COMPLEX EVENT PROCESSING
WHAT'S THAT?
makeameme.org

About me

- Data Engineer at GetInData
- Apache Flink Committer
- Involved in Flink CEP library development

Dawid Wysakowicz

@dwysakowicz

getindata

big data. experience. passion.

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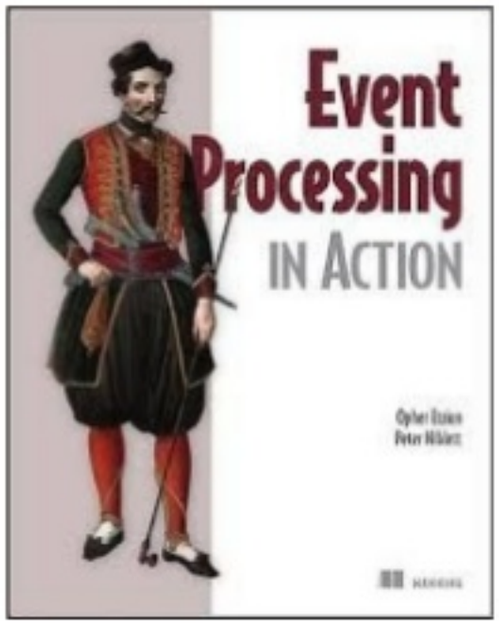
CEP engines' features

- Event-pattern detection
- Event abstraction
- Event filtering
- Event aggregation and transformation
- Modeling event hierarchies
- Detecting relationships (such as causality, membership or timing) between events
- Abstracting event-driven processes



David C. Luckham. 2001. *The Power of Events: An Introduction to Complex Event Processing in Distributed Enterprise Systems*. Addison-Wesley Longman Publishing Co., Inc., Boston, MA, USA.

Opher Etzion and Peter Niblett. 2010. *Event Processing in Action* (1st ed.). Manning Publications Co., Greenwich, CT, USA.

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CEP engines' features

- **Event-pattern detection** ← FlinkCEP
- Event abstraction
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CEP engines' features

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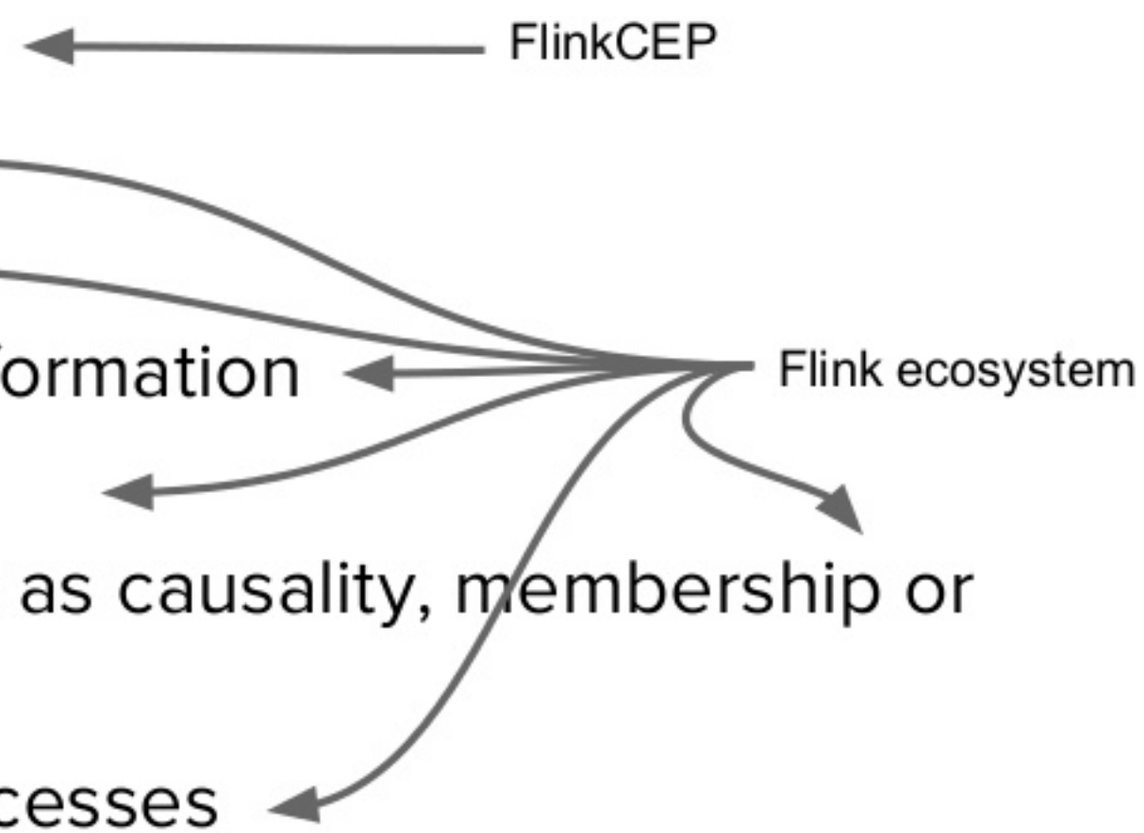

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Your address and choice of cover

House number or name

Postcode

Find address

Do you own this home? Yes No

Your cover

Buildings & Contents	Buildings only	Contents
○	○	○

Cover start date 31 08 2017 25

About your home

Property type -- Please select --

Number of bedrooms 1 2 3 4 M

Build date -- Please select --

About you

Title Mr Mrs Miss Ms

First name

Surname

Date of birth DD MM YYYY

Would you like to add a joint policyholder? Yes No

Would you like to add an interested party? Yes No

Have you had any home insurance claims or losses in the last 5 years? Yes No

You must declare all home insurance claims or losses, including:

- Claims or losses for you and anyone living with you
- Home insurance claims at home or away from home
- Loss or damage which did not lead to a claim
- Loss or damage whether insured or not

How long have you held buildings insurance without making a claim? -- Please select --

How long have you held contents insurance without making a claim? -- Please select --

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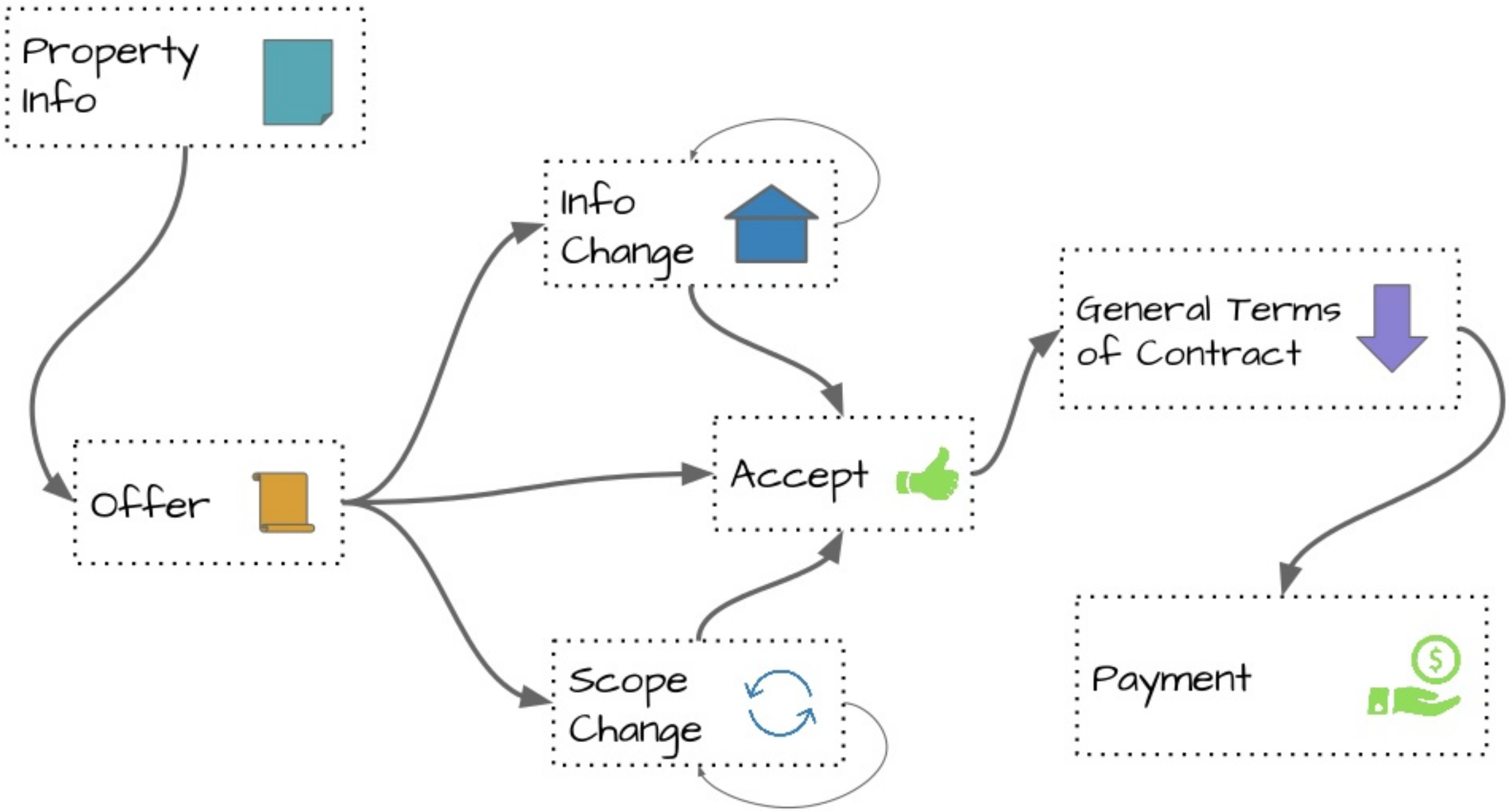
Buying Home Insurance Online



