinary and Collaborative Emphases (minimum of 18 units)
  * Bioengineering Informatics
    - Bioengineering Foundations: ME 564, ME 573, BIO 540, BIO/ME 698 (10 units)
    - Select an additional 8 units from other INF-prefixed seminars or other graduate-level coursework at NAU, as guided by research needs and advisor input

The program is designed to be completed in 5 years, consisting of at least 60 (but likely more, varying as the needs of a student’s research dictate) units of study.

8.4 Milestones

The central focus of this graduate course of study is engaging in original research in one of the emphasis areas. Students will be primarily mentored through this program by their advisor: Students must affiliate with a specific advisor at the latest by the end of their first term of study, and faculty must either be members of ICP or hold an affiliation to qualify to serve as advisors (as discussed in Section 8.2).

- **Qualifying Exam (year 2, Spring):** An emphasis-specific comprehensive examination intended to establish a student’s mastery of foundational informatics topics, key expertise in their emphasis area, analytical and synthesis abilities, and potential for excellence in original research. The outcome of this exam, as agreed upon by at least 3/4 of the full Graduate Advisory Committee, may be a **Fail**, **M.S. Pass**, or **Ph.D. Pass**. Only students achieving a **Ph.D. Pass** may continue their course of study toward the Ph.D. degree and students may elect to re-take the exam once within a six-month period from their first attempt. Students who achieve an **M.S. Pass** and have completed at least 30 credit hours of appropriate coursework are eligible to receive the M.S. degree in Informatics and Computing.

- **Assignment of Dissertation Committee (year 3, Fall):** The Dissertation Committee is formed in the beginning of a student’s third year of study with advisor consultation. This group will guide the student through the final phases of their research. The committee must
consist of five faculty, with at least two faculty members from ICP and at least one faculty member from outside the program.

- **Advancement to Candidacy (year 4, Fall)**: This examination consists of written and oral portions: the Advancement Proposal and Advancement Defense respectively. The Advancement Proposal consists of a comprehensive and well-organized survey of foundational and related work to the student’s dissertation topic, a dissertation abstract, a description of the methodology used, outcomes of major milestones completed, and a clear plan for completing any remaining work and preparing the final dissertation. The Advancement Defense is an oral seminar that presents and defends this work to the student’s Dissertation Committee. The outcome of this combined exam may be a Fail or Pass, with 3/4 consent of the Dissertation Committee needed for a Pass. Students that do not achieve a Pass on this exam may elect to re-take the exam within a six-month period from their first attempt.

- **Dissertation Defense (year 5, Spring)**: This examination consists of written and oral portions: The Dissertation and Dissertation Defense respectively. The Dissertation captures the summative outcomes of a student’s research and the Dissertation Defense allows for a comprehensive oral examination by the Dissertation Committee to determine the merits and adequacy of the work. The outcome of this combined exam may be a Fail or Pass, with 3/4 consent of the Dissertation Committee for a Pass. Students that do not achieve a Pass on this exam may elect to re-take the exam within a six-month period from their first attempt.

### 8.5 Relevant Constituencies

In addition to the academic collaborations this proposed program will support (discussed in Section 5), our work will also foster collaborations with important regional industry and government entities working in the intersection of computing with science and engineering. First and foremost, we will pursue the initiation of joint research projects which will provide our students with the seeds for their doctoral research. This effort will thus strengthen our research profile as well as the innovative capacity of our likely partners (letters of support can be found in Appendix A) including:

- **Translational Genomics Research Institute** in areas of genetic and genomic research for human health;
- **Northern Arizona Healthcare** in research pertaining to population health and technological solutions that improve patient care;
- **U.S. Geological Survey** in remote sensing and ecological and environmental research; and
- **Northern Arizona Planetary Science Alliance** in planetary research involving astroinformatics.
- **North Country HealthCare** in community and population health using large data-sets.

