Advances in Programming Languages and Neurosymbolic Systems (AIPLANS)

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Tagline: AIPLANS: a new workshop at NeurIPS 2021 fusing ML with programming theory to create neurosymbolic program-writing machines! `https://aiplans.github.io`

Neural information processing systems have benefited tremendously from frameworks for automatic differentiation (AD). These frameworks are **programming languages** (PLs) which consist of differentiable and stochastic primitives. When composed to form a neural language model, such systems are increasingly capable of generating symbolic programs a human programmer might write in a high-level language. However, developing **neurosymbolic systems** [20] for automatic program synthesis will require insights from both statistical learning and programming language research. AIPLANS welcomes researchers building PLs and neurosymbolic systems of various forms, e.g.:

- **Machine learning researchers** would present advances in meta-learning, reinforcement learning and program synthesis. AIPLANS would afford these participants an opportunity to learn about new automatic programming languages and techniques for inference.

- **Language designers** would be able to give tutorials on newly developed software such as JAX, DEX, PyTorch and their latest features. AIPLANS would give them an opportunity to engage their users and stay in touch with the community's needs and research directions.

- **PL theorists** would present fundamental theory behind the design of automatic programming languages, such as functional, semiring or array programming. At AIPLANS, they would gain a better understanding of practical research problems the ML community is tackling.

- **Probabilistic programming researchers** would present progress in a long history of extending programming paradigms (e.g. functional or logic programming) to handle learning and uncertain reasoning. AIPLANS would provide them with new insights for extending these (often symbolic) languages with primitives for expressing neural models.

Prior workshops [20, 21, 22, 10, 19] have explored these topics separately, but few have highlighted the synergies between them. Due to the historical disconnection between ML and PL, many ideas were independently rediscovered. AD was itself invented at least half a dozen times over the last century [4] and research continues to reveal unexpected connections to implicit differentiation [8], bilevel optimization [18], optimal control [16], differential equations [7] and stochastic processes [14]. Semiring programming [12] has existed for many decades and shares deep connections to reinforcement learning [2], graphical models [17] and probabilistic programming [5]. Other examples abound.

Likewise, many recently-transplanted ideas in machine learning are catechism in the programming language literature [9]. For example, functional and type-safe programming are lingua franca in PL circles but relatively new to Python, the primary language used in machine learning. The duality between code and data is well-known in PL under the aegis of homoiconicity [1]. PL theory has thought carefully about categorical semantics [3], process calculi [6], linear logic [11], type theory [15], algebraic data types [13] and other deeply useful concepts which remain, to this day, largely unfamiliar to the machine learning community. A joint workshop such as the one put forth in this proposal could help to reveal yet-unrealized research connections awaiting rediscovery.

Proposed Workshop Logistics

AIPLANS will be a one-day workshop hosted online, enabling an economically and geographically diverse audience to participate. Talks will be hosted in English, following the standard format of oral presentations and panel discussions, to be concluded with a virtual poster session. Proceedings will be non-archival. Outside of standard videoconferencing and SlidesLive assistance, we anticipate no other technical requirements. If accepted, we expect to receive a hundred or so participants, including speakers and workshop submitters, based on attendance at similarly-themed workshops in prior years. A partial list of speakers who have confirmed their presence (pending workshop acceptance) follows:

Marie Kerjean (LIPN)   Joshua Tenenbaum (MIT)   Gail Weiss (Technion)

Ryan Adams (Princeton)   Alexander Rush (Cornell)   David Duvenaud (Toronto)

The workshop itself will run for approximately eight hours during daylight saving time on five continents, and feature up to four 45-minute keynote talks and up to six 20-minute contributed talks. In addition, AIPLANS will solicit four-page paper submissions in a CFP to be circulated pending workshop acceptance. To encourage submissions from the broader ML/PL community, accepted authors will be given an opportunity to showcase their work in a virtual poster session or lightning talk for outstanding contributions. We expect to receive 20-30 submissions in total, and pledge that each paper will receive at least two fair and independent reviews. To minimize potential conflicts of interest, AIPLANS will manage submissions via the OpenReview conference management system.