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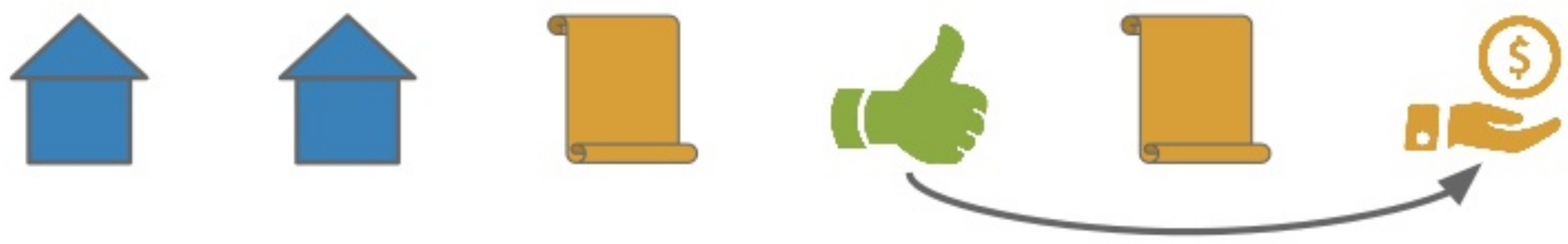
Simple Example - Matching Payments

Notify whenever a payment for accepted offer arrives



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Patterns

Pattern

```
.begin("Offer accepted")
    .subtype(OfferAccepted.class)
    .where(...)
    .or(...)
```

```
.followedBy("Payment received")
    .subtype(Payment.class)
    .where(...)
    .where(...)
```

Basic building blocks

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Conditions

Pattern

```
.begin("Offer accepted")
    .subtype(OfferAccepted.class)
    .where(...)
    .or(...)
.followedBy("Payment received")
    .subtype(Payment.class)
    .where(...)
    .where(...)
```

Basic building blocks

Condition specification

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Pattern succession

```
Pattern
    .begin("Offer accepted")
        .subtype(OfferAccepted.class)
        .where(...)
        .or(...)
    .followedBy("Payment received")
        .subtype(Payment.class)
        .where(...)
        .where(...)
```

Basic building blocks

Condition specification

Pattern succession

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Time Restrictions

Pattern

```
.begin("Offer accepted")
    .subtype(OfferAccepted.class)
    .where(...)
    .or(...)
.followedBy("Payment received")
    .subtype(Payment.class)
    .where(...)
    .where(...)
.within(Time.seconds(3))
```

Basic building blocks

Condition specification

Pattern succession

Time restrictions

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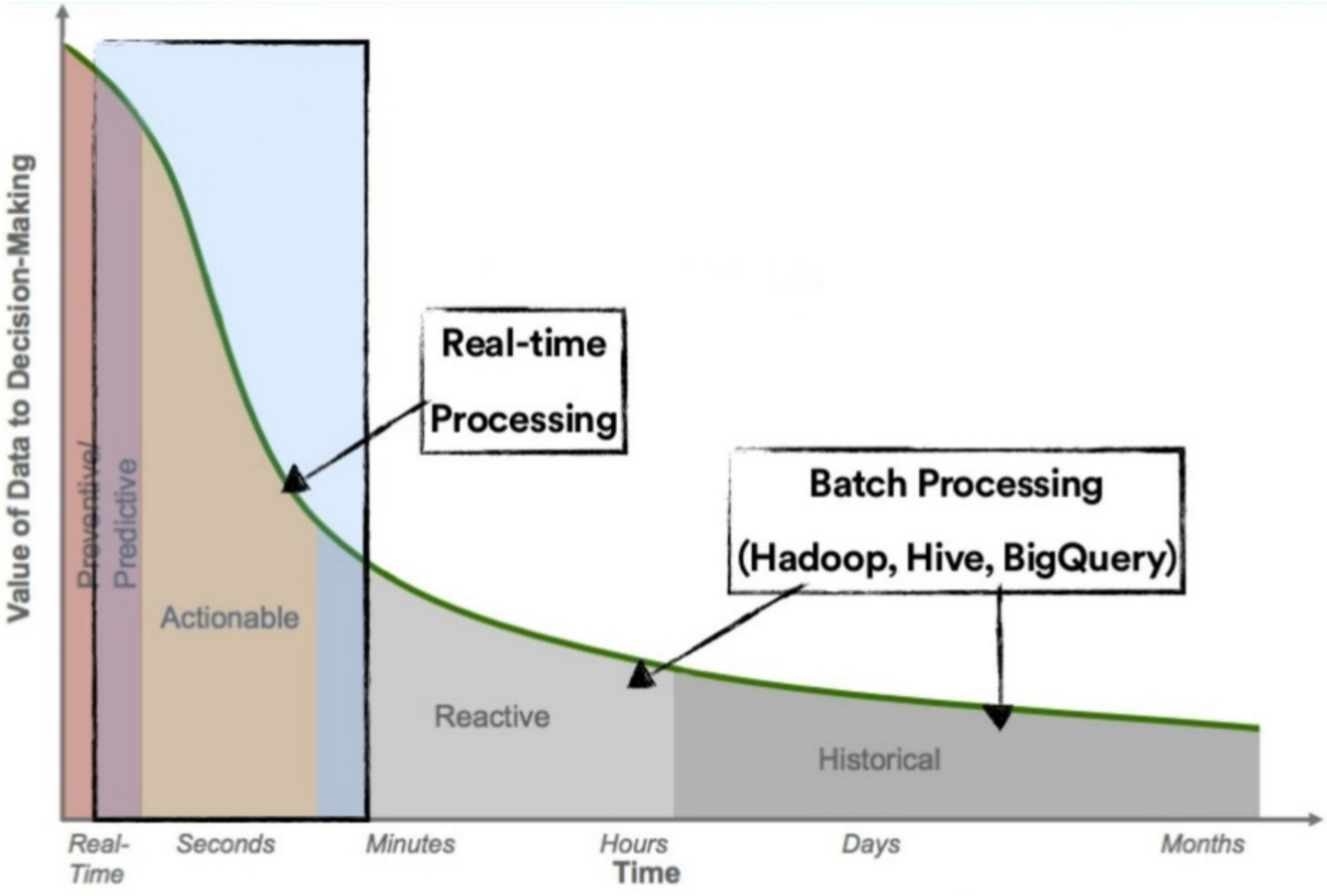

Image source: "Continuous Analytics: Stream Query Processing in Practice", Michael J Franklin, Professor, UC Berkley, Dec 2009 and http://www.slideshare.net/JoshBaer/shortening-the-feedback-loop-big-data-spain-external

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Consuming Strategy

- **followedBy**

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Consuming Strategy

- followedBy
- next

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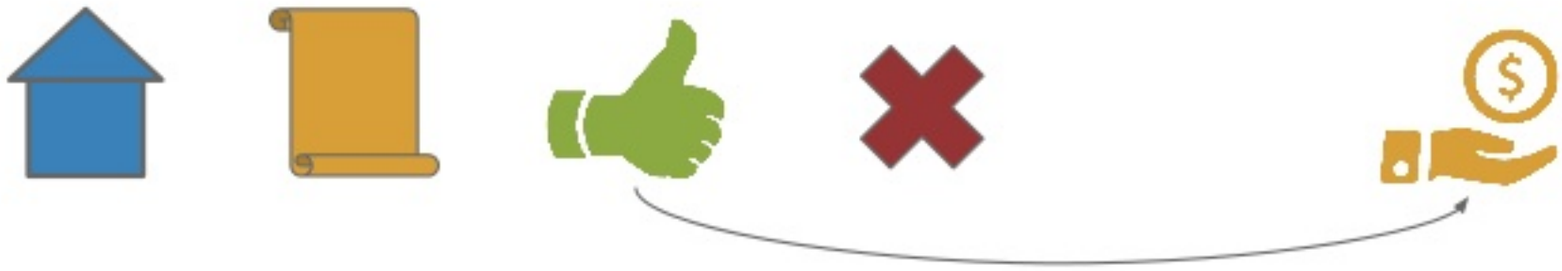
Consuming Strategy

