Pacific Northwest
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Analysis in Motion Initiative

NIAC DAY@PNNL

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PNNL-SA-101021

Analysis in Motion

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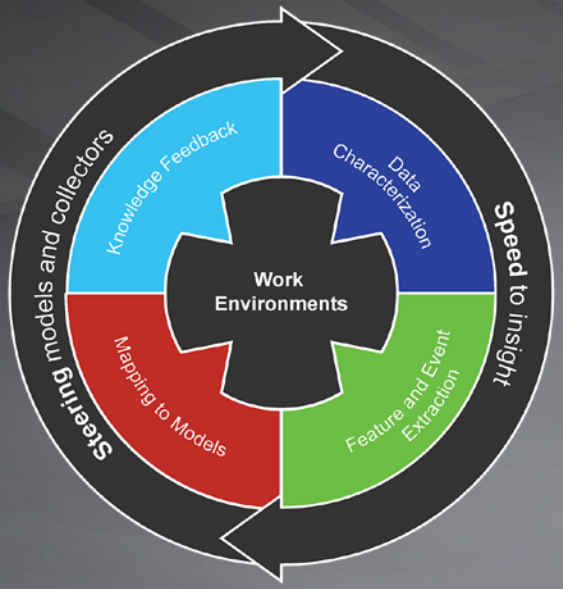
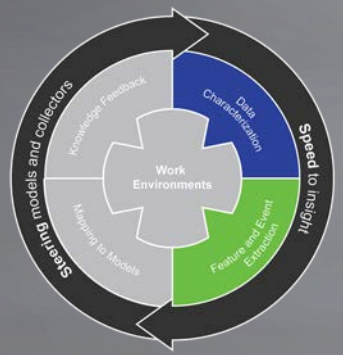
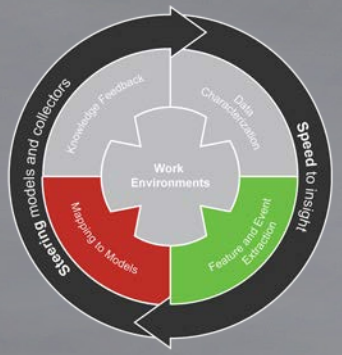


AIM is developing new methods for semi-automated knowledge discovery from high-volume data streams. AIM will reduce the time to discovery by performing hypothesis generation and testing in parallel with a stream.

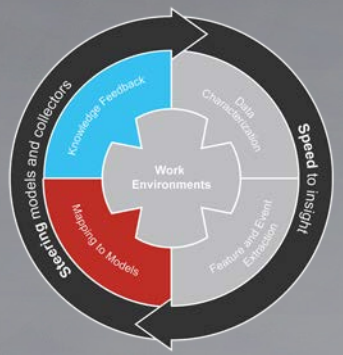
R&D Thrust Areas



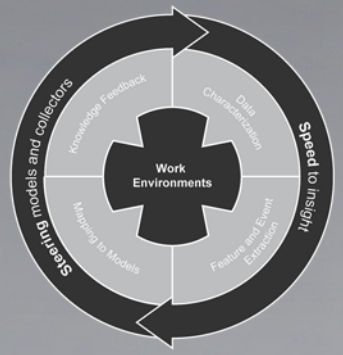
Streaming Data Characterization



Hypothesis Generation and Testing

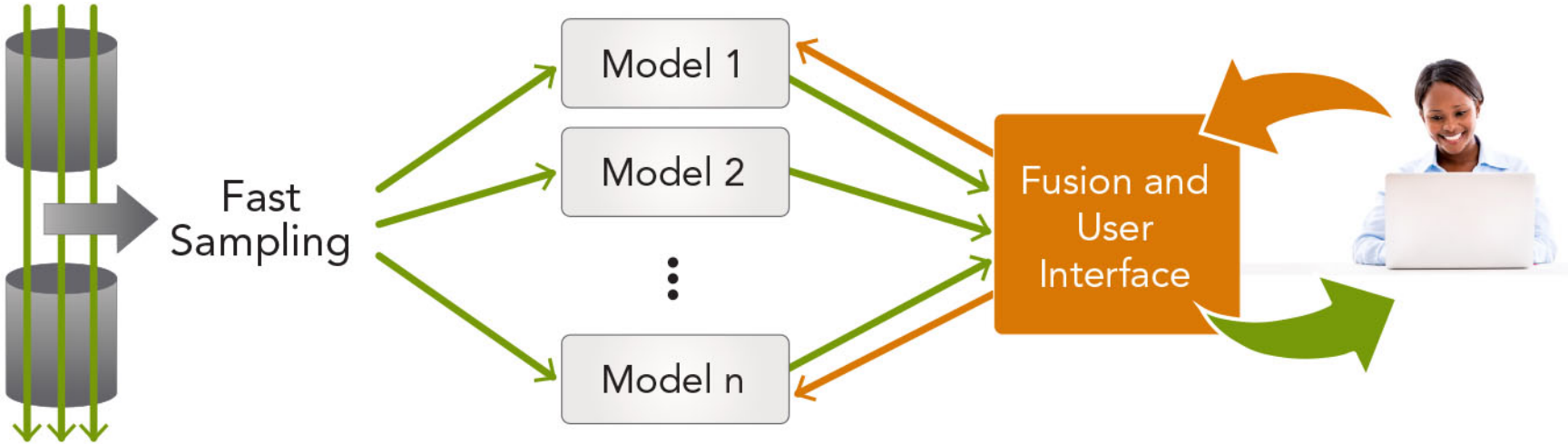


Human-Machine Feedback



Work Environments

AIM Streaming Context



- **Data is forgotten**
  - Each model's cache is small relative to the data volume
- **Single-pass**
  - No access to the data stream beyond the sample
- **Cooperative user**
  - Important problem knowledge isn't in training data

AIM Initiative Goals

- **AIM will develop new techniques for building multiple classifier systems in a streaming context**
  - Employ a user-directed fusion function to augment training data, so that the user can iteratively tweak and re-weight models on the fly
  - Include diverse dynamic model types (symbolic, PGMs, terminological)
  - Use high-level user feedback to steer the data production system

- **FY 2014 research focus**
  - Get smart
    - Build a broad resource of known streaming algorithms and techniques
  - Fail fast
    - Can we perform scalable symbolic deduction on streams?
    - Can statistical models evolve new structures to track the stream?
    - Can we gain useful information from implicit user behavior?
  - Get ready
    - Construct AIM's integration and testing infrastructure

AIM Research Challenges

- **Algorithms**
  - Stream sampling and cache maintenance/eviction
  - Anytime online algorithms for feature extraction and analytics
  - Algorithm ensembles and multiple classifier systems
  - Model evolution
  - Continuous time-sensitive hypothesis generation, testing, and filtering
  - Non-relational and noisy data formats
  - Scaling to high data rates
- **Human-machine feedback**
  - UX to usefully perform model steering and training
  - UX for data exploration and hypothesis testing in a streaming context
  - Hypothesis depiction

Additional Expertise Needs

- **All of the previously identified research challenges**
- **Streaming data wrangling**
  - Data ingestion and cleaning
  - Normalization and semantic processing
  - Feature extraction over streams
- **Cloud-based stream processing architectures**
- **Novel stream analytics algorithms and approaches**
- **Processing distributed streams**