ACI MASSES DE DONNEES - PROJET MD33/04-07 - APMD: ACCES PERSONNALISE A DES MASSES DE DONNEES

Data Freshness Evaluation in Different Application Scenarios

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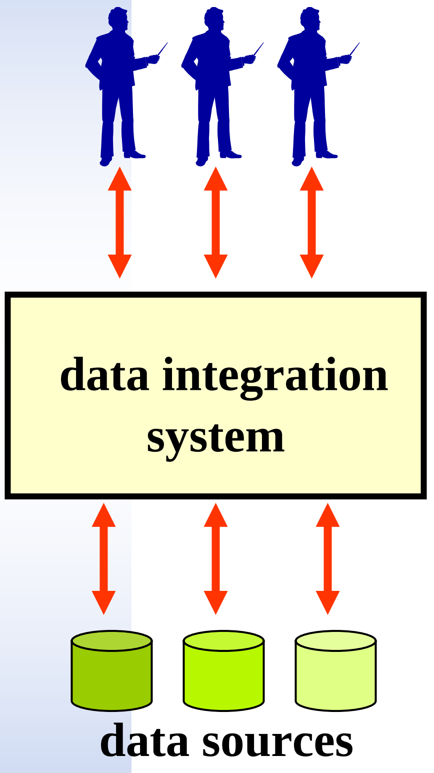
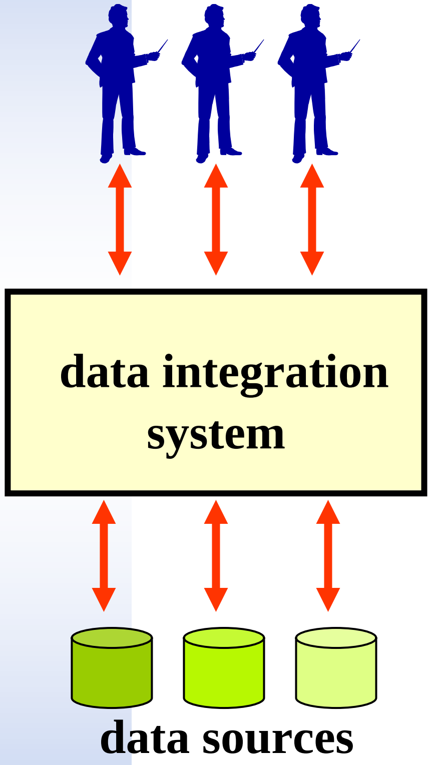
Context



- **Data freshness evaluation in a Data Integration System (DIS)**
  - A set of distributed autonomous data sources, possibly providing same data
  - Each data source may have its own freshness
  - Data sources my have access constraints
  - DIS activities may range from simple query evaluation to data cleaning, transformation and aggregation
  - User queries may concern one or several sources
  - Users accept stale data within fixed boundaries

Motivation



- **Freshness of results depends on:**
  - Source data freshness
  - Production processes

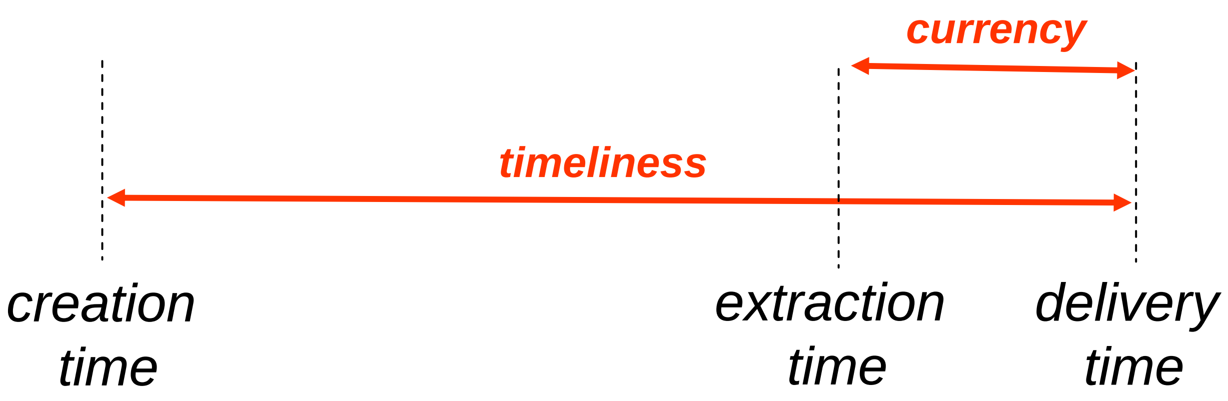
Several Problems:
- Acquire source freshness values
- Acquire DIS property values
- Propagate (and combine) freshness values to query results
- Improve the result freshness

