PIERRE-LUC DROUIN
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PROFILE

I am a senior developer and modeller with an academic background in modelling, data analysis and optimisation through engineering and applied physics degrees, and I have over 25 years of C, C++ programming experience and over 23 years of experience working with Linux and BSD-based operating systems. I have significant experience working on simulation, modelling of physical systems and optimisation for different domains (detection, localisation, imaging, networking, signal processing, health science, etc.) and on control systems through different projects as well (PID, engine management, home automation). I also have experience with low level development for embedded applications, kernel and hardware drivers, and circuit designs.

SKILLS

- Extensive experience developing C, C++ software, including for embedded devices on ESP32, ARM, AVR.
- Expert in system modelling and simulation by training and professional experience.
- Bayesian and frequentist statistical inference/optimization.
- Circuit design (KiCAD) and analog simulation (Spice).
- Cloud development experience using Python/NodeJS on Docker/EC2/ECS.
- Fully competent FreeBSD, OpenBSD and Linux system and cluster administrator.
- Code development and implementation using C, C++, Python, Java, F77, Perl, SQL, PHP and shell scripting for various types of applications, including networking. Assembly experience.

EDUCATION

Ph.D. in High Energy Physics **2011**

Carleton University, Ottawa (Ontario)

B.Sc. in Engineering Physics (specialisation in photonics**)** **2004**

Université Laval, Québec (Québec)

WORK EXPERIENCE

Defence Scientist **2014-present**

Defence Research and Development Canada, Ottawa

- Development of a statistical model and simulation software (C) to perform procurement prioritization, given importance and urgency metrics for the requests.
- Development and use of a Monte Carlo simulator (Python) to assess cost/effectiveness and perform an associated sensitivity analysis for some preventive medicine to be offered to the armed forces.
- Development, building and deployment of backend (Python) and frontend (NodeJS), using Docker, EC2 and ECS services for a disease point prevalence model.
- Development, implementation and simulation of outbreak statistical propagation models.

- Development of software and firmware code for monitoring and exploitation of Internet of Things devices and networks.
- Reverse engineering of unmanned aerial system signal through development of algorithms, software-defined radio (SDR) code and firmware.
- Development and integration of detector localisation (GPS) and orientation (AHRS) capabilities into a radiation source localisation system (including development and implementation of device drivers).
- Development and implementation of a source localisation algorithm on a robotic platform for a project with MacDonald, Dettwiler and Associates (MDA).
- Development, implementation and optimization of a multi-threaded imaging algorithm for a Compton imaging detector project.
- Hiring and supervision of contractors, undergraduate and graduate students.
- Evaluation of special nuclear material detection performance of various detection systems through Monte Carlo simulation.
- Development of statistical models for the imaging of radiation sources and the scanning of containers.

Technical environment: C, C++, Pthread, Python, freeRTOS, Linux, GCC Tool chain, Embedded systems, Git, shell scripting, Real–time, USB, I2C, SPI, UART, JTAG, EEPROM, interrupt handlers, GPS, AHRS, parallel computing, micro–controllers, SDR, IoT, NodeJS, AWS, EC2, ECS, statistical modelling and inference/optimization, Monte Carlo simulation, MCMC.

Research Engineer **2013-2014**

Science and Engineering Directorate, Information, Science and Technology Branch, Canada Border Services Agency, Ottawa

- Monte Carlo simulation of neutron source detection using the Geant4 portal model.
- Participating to the radiation detection network as an on-call expert.
- Calibration of deployment of radiation portal monitors.
- Radiation portal monitor modelling using Geant4.
- Evaluation of the detection efficiency of different neutron detection technologies.
- Evaluation of a new generation of radiation portal monitors.

Technical environment: C, C++, Linux, GCC Tool chain, SVN, statistical modelling and inference, Monte Carlo simulation, detector calibration and modelling.

