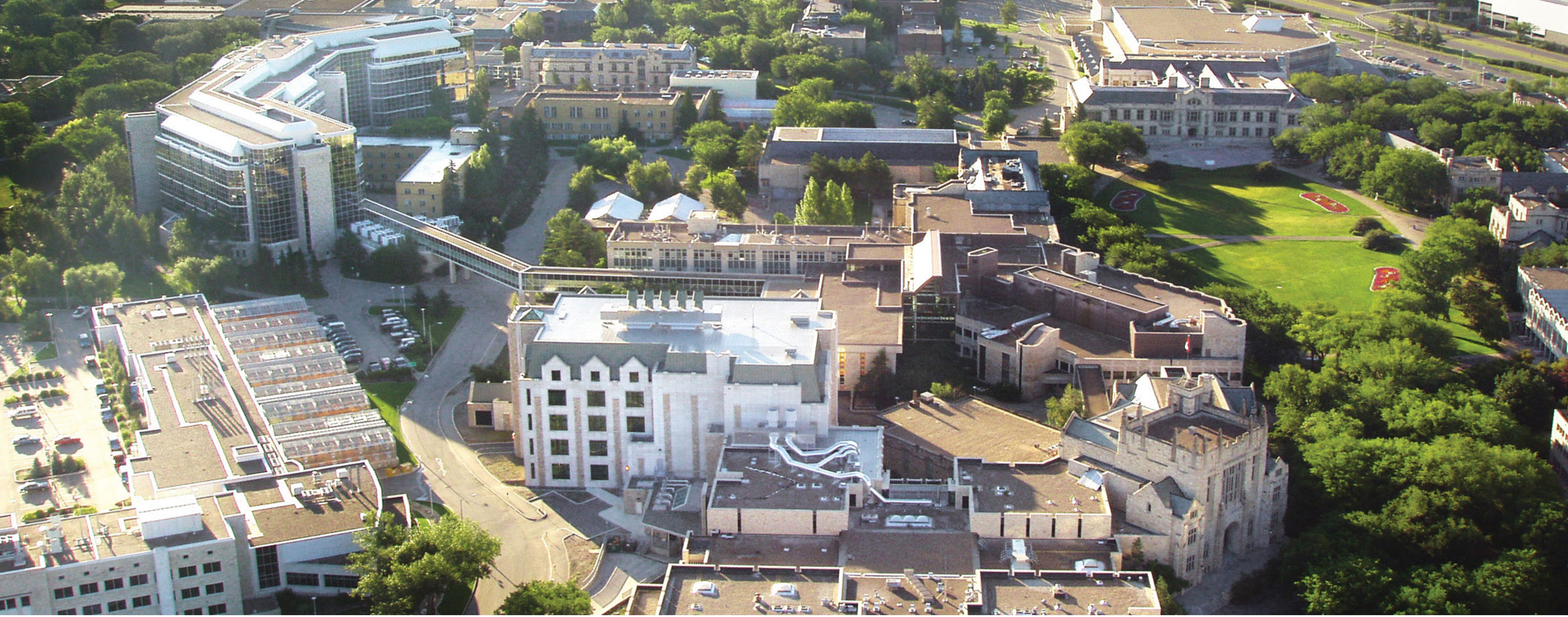

GWF Core Computer Science Inception Strategy

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Balsillie School of International Affairs, Waterloo ON
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GWF Core Computer Science Team

- Co-leads
  - Dr. Kevin Schneider, Computer Science, UofS
  - Dr. Jimmy Lin, Computer Science, UofWaterloo
- 3 Research Scientists
  - 2 FTE research scientists located at the UofS
  - 1 FTE research scientist located at UofWaterloo
- 4 PhD students, 1 MSc Student
- 6 Faculty
  - Co-leads, Dr. Ray Spiteri, Dr. Chanchal Roy, Dr. Jyoti Mondal, Dr. Carl Gutwin

Goal

- Create a common GWF Cloud platform
  - To support integration of hydrological, water quality and economic models
  - To provide infrastructure for migrating existing modelling tools to the common GWF platform
  - To design new algorithms and approaches for accelerating modelling tool performance
  - To support interactive visualization and end-user mobile applications
  - To provide a next-generation data management environment

