PURDUE UNIVERSITY | Center for Artificial Intelligence for Digital, Autonomous and Augmented Aviation

Requirements for Doctoral/Postdoctoral Fellows of AIDA3

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AIDA^3 is a multidisciplinary research center founded by Purdue University and Windracers, a leading cargo drone operator and a developer of the ULTRA unmanned aerial vehicle platform, with opportunities for additional partners dedicated to innovation related to physical AI in aviation. Windracers has donated two of their ULTRA to AIDA3, and AIDA^3 will be using those as part of the research from "lab to life".

The center involves faculty and students from four colleges and one dedicated institute: The Institute of Physical AI, the College of Engineering, the College of Science, and the College of Liberal Arts, and the Polytechnic Institute of Technology. Affiliated faculty from these centers participate in regular meetings and workshops to implement the center's mission to transform airmobility and autonomous aviation with the help of AI/ML. Every year AIDA^3 allocates seed funds to support exceptional candidates to become doctoral/postdoctoral fellows that will advance the research on physical AI for digital, autonomous, and augmented aviation performed by AIDA^3. To qualify as doctoral/post-doctoral fellow, the following requirements need to be met:

1 Alignment with the AIDA3 R&D pillars and "problems-to-solve"

Following the requirements for AIDA^3 doctoral fellowship, your research has to fall within one of the five R&D pillars/thrusts:

(1) AI/ML-enabled human-autonomy teaming for scalable and safe remote UAV operations,
(2) AI/ML for onboard systems advancing UAV autonomy,
(3) AI/ML for aerial transportation and multi-modal supply chain
(4) AI/ML for UAV-enabled meteorological and agricultural sensing,
(5) AI/ML for cybersecurity in autonomous aviation.

In addition, the fellows' research problem statement has to relate to one of the five key practical problems "problems-to-solve"

- #1: 1:100: 1 human operator being able to operate 100 ULTRAs at the same time
- #2: Simple to use: "Standard" human operator 100% proficient after two hours training
- #3: Always flying: 70% asset utilization
- #4: Sensing dynamically without constraints
- #5: Attack resilience: No outsider can take control

Fellows working on #1 should align their research with the following vision statement.

Year 1 Vision Statement (2024): "2 humans safely operating 15 night vapors remotely from taxiing to landing and delivering paper clips between multiple locations"
Year 2 Vision Statement (2025):"2 humans safely operating 15 ULTRA in multiple airfields remotely from taxiing to landing and delivering payloads between multiple locations outside of controlled airspace"

If the fellows tackles another problem statement, a new vision statement can be proposed as part of the application process (see section 6).

2 Interdisciplinary research and alignment with IPAI vision

AIDA^3 is a key product of Purdue's Institute of Physical AI, and thus, adopts and aligns with IPAI's mission to pursue interdisciplinary research. AIDA^3 fellows are expected to perform interdisciplinary research spanning multiple disciplines and fields directly relevant for physical AI in the context of UAVs and remote UAV operations: such as machine learning/deep learning, control theory, cognitive science/neuroscience, aeronautical engineering and aerodynamics, aerospace but also operations research, network science, computational linguistics meteorology, and others. Thus, we require their committee to be interdisciplinary and involve faculty affiliated with AIDA^3 from different disciplinary backgrounds and also different colleges/schools/departments at Purdue University. Co-advisory by two faculty members from two disciplines (and also different colleges/schools/departments) is preferred following IPAI's mission for interdisciplinary research but not required.

3 Expectation of scientific thought leadership and publication policy

AIDA^3 encourages scientific excellence and seeks to establish its fellows as scientific thought leaders. Thus, the doctoral and post-doctoral researchers are encouraged and expected to demonstrate the scientific novelty of their research through scientific publications in leading conference proceedings (e.g. in AI/ML at NeurIPS, ICML, AAAI or robotics in ICRA, IROS, or ACM CHI and collective intelligence in the field of human factors in computer systems and AGL in computational linguistics and LLMs) and journals (E.g. Science, Nature, PNAS for interdisciplinary journals, JMIR for Machine Learning, IEEE Transactions on Automatic Control for Control Theory, Informs Operations Research, Information Systems Research, MISQ in information systems and decision sciences, etc.) related to the research topics pursued within AIDA3. As part of their 2 years research plan developed at the beginning of their fellowship, fellows are asked to include a publication plan that is convincing in terms of scientific merit. The publication plan should balance both quality and quantity and align with the candidate's scientific fields.

