

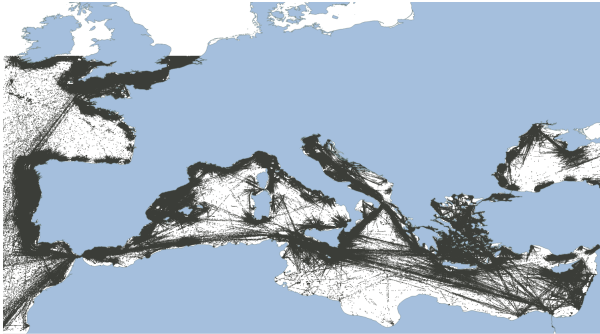
Incremental Event Calculus for Run-Time Reasoning

Efthimis Tsilionis, Alexander Artikis, Georgios Paliouras

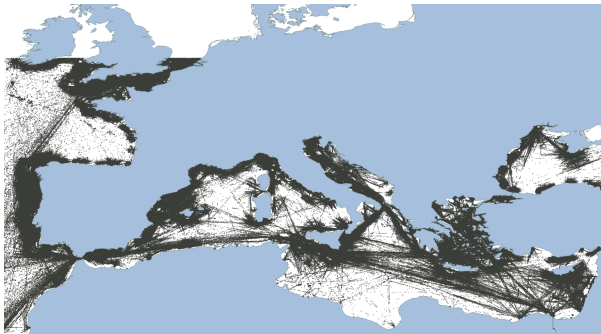
NCSR Demokritos
<http://cer.iit.demokritos.gr/>

16 April 2019

Motivation for Incremental CER

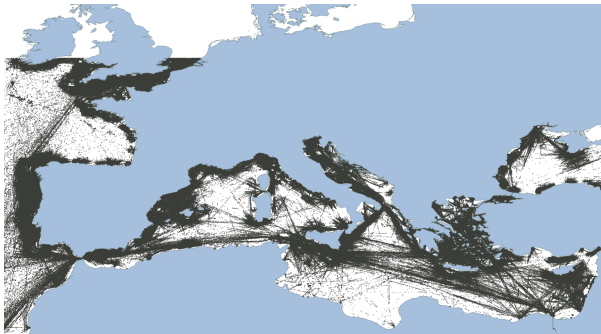


Motivation for Incremental CER



- ▶ Delayed events (e.g., satellite GPS messages)

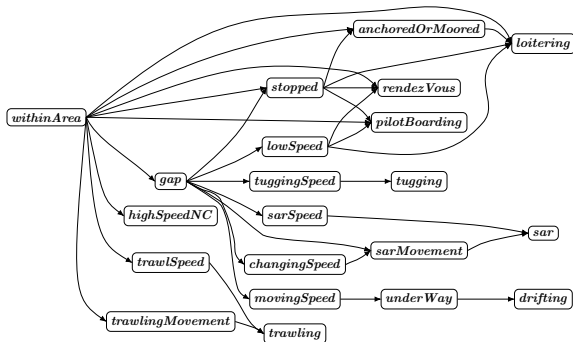
Motivation for Incremental CER



- ▶ Delayed events (e.g., satellite GPS messages)
- ▶ Overlapping temporal windows

Motivation for Incremental CER

- Propagation of changes



Event Calculus

- ▶ A **logic programming language** for representing and reasoning about events and their effects.

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- ▶ Built-in representation of **inertia**:
 - ▶ $F = V$ holds at a particular time-point if $F = V$ has been *initiated* by an event at some earlier time-point, and not *terminated* by another event in the meantime.