In addition to the likely joint projects with these organizations, these partnerships will also foster participation in our program’s advisory board, student internships, and possibly support our program through financial means such as graduate research fellowships. Other potential partners include regional technology-focused organizations such as **Intel**, **International Business Machines**, **Raytheon**, **Boeing**, **Northrop Grumman**, **Jet Propulsion Laboratory**, and **National Aeronautics and Space Administration**.

### 9 Estimated Lead Time

This degree program benefits from a rich and long-lasting scholarly area with immediate scientific and social relevance and the ability to be implemented quickly. We are confident that we will be able to accept the first cohort of students into this program in Fall 2016.
As discussed in Section 4, there is an immediate state need for a program exhibiting the depth and breadth of what we propose. Supporting this program would establish NAU as a state and regional leader in informatics-driven research and education: Firstly, the program would allow NAU to more strongly participate in the thriving Arizona research community in bioinformatics while also supporting a unique emphasis in population health. Furthermore, it would establish our university as regional leaders with our emphasis on a training program that supports ecological informatics and cyber and software systems—areas that either absent or not represented in regional graduate programs in the field. This is an important opportunity for our university that we feel motivates all possible haste in establishing this program.

While we are requesting additional faculty and staff resources as part of this degree proposal, the current faculty affiliated with the Informatics and Computing Program provide a robust and stable foundation upon which to build this program, with their expertise having been considered in the program’s design. The Health and Bioinformatics emphasis will be supported by Dr. Fofanov and Dr. Hepp, Ecological Informatics will be supported by Dr. Ogle and Dr. Sankey, and Cyber and Software Systems will be supported by Dr. Flikkema, Dr. Georgas, Dr. Winfree, and Dr. Cambou. With sufficient faculty resources and expertise already available, we do not foresee any barriers that would prevent us from establishing the program very quickly and begin accepting students, pending the securing of approvals, as early as Fall 2016.

10 Resources and Budget Justification

While we are building on a solid foundation of existing faculty and expertise, a thriving program such as what we propose will demand additional resource allocations. Important items include:

- **Faculty:** We request an additional three tenured or tenure-track faculty positions with competitive start-up packages, to join our existing team of seven ICP faculty. As a result, we propose that all four of these additional ICP positions requested here are fully devoted to the Health and Bioinformatics and Ecological and Environmental Informatics emphases, which will provide much needed expertise depth in these areas, support the necessary mentorship capacity for our program’s growth, and enhance ICP’s potential for achieving extramural funding. Additionally, we note that these faculty additions are important in ensuring that our research areas are well balanced in terms of faculty support and equally credible.

- **Staff:** To support this graduate degree program, we request a program coordinator staff member (1 FTE) to support our faculty in various curricular and administrative tasks, including application processing and applicant communication, arrangements for our recruitment activities, curricular and degree milestones coordination with the Graduate College, graduate course scheduling and coordination, and management of research and teaching assistantships.

- **Teaching assistantships:** Given the research-centric nature of our faculty workloads, we see a critical need to provide teaching assistant support for ICP faculty that optimizes their investment of time in teaching obligations. As a result, we request 10 fully-funded graduate teaching assistantships (GTAs) for the life of this program, adding five of these positions in fiscal year 2017 and five additional positions (for a total of 10) in fiscal year 2018. These GTAs will be responsible for a variety of instructional support tasks; these include bearing full responsibility for laboratory sections and overseeing collaborative groups in project-based courses. These GTA positions will be used to admit five students per year into the program, based on our plan to support graduate students for two years using GTA positions and grant funding for the remainder of their term of study.
• **Operations:** We include a request for an operations budget (with phased increases through fiscal year 2018) to support the following: a robust graduate student recruitment event that would allow us to bring prospective students to campus to meet our faculty and increase our program’s competitiveness, faculty travel needs, communications material preparation and dissemination, advertising for the graduate program, student wages to support administrative functions, materials and supplies for the program, support for software purchases and licensing agreements to support student research, support for initial purchase and replacement of furniture for graduate teaching and research assistant office spaces, and support for initial purchase and regular replacement of computers and other equipment for graduate teaching and research assistants.
A Appendix: Letters of Support
To Whom It May Concern:

The proposed PhD Program in Informatics & Computing includes three courses offered by the Department of Mathematics and Statistics, STA 570, 571, and 572, in its core curriculum. In addition there is the potential for research faculty in the Department of Mathematics and Statistics to affiliate with the program to advise graduate students and chair or serve on dissertation committees.

