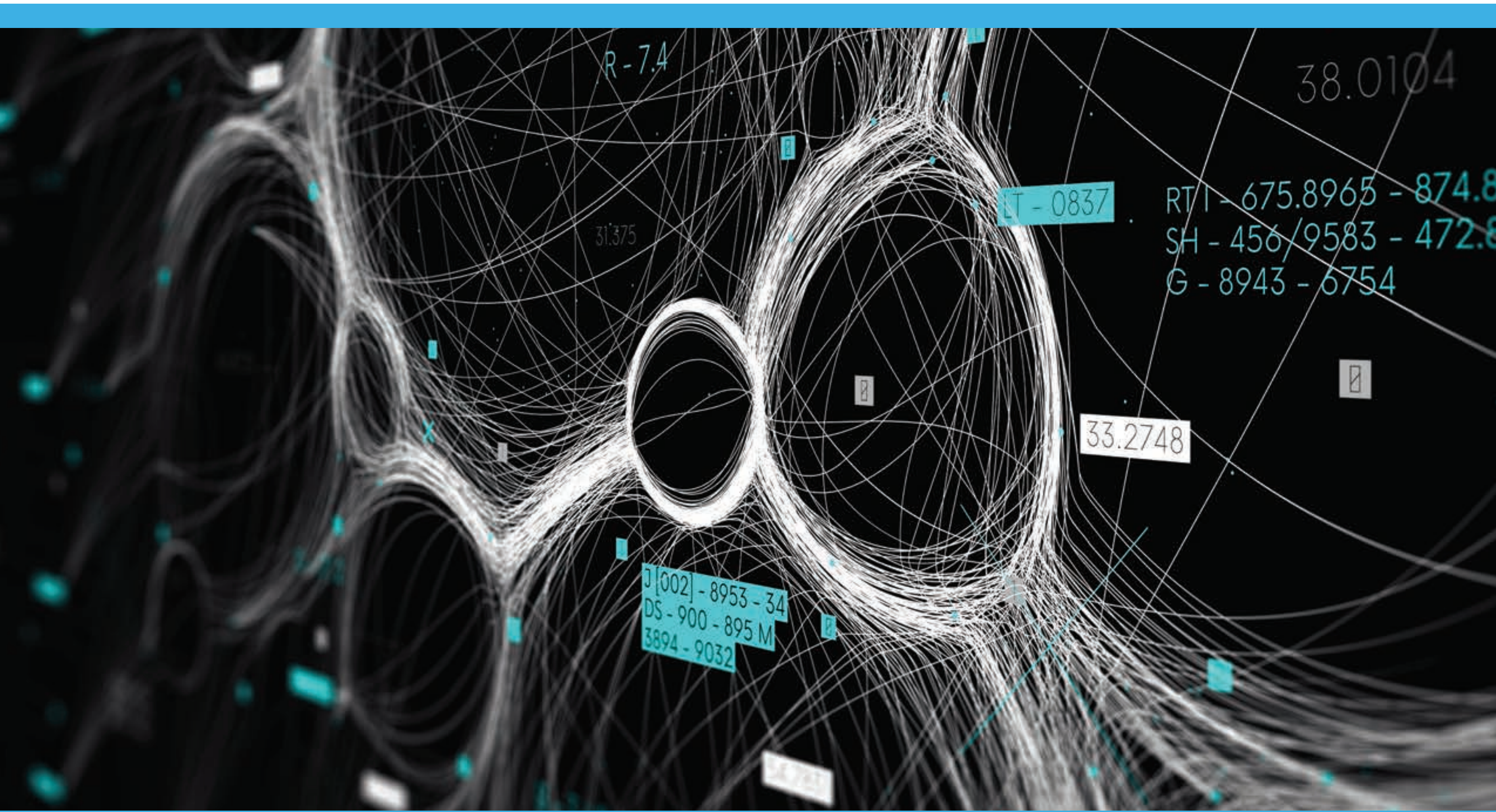
AI/ML Enables Study of the Human Brain & Mental Disorders through Cognitive Neuroscience & Computational Psychiatry