Event Calculus

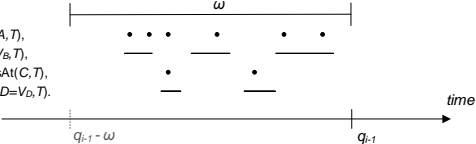
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- ▶ RTEC is a CER system based on the Event Calculus formalism

Problem Statement

initiatedAt($F=V, T$) ←

↑ ↑ ↑ ↑ ↑

happensAt(A, T),
holdsAt($B=V_B, T$),
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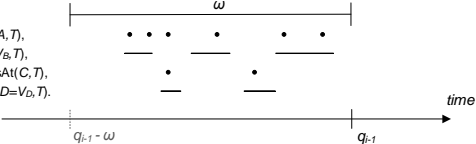


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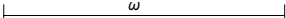
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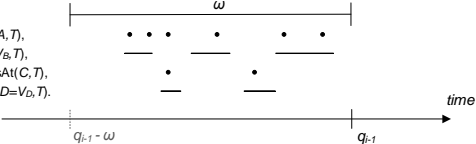


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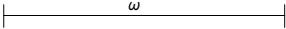
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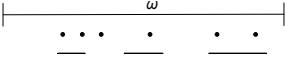


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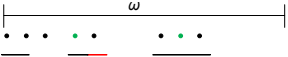
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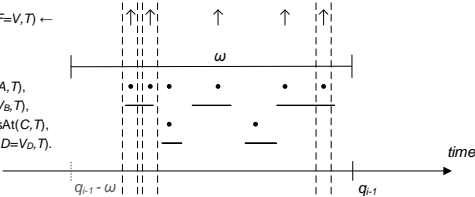
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Problem Statement: Inefficiency

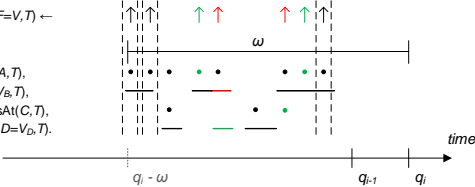
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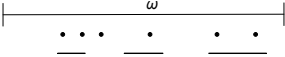


Incremental RTEC

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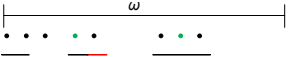
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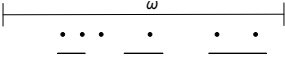


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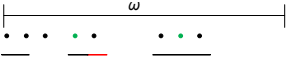
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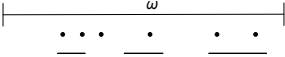
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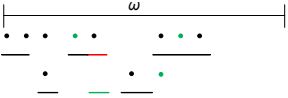
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$q_{i-1} - \omega$ q_{i-1}

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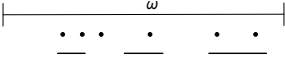
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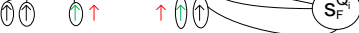


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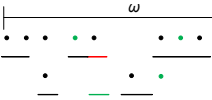
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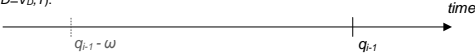
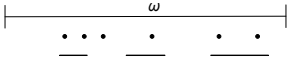
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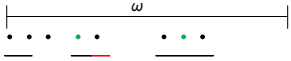
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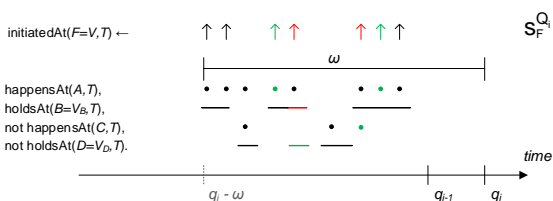
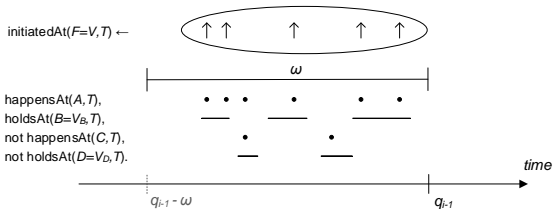