Those who traditionally publish in venues such as SIGPLAN, SIGSOFT and other ACM venues are encouraged to submit work that may be considered relevant to the machine learning and reasoning community, provided that effort is taken to ensure its accessibility. Special consideration will be given to didactic submissions of outstanding clarity. Further information, including evaluation criteria, examples of relevant literature, deadlines and workshop logistics will be provided for reference.
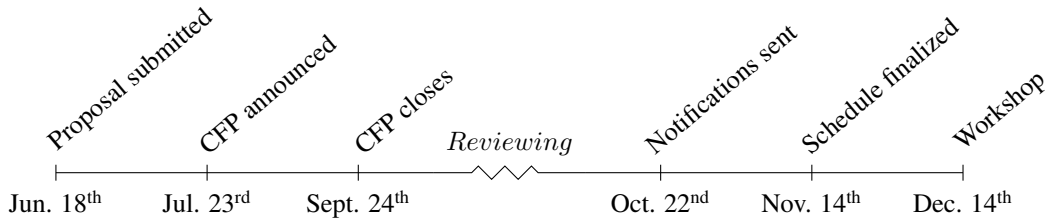

Figure 1: A tentative timeline for our proposed workshop at NeurIPS 2021.

If accepted, AIPLANS will announce its CFP and pursue contributions from the broader ML/PL community shortly thereafter. Two months later, the CFP will close on Sept. 17th. This deadline may be extended to no later than Sept. 24th, depending on the volume of submissions received, leaving sufficient time for referees and program chairs to leave feedback. Authors will be notified of acceptance no later than Oct. 22nd. We intend to finalize the schedule and coordinate presentation logistics between Nov. and Dec. 14th. Those who wish to prerecord talks will be given an opportunity to do so. The final workshop will consist of prerecorded and live talks with Q&A, followed by a moderated panel, and virtual poster session hosted on Gather.town. Further details about schedule and logistics will be made available, pending acceptance at: `https://aiplans.github.io`.

AIPLANS is an equal-opportunity workshop that celebrates cultural, linguistic, ethnic and intellectual diversity in all forms. Not only are we committed to nondiscrimination on the basis of, e.g., race, creed, age, gender, orientation, physical or mental handicap, but also aim to encourage individuals from other disadvantaged and underrepresented socioeconomic backgrounds to participate. Should our workshop be accepted, scholarships covering the cost of registration will be extended for those who wish to attend but would otherwise be unable to do so due to financial hardship. If needed, AIPLANS may pursue industry sponsorship for this initiative to enable a wider audience to attend. Further details about registration and funding availability will be provided in a timely manner.

Confirmed Workshop Organizers
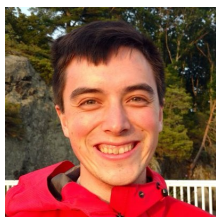
Breandan Considine is a Ph.D. student at McGill University co-supervised by Jin Guo and Xujie Si. His research studies how to reason about the behavior of real-world programs and use those insights to build more intelligent programming tools for developers. This year, he organized the Computer Calculus RG and co-organized the ICLR workshop, Rethinking ML Papers. Breandan is enthusiastic about AI as a tool for augmenting human reasoning and eager to help bring together PL and ML researchers at AIPLANS.

⌂ https://breandan.github.io 🐦 @breandan

Disha Shrivastava is a Ph.D. student at Mila, working with Hugo Larochelle and Danny Tarlow. She also works part-time at Google Brain, Montreal as a Student Researcher. Earlier, she worked at IBM Research, India as a Research Software Engineer for two years on unsupervised construction of knowledge graphs, metrics for computational creativity and topical coherence. Disha's current research studies code representation learning, program synthesis, meta-learning, out-of-distribution generalization, structured prediction with discrete latent variables and reasoning-based systems for QA tasks. She has co-organized the ML for Creativity workshop at KDD 2017.

