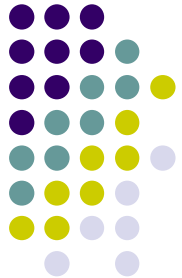
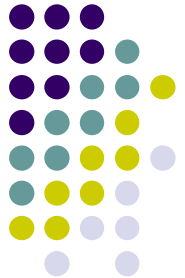
Tagging Stream Data for Rich Real-Time Services



Rimma V. Nehme
Elke A. Rundensteiner
Elisa Bertino

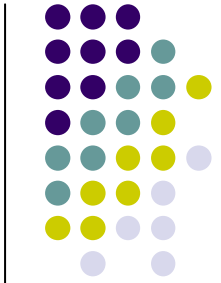
Presented by: Shujie Li
13. 01. 2010

Contents



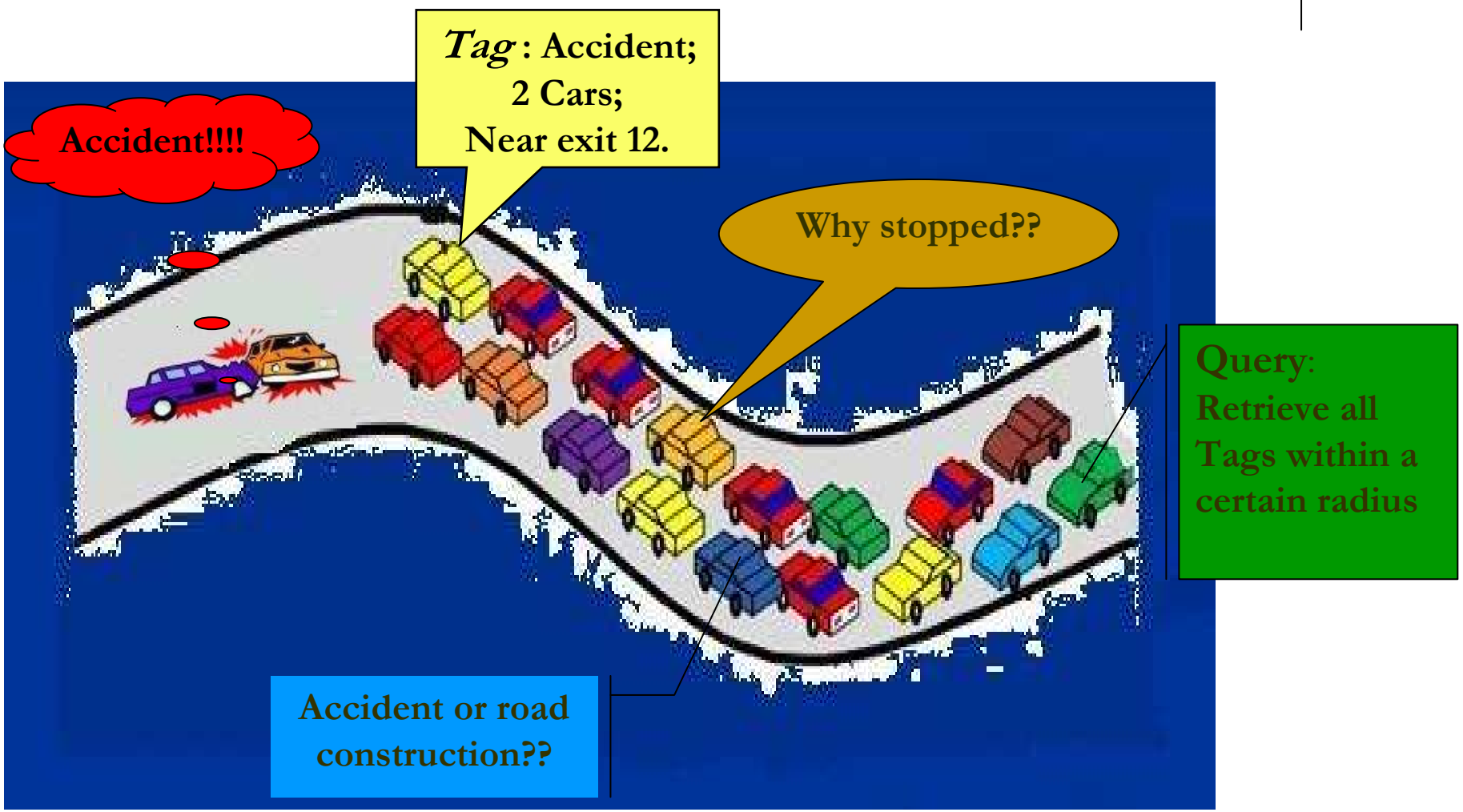
- **Introduction**
  - Approach
  - Fundamentals
- **Tag Model**
- **Tag Query Language (TAG-QL)**
  - Key Statements
  - Attach/Generate a tag to objects
- **Tag-Base Query Processing**
  - Tag-Oriented Query Processing
  - Tag-Aware Query Processing
- **Experimental Analysis**
- **Conclusion**

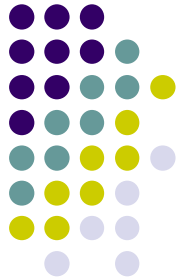
Contents



- **Introduction**
  - Approach
  - Fundamentals
- Tag Model
- Tag Query Language (TAG-QL)
  - Key Statements
  - Attach/Generate a tag to objects
- Tag-Base Query Processing
  - Tag-Oriented Query Processing
  - Tag-Aware Query Processing
- Experimental Analysis
- Conclusion

Introduction: Approach





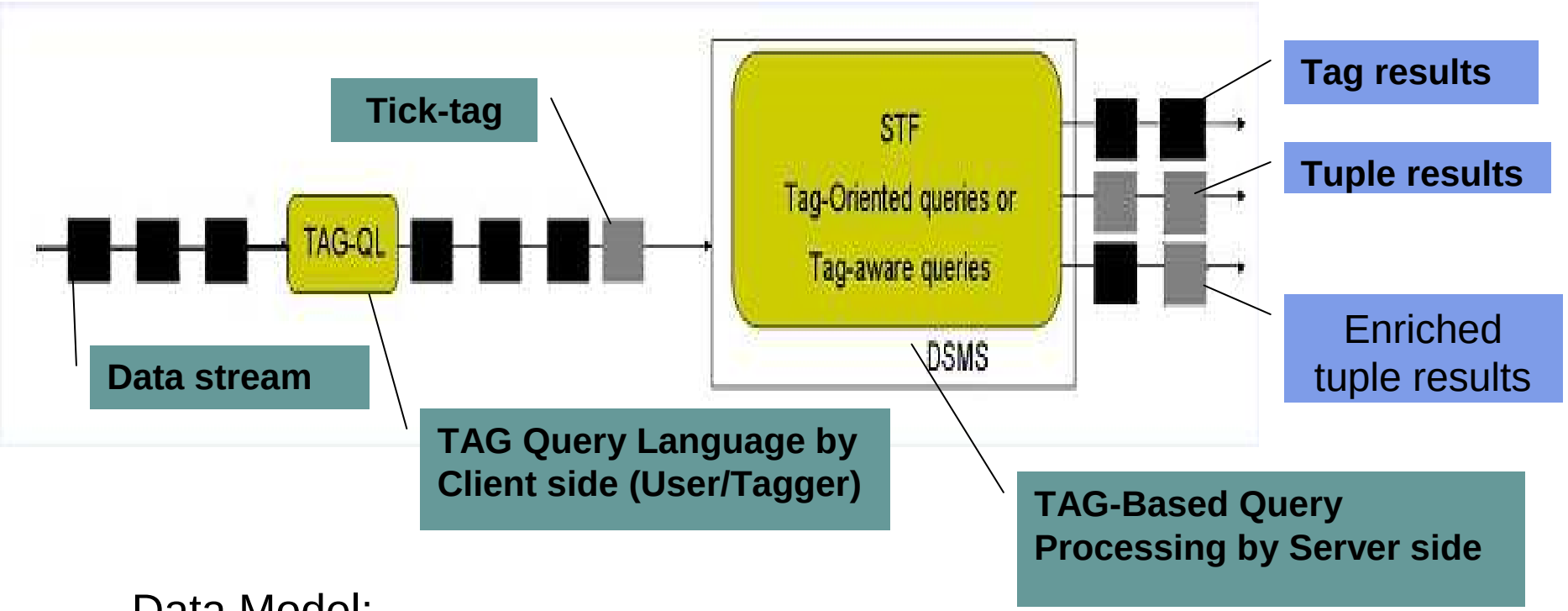
- Premise of tagging: Users can label data in order to get more informative query results.