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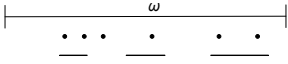
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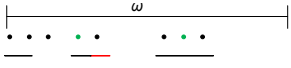
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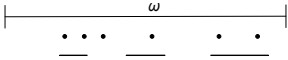
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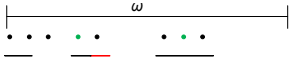
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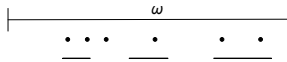
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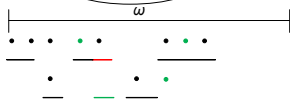
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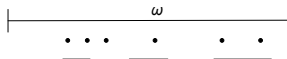
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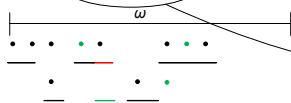
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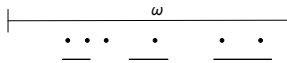
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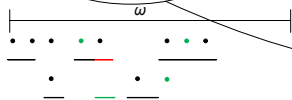
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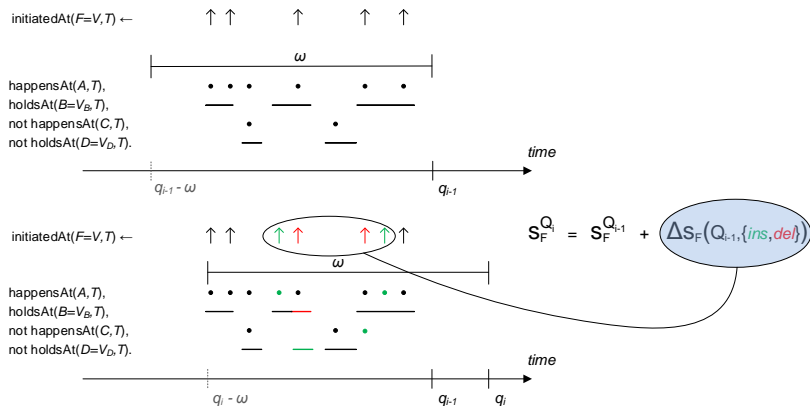
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Incremental RTEC



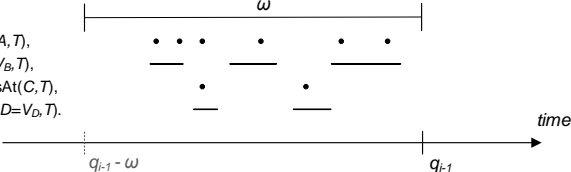
- ▶ Two phases:
 - ▶ Deletion phase
 - ▶ Addition phase

