# WAFARi 2.0: Upgrade of an operational modelling system for the seasonal streamflow forecast service of the Bureau of Meteorology, Australia

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**Abstract:** The Bureau of Meteorology (the Bureau) launched a new Seasonal Streamflow Forecasting (SSF) service using a statistical modelling approach in December 2010. In addition, the Bureau developed a new modelling system to ensure the timely and reliable delivery of the service's three monthly streamflow forecasts (updated every month) called WAFARi (Water Availability Forecasts of Australian Rivers).

WAFARi is written primarily in Python with the user interface consisting of simple Python methods accessed interactively through the IPython interpreter. WAFARi is equipped with a variety of tools to support the entire SSF workflow from end to end. This includes diverse tasks such as data ingestion from a database, model simulation, and web publication on the Bureau's operational web servers. Using WAFARi hydrologists can store and manage data in self-descriptive files and generate publication-quality graphics products. All these tools are available through the scripting environment of Python, either in an interactive command shell or using script files. The Bureau pushed WAFARi version 1.0 into production for driving the public forecasts from December 2010.

Recently, the Bureau upgraded WAFARi to version 2.0 in order to support a dynamic modelling approach as well as the statistical method. The dynamic modelling approach generates streamflow forecasts by running rainfall–runoff models calibrated using a novel approach and driven by downscaled rainfall forecasts from a global circulation model. The challenge was to maintain the system's standard for a manageable and highly usable architecture, even with the introduction of new modelling components. To facilitate the support of both statistical and dynamic approaches, WAFARi has been refactored over two years into a Model–View–Controller (MVC) architecture. This has enabled greater re-use of code between the approaches and facilitated the standardisation of method interfaces and data structures. WAFARi's system architechture and file formats were redesigned to support both modelling approaches with existing program code and the same user interface.

As the forecasting output from both the statistical and dynamic approach is an ensemble of possible streamflow outcomes, all the existing products could be reused to visualise the ensemble forecast. To enable switching between the models used for dynamic forecasting, they were isolated as kernels and interfaced with WAFARi using adapters. These adapters wrap existing FORTRAN code that implements the rainfall–runoff models to provide a common interface regardless of the model used.

Insights from this development can be useful in guiding other projects building operational systems that support multiple modelling methods.

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