- The additional label with type of metadata

Tick-tags

- Continuous query processing with tags, address the Tick-tag issues and efficiency concerns.

Proposed Solution: Stream Tag Framework (STF)



Data Model:

tuple = [*stream_id, tuple_id, A, timestamp*]

Introduction: Fundamental

Data Stream Management System (DSMS):

The database for managing continuous data streams which are sequences of data tuples.

Tagging:

The process of adding comments or labels to something.

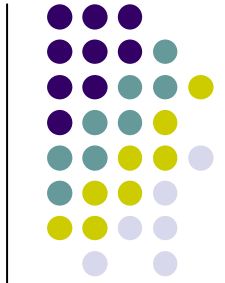
Tagging in Data Stream Environments:

Additional information to streaming objects (tuples, tuples attribute, etc.).

streaming objects

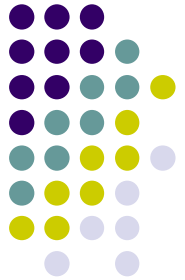
tagged stream

Contents



- Introduction
  - Approach
  - Fundamentals
- **Tag Model**
- Tag Query Language (TAG-QL)
  - Key Statements
  - Attach/Generate a tag to objects
- Tag-Base Query Processing
  - Tag-Oriented Query Processing
  - Tag-Aware Query Processing
- Experimental Analysis
- Conclusion

Tag Model: Fundamental



- **Definition:**

  Meta-Data tuples that attach additional information to stream objects.

- **Characteristics:**

  transient, sequential access, high input rate, potentially infinite size, continuous tag processing.

Tag Model: Design

Tagger identifier

TID:

Unique id of the tagger / user, determined by the system.

Applicability

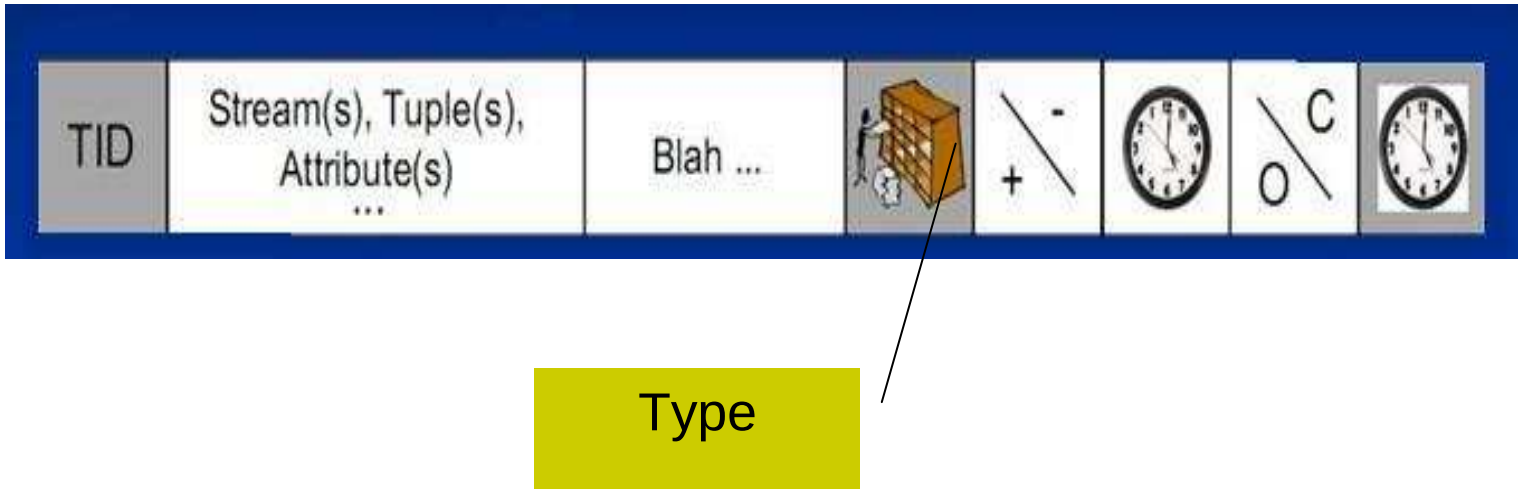
Applicability:

Describes the stream object, regular expression.

Content

Content:

A string datatype, stores the actual tag value. E.g. “Accident”.



Type:

To classify streaming tags: Objective type (i.e. "2 Car Accident"), Subjective type (i.e. "Nice", "Interesting"), etc…

Sign:

To serve as a qualitative description of a tick-tag based on the content to generate an overall opinion for the tagged information.

"+": Positive content; "-": Negative content.

Lifespan

Lifespan:

A time interval in which the tick-tag is active.

Exception "I" (Instant): if a single applicability is wanted.

Mode:

Indicates the user's preference regarding the combination of the actual tag with earlier ones.

"O": Overwrite; "C": Combine.

Point: Tagger specifies only self tags.

Timestamp:

The time when the tick-tag was generated.

Example:

Auction Stream contains items to sell

Schema:

Seller_id	Product	Product feature	St_price	time

Example:

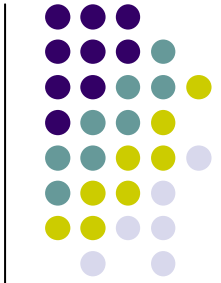
123	Dell Laptop	pink, 1420	600 Euro	2:00 pm

TAG1: with respect to VALUE of start price (St_price).