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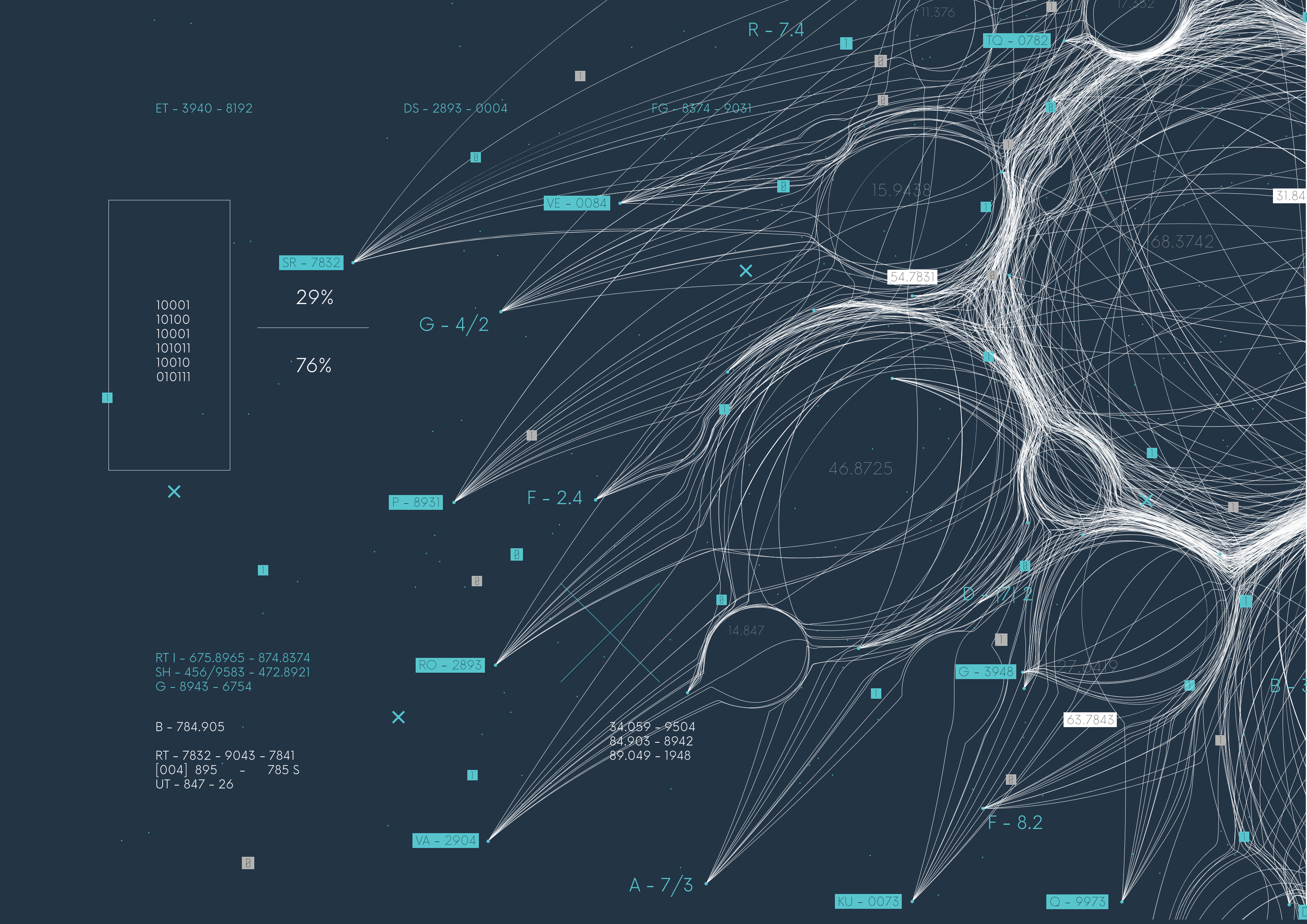

Background

The brain is a complex organ residing in every individual, enabling our ability to see, comprehend, write, and even read this paper. Its complexity is profound and has intrigued scientists for centuries. Guillaume Dumas, a professor and research scientist at the University of Montréal, dives deep into the study of the brain to understand mental health disorders through the use of cognitive neuroscience and computational psychiatry. Dr. Dumas and his lab, the Precision Psychiatry & Social Physiology (PPSP) team, aim to uncover a deeper understanding of the human brain by studying it at biological, behavioral, and social scales. The team combines data from genomics, brain imaging, and cognitive psychology thanks to the help of machine learning and data science. The applications of their research program range from personalized approach to mental health to neuro-inspired AI algorithms.

