AO#: 9231

Project Title: Machine Learning Infusion for the Deep Space Network

Background Information: The Deep Space Network (https://deepspace.jpl.nasa.gov/) operates spacecraft communication links for NASA deep-space spacecraft, and has done so for over 50 years. The Complex Event Processing (CEP) sub-project is focused on building next-generation infrastructural tools for correlating real-time network data with other critical data assets which human operators manage on a regular basis.

Description: The task work involves conducting R&D activities in infusing a machine-learning classifier into a real-time stream processing system (Apache Kafka) within an operational setting. The candidate will be responsible for researching best practices in having machine learning classifer software (developed externally) running in a continuous streaming fashion, looking for anomalies in real-time incoming data packets. The candidate will be expected to conduct this research by developing a hands-on integration of a machine-learning algorithm into a real-time processing environment. Knowledge of Python and Java are required.

Suggested/Required Background: - Knowledge of Java and Python programming - Background / preliminary knowledge of machine-learning and classification

References: - Apache Kafka: https://kafka.apache.org/ - Apache Kafka Streams: https://kafka.apache.org/documentation/streams/ - Elasticsearch: https://www.elastic.co/products/elasticsearch

Major 1: Computer Science

Major 2: Computer Science

Other Major:

Hazard(s) if applicable: NONE

End of Record

AO#: 9226

Project Title: PDS Imaging Node: Infrastructure Tools Improvements

Background Information: The Imaging Node (IMG) of the NASA Planetary Data System (PDS) is the home to over 700 TB of digital image archives, making it one of the richest data repositories of planetary imagery in the world. Every day, scientists come up with new ideas for manipulating and studying image data products, and they require tools to make those products standardized and archive-ready. The Imaging Node is responsible for developing those tools and making them available to the public so these scientists can continue to make discoveries.

Description: The candidate will be tasked with leveraging Python and/or Java programming language(s) and 1 or more database management system to implement and enhance tools used by Planetary scientists all over the world to produce archive-ready software products.

Suggested/Required Background: Required: Unix/Linux, Python/Java, SQL. Suggested: Git/GitHub, experience with NoSQL databases, web development, software engineering coursework

References: PDS Imaging Node - http://pds-imaging.jpl.nasa.gov/ . Planetary Image Atlas - http://pds-imaging.jpl.nasa.gov/search/ . (PDS Imaging Node - http://pds-imaging.jpl.nasa.gov/ . Planetary Image Atlas - http://pds-imaging.jpl.nasa.gov/search/ .)

Major 1: Computer Science

Major 2:

Other Major:

Hazard(s) if applicable: Repetitive Motion (Ergonomics)

End of Record

AO#: 9219

Project Title: PDS Imaging Node: Image Atlas Enhancements

Background Information: The Imaging Node (IMG) of the Planetary Data System (PDS) is home to nearly 1 PB of digital image archives from about two dozen different missions, making it one of the richest data repositories of planetary imagery in the world. The Image Atlas is a search tool that is frequently used by scientists and other enthusiasts to find the data they need within our massive archive. The Image Atlas archive is frequently undergoing upgrades to support new imagery, metadata types, and other user needs. These upgrades are frequently driven by user requests, and a streamlined system is needed to bridge the gap between end users and the development team.

Description: The intern will be tasked with developing a service that will encourage user participation in Image Atlas development. The service will have two parts: 1. An interface for users to provide information including, but not limited to, their contact information and comments/suggestions that they would like to provide, and 2. A backend that keeps track of users' contact information and handles automated responses based off of external triggers and other criteria. For example, a user should be able to subscribe to Image Atlas updates, so that they are made aware when features/bug fixes have been released. They should be able to provide feedback about these changes as well. Time willing, the intern will also aid in various tasks related to Image Atlas data releases.