	,, {St_price. value}	Fair		+	1 day	O	

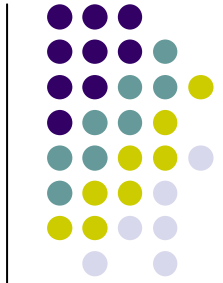
Value is given by system

Contents



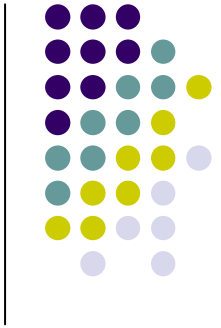
- Introduction
  - Approach
  - Fundamentals
- Tag Model
- **Tag Query Language (TAG-QL)**
  - Key Statements
  - Attach/Generate a tag to objects
- Tag-Base Query Processing
  - Tag-Oriented Query Processing
  - Tag-Aware Query Processing
- Experimental Analysis
- Conclusion

Tag Query Language: Key Statements



Syntax	Meaning
ATTACH TAG...	Attaches a tag to a streaming object
SELECT TAGS...	Selects tags that satisfy a certain search predicate
SELECT TAGGED OBJECTS…	Selects tagged objects
SELECT… WITH TAGS	Returns tag-enriched query results

Tag Query Language: Attach a tag to objects



How to attach a tick-tag to a streaming object ?

Method 1: manually attaching

Syntax:

```
ATTACH TAG <tag_content>
TO <object_description>
(WHERE <condition_description>)
(WITH
        TAG_SIGH = <+ | - >
        TAG_LIFESPAN = <lifespan_value>
        TAG_MODE = <mode_value>)
```

Indicates the object to which the tag should be attached

Decides the location of the tag

Example1:

Tag with respect to VALUE of St_price


```
ATTACH TAG ‘ Fair ’
TO Auction . St_price . Value
WITH
        TAG_SIGH = ‘+’                  AND
        TAG_LIFESPAN = 1 day            AND
        TAG_MODE = OVERWRITE
```

■	*,*, {St_price. value}	Fair	■	+	1 day	O	■

How to attach a tick-tag to a streaming object ?

Method 2: continuous attaching

Example2:

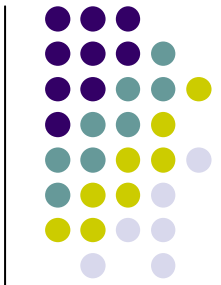
Tag with respect to VALUE of Seller_id

```
ATTACH TAG ‘ Expensive ’
CONTINUOUSLY
TO Auction . Seller_id . value
WHERE( SELECT Seller_id
       FROM   Auction
       WHERE St_price > 600 )
WITH
TAG_SIGH = ‘ - ’
```

Keyword: Tagging is continuous

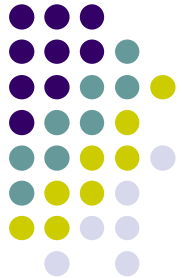
Continuous adding tick-tag to the seller id’s value of auction with St_price > 600.

Contents



- Introduction
  - Approach
  - Fundamentals
- Tag Model
- Tag Query Language (TAG-QL)
  - Key Statements
  - Attach/Generate a tag to objects
- **Tag-Base Query Processing**
  - Tag-Oriented Query Processing
  - Tag-Aware Query Processing
- Experimental Analysis
- Conclusion

Tag-Based Query Processing



Category:

- Tag-Oriented Query Processing (TOQ Processing):
  - ⟹ Users query tick-tags explicitly
- Tag-Aware Query Processing (TAQ Processing):
  - ⟹ Users query tick-tags implicitly

Tag-Oriented Query Processing

Expressing in TAG-QL:

Q1: Tags where the tags values are of interest ('select tags')

Q2: Tags where the corresponding base data values are of interest ('select tagged object')

Patient Stream:

pid	measure	location	time

Q1:
```
SELECT TAGS
FROM   Patient
WHERE OBJECT =
Patient. measure     AND
TAG_SIGN = ' - '
```

Q2:
```
SELECT TAGGED OBJECT
FROM    Patient
WHERE TAG =' Emergency '
```

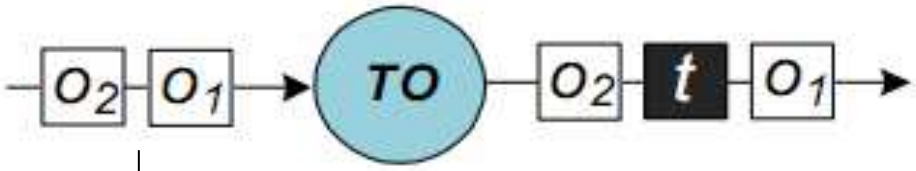
Tag-Oriented Query Algebra:

Tagger Operator:

Input: a stream of objects & Output: a stream of objects with an inserted tag t

$$[TO\ (O\ ,\ p_o\ ,\ t) \rightarrow \overbrace{O}^{T'}\ ] \quad \text{with} \quad \forall t_i \in T', t_i = t$$

Search predicate on objects



O_2 satisfies p_o

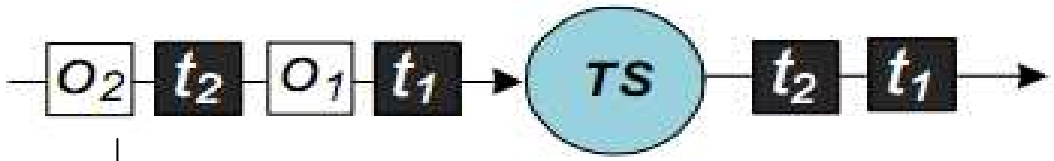
Tag-Oriented Query Algebra:

Tag Selection:

Input: a stream objects with tags **Output: a stream of tags**

$$[TS\ (\overbrace{O}^{T}, p_t) \rightarrow T'] \quad \text{with} \quad T' \subseteq T$$

Search predicate on tag



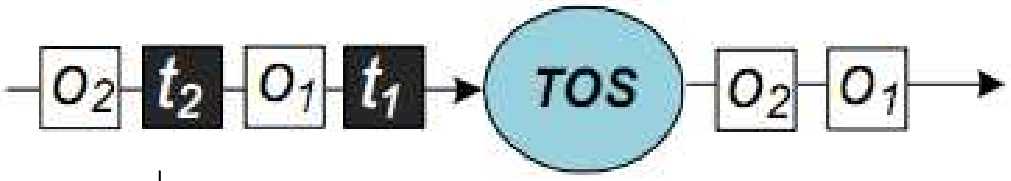
t_1 and t_2 satisfy p_t

Tag-Oriented Query Algebra:

Tagged Object Selection:

Input: a stream of objects with tags **Output: stream of objects**

$$[TOS\ (\overbrace{O}^{T}, p_t) \rightarrow O'] \quad \text{with} \quad O' \subseteq O$$



