Alexandre Kirchmeyer

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EDUCATION

Carnegie Mellon University – *Pittsburgh, PA*   *Sep. 2022 – Dec. 2023*
M.S. in Machine Learning   ***QPA: 4.06/4.0***
École Polytechnique – *Palaiseau, France*   *Aug. 2019 – Aug. 2022*
M.S. in Mathematics and Computer Science   ***GPA: 3.90/4.0***

EXPERIENCE

Research Assistant – *advised by Prof. Jia Deng, Princeton University*   *Mar. 2022 – Aug. 2022*
Researched the use of a novel oriented 1D convolution operator, to improve the long-range scaling of CNNs at linear cost.
- Implemented personalized CUDA kernels from scratch which are up to 1.5x faster than PyTorch 1D and 30x faster than 2D.
- Trained first state-of-the-art fully 1D ConvNeXt model, demonstrating that our 1D approach can match 2D on image classification, semantic segmentation and object detection. 1st author publication at ICCV 2023. [paper][poster][code]

Research Assistant – *advised by Prof. Deepak Pathak, Carnegie Mellon University*   *Dec. 2022 – Present*
Investigated the use of diffusion models for zero-shot 3D reconstruction from one image using a DreamFusion approach.
- Created 100k multiview synthetic dataset by generating partial point clouds with StableDiffusion/MiDaS and doing inpainting.
- Fine-tuned StableDiffusion on synthetic data with LoRA/ControlNet/InstructPix2Pix conditioned generation. [report][code]
Exploring sim2real transfer and perception for the task of catching dynamic objects in the context of embodied AI.
- Training RL catching policy in simulation (80% success rate) and transferring to real-world via policy distillation.
- Perception using 3D vision (point cloud, depth, SDF), supervised by dexterous grasping (DexGraspNet losses, eigengrasps).

Research Assistant – *advised by Prof. Andrej Risteki , Carnegie Mellon University*   *Jul. 2023 – Present*
Analyzing the trade-off between masking and downstream performance in language models using statistical tools.

Research Assistant – *advised by Pr. Maks Ovsjanikov, INRIA, Ecole Polytechnique*   *Sep. 2021 – Mar. 2022*
Examined the use of hyper-networks and deformed implicit fields for the task of non-rigid 3D shape correspondence.
- Re-implemented Microsoft DIF-Net on JAX and evaluated shape correspondence performance on KeypointNet dataset.
- Devised hybrid correspondence approach, halving error threshold to achieve 50% keypoint accuracy. [report][code]

Research and Development Intern – *HarfangLab Cybersecurity Startup*   *Jun. 2021 – Sep. 2021*
Implemented HarfangLab's first intrusive antivirus method to detect malicious behavior using DLL injection and API hooking.
- Designed a C++ Windows driver from scratch and automated testing of 10+ malicious behaviors using virtual machines.

PROJECTS

Carnegie Mellon University   *Sep. 2022 – Dec. 2022*
Introduced concepts to improve model robustness on visual question answering – *advised by Prof. Louis-Philippe Morency*
- Proposed to use concepts (color, ...) to improve downstream performance in a teacher-student setup: first train concept teachers with a multimodal knowledge base, then train students with pseudo-labels from teachers and multi-task objective.
- Mined unsupervised multimodal concepts with prefix tuning & contrastive learning, and analyzed explainability with clusters.
- Introduced diffusion-based synthetic causal interventions as data augmentations on the Visual7W dataset. Measured the sim2real and causal gaps and showed that causal interventions improve robustness on the ViLT model by 10%.
- Selected as one of the two *Best Midterm Presentation* for the course out of 24 groups. [report][poster][code]
Generated multi-agent trajectories with diffusion models to improve self-driving multi-agent trajectory planning policies.
- Trained a diffusion and VQ-diffusion model on the task of multi-agent trajectory generation and experimented with different samplers. Experimentally observed that continuous diffusion and deterministic samplers generated better trajectories.
Explored the use of zero-shot vision foundation models for determining driving intent for self-driving applications.
- Fine-tuned a YOLOv8 object detector and evaluated zero-shot vision foundation models like DETIC, Grounding DINO and ODISE on the task of identifying rear vehicle signals.

SKILLS

Programing Languages: C, C++, Python, CUDA, JavaScript, OCaml, Lua, Java, OpenGL, OpenCL, Vulkan, SQL
Software: PyTorch, JAX, ArchLinux, ROS, ReactJS, Slurm, Git, LXC, WandB, transformers, diffusers, IsaacGym, Cutlass

RELEVANT COURSEWORK

Machine Learning (PhD)	*Competitive Programming*	*Computer Vision (PhD)*	*General Algebra & Galois Theory*
Natural Language Processing	*Convex Optimization (PhD)*	*3D Computer Vision*	*Real Analysis & Variational Methods*
Reinforcement Learning (PhD)	*Probabilistic Graphical Models (PhD)*	*Multimodal ML (PhD)*	*Advanced Quantum Physics*

AWARDS

- *Ranked 4th out of 107* at the ACM ICPC SWERC 2020-2021 European Algorithmics Contest   *Mar. 2021*
- *Ranked 3rd out of 12* at the ICPC Ecole Polytechnique Championship 2020   *Jun. 2020*
- *Ranked 8th out of 62* at the French-Australian Regional Informatics Olympiad 2017   *Mar. 2017*
- *USACO Platinum* level   *Dec. 2016*

PUBLICATIONS

- **Alexandre Kirchmeyer**, Jia Deng, *Convolutional Networks with Oriented 1D Kernels,* ICCV, 2023. [paper] [code]