Agenda

- Data Freshness
- Quality Evaluation Framework
- Data Freshness Evaluation
  - General Approach
  - Instantiation Process
- Data Freshness Enforcement
- Conclusions

Data Freshness

- **Data freshness quality factors:**
  - Currency: Gap extraction – delivery
    - How stale is data with respect to sources?
  - Timeliness: Gap creation/update – delivery
    - How old is data? Is its age appropriate?



Quality Evaluation Framework

- **Composed of:**
  - Data sources
  - Query classes
  - DIS calculation processes

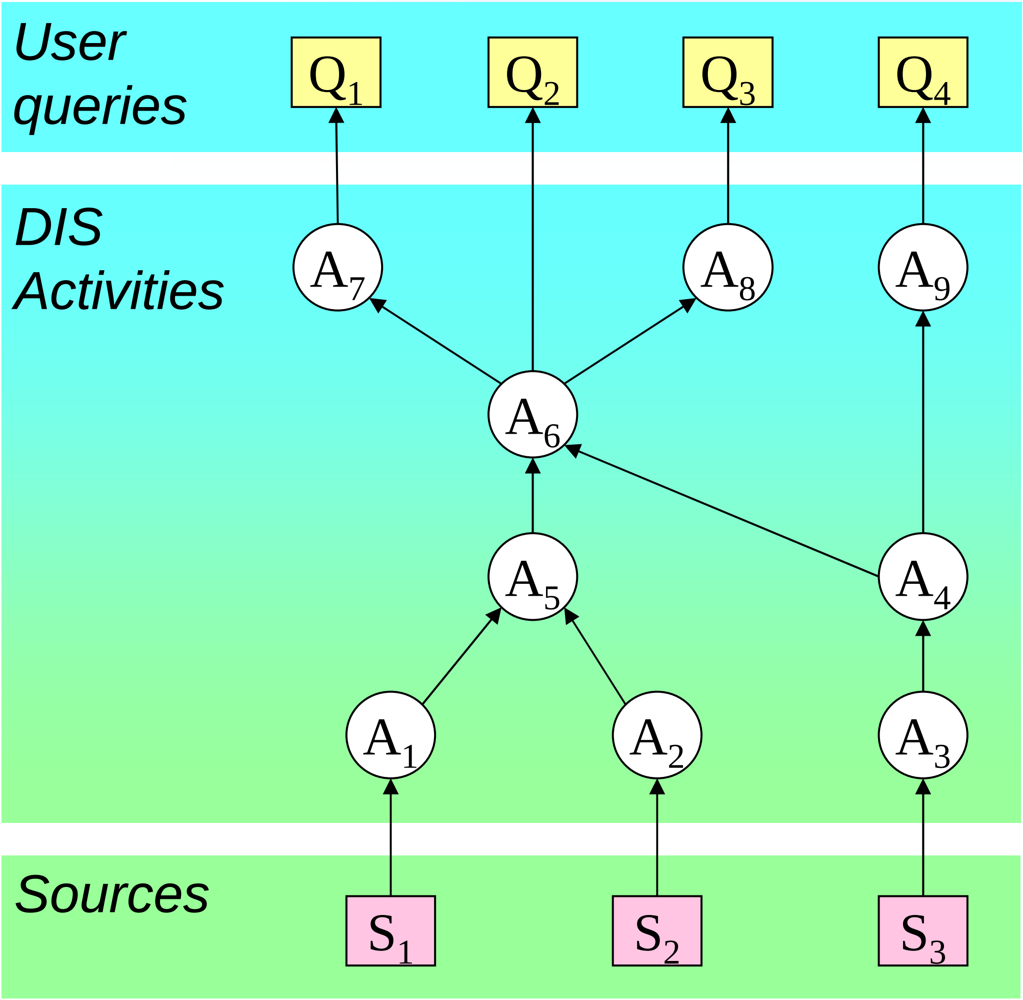
  } represented as a graph

  - Properties (DIS features and quality measures)
  - Algorithms (for propagating quality values)