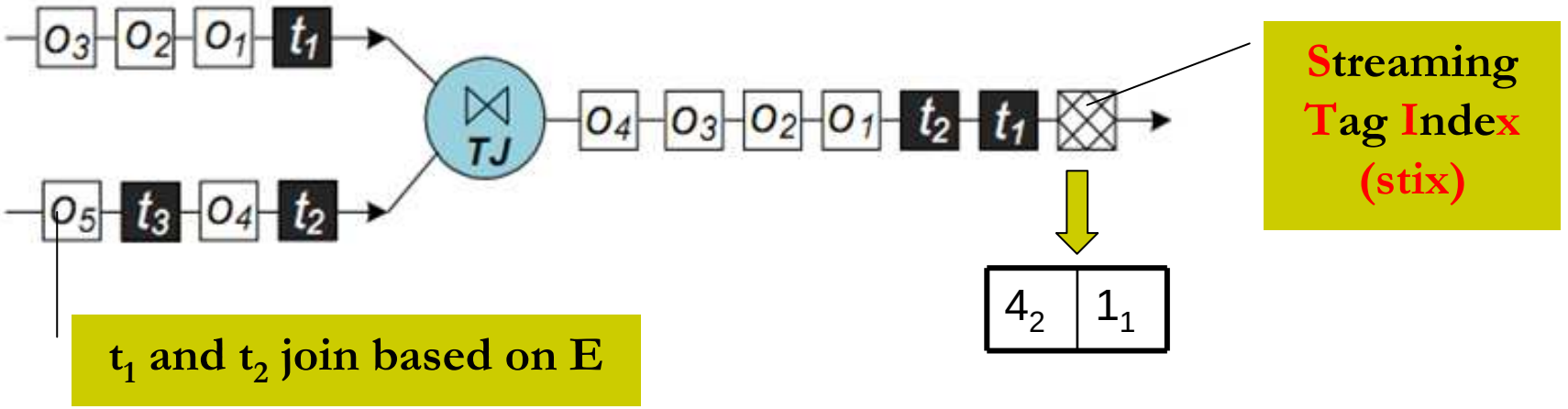
t_1 and t_2 satisfy p_t

Tag-Oriented Query Algebra:

Tag Join:

$$[TJ\ (\overbrace{O_1}^{T_1}, \overbrace{O_2}^{T_2}, E) \rightarrow \overbrace{O'}^{T'}] \quad \text{with} \quad T' = E(T_1, T_2) \neq \emptyset$$

E: Some tag Join condition, i.e., if the both tags are equivalence, or if the both have the same meaning



Tag-Oriented Query Algebra:

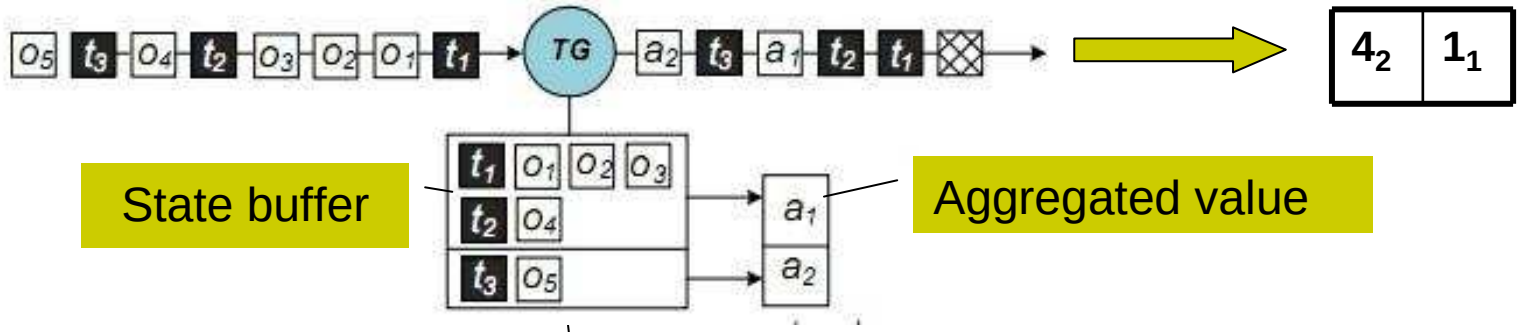
Tag-Based Aggregation:

A certain aggregate function

$$[TG\ (\overbrace{O}^{T}, E, G_T^{agg}\ ) \rightarrow \underset{G_T^{agg}}{\overbrace{O}^{T'}}\ ]$$

Some tag join condition

Streaming Tag Index (stix)

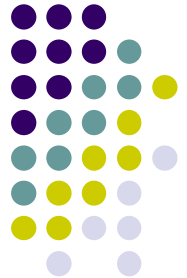


State buffer

Aggregated value

t_1 and t_2 "are the same" based on E

Tag-Aware Query Processing



Goals Tag-Aware Query:

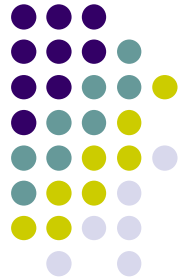
Returns continuous query results that are "enriched" with the tags attached to the original base data.

i.e. enriched tuples / tagged data tuples

Idea:

with statement "WITH TAGS".

Expressing in TAG-QL:

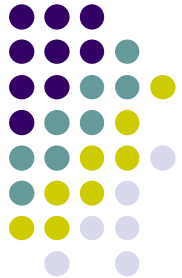


Patient Stream:

pid	measure	location	time

```
Q3:  SELECT  pid, location, time
     FROM    Patient
     WHERE measure > 80
     WITH TAGS
```

Tag-Aware Query Algebra:



Projection operator:

Process tuples by extracting wanted attributes.

Propagates tick-tags and thereafter the projected tuples.

Discard the tick-tag which is attached to the projected attributes.

Example:

Data schema

Stream R_1

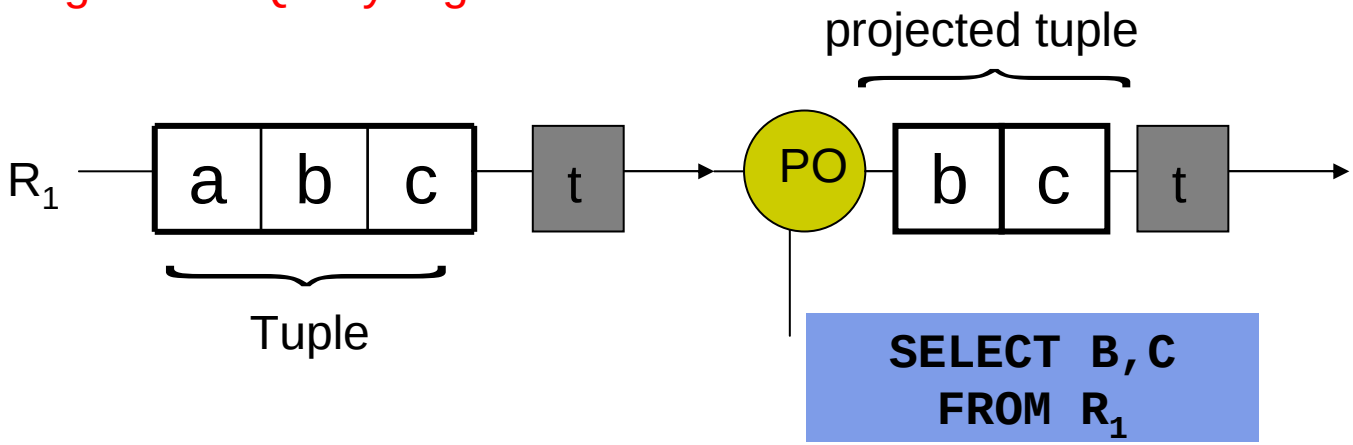
A	B	C
a	b	c

Relation Algebra Projection:

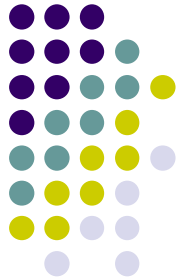
$$\Pi_{B,c}(R_1) =$$

B	C
b	c

Tag-Aware Query Algebra:



Tag-Aware Query Algebra:



Selection operator:

Drops tuples that do not satisfy the selection condition.