Doctoral students pursuing a PhD program during their fellowship are expected to align their doctoral research with the research performed as a fellow. In such cases, the research is typically an integral part of the doctoral thesis submitted and defended at the end of the PhD program. Other forms of alignment may also be considered. In such cases, the students are still expected to make sufficient time to publish the research produced as fellow students.

Following the center's governance policy, all publications need to be submitted for review to the governance council members of AIDA^3 , including representatives from Windracers and Purdue. The consortium agreement expects a review period of 30 days prior to the planned submission.

4 Expectation of intellectual property developed under AIDA3 center-funded projects

All intellectual property developed during the course of the Doctoral/Postdoctoral fellows appointment will be subject to the Purdue University Intellectual Property Policy (Policy I.A.1) and managed in accordance with the AIDA3 Consortium Membership Agreement.

Purdue's intellectual property policy requires all fellows to disclose intellectual property to the Office of Technology Commercialization Office, comply with instructions regarding custody and protection of Purdue intellectual property (IP) and execute a general assignment of title for Purdue IP in accordance with this policy's supporting procedures. Disclosures should be discussed with the project principal investigator and submitted via the disclosure portal (https://purdueinnovates.org/otc/disclosure/).

Center-funded research project IP will be managed under the AIDA3 membership guidelines. The term "Intellectual Property" or "IP" includes the following:

a. Inventions and any associated patent applications or patents;
b. Copyrightable works and any associated copyright or copyright registrations;
c. Trademarks and any associated registrations;
d. Research data;
e. Trade secrets; and
f. Integrated circuit mask works (i.e., layout-designs (topographies) of integrated circuits).

All background IP created prior to the center-funded project or developed independently from the center-funded project that is used or incorporated into a center-funded project is required to be identify in the project approval form or be separately communicated to the AIDA3 leadership to ensure it won't impact anticipated results of the center-funded project or infringe on others rights.

Purdue shall own all IP which results from a center-funded research project conducted by Purdue for which they are the sole inventor. Each other consortium member shall own all IP which results from a center-funded research project conducted by that member for which they are the sole inventor. IP developed jointly by multiple consortium members in the course of conducting a center-funded research project shall be jointly owned by the members who are determined to be a contributing inventor. Such members shall have an equal undivided interest in the intellectual property rights.

The Consortium Governing Council (CGC) shall manage the communication and oversight of IP rights to the member institutions. Each member institution will be granted non-exclusive license to all center-funded project IP in accordance with their membership level defined in the Consortium Membership Agreement

5 Broader impacts: From lab to life

The fellowship aims to implement Purdue's vision "from lab to life" and ensure that research translates into technical artifacts and applications that make real-world impact. The vision is that physical AI translates into actions in the real world. This principle will be implemented in the following way.

First, all fellows have the unique opportunity to design AI/ML experiments and studies that balance scientific rigor with realistic environments, e.g. when collecting data to train and validate a ML/AL model. For example, fellows working on cognitive modeling to sense a remote operator's cognitive state in real-time using deep learning models trained on physiological data collected via multiple sensors (EEG, eye-tracking, etc.) during human subject experiments are expected to move from abstract experiments to realistic set-ups where remote operators performing realistic simulated missions or actual "real" missions. In a similar way, data collected to train an onboard sensing algorithm for navigation using computer vision, Lidar, GPS, and other air traffic information are expected to be based on realistic experiments allowing the collection of ground truth data for validation.
For all such experiments, the fellows have access to unique facilities of AIDA, such as the indoor testing facility PURT, the smart operations center for remote operations, and our outdoor operations for operating

the ULTRA vehicle. Further, they can create synthetic data collection environments, e.g. using the mixed-reality environment and digital twin of PURT.

Fellows are expected that their research translates into technical artifacts that can be incorporated into the existing software and hardware stack of ULTRA. For example, fellows have the opportunity and are expected to produce modular software code, and algorithms that integrate well with the existing remote operations software used for operating AIDA3s UAVs, including the Windracers cloud/ground control software, or the remote operations software used for other aerial vehicles used as part of AIDA. In addition, fellows working on pillar 2, are expected to produce AI/ML models and algorithms that can be tested and integrated with existing autopilot of the ULTRA and its revisions, as well as other widely used OSS autopilots (Ardupilot, PX4).