- followedBy
- next
- notFollowedBy



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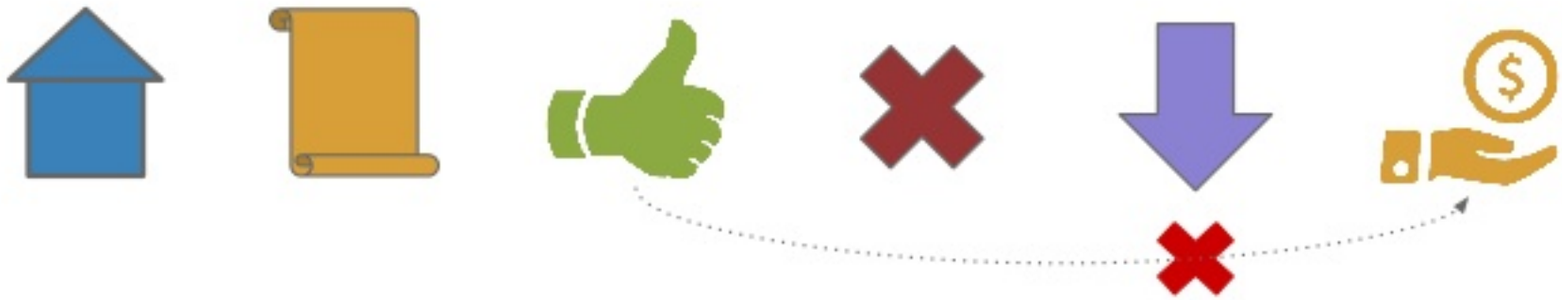
Consuming Strategy

- followedBy
- next
- notFollowedBy



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Consuming Strategy

- Skip till next
- Strict continuity
- Skip till any

- Not follow
- Not next

See more:

https://ci.apache.org/projects/flink/flink-docs-release-1.3/dev/libs/cep.html#conditions-on-contiguity

https://www.slideshare.net/DawidWysakowicz/flink-complex-event-processing

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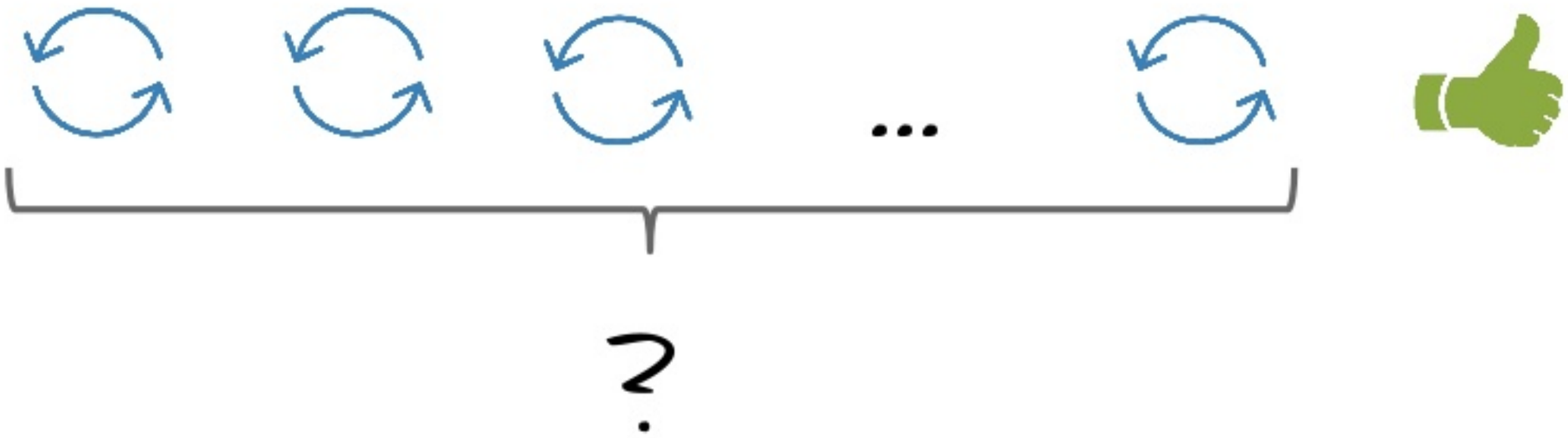
Looping Example

How many offer changes before accepting?



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Quantifiers

Pattern

```
.begin("start")
    .subtype(Event.class)
    .where(...)
    .or(...)
    .times(3)
.followedBy("next")
    .subtype(Event.class)
    .where(...)
    .where(...)
    .oneOrMore().optional()
.within(Time.seconds(3))
```

Basic building blocks

Condition specification

Pattern succession

Time restrictions

Quantifier application

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EVER WONDERED
HOW IT WORKS INSIDE?
imgflip.com

Nondeterministic Finite Automaton

- **Graph where:**
  - Vertices = States
  - Edges = Transitions
    - IGNORE - event not consumed
    - TAKE - event consumed
    - PROCEED - event analyzed in the target state

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Example of NFA

```
Pattern
        .begin("A")
        .followedByAny("B").optional()
        .next("C")
        .followedBy("D")
```

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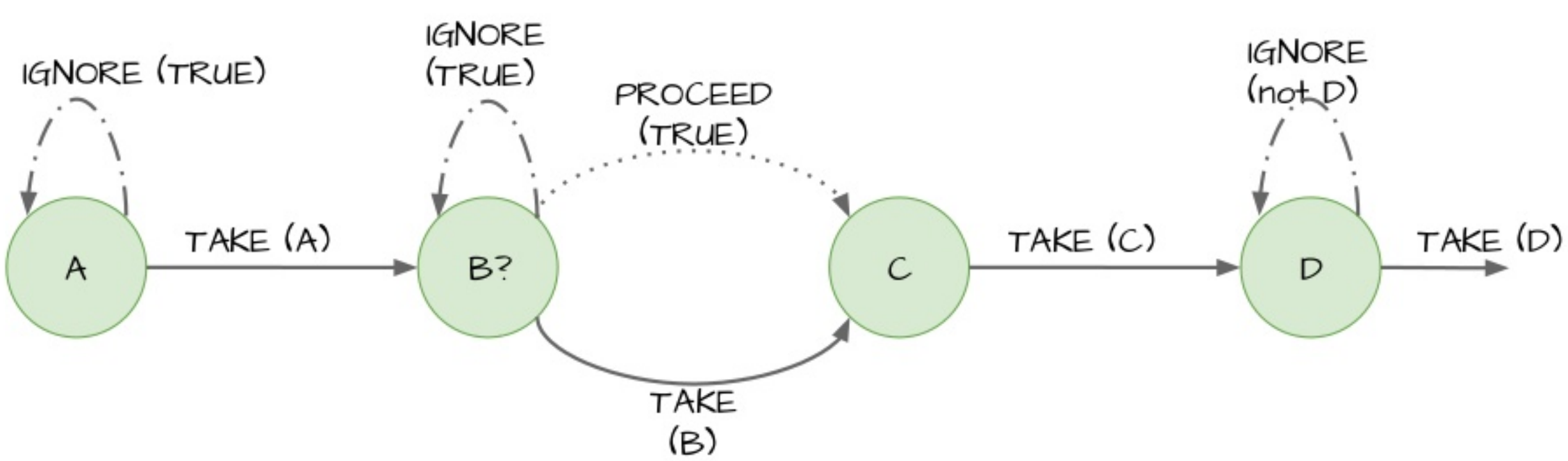
Example of NFA

```
Pattern
        .begin("A")
        .followedByAny("B").optional()
        .next("C")
        .followedBy("D")
```



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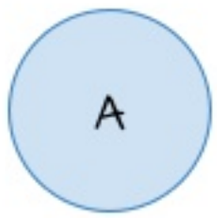