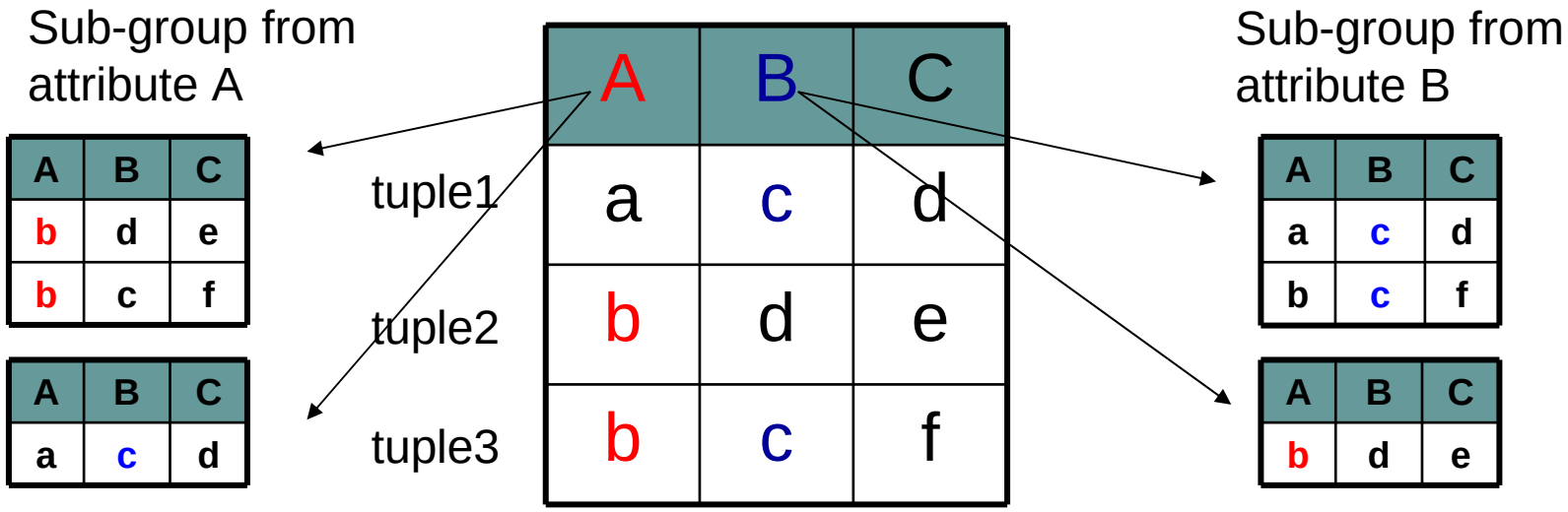
Propagation of tags delayed until min. one tagged tuple which fulfills the selection condition found.

If all tagged tuples are filtered then their corresponding tag is discarded.

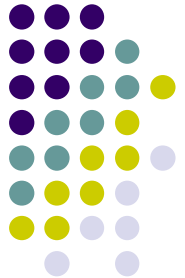
Tag-Aware Query Algebra:

Aggregation operator:

Each attribute domain is split into attribute sub-groups which contain the tuples with the same attribute value.



Tag-Aware Query Algebra:



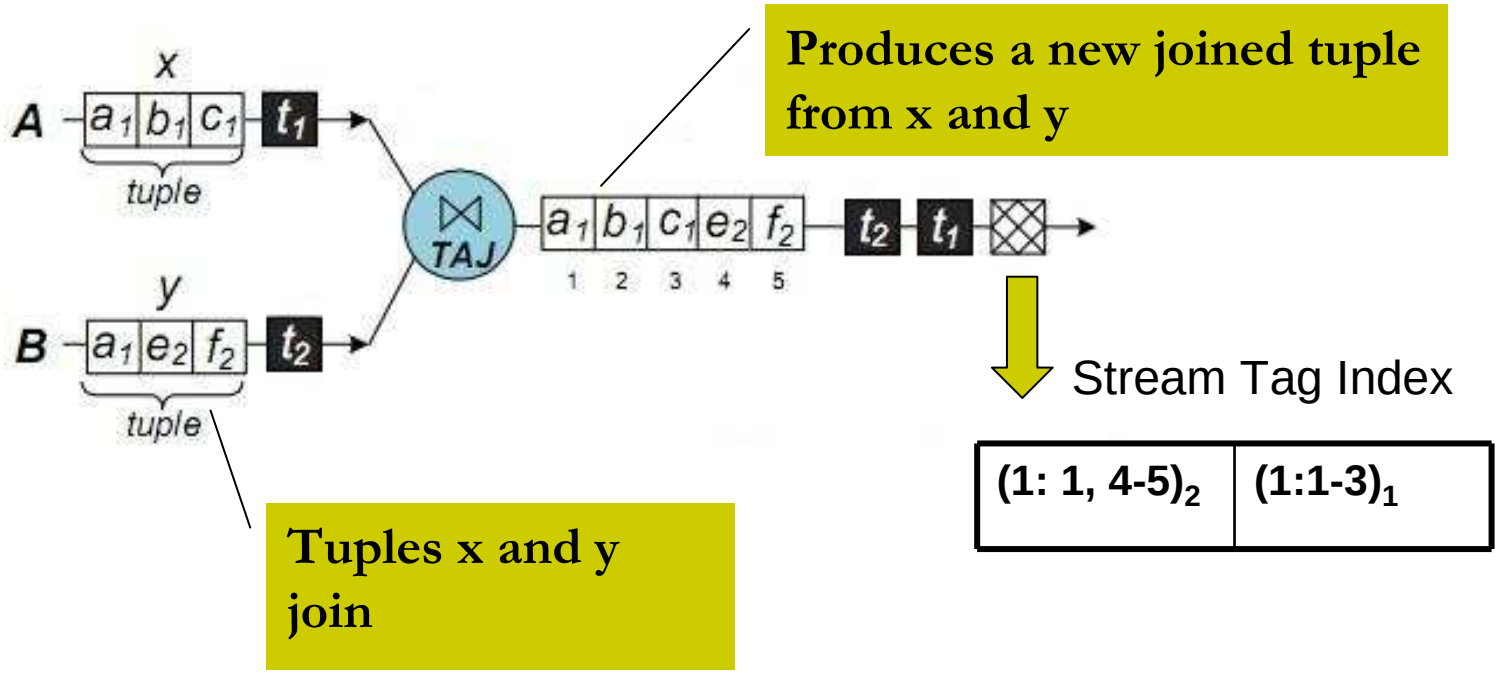
Aggregation operator:

Calculate a result for each sub-group.

Sends the result to the output stream preceded by the collection of tags which are applicable to any object in that sub-group.