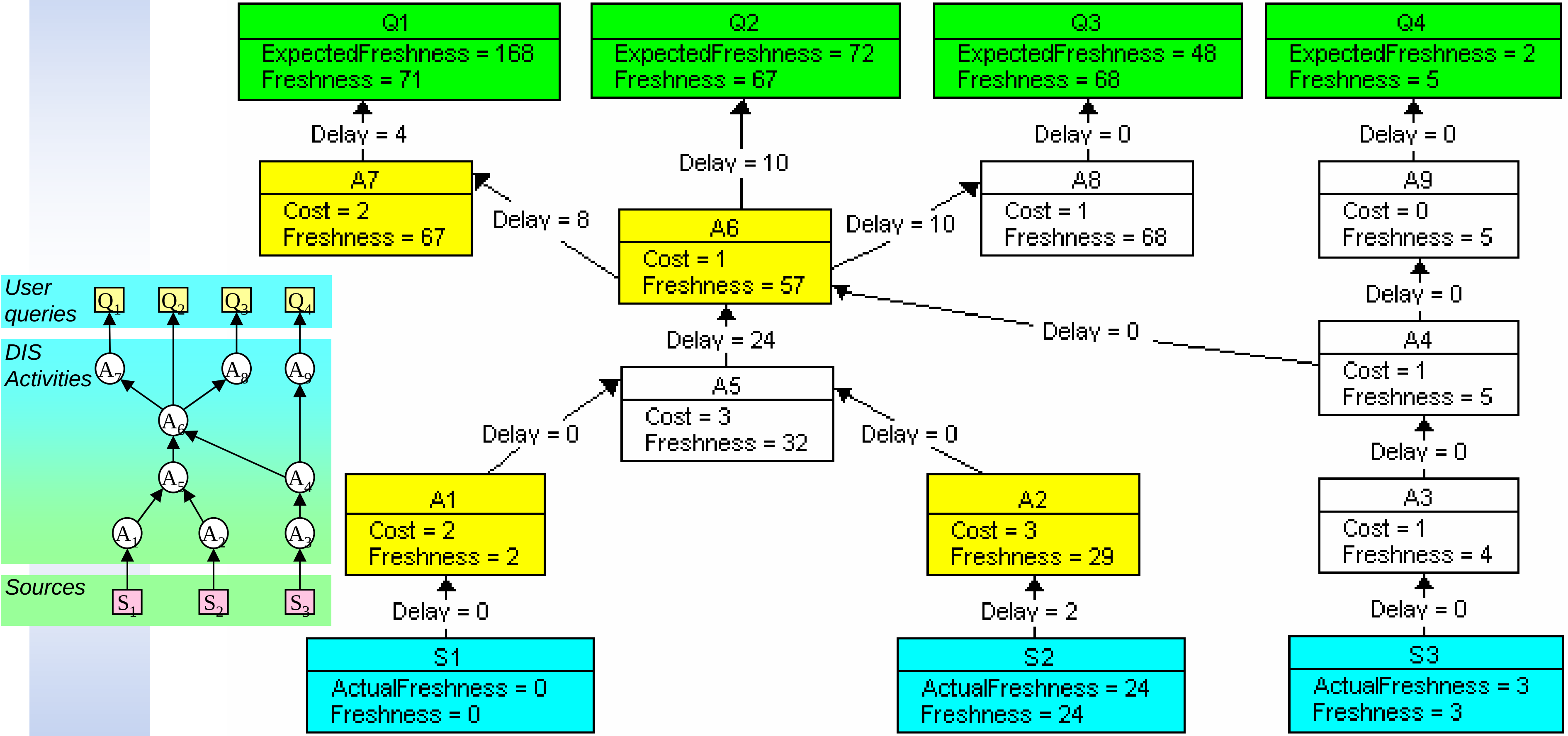
DIS representation

- DIS represented as a workflow of calculation activities (steps).