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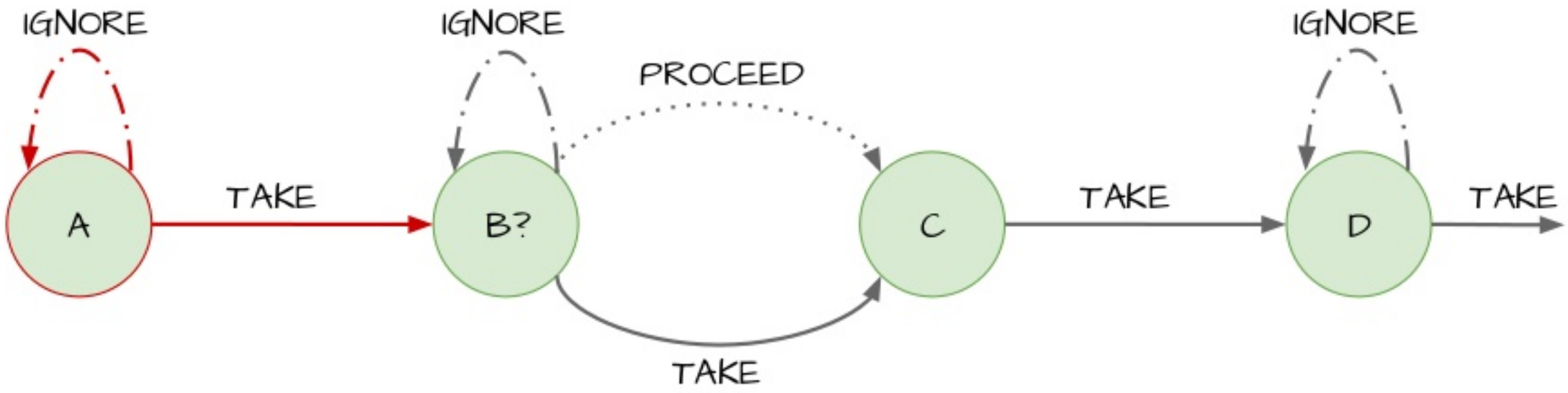

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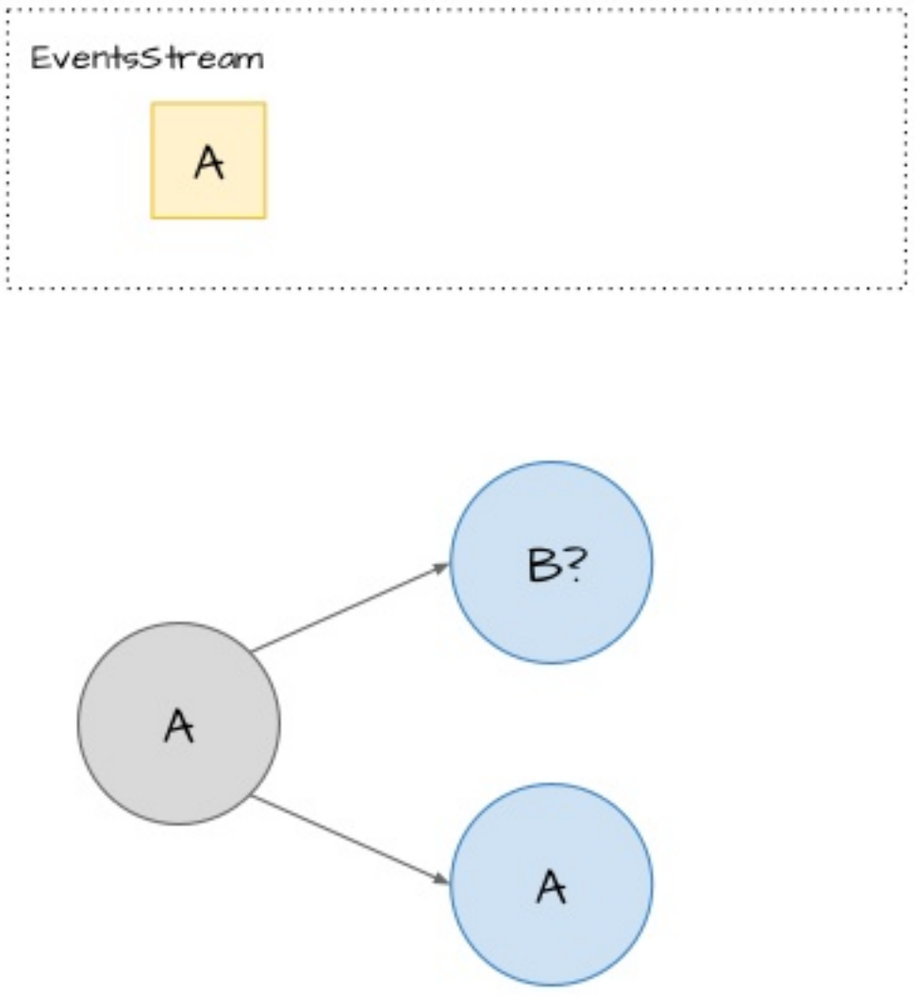

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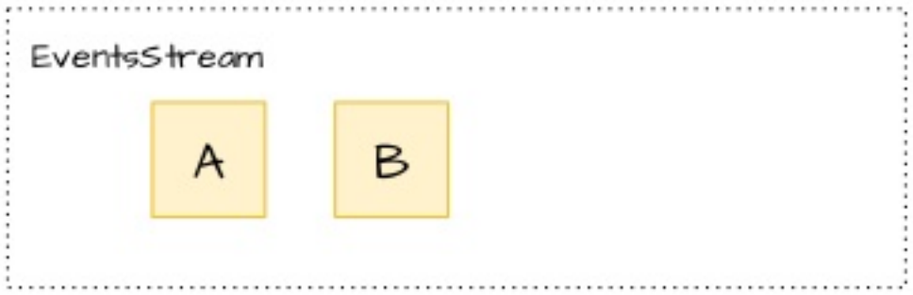