Tag-Aware Query Algebra:

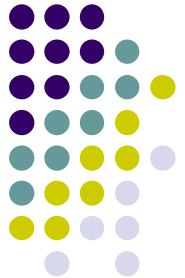
Join operator:



Contents

- Introduction
  - Approach
  - Fundamentals
- Tag Model
- Tag Query Language (TAG-QL)
  - Key Statements
  - Attach/Generate a tag to objects
- Tag-Base Query Processing
  - Tag-Oriented Query Processing
  - Tag-Aware Query Processing
- **Experimental Analysis**
- Conclusion

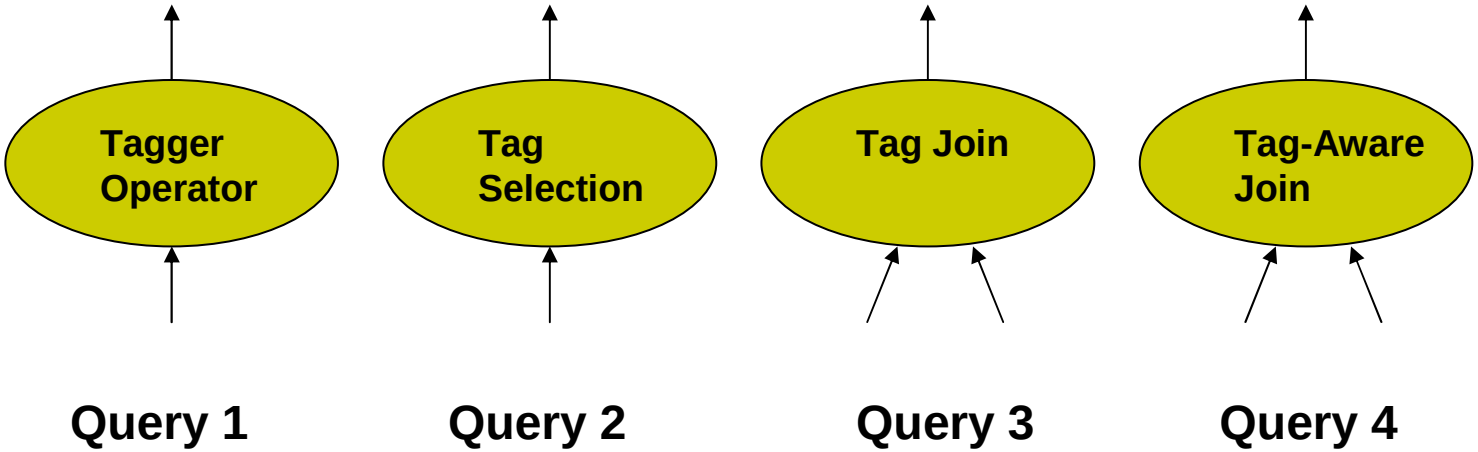
Experimental Analysis



Setup:

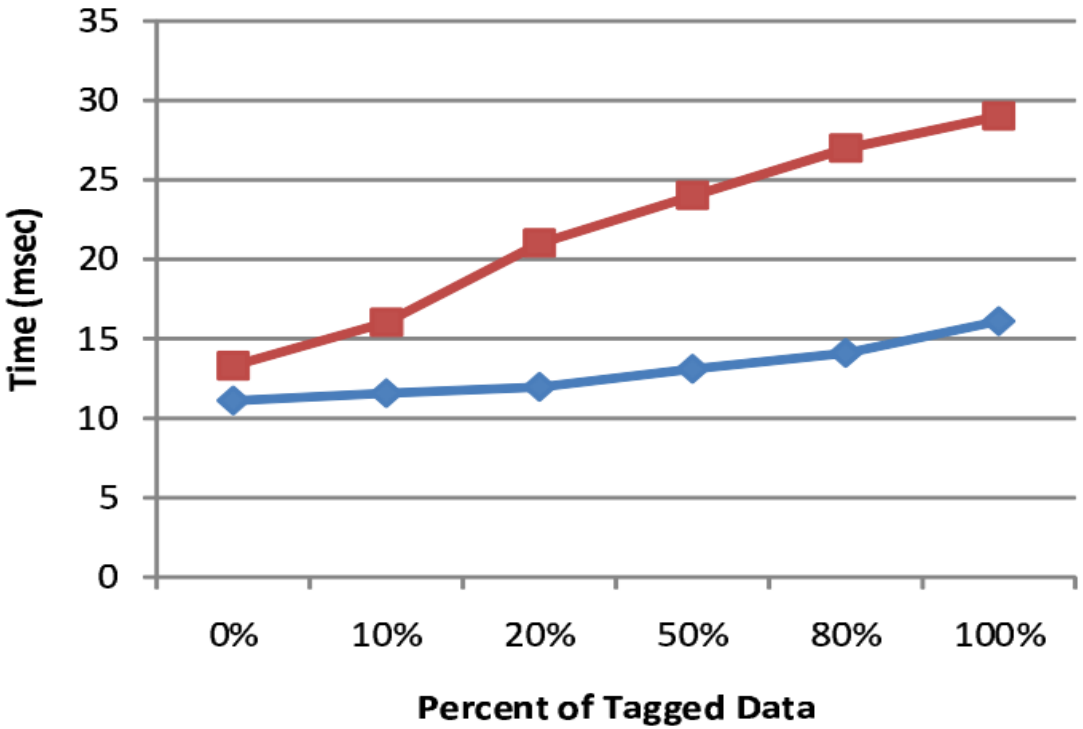
- ***Stream Tag Framework*** is implemented in a DSMS prototype ***CAPE***.
- Data generated by the ***Network-based Moving Objects Generator***.
- ***100K*** of moving objects, which present ***cars***, ***cyclists***, ***pedestrians***.
- The moving objects stream are broken up into ***several streams*** based on the ***id of objects***.

Four Types of queries are used:



Comparison:

Tagger Operator VS. regular Selection Operator

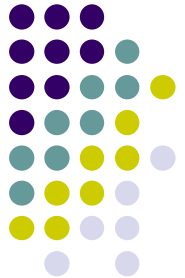


Tagger Operator is used!!

Tagger Operator is larger than **regular Selection Operator** !!!