Research

Dr. Dumas and his team's research has three focuses: Computational Psychiatry, Precision Medicine, and Social Neuro-AI. By leveraging big data, they deploy large computational models to help propel detailed research in mental health, personalized care, and the development of new machine learning algorithms.

Mental health, for quite some time, has been studied mainly through observation of symptoms, behaviors, and verbal experiences. Neuropsychological testing and psychotherapy are indeed the traditional means of approaching mental health. While some early forms of computational modeling and data analysis were used in genetics and brain imaging, they were strongly limited by the quantity of data and the computational resources available at the time.

The increase in computing power over the last decade brought new ways to study genomics and brain activity, paving way for the study of mental health using computational psychiatry. Dr. Dumas and his team study the effect of genome architecture and its relationship to constrained brain development through machine learning's ability to parse large datasets. Being able to study the whole genomes and map the entire brain's activity unlocks new methods of discovering the relationship between cognitive development and an individual's biological profile.

As a result, neurogenomics, personalized care, & precision medicine can greatly benefit the patient with more individualized approaches. Precision medicine acts on the individual's unique profile to determine the optimal approach to dosage, treatment, and management of health conditions. While precision medicine is still in its infancy, its potential also includes the development of preventive measures and lifestyle interventions that are customized to the individual's genetic and biological makeup. By taking a more personalized approach to medicine, precision medicine holds promise for improving patient outcomes and reducing the burden of disease.

Finally, Social Neuro-AI is the reverse engineering of how the brain gives our ability to socially interact with others. Using multi-brain neuroscience methods, the combination of vast amounts of data and the excellent analytical skills of AI, Dr. Dumas and his team hope to obtain a deeper understanding of human social behavior and its neural underpinning. Then, they translate this knowledge into new forms of machine learning algorithms to support more social and cooperative AI systems.

Challenge

Working with children and gaining a further understanding of cognitive health and mental conditions, as well as shedding light on different ways to identify and help them, are Dr. Dumas's passions. The brain is among the most powerful and intelligent natural systems; unveiling its mechanisms and capabilities can bring new perspectives in designing artificial systems. Artificial intelligence, deep learning, and machine learning have come so far as to bring researchers like Guillaume Dumas not just a better way to approach problems but to enable new approaches altogether.

His investigation of the brain connects natural intelligence and humanity with artificial intelligence and machines. This relies on building complex computational methods and extravagant artificial intelligence models. Dr. Dumas often leverages supercomputers for his research allocated by the Canadian Government and Oak Ridge National Laboratory.

However, supercomputers do not always allow the flexibility necessary for prototyping. Moreover, cloud computing and remote access are not always possible. His laboratory is embedded in a children hospital, and the data gathered for biomedical projects are often confidential, and thus cannot be transmitted over a network, especially between countries.

Dr. Dumas thus needed a local system to allow him to pursue his research in its early stages as well as develop proof of concept prior to deployment on supercomputers. His research is sometimes bound to the records of patients; executing these computationally intensive workloads on a simple desktop is not feasible, nor could be sent over a network. Since most of his heavy-scale computing was predominantly executed on extremely powerful HPC Supercomputers, Dr. Dumas was looking for something that could get him through his prototyping and smaller scale research. A powerful workstation is what he needed.

Solution

When considering a local workstation for Dr. Dumas's needs, **Exxact Corporation** stood ahead of the competition and delivered a robust system for his research. After considering other systems integrators, Dumas sided with Exxact to provide him with a high-performance multi-GPU workstation. Equipped with dual NVIDIA RTX A6000 and an AMD Threadripper PRO, the workstation is built to accelerate large computations with a 32 Core 64 Thread CPU, a total of 96GB of DDR6 ECC VRAM with over 20,000 CUDA cores, and 256GB of DDR4 RAM on a single local machine. Exxact's resources demonstrated expertise in providing a compelling solution in workstation form factor able to handle the heavy deep learning workloads.

Though this system does not hold a candle to the super-computers Dumas is used to, having complete access to his own system enables Dumas and his team to prototype AI models, evaluate proof of concepts, and validate their research prior to deployment on HPC. A local GPU workstation meant that they could study medical data while still complying with data governance laws. They are also now able to train and tune AI models with freedom accelerating smaller-scaled research and testing.

" Exxact has been extremely helpful and a pleasure to work with in supplying us with a powerful HPC workstation for our everyday researching needs, supporting my teams work on computational psychiatry, cognitive neuroscience, and machine learning."

Guillaume Dumas, Professor & Research Scientist, University of Montréal