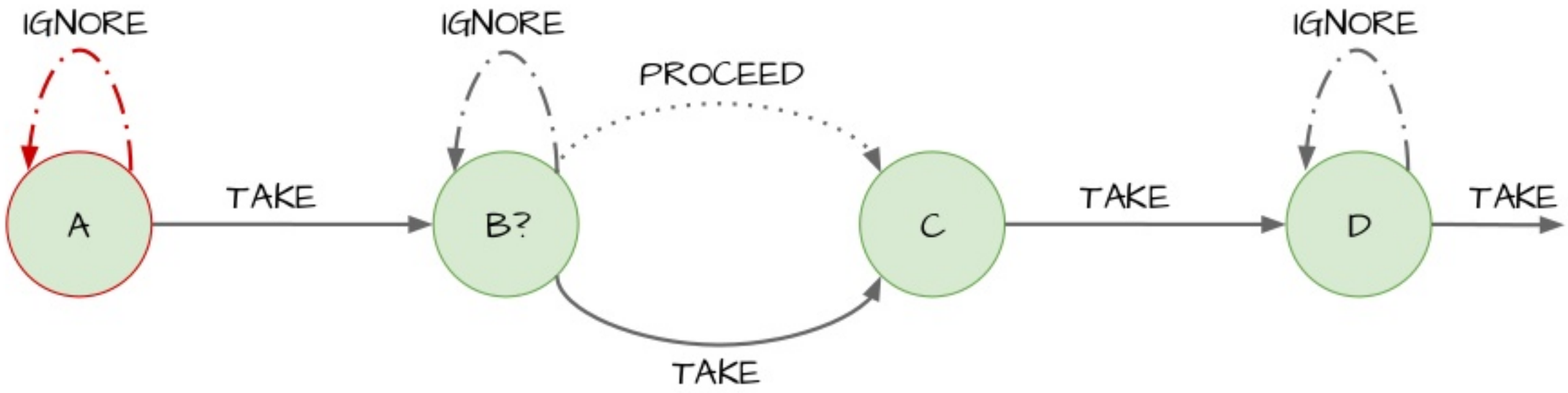

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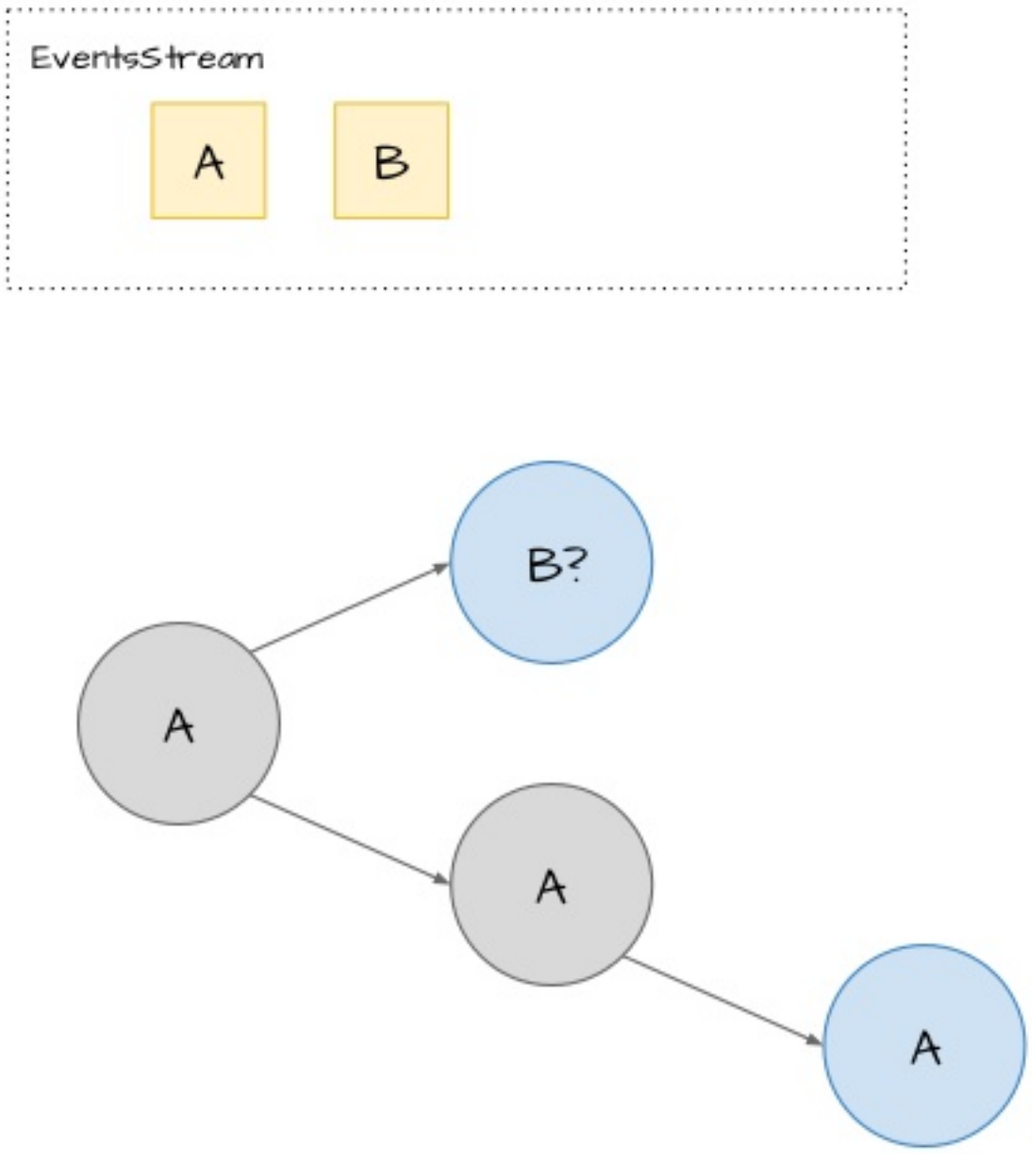

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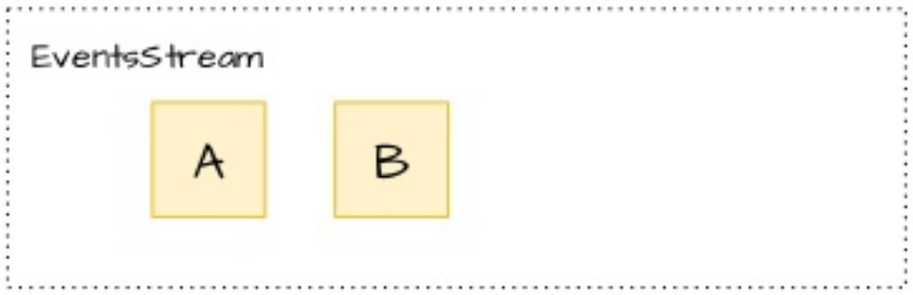

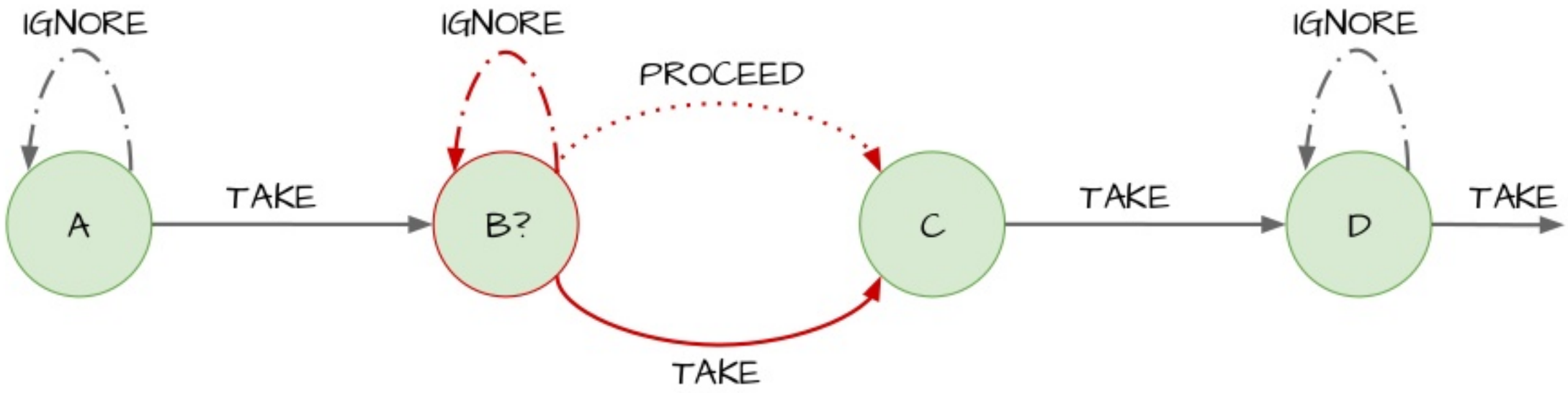

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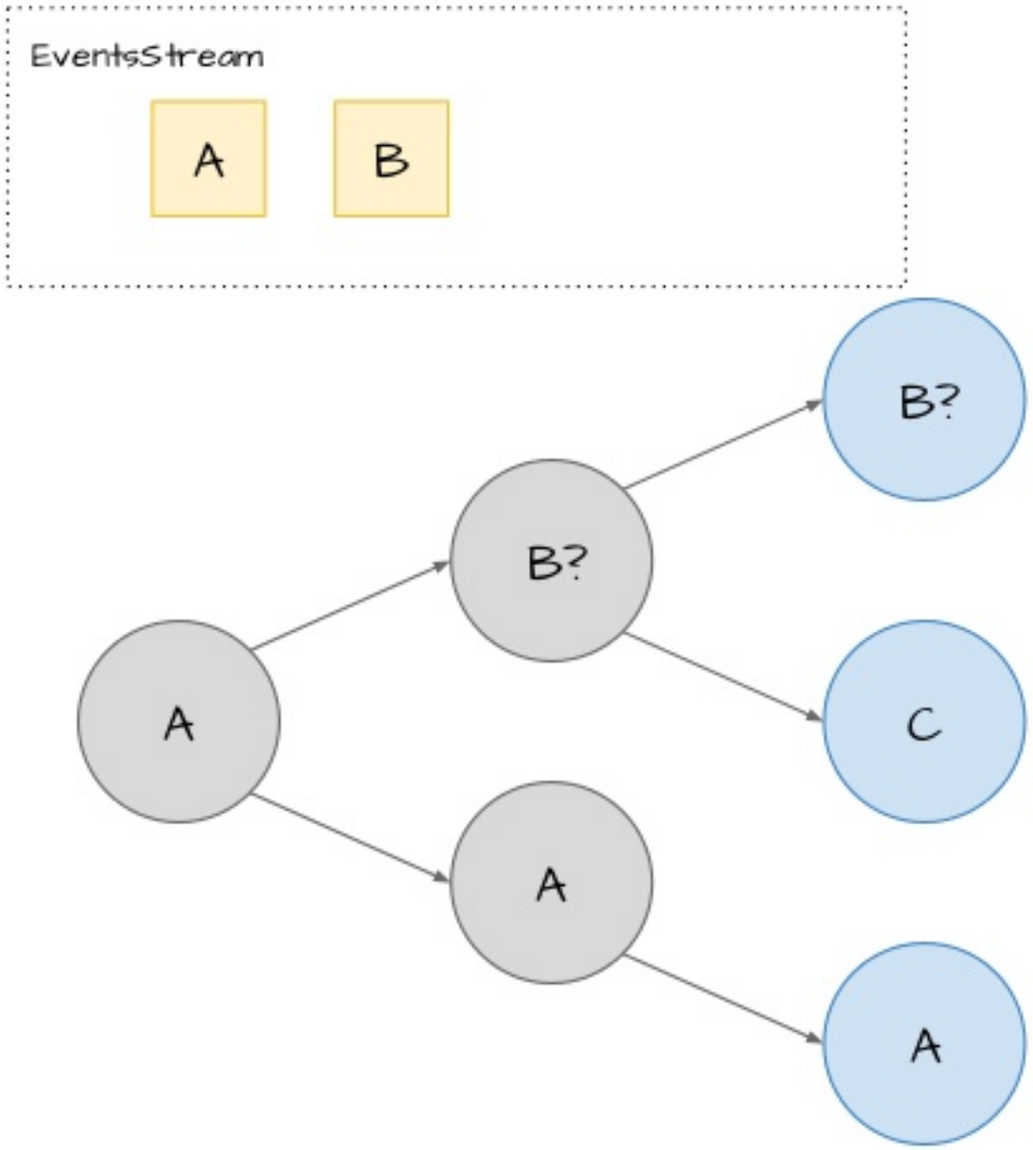