Comparison:

Tick-Tag *VS* Alternative Tagging Approach



Alternative Tagging Approach:

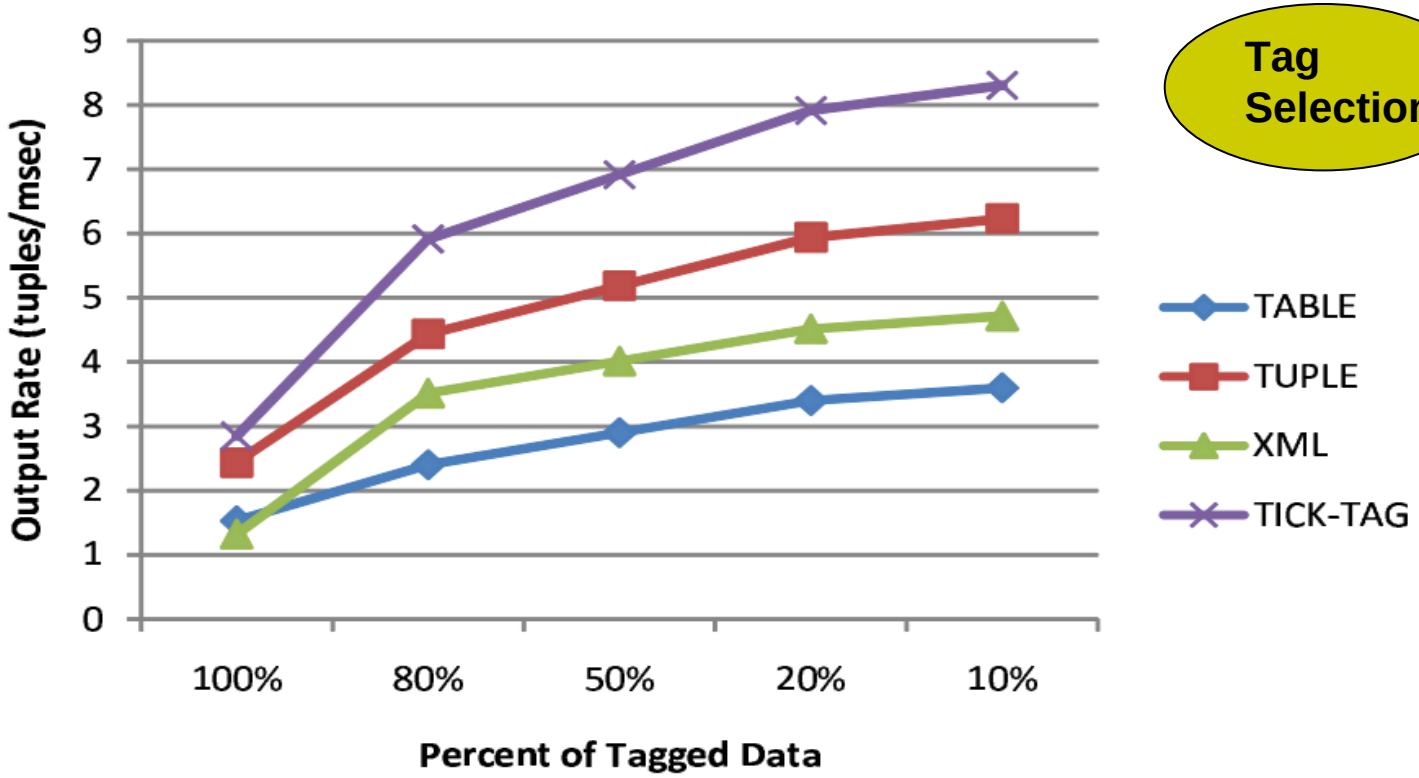
- Table Approach
  Produce a separate global table which maintains all tags.

- Extended Data Tuples
  Extend the data tuple by adding an attribute for tag information.

- Streaming XML
  Dynamic data which is in an XML format

Comparison:

Tick-Tag *VS.* Alternative Tagging Approach

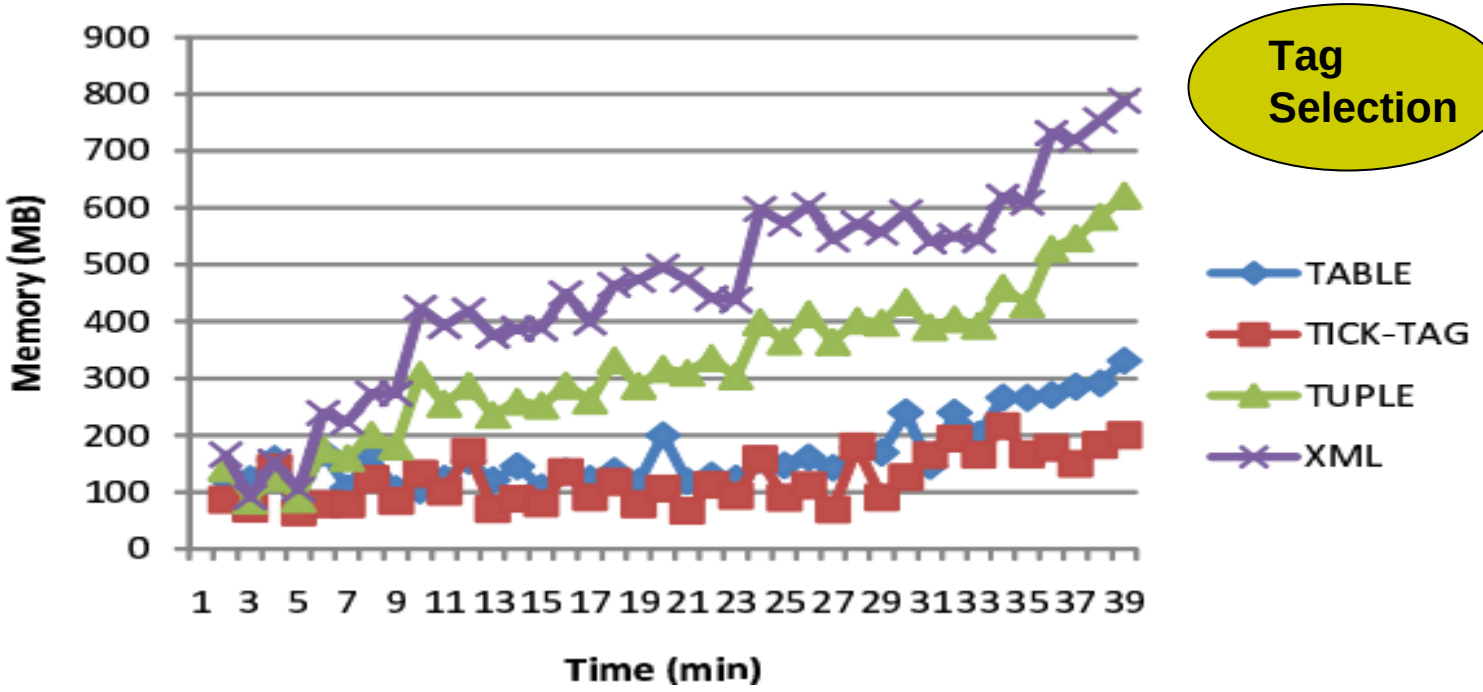


Tag Selection **is used!!**

Tick-Tag approach produces higher output rates !!!