- A labeled calculation dag (LCDag) is a dag, with the same dataflow structure and properties associated to nodes and edges



Labeled Calculation Dag (LCDag)



Properties

- **Two types of properties:**
  - Descriptions: Indicate DIS features
    - E.g.: costs, delays, policies, strategies, constraints
  - Measures: Indicate freshness values
    - A source actual value acquired from a source
    - A calculated value obtained executing an evaluation algorithm
    - An expected value expressed by users

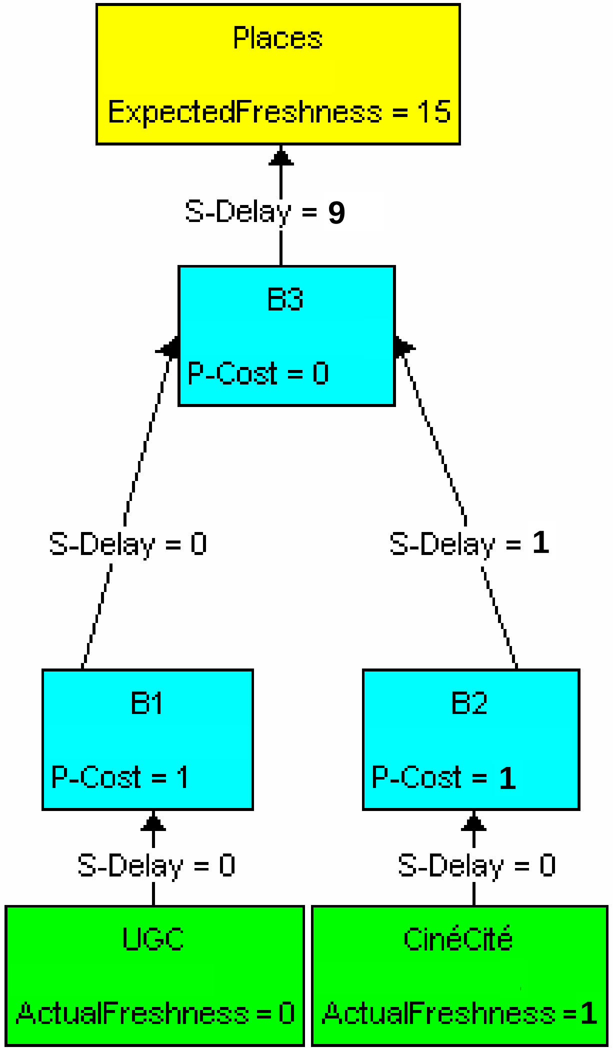
Properties Associated to Freshness

- **Freshness of delivered data depends on:**
  - Source data freshness.
  - Execution delay of the DIS.
- **Properties associated to data freshness:**
  - Processing cost: Time needed for executing an activity.
  - Synchronization delays: Delay between the execution of consecutive activities.
  - Source actual freshness: Freshness of data in a source.

Freshness Evaluation Algorithm

Algorithm principle:

- Source nodes S:
  - **Freshness (S)** = ActualFreshness (S)
- Other nodes N:
  - **Freshness (N)** = Freshness (P) + S-delay (P,N) + P-Cost (N)
- Freshness of several input nodes are combined



Freshness Evaluation Algorithm

```
FUNCTION DataFreshnessEvaluation (G: LCDag) RETURNS LCDag
BEGIN
  INTEGER value;
  FOR EACH source node A DO
      value= getActualFreshness(G,A);
      G.addProperty(A,“freshness”,value);
  ENDFOR;
  FOR EACH activity and target node A in topological order DO
      HASHTABLE valList;
      FOR EACH node B in G.getPredecessors(A) DO
          value= G.getPropertyValue(B,“freshness”) + getSyncDelay(G,B,A);
          valList.add (B, value);
      ENDFOR;
      value= combine(valList) + getProcCost(G,A);
      G.addProperty (A,“freshness”,value);
  ENDFOR;
  RETURN G;
END
```