ICP expects an annual load of 10-12 additional students in those courses. In light of recent enrollment figures, this may require us to offer an additional section of STA 571 each year, and/or offer STA 572 each year instead of in alternate years as we currently do. Thus this new program may have minor staffing implications in our department. The CEFNS Dean has committed to provide staffing support for the additional 1.5 courses per year that may be required. The potential benefit to our research faculty of a Ph.D. program in ICP is great, as we believe is the benefit to the College and University, and for those reasons the Department of Mathematics and Statistics supports the proposal.

Sincerely,
Michael

Michael Falk, Professor and Chair
Department of Mathematics and Statistics
Northern Arizona University
Flagstaff, AZ 86011-5717

tel: (928) 523-6891
fax: (928) 523-5847
michael.falk@nau.edu
cefns.nau.edu/~falk
TO: Informatics and Computing Program at Northern Arizona University  
FROM: Mark Carroll M.D.,  
       Chief Medical Officer  
       Flagstaff Medical Center  
SUBJECT: Letter of support and collaboration for Informatics and Computing Ph.D. Program

I am writing to offer support from Flagstaff Medical Center for the development and launch of the Informatics and Computing Ph.D. Program at Northern Arizona University. In the age of expanding data, such as that related to healthcare, our team at FMC sees the need for developing analytical skills for future NAU graduate students.

Flagstaff Medical Center is a 267 inpatient bed facility with 209 active physicians. We have more than 13,000 inpatient, 68,000 outpatient, and 39,000 emergency department visits each year. The FMC service area encompasses all of Northern Arizona, which is composed of five of the geographically largest counties in the United States. These communities are predominately rural, include many Tribal reservation nations and communities, as well as appreciable Hispanic populations. The ability to provide patient-centered care to everyone within our diverse patient population is at the core of Flagstaff Medical Center’s mission.

The NAU Informatics and Computing Program’s emphases on Health and Bioinformatics, Ecological and Environmental Informatics, and Cyber and Software Systems bring many opportunities for collaboration, including possibilities for joint extramural funding. FMC has already participated in extramural funding proposals with the Health and Bioinformatics Informatics and Computing Faculty members (Drs. Hepp and Fofanov), are committed to our joint funding of Dr. Hepp’s faculty position, and look forward to working together in the future. In addition to collaborative research opportunities, we are also happy to participate in program development and refinement through participation in the program’s advisory committee.

Sincerely,

[Signature]

Mark Carroll, M.D.  
Chief Medical Officer  
Flagstaff Medical Center  
Email: Mark.Carroll@nahealth.com
TO: Informatics and Computing Program

FROM: Kiisa Nishikawa, Ph.D.  
Director, Center for Bioengineering Innovation

DATE: August 14, 2015

SUBJECT: Statement of Collaboration/Support for Informatics and Computing Ph.D.

The Center for Bioengineering Innovation (CBI) offers its enthusiastic support for the development and launch of the Ph.D. degree in Informatics and Computing, supported by your program.

The mission of CBI is to build NAU’s capacity to produce nationally recognized basic science discoveries in the area of bioengineering; to transform these discoveries into applications that improve lives and foster economic growth in Arizona and beyond; and to provide cutting-edge training in bioengineering research for undergraduates, graduate students, and post-doctoral scholars who will join the biotechnology workforce.

In partnership with the College of Engineering, Forestry and Natural Sciences, the Department of Biological Sciences, and the Department of Mechanical Engineering, CBI is also launching a new Ph.D. Program in Bioengineering, with areas of emphasis including biomaterials and biomechanics in the broadest sense.

These areas of research have a natural synergy with the research focus of the Ph.D. in Informatics and Computing, in interdisciplinary research that applies computational science to a variety of domains, such as genetic and genomic analysis, population health, remote sensing, ecological modeling, and cyber- and software-centric systems. Indeed, ICP and CBI faculty are already engaged in collaborative work to address the data analysis needs of complex prosthetic devices.