Suggested/Required Background: (Required): Excellent communication skills; Experience in vanilla Javascript, HTML, and CSS; Familiarity with Python and/or NodeJS; Basic understanding of relational databases. (Nice-to-have): Knowledge of the Apache Solr search platform; Experience with Docker deployment in a continuously integrated environment; Experience with Git and GitHub; Comfortable in a Linux environment.

References: https://pds-imaging.jpl.nasa.gov ; https://pds-imaging.jpl.nasa.gov/search ; http://lucene.apache.org/solr/ ; https://www.docker.com

Major 1: Computer Science

Major 2: Information Systems/Technology

Other Major:

Hazard(s) if applicable: NONE;

End of Record

AO#: 9214

Project Title: Monitoring water resources using airborne radar

Background Information: The NASA-ISRO Synthetic Aperture Radar (NISAR) mission has a potential for global soil moisture mapping that will facilitate new science and application areas (agriculture, flood, drought etc). Prior to the satellite launch in 2021, we develop and test the algorithms to derive soil moisture using airborne NISAR-like radar instruments. The results of this research will contribute to NISAR's soil moisture algorithms.

Description: Airborne radar data and in situ soil moisture data were collected in the Arctic region and Australia. With these data, computer models simulating the radar observation will be refined. Soil moisture will be derived using the radar data and will be validation with truth observation. The outcome may produce publication.

Suggested/Required Background: Strong programming skills, electrical engineering, physics

References: https://nisar.jpl.nasa.gov/

Major 1: Electrical Engineering

Major 2: Physics/Applied Physics

Other Major: Computer science

Hazard(s) if applicable: NONE;

End of Record

AO#: 9213

Project Title: Engineering Tool Development for NISAR

Background Information: The NASA-ISRO Synthetic Aperture Radar (NISAR), is a joint mission between NASA and ISRO to develop a dual band synthetic aperture radar (SAR) for satellite remote sensing measurement of the Earth's surface. The instrument will provide an unprecedented detailed view of Earth providing insight to a wide range of scientific research application including land use, water resources, ocean, sea ice, and disaster response. NISAR Radar Engineering team at JPL is responsible for the design, implementation, and testing of the L-band radar. We are seeking for a candidate to support the development of software applications that are essential for instrument testing.

Description: You will work with radar system engineers to develop and utilize software for facilitating instrument testing activities in preparation for system-level Integration and Testing stage, a critical stage for this mission. Depending on experience and interest, you may also support implementation and testing of a data analysis tool for processing and validating engineering data as well as performance evaluation and optimization of the tool.

Suggested/Required Background: - Advanced hands-on experience on Python computing language. Experience on C, C++, MATLAB is a plus. - Working knowledge of Unix. - Experience with Lua programming language and/or LabView is also highly desired. - Knowledge of basic computer science topics such as data structures, algorithm development, modular programming, and unit testing.

References: http://www.jpl.nasa.gov/missions/nasa-isro-synthetic-aperture-radar-nisar/

Major 1: Electrical Engineering and Computer Science

Major 2: Computer Engineering

Other Major:

Hazard(s) if applicable: NONE

End of Record

AO#: 9190

Project Title: Data Management for Astrobiology

Background Information: Astrobiology research is inherently interdisciplinary and thus entails diverse data types and formats. Ensuring the security and accessibility of those data is critical to the research conducted in JPL's Astrobiogeochemistry Lab (the abcLab). The mission of the abcLab is to study the formation, preservation and detection of morphologic, mineralogic, molecular and isotopic signs of life and environment in geologic samples. We seek to understand the co-evolution of living and non-living planetary systems from the earliest evidence for life on Earth to the present. While most of our field and laboratory work focuses on Earth systems, our goal is always to apply what we learn to the search for signs of life and environment beyond Earth. In particular, we seek to develop innovative methods and interpretive contexts to inform the selection, acquisition, potential return and analysis of samples from Mars.