Comparison:

Tick-Tag *VS.* Alternative Tagging Approach

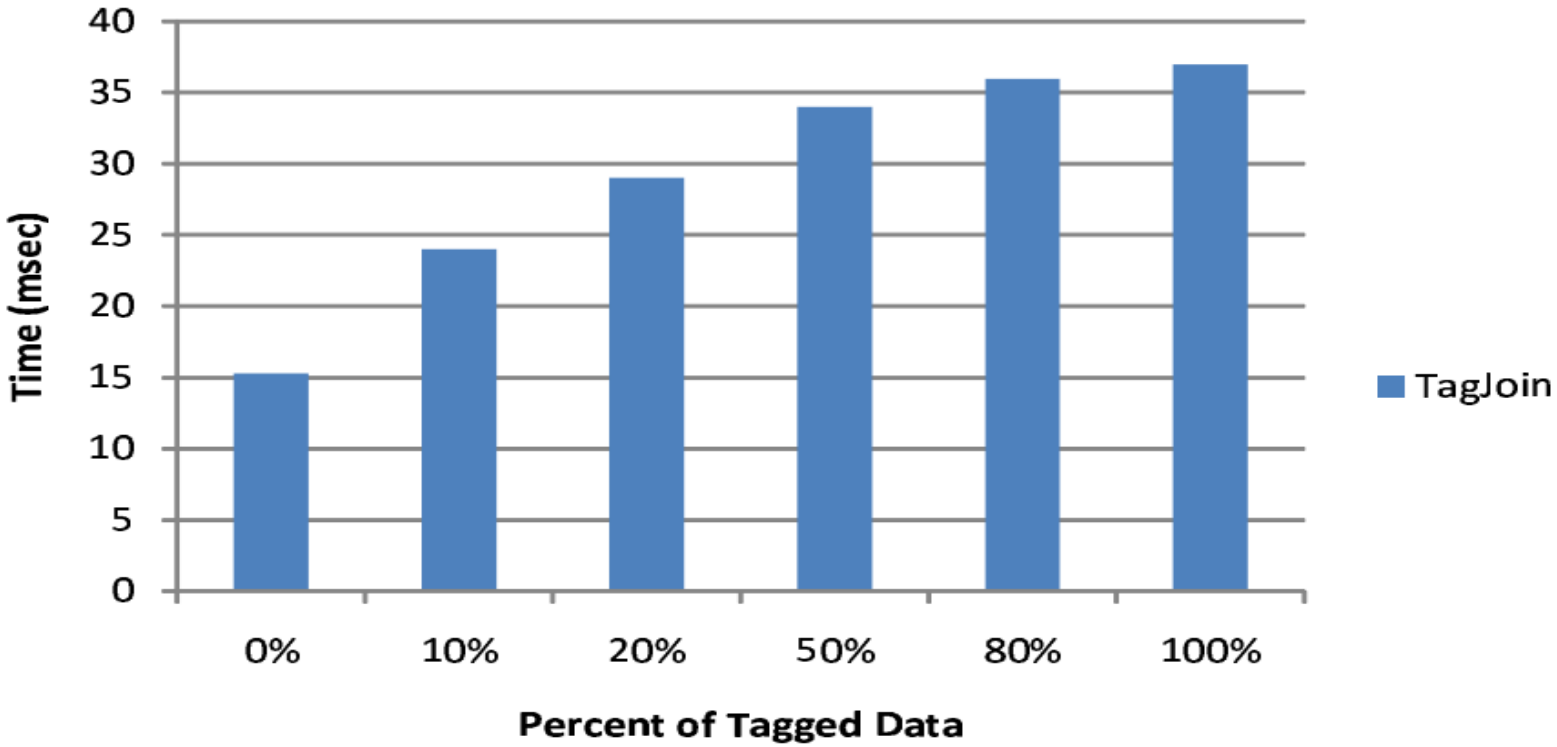


Tag Selection **is used!!**

Tick-Tag approach produces smaller memory usage !!!

Cost of Tag Join Operator :

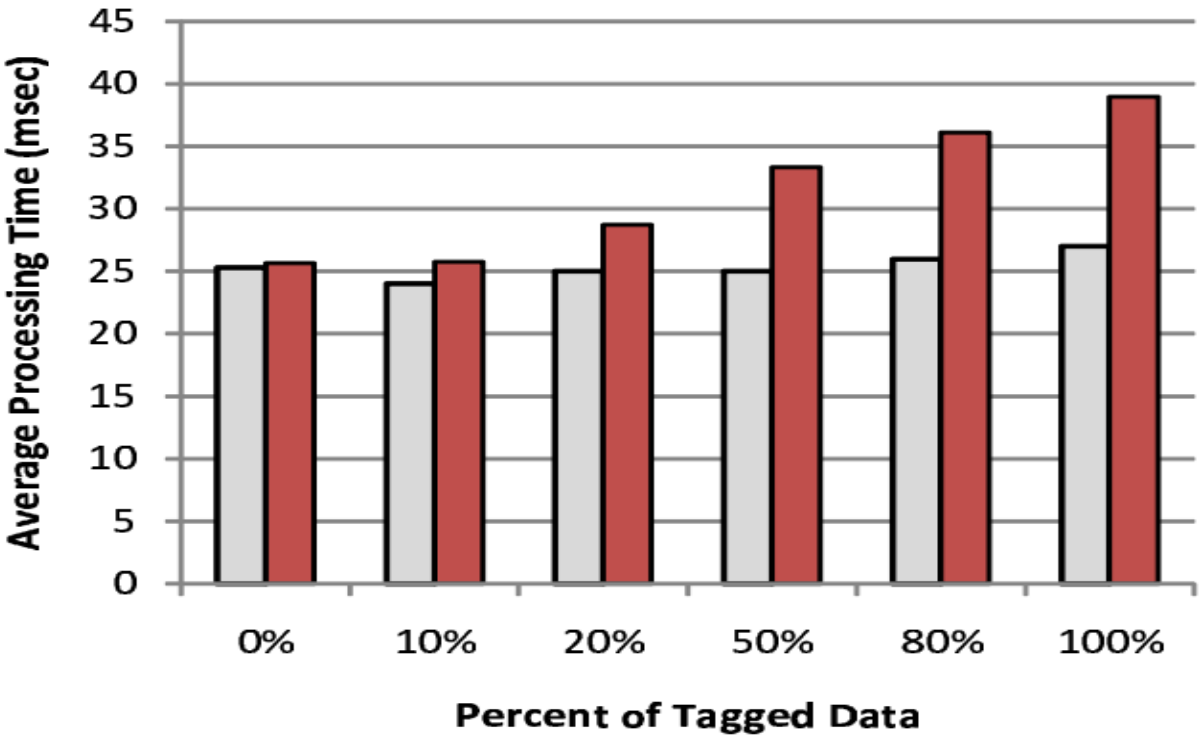
Tag Join **is used!!**



More tags, more overhead !!!!

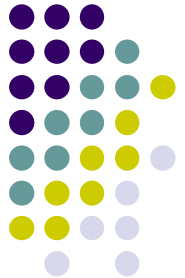
Comparison:

Tag-Aware Join *VS.* regular Join Operator



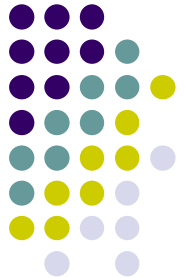
Tag-Aware Join **is used!!**

Contents



- Introduction
  - Approach
  - Fundamentals
- Tag Model
- Tag Query Language (TAG-QL)
  - Attach a tag to an object
  - Tag-Based Query Processing
    - Tag-Oriented Query Processing (TOQP)
    - Tag-Aware Query Processing (TAQP)
- Experimental Analysis
- Conclusion

Conclusion



- Propose the flexible STF to support for tagging data stream, and where the Tick-tags are attached to the objects.
- Tag Query Language enable attachment and query of streaming tags.
- Tag-Based Query Processing contains two aspects.
- Experiment shows the scalability and benefits of Tick-tags in contrast to the traditional theory.


Thank You