We look forward to working closely with ICP to integrate the development of these new doctoral programs through the creation of a collaborative Bioengineering Informatics emphasis supported through both degree programs. Students in the Ph.D. in Informatics and Computing will be able to focus in this emphasis by taking 18 units of coursework from the Bioengineering program, while students in the Bioengineering program will take at least 12 units of coursework from Informatics and Computing coursework. This interdisciplinary emphasis will provide a concrete mechanism for collaborative ICP/CBI research projects and graduate student training.

We look forward to working with you on the development and coordination of the exciting new opportunities at NAU.
July 24, 2015

Informatics and Computing Program
Northern Arizona University
Flagstaff, Arizona

RE: Support and collaboration for Informatics and Computing Ph.D. Program

To Whom It May Concern:

I write to offer my support, and the support of TGen North, for the development and launch of the Informatics and Computing Ph.D. Program at Northern Arizona University. TGen North is the heart of the Translational Genomics Research Institute’s (TGen) Pathogen Genomics Division, and we work closely with a number of Centers and Departments at NAU. TGen North is focused on diagnostic, analytic, forensic and epidemiologic research related to pathogens important to medicine, public health and biodefense. In addition to NAU, TGen North has many local, national and international research partners, including universities, biotech companies, security agencies, health care providers, and public health departments. TGen North is making great strides in translational pathogen genomic research including: A) the development and validation of novel diagnostic assays for pathogens that cause hospital acquired infections, valley fever, influenza, tuberculosis and others, several of which have been out-licensed or adapted for other labs; B) assisting state, federal and international health authorities in numerous disease outbreaks and criminal investigations; C) conducting early stage drug candidate screening for pathogenic fungi therapeutics; and D) developing multiple bioinformatic software programs for use by internal and external researchers.

With the emphases of Health and Bioinformatics, Ecological and Environmental Informatics, and Cyber and Software Systems, we at TGen North see many opportunities for collaboration, including possibilities for joint extramural funding. In fact, we are already collaborating with the Health and Bioinformatics Informatics and Computing Faculty members (Drs. Crystal Hepp and Slava Fofanov), and we look forward to continuing to work together in the future. In addition to collaborative research opportunities, we are also happy to participate in program development and refinement through participation in the program’s advisory committee. We see the implementation of a Ph.D. program in Informatics and Computing to be a fulfillment of a long sought bioscience and bioinformatics “college to career” pipeline between our two institutions.

Please let me know how I can assist to make this endeavor successful.

Sincerely,

David Engelthaler, PhD
Associate Professor
Director of Programs, TGen North
Translational Genomics Research Institute
July 27, 2015

To Whom It May Concern,

We write to offer our support for the development and launch of the Informatics and Computing Ph.D. program at Northern Arizona University, with emphases that include Health and Bioinformatics, Ecological and Environmental Informatics, and Cyber and Software Systems.

The Northern Arizona Planetary Science Alliance (NAPSA) is a consortium of research institutions in Northern Arizona that is committed to leveraging each other’s strengths to establish a formalized framework for promoting research and education collaboration in the planetary sciences. NAPSA currently consists of representatives from the USGS, Lowell Observatory, the US Naval Observatory, and multiple physical science departments at NAU.

With this new Ph.D. program at Northern Arizona University, we see exciting potential collaboration and joint extramural funding application opportunities with NAU faculty and students in pursuit of the spatial analysis of planetary surfaces, which falls within the Cyber and Software Systems emphasis of the new Ph.D. program.

In addition to collaborative research opportunities, we are also happy to participate in program development and refinement through participation in the program's advisory committee. We are also excited to offer a variety of opportunities for students to become involved in cutting edge science related to NASA’s space exploration program.