Description: The abcLab seeks a student to assist in the development of an instrument and analytical data management system. The system will provide redundancy and security for all data as well as access to and visualization of diverse data types. This will require familiarity with networking among Windows-based PCs, basic Python programming skills, and some experience with image processing and database programming. Experience working with Amazon Web Services would also be helpful.

Suggested/Required Background: Basic Python, Windows networking, image processing, databases, Amazon Web Services

References:

Major 1: Computer Science

Major 2: Planetary Science

Other Major: Astrobiology

Hazard(s) if applicable: NONE

End of Record

AO#: 9182

Project Title: Entrapment of small molecules in astrophysical and planetary ice analogs

Background Information: The chemical composition of planetary bodies, including those in our own Solar System, is related to that of the icy planetesimals that make-up these bodies and/or enriched them in molecular species at a later stage of their evolution. A key process that regulates ice chemical composition is the ability of water ice to trap volatile species. We propose to study experimentally volatile entrapment by amorphous water ice. The experiments will investigate a wide range of experimental details for carefully chosen molecular systems. This work will improve how astrochemical models address ice-gas partitioning of volatiles, help interpret observation of molecules around protostars, and shine light on the origin of volatiles in planet forming regions.

Description: The intern for this project will perform experiments to study and quantify the entrapment of volatile species (CO2, H2S, COâ€¦) by a H2O ice matrix using (ultra) high-vacuum and cryogenic techniques to grow ices and use mass spectrometry and a microbalance as detection tools.

Suggested/Required Background: Field of study: Physical chemistry, molecular physics, planetary science, or astrophysics. Experience with vacuum systems, microbalance, quadrupole mass spectrometer, and plotting/spectra analysis are desired. Programing skills (python and labview) are a plus.

References: Pontoppidan KM, Salyk C, Bergin EA, Brittain S, Marty B, Mousis O, et al. Volatiles in Protoplanetary Disks. Protostars and Planets VI 2014; :363â€“385. Bar-Nun A, Herman G, Laufer D, Rappaport ML. Trapping and release of gases by water ice and implicatio

Major 1: Planetary Science

Major 2: Chemistry/Chemical Engineering

Other Major: astrophysics

Hazard(s) if applicable: Chemicals,Cryogens,Pressure/Vacuum Systems; CO2, H2S, CO;

End of Record

AO#: 9171

Project Title: Mars Data Analysis

Background Information: The Jet Propulsion Laboratory is seeking highly motivated undergraduate students to participate in Mars data analysis focused on information returned by the Mars Global Surveyor, Mars Odyssey, the Mars Reconnaissance Orbiter spacecraft, the Mars Exploration Rovers and InSight. Data to be studied will be from the Mars Orbiter Camera (MOC), Mars Orbiter Laser Altimeter (MOLA), Thermal Emission Spectrometer (TES), Thermal Emission Imaging System (THEMIS), High Resolution Imaging Science Experiment (HiRISE), the Context Imager (CTX), InSight cameras and instruments of the Mars Exploration Rover Athena Science Payload.

Description: Work will be directed at characterizing the geology and safety of candidate landing sites for future Mars missions, including the NASA Discovery Program, InSight mission and the Mars 2020 Rover. Safety issues focus on quantification of slopes of concern for landing safely in potential landing sites using MOLA data and digital elevation models from stereo images. Work will also be related to measuring rocks on the surface of Mars and understanding their context. This will include analyzing rocks visible in high-resolution HiRISE images and quantifying their size-frequency distribution to better understand landing safety. HiRISE and CTX images will also be georeferenced to lower resolution images (CTX, THEMIS) and topographic maps (MOLA). Additional work may include analyzing craters on Mars to investigate rock distributions in their ejecta, how they change with time and their morphologic state as well as the geomorphology as a clue to the subsurface geology.