Instantiation

- **Different algorithms for different scenarios:**
  - Different metrics and units
    - E.g. timeliness, currency. → different quality actual values
  - Different DIS features
    - E.g. In virtual DIS there is no delay between activities execution → different cost models
  - Different user quality requirements
    - E.g. When users tolerate freshness values of “weeks” activity costs of “seconds” can be omitted. → different cost models

Instantiation

- **Examples:**
  - A mediation system that answers queries about films, cinemas and billboard.

    timeliness, no cost, no delay, priorities
  - A web portal that caches information about availability of places.

    currency, cost model, refreshment delay, maximum
  - A data warehousing system that stores statistics about films and opinions.

    timeliness, cost model, materialization delay, maximum

Instantiation

```
FUNCTION DataFreshnessEvaluation (G: LCDag) RETURNS LCDag
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      G.addProperty (A,“freshness”,value);
  ENDFOR;
  RETURN G;
END
```
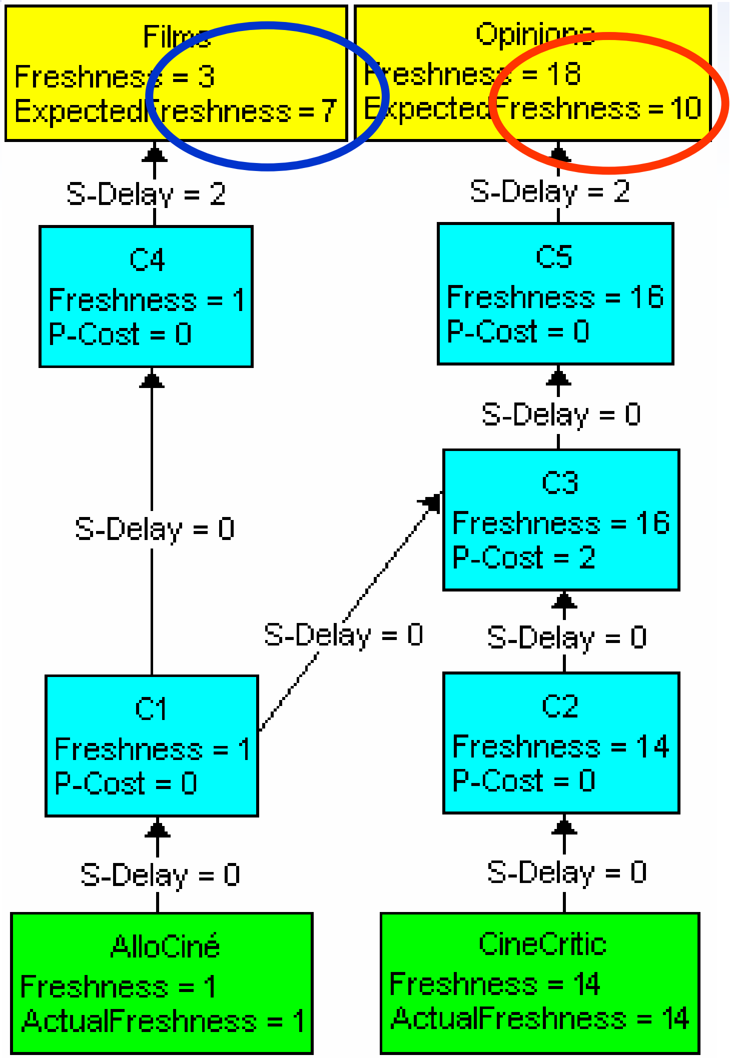
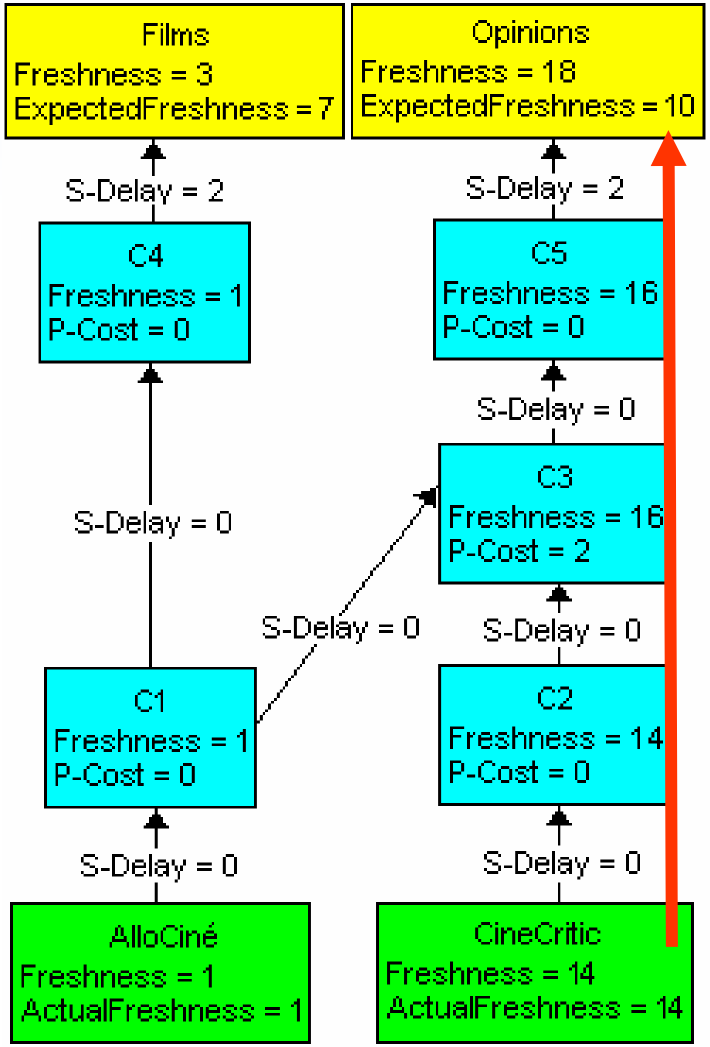