Best regards,

Justin Hagerty and Tim Titus
Dr. Kyle Winfree  
Informatics and Computing Program  
College of Engineering, Forestry, and Natural Sciences  
Northern Arizona University  
P.O. Box 5693  
Flagstaff, AZ 86011

Subject: Letter of support and collaboration for Informatics and Computing Ph.D. Program

I write to offer our support for the development and launch of the Informatics and Computing Ph.D. program at Northern Arizona University (NAU) with emphases that include Health and Bioinformatics, Ecological and Environmental Informatics, and Cyber and Software Systems.

The U.S. Geological Survey - Southwest Biological Science Center is an environmental science research organization based in Flagstaff, with additional offices in Moab, Utah, and Tucson, Arizona. Our research efforts can be broadly categorized into two broad themes: dryland ecology and river ecology and restoration. The science we develop assists resource managers, policy makers, and the public understand and respond to the challenges of climate change, human population growth, increasing water demand and decreasing water supply, land use and land cover change, and more. Our research scientists are highly collaborative, and we have partnerships with State and Federal agencies, non-governmental organizations, and universities, including NAU.

With this new Ph.D. program at NAU, we see exciting potential collaboration and joint extramural funding application opportunities with NAU faculty and students across our research portfolio. Our research efforts in the Grand Canyon and across the Southwest are increasingly reliant upon automated, real-time sensor networks; utilize remotely sensed data acquired from land-based, aerial, and satellite platforms; and assess the genetic diversity of the region's native flora and fauna. In each of these areas and others, new tools and technologies challenge us to rethink how we collect, store, manipulate, and most importantly, interpret, the vast quantities of data we can now access. A Ph.D. program in Informatics and Computing at NAU would open the door to new collaborations between the USGS and NAU, and will allow us to develop new insights into the environmental challenges facing Arizona and the entire Southwest.
In addition to collaborative research opportunities, we are also happy to participate in program development and refinement through participation in the program's advisory committee.

Please feel free to contact me at dlytle@usgs.gov or 928-556-7194 if you would like additional information about the Southwest Biological Science Center.

Sincerely,

David Lytle, Ph.D.
Director
July 27, 2015

TO: Informatics and Computing Program Northern Arizona University
FROM: Robert J. Hart, Scientist in Charge, Flagstaff Science Campus
SUBJECT: Letter of support and collaboration for Informatics and Computing Ph.D. Program

I write to offer our support for the development and launch of the Informatics and Computing Ph.D. program at Northern Arizona University, with emphases that include Health and Bioinformatics, Ecological and Environmental Informatics, and Cyber and Software Systems.

The Flagstaff Science Campus of the U.S. Geological Survey (USGS) has staff that represents 5 USGS Mission areas including Ecosystems, Water, Natural Hazards, Climate and Land Use, and Core Science Support. Our scientists work primarily in the southwest U.S. on various environmental issues, but also we work world wide and beyond in the solar system. Our expertise includes hydrologists, ecologists, remote sensing scientists, geophysicists, biologists, computer scientists and analysts, geomorphologists, geologists, and much more. We meet the primary mission of the USGS to provide the Nation with understanding and responding to global change, changes in climate, water availability, land use and land cover, ecosystems, and global biogeochemical cycles.

With this new Ph.D. program at Northern Arizona University, we see exciting potential collaboration and joint extramural funding application opportunities with NAU faculty and students in pursuit of programs that address population health, remote sensing applications, ecological and environmental assessments, and large-scale software development, all of which fall within the three new Ph.D. program’s needs. In addition to collaborative research opportunities, we are also happy to participate in program development and refinement through participation in the program’s advisory committee.

Sincerely,

Robert J. Hart, SIC
USGS, Flagstaff Science Campus
I am writing to offer support from North Country HealthCare for the development and launch of the Informatics and Computing Ph.D. Program at Northern Arizona University. In the age of big data, such as those housed within our medical databases, we see the need for developing analytical skills in future NAU graduate students.

North Country HealthCare is the only publicly supported community health center in the Northern Arizona. In 1996 the clinic transitioned from a volunteer organization into a state and federally recognized community health center. Today we have expanded our services to 14 communities across northern Arizona through 22 clinics. Through evidence based practice and self-management support, we provide a variety of services to our patients.

