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Associating Blizzards with Corresponding Extratropical Cyclones as an Example of Phenomenon Hierarchies

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Complex computer simulations of complex things serve a useful, if not indispensable, role in science today. Alongside the philosophical reservations of doing science this way lies the daunting tasks of conducting an insightful evaluation and validation of a model dataset that is likely to mirror or exceed the volume and complexity of its real world counterpart.

In many ways this problem is akin to that of a Turing test; scientists are asked to compare two very complicated entities (say climate data and a climate model) and determine, by way of revealing questions and clever analysis, if some functional level of equivalence exists between the two?

Revealing questions are, however, hard to come by for complicated systems like climate. For example, simple, static characterizations make notoriously dull probes for exploring complicated things like climate (e.g. the heavy-handed use of univariate averaging). A useful strategy for this undertaking, and a common tool for revealing an algorithmic response during a Turing test, is to make use of context. Phenomenon hierarchies, in which episodes of child phenomena are associated with the episodes of their parent phenomena as in the case of blizzards (child) and extratropical cyclones (parent), offer such contextual information.

We have implemented an algorithm linking blizzard conditions to mid-latitude cyclones. Its workflow is roughly: 1) identify cyclone and blizzard instances and store their spatial-temporal footprints in a compact and searchable database, 2) link blizzard and cyclone instances, with the idea that blizzards are a child-phenomena of the cyclone process, 3) use high-context conditional statistics, paired with alignment/compositing (e.g., shifting to a common reference like peak intensity) and categorization (e.g., sorting by an attribute like duration), to draw out key patterns, dependencies and predictive analytics from the aggregated data.

We report the conditional statistics obtained from such associations and discuss how such statistics may enable Bayesian inference for process-based model diagnostics and predictive analysis.