Incremental RTEC - Deletion phase

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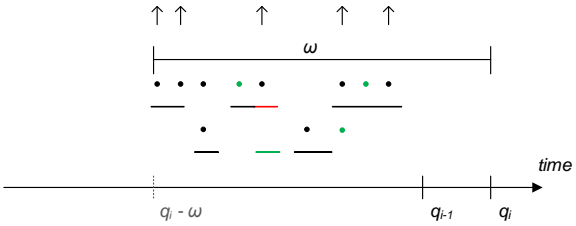
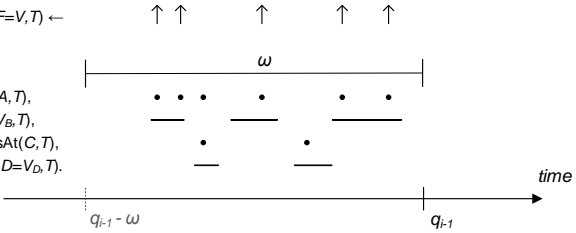
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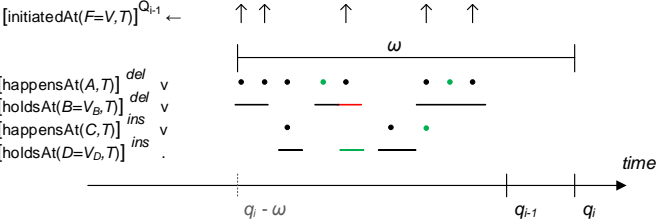
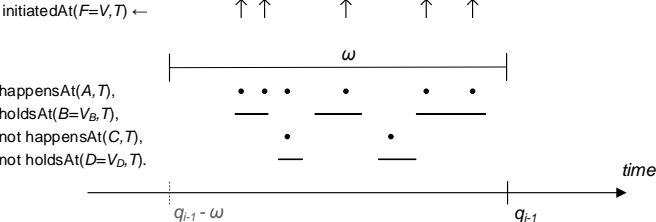
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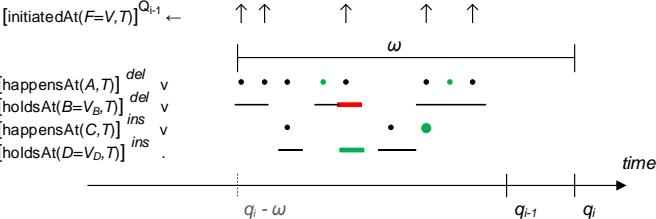
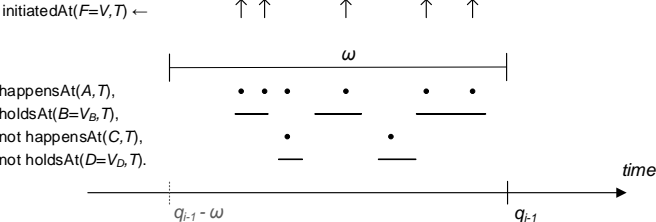
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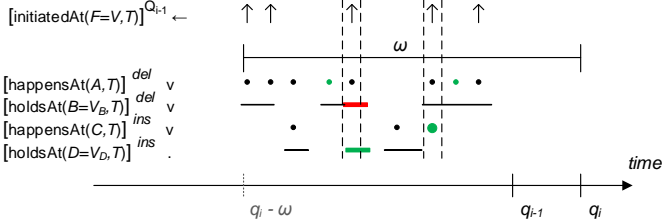
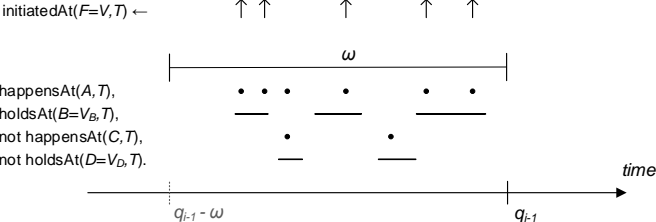
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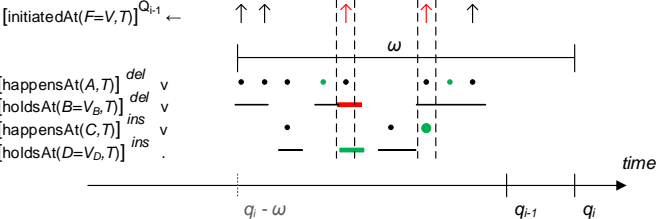
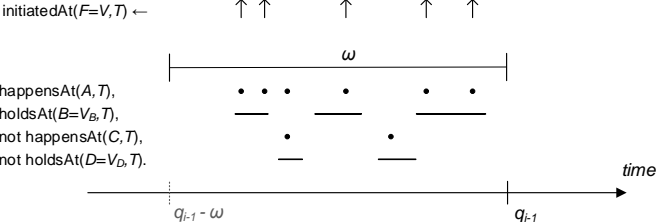
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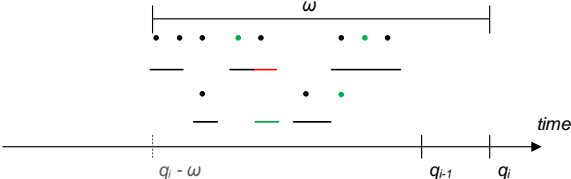
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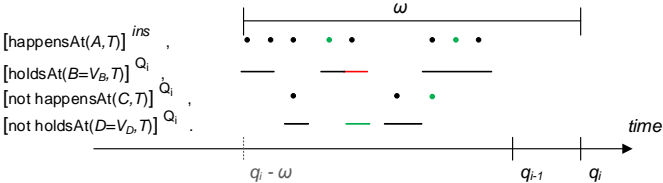
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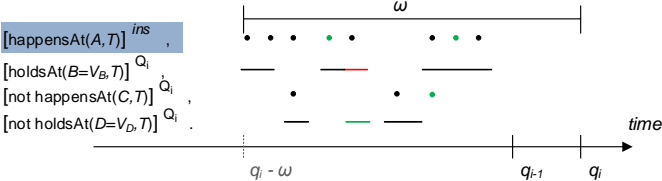
Incremental RTEC - Addition phase