With the emphases of Health and Bioinformatics, Ecological and Environmental Informatics, and Cyber and Software Systems, we at North Country HealthCare see many opportunities for collaboration, including possibilities for joint extramural funding. In fact, we are already part of an extramural funding endeavor with Drs. Trotter and Baldwin, as well as with the Health and Bioinformatics Informatics and Computing Faculty members (Drs. Hepp and Fofanov). In addition to collaborative research opportunities, we are also happy to participate in program development and refinement through participation in the program’s advisory committee. Finally, North Country HealthCare has made a commitment to teaching excellence, and we can envision graduate students in the Informatics and Computing Program performing internships within our clinics.

Sincerely,

Sean Clendaniel, MPH
Director, NAHEC
Director, Education and Technology
Compliance Officer
September 8, 2015

Dr. Paul Flickkema
Director, Informatics & Computing Program

Dear Paul,

I am writing to express my support for the proposed Ph.D. program in Informatics. I see this as a welcome and timely addition to the Ph.D. programs currently offered by NAU. The investments that will need to be made in this Ph.D. program and the Informatics and Computing Program (ICP) are significant, but I believe they will benefit the university as a whole, including the School of Forestry.

In our case, I see the following possible benefits:

- This Ph.D. program will increase opportunities and capacity for interdisciplinary research between the School of Forestry and ICP. Informatics is an area that can be quite relevant to the practice of forestry and to forestry-related research. The proposed emphasis area in ecological and environmental informatics certainly would be a good fit with our school.
- The increase in informatics capacity should help strengthen some of our faculty’s grant proposals. When seeking external funding this program could be cited as a demonstration of NAU’s commitment to using high technology and analytical tools to support site-specific economic, environmental, and sustainable decision making for the forestry sector.
- There are already examples of strong collaboration between ICP and School of Forestry faculty and staff (e.g., Andrew Sánchez Meador serving on the committees of two of Teki Sankey’s Ph.D. students and the Chambers, Walker, Fofanov, and Flickkema NSF and NIH proposals). Other School of Forestry faculty members also have strong backgrounds in areas that should lead to fruitful collaborations with ICP faculty, staff and students.
- We look forward to exploring new educational opportunities for our own students who might be interested in working at the interface of forestry and informatics.

Thanks for contacting me and sharing information about your proposed Ph.D. program. I am confident it will be approved and that it will have a positive impact on our university.

Sincerely,

James A. Allen
Professor and Executive Director
Subject: ICP PhD program - request for letter of support

Date: Thursday, September 3, 2015 at 4:13:08 PM Mountain Standard Time

From: Stephen Christopher Tegler

To: Paul G Flikkema

CC: Stephen Christopher Tegler

Paul,

I've talked with David Trilling and we are big supporters of your proposed PhD program. I've attached a letter of support. Is this the sort of text you need from us. If not, please let me know and we can work on the words together.

Regards,
Stephen

******************************************************************************

Stephen C. Tegler
Professor and Chair, Physics and Astronomy
Northern Arizona University
Box 6010
Flagstaff, AZ 86011
Phone: (928) 523-9382
Fax:     (928) 523-1371
******************************************************************************

From: Paul G Flikkema
Sent: Wednesday, September 02, 2015 12:33 PM
To: Stephen Christopher Tegler
Subject: ICP PhD program - request for letter of support

Dear Steve,

As I am sure you have heard, Informatics & Computing received approval to develop a full proposal for a PhD program from the PALC in January of this year. In August the PALC met again and approved our full proposal.

In its review, the PALC recommended that ICP obtain letters of support and collaboration from the other units in CEFNS that offer PhD programs. I see this as an opportunity to interact with Physics & Astronomy and the other units, and begin discussions around potential collaborations, including collaborative emphases (such as one already in the works with the Center for Bioengineering Innovation) and cross-listed courses.

I have attached for your review the proposal. I would be happy to meet with you to discuss the proposal, the overall program, or the contents of the letter.