Suggested/Required Background: Most of the work will be done on personal computers utilizing mixed operating systems (Windows and Macintosh), so experience with them is important. The ability to measure and tabulate rocks, place the data into standard spreadsheets, and plot the results is required for the work on rock distributions. Experience with ArcGIS mapping software (10.x), especially georeferencing imagery, is preferred as our landing site data is specifically formatted to work with this GIS package. Additional knowledge of Integrated Software for Imagers and Spectrometers (ISIS 3.x), SOCET SET, or Matlab software would be a plus. Preference will be given to students with backgrounds in geology or planetary science and other related disciplines such as geographic information science, physics, chemistry, astronomy, engineering, and computer sciences. The students will spend most or all of their time at JPL. They may be supervised by one or two research scientists and may also work alongside other researchers and students.

References: Information on the Mars landing sites and selection can be found at: Golombek, M. P., et al., 2003, Selection of the Mars Exploration Rover landing sites: Journal of Geophysical Research, Planets, v. 108(E12), 8072, doi:10.1029/2003JE002074, 48pp. Golombe

Major 1: Planetary Science

Major 2: Earth Science

Other Major:

Hazard(s) if applicable: NONE

End of Record

AO#: 9166

Project Title: Office of Safety and Mission Success (OSMS) SharePoint Architect

Background Information: The SharePoint architect intern will assist the OSMS Training Advisory Board, 5XTAG, with the ongoing development of an interactive and dynamic website.

Description: With guidance from a JPL mentor the student intern will lead an internal SharePoint development effort. The student will also develop custom reports in the Learning Management System ("LMS") and link data to the SharePoint site. Responsibilities will include but are not limited to: 1. SharePoint development · Ability to work from concept · Edit/Update existing SharePoint pages and lists · Create new lists, surveys, forms, libraries 2. Custom Report Creation · Utilize/bring in data from other applications (LMS) · Write/build custom reports in LMS and link data to SharePoint 3. Create how-to guides explaining tools/reports built

Suggested/Required Background: Required Qualifications: · Strong written and verbal communication skills and ability to work in a team environment Desired Qualifications: · Experience developing in Microsoft SharePoint · Experience in Learning Management Systems · Experience in custom report writing

References:

Major 1: Information Systems/Technology

Major 2:

Other Major:

Hazard(s) if applicable: NONE

End of Record

AO#: 9162

Project Title: Performance Characterization of Thruster Controllers with Planar Air Bearings

Background Information: Founded in 2015, the Small Satellite Dynamics Testbed (SSDT) is a facility at JPL that supports the development and testing of guidance and control systems for small satellites. The testbed offers three sophisticated development environments: a dynamics simulator, a spherical air bearing platform, and multiple planar air bearing platforms. The testbed has already proven to be a valuable asset to a number of CubeSat projects, as projects such as MarCO, Lunar Flashlight, and ASTERIA have come to the testbed to perform various attitude control testing and simulation support. The lab has also been a pioneer in small satellite sensor and actuator characterization, and an incubator for technology projects similar to the one proposed here. New development efforts are being conducted to expand the capabilities of the SSDT, including a thruster system to enable closed-loop position control and multi-satellite relative motions. This thruster system allows one satellite to maneuver actively around the other on the planar air bearing, as well as to allow various architectures for combining position and attitude control to be tested.

Description: The intern is expected to work closely with other members of the SSDT team to write the necessary software to enable the thruster hardware to interface with the SSDT core software to support the implementation of several control architectures. This process will require writing new control code and any required software hooks that will enable controllers to be tested with the SSDT's thruster system. The intern is expected to conduct incremental tests both to help the coding process and to demonstrate the functionality of the code, culminating in the demonstration of closed-loop maneuvering on the Formation Control Testbed's flat floor. Other tests that are desired include docking approach scenarios in which one satellite is free to drift as the satellite with the thruster system approaches. Each intern will also have the opportunity to work on other systems engineering tasks as part of the SSDT in support of ongoing SSDT improvements. In addition to program-required deliverables, the intern will be expected to present short status updates at weekly team meetings and write a user's guide/readme so that others may use the code.