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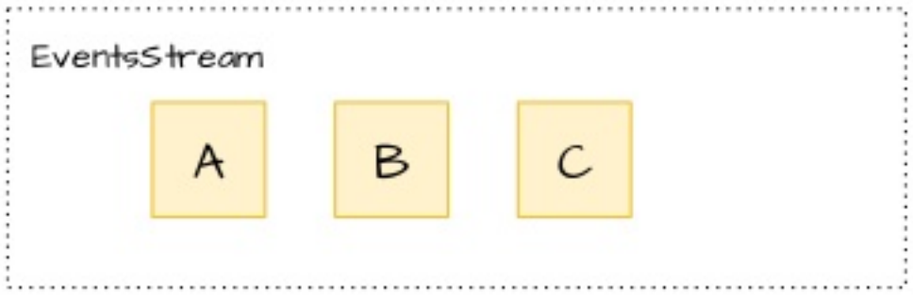

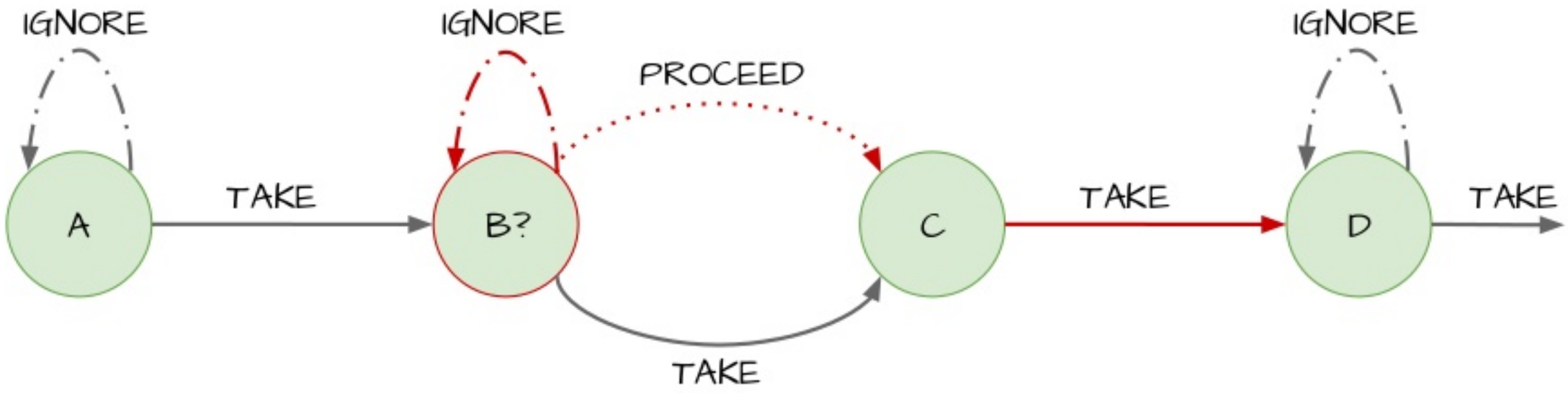

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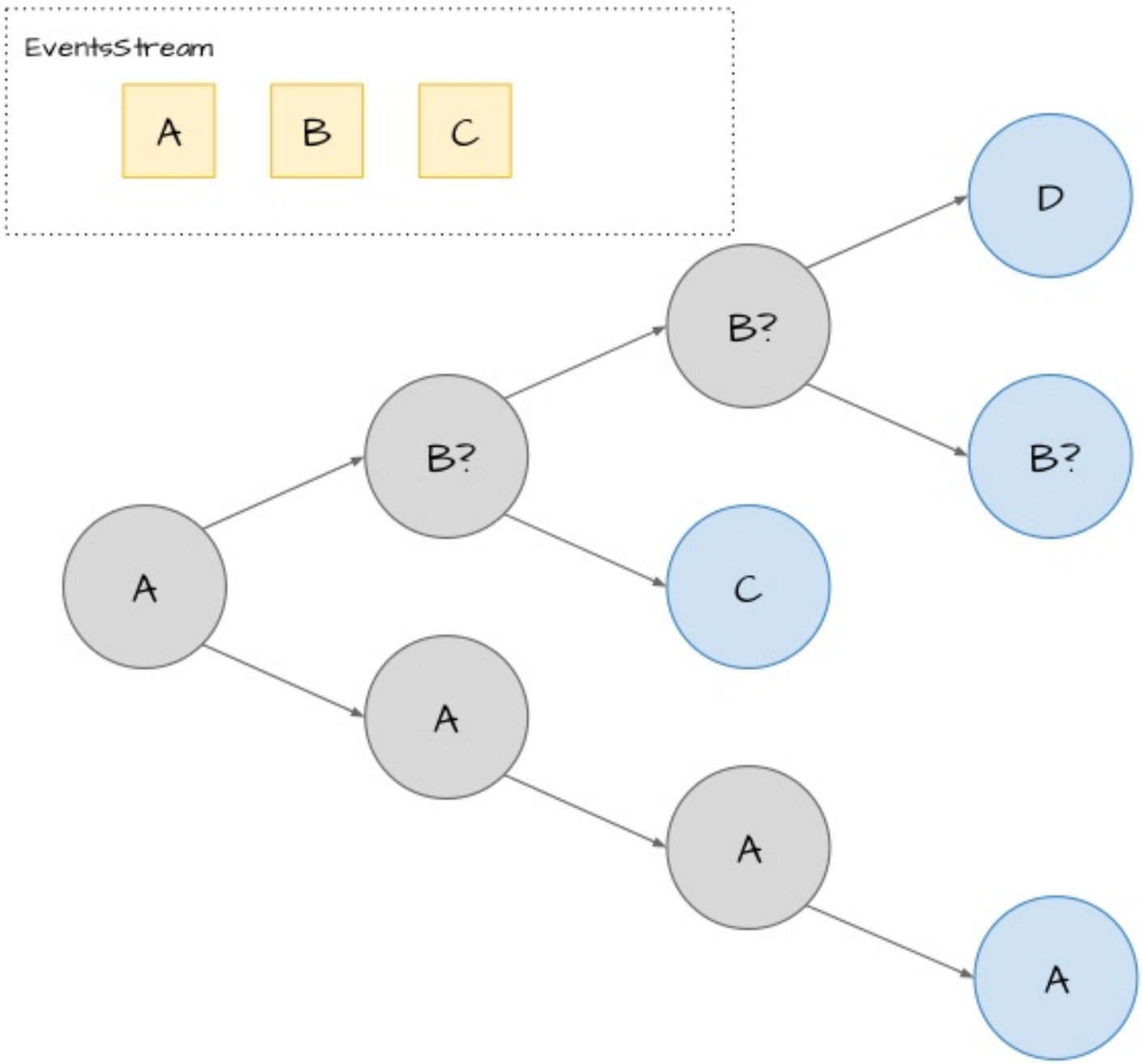

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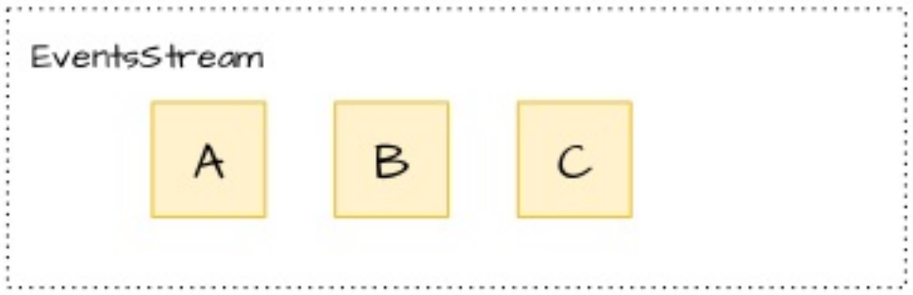