Data Freshness Enforcement

- **Improving DIS design:**
  - Reducing costs.
  - Synchronizing activities.
- **Negotiate with users to relax freshness requirements**
- **Negotiate with source providers to relax source constraints**



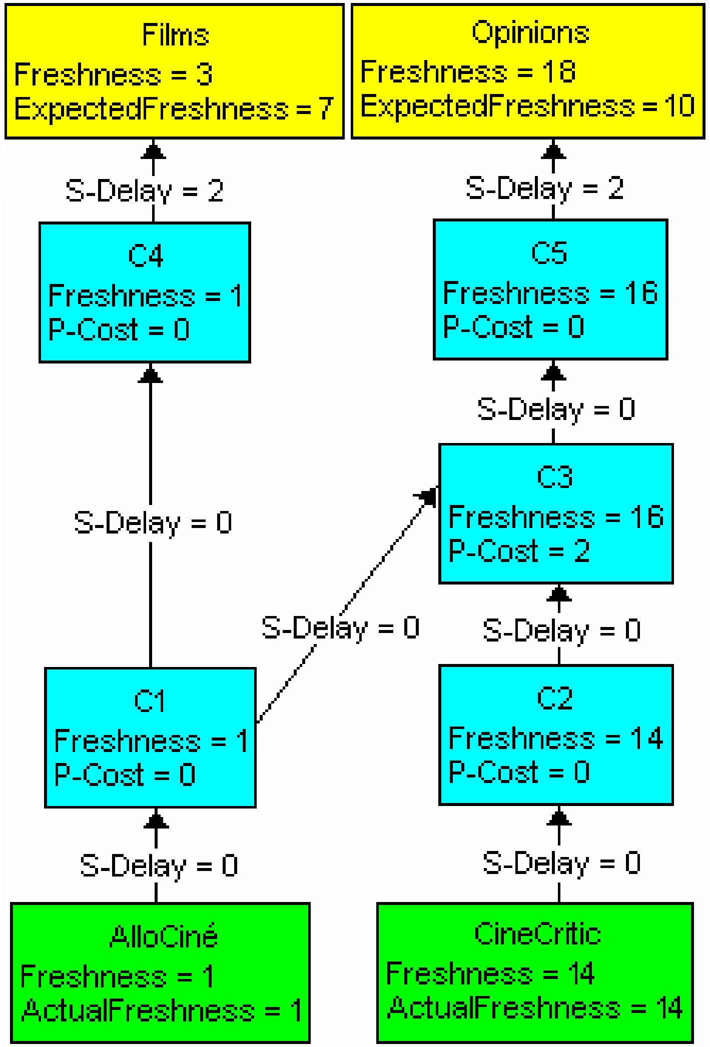
Improving DIS design

- **Strategies:**
  - Reduce activity costs
  - Synchronize activities to reduce delays.
- **Sometimes we can concentrate in critical paths**
- **The tool allows:**
  - Identifying critical paths
  - Changing property values and re-executing