Suggested/Required Background: SolidWorks CAD modeling required; C, C++, and Matlab programming recommended; mechatronics experience suggested.

References: Sternberg, D., Pong, C., Filipe, N., Mohan, S., Johnson, S., and Jones-Wilson, L., "Jet Propulsion Laboratory Small Satellite Dynamics Testbed Simulation: On-Orbit Performance Model Validation:, JSR, Article in Advance, pg. 1-13, DOI 10.2514/1.A33806. htt

Major 1: Aerospace Engineering

Major 2: Computer Engineering

Other Major:

Hazard(s) if applicable: Pressure/Vacuum Systems,Robotics

End of Record

AO#: 9161

Project Title: Analysis and Archiving of Near- and Mid-Infrared Observations of Jupiter and Saturn

Background Information: Images and spectra of Jupiter and Saturn from visible, near- and mid-infrared instruments are sensitive to temperatures, abundances of a major condensate (ammonia) opacity of clouds and the variability of the molecular para vs. ortho-H2 ratio. These define the fundamental state of the atmosphere and constrain its dynamics. This research will focus on observations obtained from a variety of instruments used at large professional telescopes: NASA's Infrared Telescope Facility, Gemini North and South Telescopes, ESO's Very Large Telescope, and the Subaru Telescope, and the Juno mission images of Jupiter in reflected sunlight from the JunoCam instrument. The general objective of the specific tasks below will be to create fully reduced data from unreduced or partially reduced sets. In some cases, our objective is to format the data for input into an atmospheric retrieval code from which atmospheric properties will be derived.

Description: Several specific topics are available: (1) A major challenge working with the Juno mission's JunoCam images is to assign accurate geometry to them for comparison with other data sets. Our objective is first to create this geometry with a code supplied by the US Geological Survey ("ISIS"). An immediate second objective is to re-map the images into standard Mercator or polar projections, with high priority on images that can address the following scientific investigations: search for and characterize mesoscale gravity waves, characterize atmospheric hazes particularly around polar regions, measure the relative altitudes of cloud features from analysis of their shadows, and characterize the colors of different cloud features. (2) To fulfill a contractual obligation to NASA, we need to archive our thermal infrared observations of Jupiter from various instruments over nearly two decades with NASA's Planetary Data System (PDS). These data must be accompanied by required ancillary files in a specific PDS format. The goal of this work is to collect copies of the data and ancillary files into a single location and submit these to review by the PDS. Aspects of this work can be done concurrently with another student working on the long-term variability of Jupiter (see 5 below). (3) We will be acquiring a large volume of observations of Jupiter that are designed to support observations from instruments on the Juno spacecraft. It will be important to reduce and, to the extent possible, analyze these results to be reported by the mentor and his colleagues to the Juno science team. There are several specific objectives in this overall category. (a) Develop of quasi-automated software for combining Mercator maps derived from images taken at different times as the planet rotates; use these to create full maps of Jupiter over all longitude, as well as to polar project those maps for example - to investigate correlations between different phenomena in the neutral atmosphere and the aurora. (b) Develop a technique for absolute photometric calibration of near-infrared images of Jupiter in the absence of cross-calibration with standard-star calibrations by reference to independent measurements of photometry by spacecraft. (c) Determine the relationship between the morphology of auroral-related stratospheric heating at Jupiter's poles with auroral emission in the ultraviolet and infrared. (d) Measure the distribution of cloud properties in the atmosphere with near-infrared reflectivity, including high-resolution adaptive-optics stabilized images. Use the to characterize the chemistry and dynamics of the atmosphere, e.g. polar hazes, their evolution and their relationship with the temperature and wind field. (e) Develop a means to reduce spectral observations of Jupiter or Saturn to derive spectra at each pixel of the slit; for scanned spectra of this type, develop a means to calibrate the geometric positions of each pixel. (4) Including these and more historical data, track high-altitude particulate wave properties of