Many thanks,
Paul

—

Paul G. Flikkema, Ph.D.
Real-Time Intelligent Systems and Networks Lab
Director, Informatics & Computing Program
Professor, EECS
nau.edu/CEFNS/Informatics-Computing/
TO: Paul Flikkema, Ph.D.
Director, Informatics & Computing Program

FROM: Stephen Tegler, Ph.D.
Chair, Department of Physics & Astronomy

DATE: September 3, 2015

SUBJECT: Statement of Collaboration/Support for Informatics and Computing Ph.D.

The Department of Physics and Astronomy at NAU offers its enthusiastic support for the development and launch of the Ph.D. degree in Informatics and Computing.

As you probably know, the Large Synoptic Survey Telescope (LSST) is a $1B project to survey the entire visible sky every three nights. It is the informatics project in astronomy for the coming decade. Professor Trilling is the co-chair of a steering committee charged with maximizing the scientific return of solar system data collected with the LSST. In addition, we are hiring a faculty member with an expertise in astro-informatics in the coming years as part of our PhD program in Astronomy and Planetary Science. Also, my own research over the next decade will make use of LSST solar system data. In short, at least three faculty members in the Department of Physics and Astronomy would very much like to closely collaborate with faculty members and PhD students in your program. There is an opportunity to make NAU a major player in astro-informatics. In addition, we would be happy to have Informatics and Computing PhD students enroll in our Astro-informatics class (PHY 520). I have no doubt our PhD students will be interested in taking classes in your graduate program.

We look forward to working with you on the development and coordination of these exciting new opportunities at NAU.
To: Paul Flikkema  
    Director, Informatics and Computing Program  

From: Jason Wilder  
    Associate Professor and Chair, Department of Biological Sciences  

Date: September 7, 2015  

Subject: Letter of Support for Informatics and Computing, PhD  

The Department of Biological Sciences at NAU is pleased to offer its unqualified support for the new PhD program in Informatics and Computing. This new graduate program will create outstanding opportunities for student training and increase research activity in areas closely aligned with existing faculty interests within the Department of Biological Sciences. Moreover, the program will enhance opportunities for interdisciplinary research and forge novel connections between biologists and faculty with specialties in diverse areas of computing and informatics. Many researchers in the Department of Biological Sciences from a broad variety of fields, including ecology, microbiology, cell biology and biomedical sciences all have potential to find common interest with activities that will be part of the new Informatics and Computing PhD program.

In the field of biology it is increasingly the case that the scale of biological datasets far outstrips traditional methods of analysis. This shift has been dramatic and recent, and requires new methods of training in informatics methods for developing scientists. As such, there is a natural synergy between the Department of Biological Sciences and the Informatics and Computing Program. We envision many students pursuing doctorate degrees through ICP to be interested in biological questions that require innovative informatics methods, and we are excited to foster and facilitate relationships that promote this arrangement. We anticipate that Biology faculty will serve on ICP graduate committees for students addressing research with biological dimensions, and expect that such service will mutually benefit researchers in both ICP and Biological Sciences. Moreover, we hope that ICP faculty serve in a similar capacity for our own graduate students whose biological research would be enhanced by expertise in informatics and computing.

Beyond adding new graduate students, the Department of Biological Sciences is enthusiastic about the faculty expansion that has occurred (and will continue to occur) to support the ICP doctorate. Many of these new members of ICP have strong expertise in informatics related to various areas of the biological sciences which complement our existing strengths in fields such as ecology and biomedical research. We are excited by the opportunities that these new faculty will provide in terms of increasing the breadth
and depth of informatics research with possible applications to research questions in biology, the potential to add a new dimension to training of graduate and undergraduate students seeking degrees in Biological Sciences, and for the new possibilities for interdisciplinary collaborative research.

In sum, we are excited to offer our strong support for the development of the PhD program in Informatics and Computing.

Please do not hesitate to contact me if I can be of further assistance.

Sincerely,

[Signature]

Jason Wilder  
Chair, Department of Biological Sciences  
Director, Biomedical Science Program  
Northern Arizona University  
Flagstaff, AZ 86011-5640  
928-523-5286