CAESAR: Context-Aware Event Stream Analytics in Real-time

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Application Contexts

Financial Fraud
- Contexts: approved, suspicious, fraud

Cluster Monitoring
- Contexts: underloaded, overloaded, crashed

Health Care
- Contexts: normal, critical, emergency

Traffic Management
- Observations:
  - Event compositions signify application contexts
  - Most event queries are appropriate only in certain contexts. They can be safely suspended otherwise to focus on the current situation

Contexts

Accident
- Alarm triggering
- Traffic redirection
- Toll computation

Congestion
- Alarm triggering
- Traffic redirection
- Toll computation

Clear
- Alarm triggering
- Traffic redirection
- Toll computation

Context Window Push Down

Ideas:
- Event queries are grouped by context windows
- Each group shares one context window
- Context windows are pushed down to suspend irrelevant operators

Context Workload Sharing

Observation: Traffic is redirected during both accident and congestion contexts that may overlap

Requirements

CEP Systems (Esper)
- Expressive queries

CAESAR
- Contexts
- Context-driven optimizations

Business Models (UML)
- Expressive queries

Goal & Challenges

Goal: Leverage application contexts to speed up system responsiveness

Challenges:
- Rich context-aware semantics
- Human-readable specification
- Real-time system responsiveness

State-of-the-Art

CAESAR Model

Context-Driven Optimization Techniques

Ideas:
- Event queries are grouped by context windows
- Each group shares one context window
- Context windows are pushed down to suspend irrelevant operators

Context Window Push Down

1. Pattern: SEQ(NOT Position f, Position s)
2. Filter: f. id = s.id A. lane = "exit"
3. Pattern: SEQ(NOT Position f, Position s)
4. Projection: r.id, s.id, s.tlt, s.at, s.datetime, s.aid, s.lane, s.pos, s.seg, s.id
5. Pattern: NewCar c
6. Context window: congestion
7. Projection: c.id, c.aid, c.aid, c.datetime

Context Workload Sharing

Observation: Traffic is redirected during both accident and congestion contexts that may overlap

Requirements

CEP Systems (Esper)
- Expressive queries

CAESAR
- Expressive queries

Business Models (UML)
- Expressive queries

Experiments

Contributions

- First full-fledged context-aware CAESAR model visually captures the application contexts and allows to associate appropriate event queries with each context
- Context windows are driven by event queries and have unbounded duration
- Context-driven optimization techniques suspend irrelevant event queries and share event queries between overlapping contexts
- CAESAR runtime infrastructure that guarantees correct yet lightweight context management at runtime
- Experimental evaluation demonstrates 8-fold speed-up on average of the context-aware execution compared to the context-independent state-of-the-art approaches

Conclusion

CAESAR system enables human-readable context-aware event query specification and real-time system responsiveness to the current situation

References