Nondeterministic Asynchronous Dataflow in Isabelle/HOL

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Introduction

Time-Aware Stream Processing

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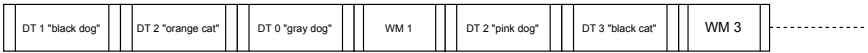
  - Time-Aware: Data has timestamp metadata; timestamps are bounded by watermarks
    - Timestamp: A partially-ordered value associated with the data (e.g., unix-time, int, pairs of ints, etc...)
    - Watermark: A value of the same type of the timestamp. Represents data-completeness.



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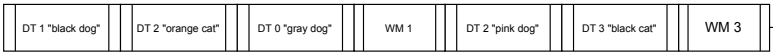

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- E.g.: Apache Flink, Apache Samza, Apache Spark, Google Cloud Dataflow, and Timely Dataflow

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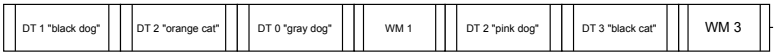

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- Why?
  - Highly Parallel
  - Low latency (output as soon as possible)
  - Incremental computing (re-uses previous computations)

Formalization in Isabelle/HOL

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- Isabelle: A generic proof assistant

- Isabelle/HOL: Isabelle's flavor of HOL

Isabelle/HOL: Codatatypes

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- Coinduction principle

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- Isabelle/HOL has a good tool set to formalize and reason about stream processing:
  - Codatatypes, coinductive predicates, corecursion with friends, reasoning up to friends (congruence),
    - Coinduction up to congruence principle is automatically derived for codatatypes (but not for coinductive principles)
- Next step: Feedback loop

Questions, comments and suggestions