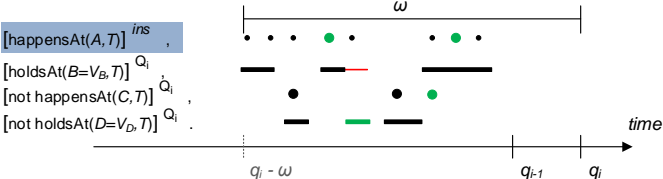
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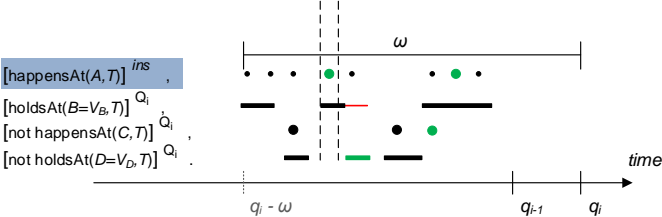
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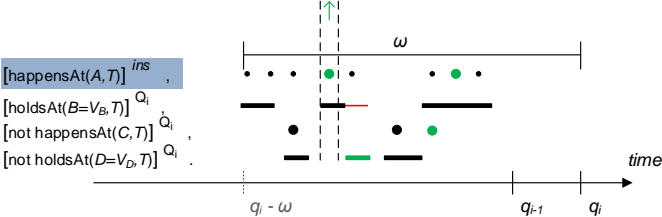
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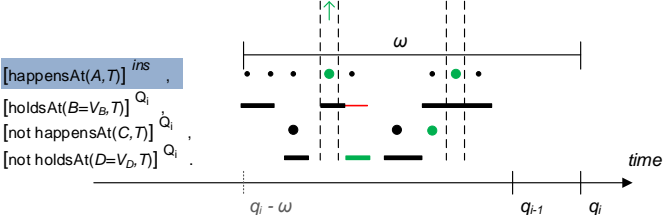
Incremental RTEC - Addition phase



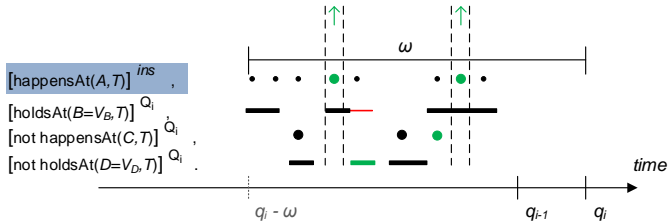
Incremental RTEC - Addition phase



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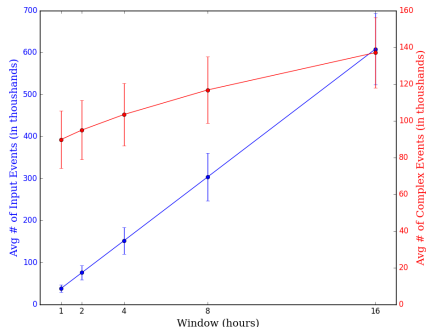
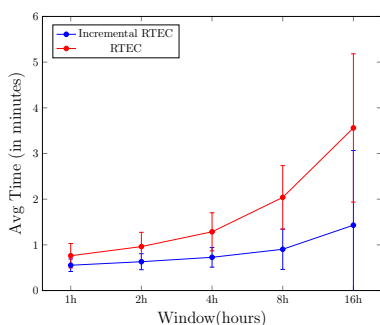


Incremental RTEC - Evaluation

- ▶ Delays up to 16 hours
- ▶ 17M position signals, 34K vessels
- ▶ European seas
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(Left) Average recognition time and (Right) average number of input and complex events. Sliding step of 1 hour

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- ▶ Future work:
 - ▶ Probabilistic version of the incremental algorithm