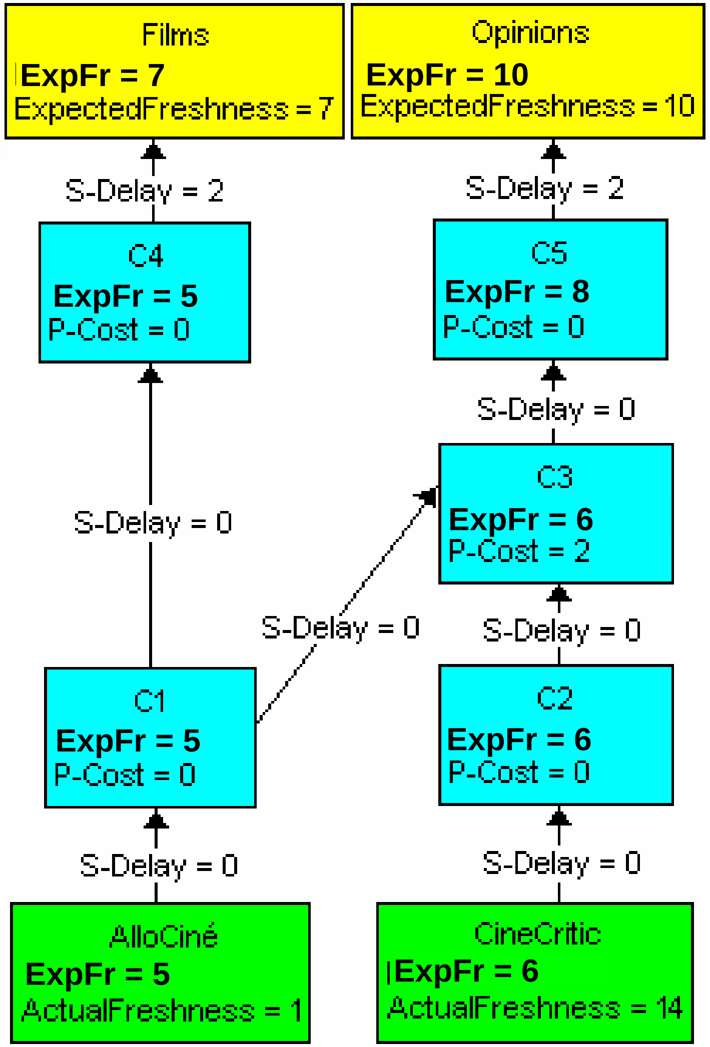
Relaxing freshness requirements

- **Bottom-up strategy:**
  - Shows users the guarantee freshness
- **Direct application:**
  - Evaluating data freshness for several alternative implementations of the DIS
  - Comparing evaluated freshness between them.
- **The tool was used in conjunction with a generator of mediation queries**
  - Evaluating the freshness of the generated queries and selecting the best one. [BDA'2004]



Relaxing source constraints

- **Top-down strategy:**
  - Shows the freshness needs for each source
- **Direct application:**
  - Comparing alternative data sources.
- **The tool allows:**
  - Bottom-up and top-down propagation



Conclusion

- ♦ **A framework for data freshness evaluation**
  - – General evaluation approach.
  - – Instantiation mechanism.
- ♦ **Prototype**
  - – Implements the framework components.
  - – Supports instantiation.
  - – Supports bottom-up and top-down propagation.
  - – Visualization facilities (e.g. critical path).
- ♦ **Future works:**
  - – Automating the instantiation process.
  - – Confront evaluated values with user expectations (profiles).
  - – Improve the tool: scalability, interfaces.

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