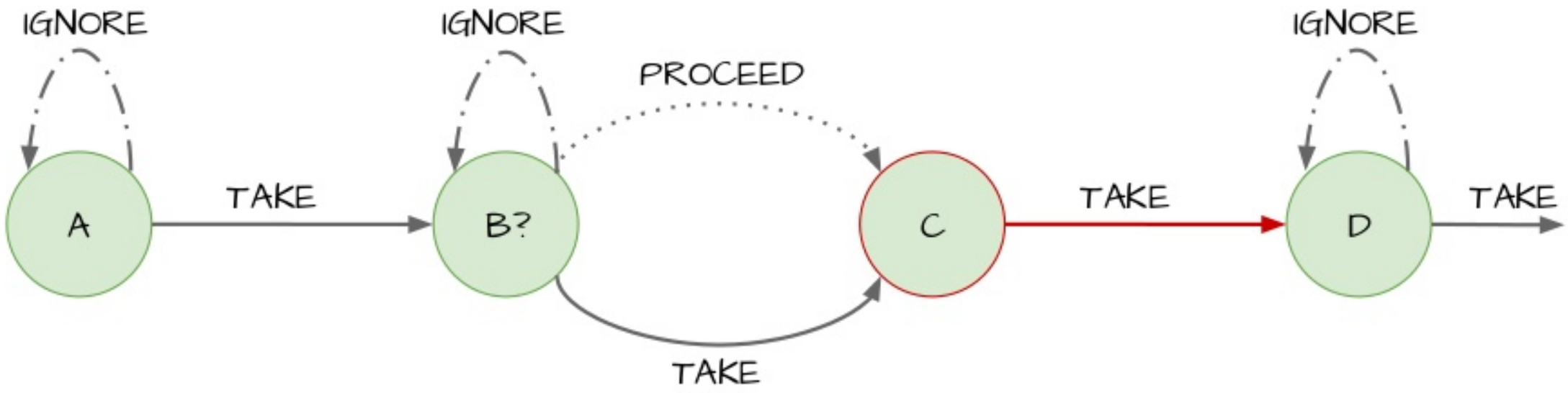

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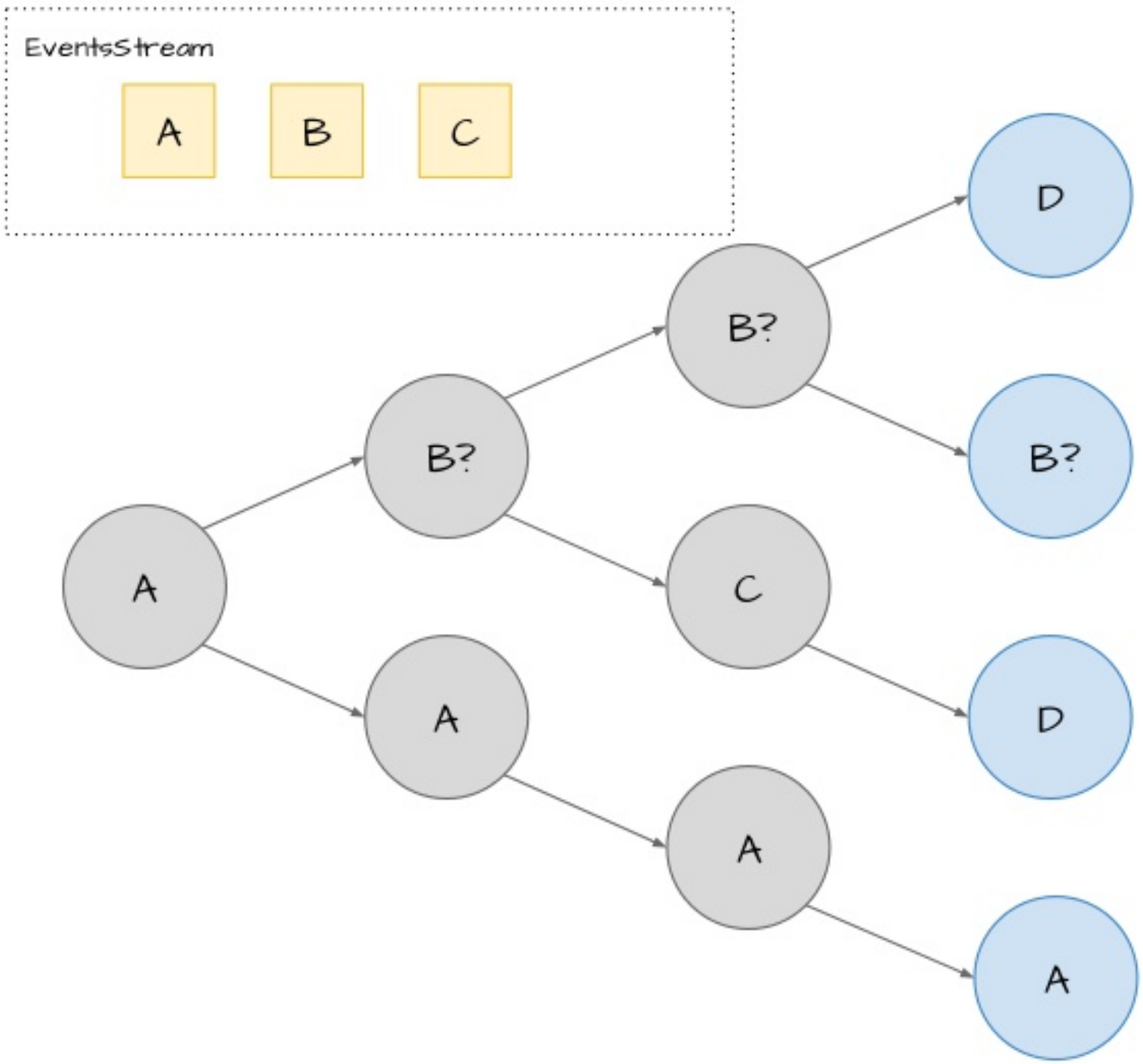

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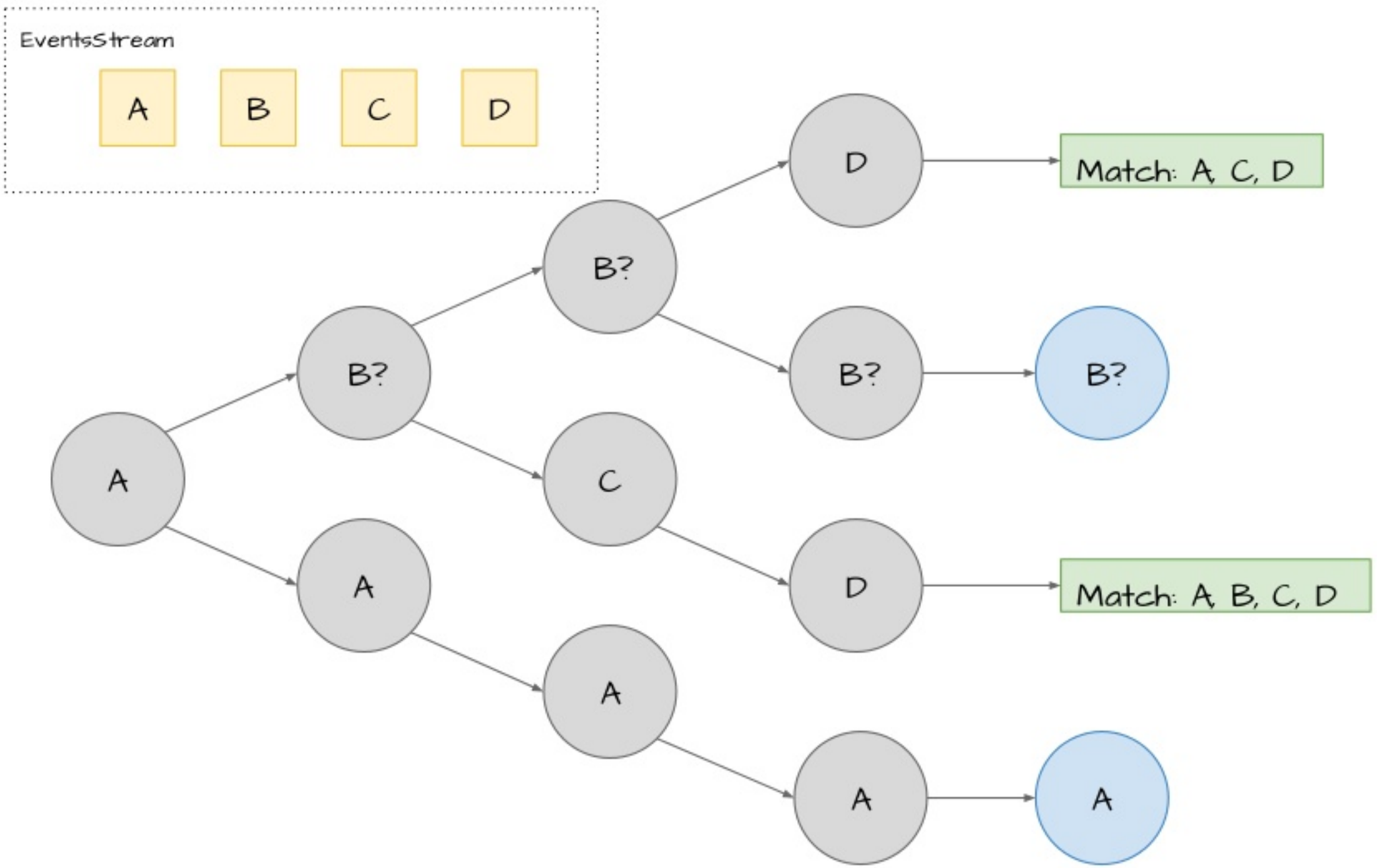

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Nondeterminism

- **When?**
  - OneOrMore
  - Times
  - FollowedByAny
  - Optional

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Nondeterminism

- **When?**
  - OneOrMore
  - Times
  - FollowedByAny
  - Optional
- **What to do?**
  - Within - restrict by time
  - Until - restrict by event

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What brings the future?