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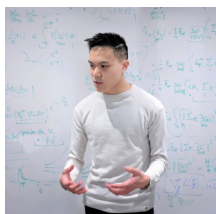
David Yu-Tung Hui is a M.Sc. student at Mila, Université de Montréal, co-advised by Pierre-Luc Bacon and Aaron Courville. David researches the design of software enabling (robotic) agents to follow procedural instructions in natural language or code. He helped develop the BabyAI environment to investigate instruction following and helps maintain the GitHub repository.

⌂ https://dyth.github.io 🐦 @dythui

Chin-Wei Huang is a Ph.D. candidate at Mila, Université de Montréal. He primarily works on likelihood-based generative models and efficient algorithms for approximate inference. He is the lead organizer of the Workshop on Invertible Neural Networks, Normalizing Flows, and Explicit Likelihood Models at ICML (2019-2021) and has contributed to the development of efficient likelihood and unbiased gradient estimation of Convex Potential Flows and Score-Based Diffusion Models using automatic differentiation.
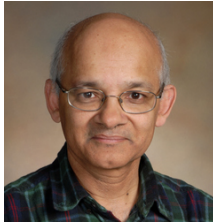
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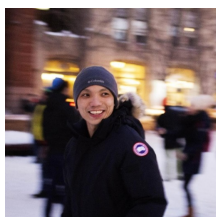
Shawn Tan is a Ph.D. candidate at Mila, Université de Montréal. He is interested in differentiable methods for structured prediction, specifically in the domain of natural language. He co-authored the Ordered Neurons paper which won best paper at ICLR 2019.

⌂ http://blog.wtf.sg 🐦 @tanshawn

Confirmed Program Committee

Prakash Panangaden is a Professor at McGill University. He has three research areas: (a) semantics and logics for probabilistic systems and languages (b) machine learning and (c) quantum information theory. His research studies the approximation of continuous-state systems and associated metrics and logics. He is working on a quantitative extension of equational logic for approximate equational reasoning. Prakash has recently begun working on diffusion and similar continuous-time Markov processes.

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Xujie Si is an Assistant Professor and Canada CIFAR AI Chair in the School of Computer Science at McGill University and at Mila - Quebec AI Institute. He finished his Ph.D. in Computer and Information Science at the University of Pennsylvania in 2020, advised by Prof. Mayur Naik. Xujie received his M.S. in computer science from Vanderbilt University in 2014, before which he obtained his B.E. (with Honors) from Nankai Unversity in 2011. He spent the summer of 2019 as a research scientist intern at DeepMind working with Pushmeet Kohli in the Robust AI team.

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Stefan Monnier is interested in the design and implementation of strongly typed programming languages. He sees a future where all programming is done in type safe languages or in assembly supplemented with safety proofs. He is also interested in investigating what such a future means in terms of how we distribute the work between compilers, runtime systems, operating systems and computer architecture. For this reason Stefan's main focus has been at the intersection between type-safety and memory-management.

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Danny Tarlow is a Research Scientist at the Google Brain team in Montreal. He is primarily interested in machine learning methods for understanding and generating programs, but has broad interests across Machine Learning. Danny is also an Adjunct Professor in the School of Computer Science at McGill University and an associate member at Mila, where he co-supervises a couple PhD students. He holds a PhD from the Machine Learning group at University of Toronto (2013) and before coming to Montreal, spent four years as a postdoc and then researcher at Microsoft Research, Cambridge.

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Guy Van den Broeck is an Associate Professor and Samueli Fellow at UCLA, in the Computer Science Department, where he directs the Statistical and Relational AI (StarAI) lab. His research interests are in ML (Statistical Relational Learning, Tractable Learning), Knowledge Representation and Reasoning (Graphical Models, Lifted Probabilistic Inference, Knowledge Compilation), Applications of Probabilistic Reasoning and Learning (Probabilistic Programming, Probabilistic Databases), and AI in general.

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Christine Tasson's research areas are at the boundary of Computer Science, Mathematics and Logics. She is interested in denotational semantics and its applications to distributed systems and functional probabilistic programming. Christine did a PhD in semantics of programming languages using topological vector spaces. She has then turned to combinatorial semantics of distributed systems and to probabilistic programming.

⌂ https://www-apr.lip6.fr/~tasson/

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