Senior Researcher (Postdoctoral Scholar) **2010-2013**

Calian Technologies Ltd, Ottawa

- Modelling, implementation, simulation and laboratory testing of a novel radiation source localisation and activity measurement software, based on the statistical combination of data from an arbitrary number of detectors.
- Modelling, simulation and sensitivity evaluation of current and future gamma ray standoff detection technologies for an international task force.
- Testing and simulation of different radiation standoff detection technologies.
- Design, development and implementation of radiation detection in the OneSAF simulation software.
- Design, development and optimization of a reconstruction tool for a detector of special nuclear material at the borders, using a Bayesian estimator to reconstruct cosmic ray muon momentum.
- Overhaul and redesign of a probabilistic risk assessment tool in Java for threats from radiological emission devices and radiological dispersion devices.

Technical environment: C, C++, Pthread, Java, Linux, GCC Tool chain, SVN, shell scripting, parallel computing, Bayesian statistical modelling and inference/optimization, Monte Carlo simulation, MCMC, probabilistic risk assessment.

Graduate Research Assistant **2004-2011**

Sudbury Neutrino Observatory (SNO) Experiment, Physics Department, Carleton University

- Design, implementation, optimization and extensive testing of the multi-threaded, SQL database-driven, parallelized C++ signal extraction package used as the main data analysis tool for the final solar neutrino paper of the SNO collaboration.
- Modelling and optimization of the final extended likelihood function used for signal extraction.
- Design, development and optimization of the vertex reconstruction engine used as the primary reconstruction tool for the third phase of the SNO experiment.
- Study of vertex reconstruction systematic uncertainties using the SNO simulation package, custom Monte Carlo methods and calibration data.
- Modelling and improvement of statistical distributions used for vertex reconstruction and signal extraction.
- Participation to the calibration of the detector through the deployment and data analysis of various radioactive and light sources.

Technical environment: C, C++, ASM, Pthread, Linux, GCC Tool chain, SVN, Perl, SQL, shell scripting, parallel computing, statistical modelling and inference/optimization, Monte Carlo simulation, detector calibration and modelling.

PERSONAL PROJECTS

- Development and implementation of a home automation system that controls heat, A/C, damp air extraction and humidity using a Modbus relay board, distributed temperature and humidity Zigbee sensors and outlets.
- Development of an isolated RS485 signal converter board for a communicating central heat pump system.
- Development and implementation of a custom firmware for a ZigBee temperature and humidity sensor.
- Modelling of heating energy consumption as a function of weather conditions to compare heating costs between a heat pump and a gas furnace.
- Reverse engineering of a dual mode fan controller (BigNG), associated writing of an open source firmware and host controlling software.
- Adding ACPI support and rewriting of a FreeBSD kernel driver for a motherboard I2C controller.
- Writing of a host software to configure an I2C fan controller.
- Design, development and implementation of a PID controller based on an ESP32 microcontroller.
- Remote configuration and tuning of a custom ECU for the retrofitting of a modern V8 engine into an antique muscle car, including through the development of engine data analysis C++ software.

Technical environment: C, C++, Pthread, Python, FreeBSD, Linux, GCC Tool chain, Cross-Platform development, Embedded systems, Git, shell scripting, JSON, Real–time, I2C, SPI, USB, UART, RS485, EEPROM, interrupt handlers, PID, PWM, ADC, Modbus, parallel computing, micro–controllers, IoT, KiCAD, Spice, OpenSCAD, iptables, pf, ZFS, FreeBSD jails, kernel driver programming, OpenVPN, WireGuard, websockets, REST, statistical modelling and inference/optimization, automation, control systems, oscilloscope, soldering, hot-air rework.

AWARDS AND SCHOLARSHIPS

Member of the winning team at GeekWeek V, Canadian Centre for Cyber Security	2018
Breakthrough Prize in Fundamental Physics, Sudbury Neutrino Observatory	2016
Domestic tuition scholarship, Carleton University	2004-2009

Departmental scholarship, Carleton University	2004-2010
NSERC postgraduate scholarship (Ph.D.)	2005-2008
FQRNT doctoral research scholarship	2005
NSERC postgraduate scholarship (M.Sc.)	2004
FQRNT masters research scholarship	2004
Graduate studies entrance scholarship, Carleton University	2004
Bechtel Canada scholarship	2002
NSERC undergraduate student research awards	2001-2003
Scholarship for academic excellence, Université Laval	2001
Welcome grant, Université Laval	2000

HOBBIES

Home automation, circuit designing, woodworking, homesteading, cycling, hiking, running, cross-country skiing.