Jupiter's North Equatorial Belt to determine whether these waves appear only at the same time as the latitudinal expansion of the dark NEB or also with other planetary-scale atmospheric phenomena. (5) Examine the long-term variability of longitudinally averaged temperatures and other properties in Jupiter, continuing previous work by students to create accurate and self-consistent calibrations of all data from a variety of telescopes. Extend a current program to input longitudinally averaged data over Jupiter's full disk to include observations at facilities where only a northern or a southern hemisphere of Jupiter could be captured. Format these data to be an input to an atmospheric retrieval program. Organize the output of this program to enable rapid plotting and correlation with previous studies and between different retrieved atmospheric properties. (6) Examine the variability of Saturn's longitudinal-mean temperatures as a function of time and compare with existing Global Climate Models.

Suggested/Required Background: The data reduction programs are written in the Interactive Data Language (IDL, which is close to Matlab in format). The analysis code is written in FORTRAN. At least rudimentary knowledge of these (or willingness to learn before the beginning of the research) is highly recommended. At least some programming experience is required of serious candidates. With a significant level of contribution, students are welcomed as co-authors on papers emerging from this research.

References: (1) The JunoCam instrument is described by Hansen et al. (2017) Space Sci. Rev. doi:10.1007/s/11214-014-0079, and initial work on polar region is described by Orton et al. (2017) Geophys. Res. Lett. 44, 4599. (2)(a) There is no published archiving report

Major 1: Planetary Science

Major 2: Astronomy/Astrophysics

Other Major: Computer Sciences

Hazard(s) if applicable: NONE

End of Record

AO#: 9098

Project Title: Holographic Examination for Life-like Motility (HELM)

Background Information: Imagine you fly to Europa, melt some ice, and stare at the liquid under a microscope. Or thick, salty Martian brines. Or the plumes shot out from Enceladus. How would you know what you see in that liquid is alive? You can test for DNA or proteins that mean life on Earth, and there are instruments for that. But what if, instead, you just looked at the movies of particles in the liquid and asked, "Is it moving like life?" Any human could watch and tell you what that meant, but try to write a program to measure it. Instead, we will use humans to provide labels like "This object here is moving like life" and "This object is not." Then we will train a machine learning program to take measurements of the particles and learn, statistically, what the human labelers are talking about. This is HELM, an algorithm that will fly to Europa, Mars, and other worlds looking for signs of life wiggling in the water. It also will be used extensively on Earth, rapidly identifying potentially dangerous organisms in our beach ocean water, lakes, streams, and even within our own blood.

Description: We are developing the above algorithms in Python while keeping our memory and compute requirements very small so that we can fit on rad-hardened space hardware in future missions. But to train our algorithm, we need a LOT of labels. Those are made by humans staring in detail at real data movies taken of known living and unliving things, so that the ML methods can figure out how to determine life from unlife. This position will require helping us label a lot of such images, some each day. You will be embedded in our development team and watch the growth of a real ML system designed for space use, be exposed to real-world ML considerations, challenges, and solutions, and get real science-data analysis experience. But don't be fooled... it takes a lot of work to provide these labels in an accurate, careful manner. You will work at JPL in the Machine Learning & Instrument Autonomy group with flexible hours, meet the group, and make connections across JPL.

Suggested/Required Background: Req: Python programming - Intermediate Req: Statistics - basic Req: Computer familarity - strong Nice: JavaScript experience Nice: Microbiology

References: http://www.caltech.edu/news/building-microscope-search-signs-life-other-worlds-48555
https://www.youtube.com/watch?v=AKHbqOD_OQU
https://www.youtube.com/watch?v=ezyT3gg3YNk

Major 1: Computer Science

Major 2: Mathematics

Other Major: Biology, any Physical Science

Hazard(s) if applicable: NONE

End of Record