Kevin Schneider

GWF Cloud

- Combines high throughput processing and data management in an integrated platform, as three components:
  - **IaaS** (Infrastructure-as-a-Service): provides a distributed cyber-physical infrastructure to support high-throughput processing of GWF data; and
  - **PaaS** (Platform-as-a-Service): provides a data management platform for collecting, storing, integrating, sharing and managing GWF data;
  - **SaaS** (Software-as-a-Service): provides a software platform for analyzing, visualizing and supporting scientific workflows; model integration; and, mobile end-user and citizen science applications

Projects

1. Software Reference Architecture
   – Kevin Schneider and Chanchal Roy
2. Software Co-evolution
   – Kevin Schneider and Chanchal Roy
3. Hydrological Model Acceleration
   – Ray Spiteri
4. Interactive Visualization
   – Jyoti Mondal and Carl Gutwin
5. Managing Environmental Monitoring Data
   – Jimmy Lin

Software Reference Architecture

- Develop a modern Big Data computing platform that supports integration of hydrological modelling tools.
- Approach/Deliverables
  - Study existing hydrological modelling tools and environments
  - Work with other GWF projects to determine new and emerging requirements for a common hydrological modelling platform
    - Y1: Analyze existing platforms and tools (CRHM, CHM, MESH, WRF, CRHMr, MSCr, WATCHr, and WISKIr); Elicit scenarios (use cases) to determine existing and future requirements for a hydrological modelling platform.
    - Y2: Create reference software architecture
    - Y3: Evaluate and refine hydrological modelling platform.

Software Co-evolution (Schneider/Roy)

- Provide toolset for migrating hydrological modelling tools to a common hydrological modelling platform.
- Approach/Deliverables
  - We will reverse engineer CRHM, and using advice from core computer science project 1 (architecture&scenarios), develop a set of tools for migrating CRHM to a modern software architecture.
    - Y1: Develop a strategy for migrating CRHM, based on a detailed analysis of the modelling tool, and using input from the reference architecture project.
    - Y2: Migrate CRHM using a set of automation tools.
    - Y3: Refine toolset and expand for use with other modelling tools.

Hydrological Model Acceleration (Spiteri)

- Extend the capability or accelerate the performance of new or existing GWF hydrological modelling frameworks
- Approach/Deliverables
  - Convert CHM from a shared-memory paradigm to a distributed-memory paradigm, test its scaling, and make improvements needed to simulate land extents of a national or continental scale
    - Y1: Analyze CHM code structure; convert to distributed-memory paradigm; test scaling; make adjustments to improve scaling as required.
    - Y2: Explore performance improvements in CHM through novel load balancing, time-stepping algorithms, and discretizations of physical processes, e.g., blowing snow; extend the capability of CHM to include new or more realistic physics, e.g., CFD models for wind flow, water transport, and blowing snow.
    - Y3: Explore link from CHM to MESH and GEM models.

Interactive Visualization (Jyoti/Gutwin)

- Develop exploratory visualization frameworks based on environmental data and model predictions
- Approach/Deliverables
  - We will use browser-based visualization technologies to answer user queries in interaction time. Given a set of parameters or user preferences, the visualization will highlight the corresponding risks and benefits. Such a web-based platform will be able to connect the users in real time, help better decision making and planning, as well as improve the understanding of the underlying hydrological models.
    - Y1: Analyse existing hydrological model visualization approaches, developing preliminary visualizations
    - Y2: Prototype interactive visualization framework and visualizations
    - Y3: Refine Interactive visualization framework and visualizations

Managing Environmental Monitoring Data (Lin)

- Develop a framework and supporting toolset to support ingesting and integrating heterogeneous data from a multitude of sensing platforms across geographically diverse settings so that they can be useful to modellers
- Approach/Deliverables
  - We will adopt a bottom-up, data-driven approach by examining a sample of environmental monitoring data that are presently available
    - Y1&2: In the short term we will examining the quality of data from current sensors and identify data quality issues – presenting opportunities for data cleaning, outlier detection, fault detection, etc.
    - Y2&3: In the medium term we will formulate concrete prediction tasks that we can tackle with machine learning models.