SQL Integration - Flink 6935

```
select orderId
  from events
  MATCH_RECOGNIZE (
       PARTITION BY userId
       MEASURES A.orderId
       PATTERN (A B)
       DEFINE
           A  AS (A.type = “order”),
           B  AS (B.type = “payment”
             and B.orderId = A.orderId)
) as its
```

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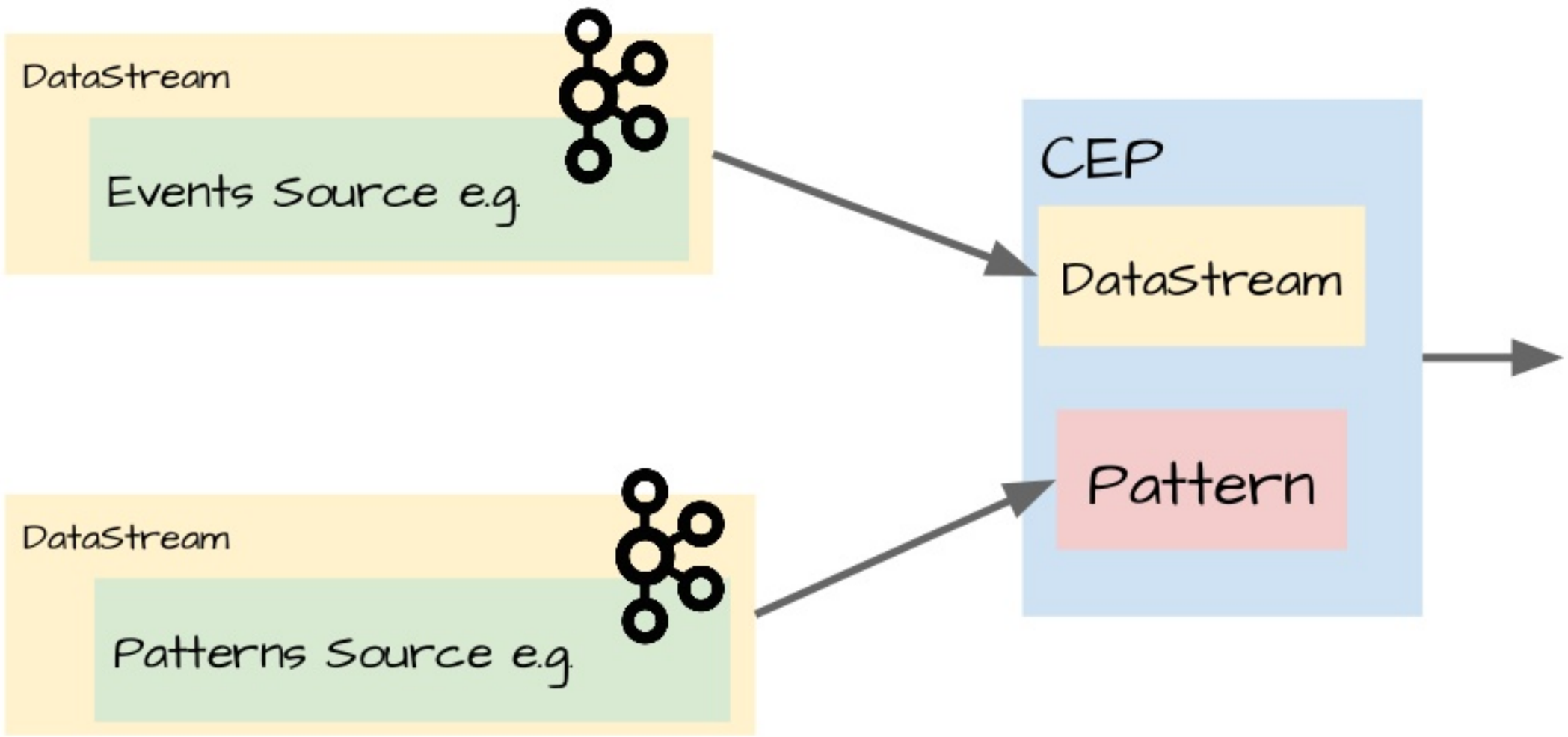
Dynamic Patterns - Flink 7129



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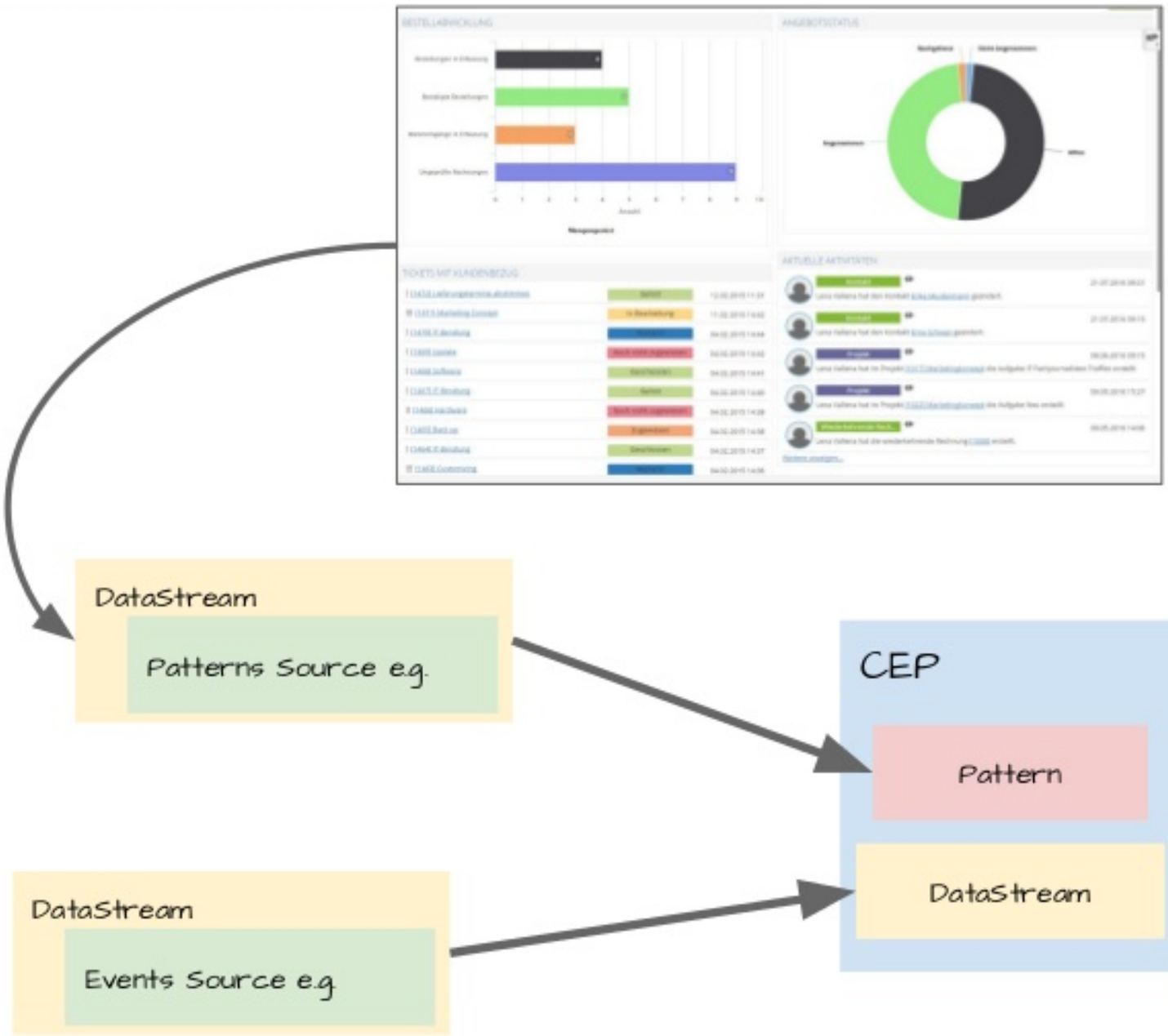
Dynamic Patterns - Flink 7129



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FlinkCEP

- **Pattern detection**
- **CEP engine with the rest of Flink**
- **What to expect:**
  - Dynamic patterns - FLINK-7129
  - SQL's MATCH_RECOGNIZE - FLINK-6935

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FlinkCEP

- **Pattern detection**
- **CEP engine with the rest of Flink**
- **What to expect:**
  - Dynamic patterns - FLINK-7129
  - SQL's MATCH_RECOGNIZE - FLINK-6935
  - YOUR ~~AD~~ IDEA HERE

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