Finally, fellows and their advisors are expected to closely collaborate and exchange with the industry partners or other stakeholders (e.g. end-users) involved in their specific "seed funded" project. Such participation takes place in regular research meetings, coordinated by the leadership of AIDA3, typically also involving an engineer or scientists familiar with the industry partners technical and business problems. Such individuals may either work for the industry partner (e.g. Windracers) or are Purdue employees that have been assigned by the industry partner to represent their industry perspective.

6 Selection and project specification process

The process for selecting and specifying seed-funded research projects can be implemented via a bi-yearly RFP solicitation process or "pop-up" processes, i.e. selection processes taking place at any point of time during the year via informal brainstorming sessions with the AIDA^3 leadership team. The formal process will take place via an interactive project specification process combining an invitation to attend interactive town halls (potentially also with breakout groups) with the preparation of a research proposal and a formal application for an AIDA^3 fellowship position. The process can be virtual or in person. Participants can be open to all faculty or by invitation only. The "pop-up" process takes place informally based on brainstorming sessions taking place at any point of time between the applicant, his/her advisor, and the AIDA^3 director and/or other core faculty. In all cases, the proposed project and the candidate typically goes through a selection process, involving a committee and/or voluntary reviewers among the AIDA^3 faculty as well as Windracers representatives. The final project plan will be reviewed by the AIDA leadership team to ensure alignment with the overall project portfolio, the problems' to solve, and the vision statement. The key selection process steps are:

1) Step 1: Fellow candidacy based on evaluation of CV, motivation letter, and other evidence (e.g. shared via GitHub)
2) Step: Fellowship approval based on review of a submission of a research proposal/research plan (max 5 pages including references) developed by the fellow and his/her advisor in collaboration with the AIDA^3 director during the process described above. The plan should contain:
    a. Problem statement articulating the alignment with the problem's to solve, the vision statement. It should also articulate the practical and the scientific research gap and the research aim/objectives (and research question).
    b. Proposed AI/ML Method and approach
    c. Activities and timeline with milestones (at least semester based)
    d. Expected outcomes/deliverables: scientific artifacts to be published (data, papers, source code/algorithms) along with publication plan
    e. Broader impacts and "lab to life" plan: Documentation of how the research will be translated into tangible outcomes that transform real-world operations; specifically, it should demonstrate how the research tackles the problems-to-solve through

demonstrations (e.g. in alignment with the center's vision statement for the #1 problems-to-solve or the proposal of a new vision statement for another problem area).

f. Plan/opportunities for future funding (e.g. potential grant applications leveraging the seed funding)

7 Funding and performance review

The center' seed funds combining contributions from Windracers as well as Purdue's colleges, will support graduate fellows as research assistants with an academic or fiscal year appointment. Their salary will be aligned with their home department's salary, and based on their experience level. Postdoctoral fellows will receive a competitive salary in alignment with IPAI postdoctoral salary ($70,000 K per year) above the minimum pay for post-doctoral fellows. Further, fellows will receive support for their research, such as human subject payments, equipment costs, subscription services. Such expenses need to be justified and require approval. Further, fellows can receive support for national conference travels, and in some cases, also a trip to the UK to visit Windracers UK, if justified (e.g. a successful presentation of an accepted paper at a leading conference).

Seed funding is committed for one year, with the goal to renew funding after one year for at least a period of 2 years. The goal is to supplement seed funding with external competitive grant funding as soon as possible to sustain doctoral students funding until graduation. In exceptional cases, shorter funding periods will be granted (e.g. doctoral students in their final year etc.)

Fellow's research progress will reviewed on a regular basis: 1) based on progress reports during regular (typically weekly/bi-weekly) research meetings and/or other forms of asynchronous communication of progress involving their advisors, other research team members related to the project as well as the professional staff of AIDA (e.g. the managing director and AI/ML software engineer), and 2) larger virtual "town hall" meetings involving faculty working on another tasks and pillars, along with representatives of Windracers, and other stakeholders, as well as in-person AIDA mini-conferences/luncheons with poster sessions and presentations by the fellows and their advisors. Further, fellows are expected to continuously share their source code using state-of-the art software development environments like github, and implement code-review practices to realize high quality technical artifacts.

Prior to the start of their research, fellows are asked to present a 2-years project plan with detailed research activities (work packages), timelines and deliverables (scientific publication, source code, algorithms, hardware, etc.). The project team will review the performance based on this 2-year timeline.