Knowledge Representation and I at NII

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National Institute of Informatics

Tuesday, 18 March 2014

Summary of works @NII from 2012/04 to 2014/03

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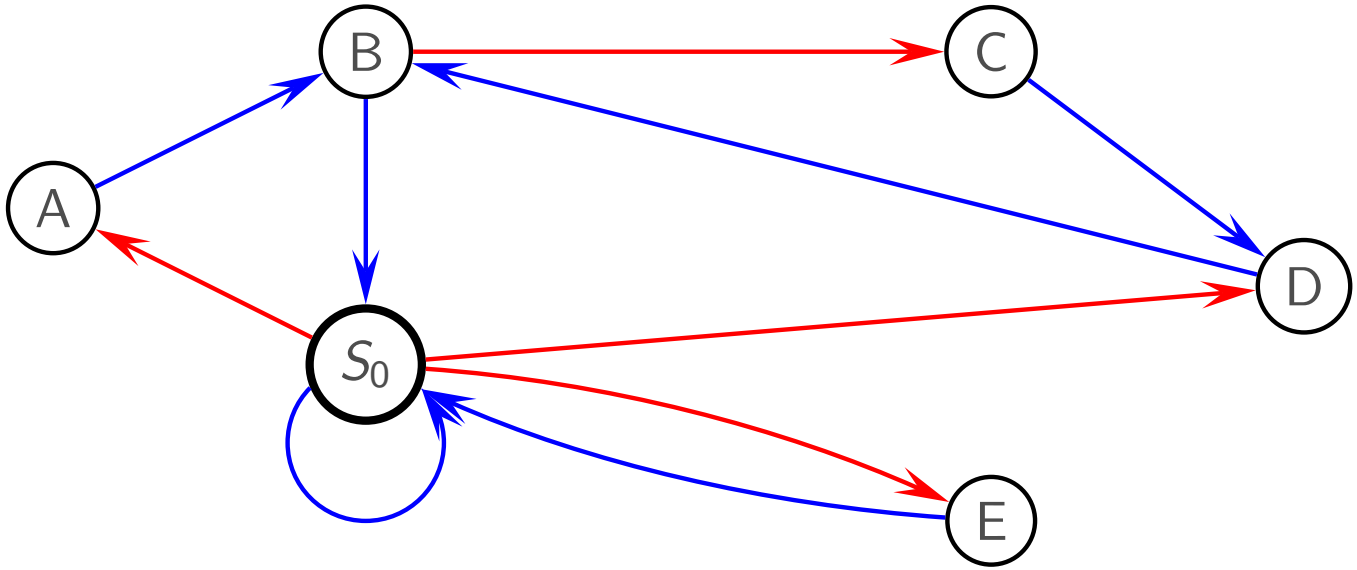
(#1) A Glimpse of Computational Resilience

- A "resilient" dynamic system should be capable to maintain its core purpose and integrity in the face of dramatically changed circumstances (e.g., the 3.11 earthquake in Japan, the ongoing economic crisis, a new strain of virus.)

- The concept of resilience has appeared in various disciplines including ecology [Holling 1973], but there is no common agreement on the definition of resilience.

- We proposed here a new challenging topic : "Systems Resilience" :
  - $\rightarrow$ we formalized the notion of dynamic system in a general way,
  - $\rightarrow$ we provided a set of design principles for resilient dynamic systems.

(#1) Our model : Dynamic System



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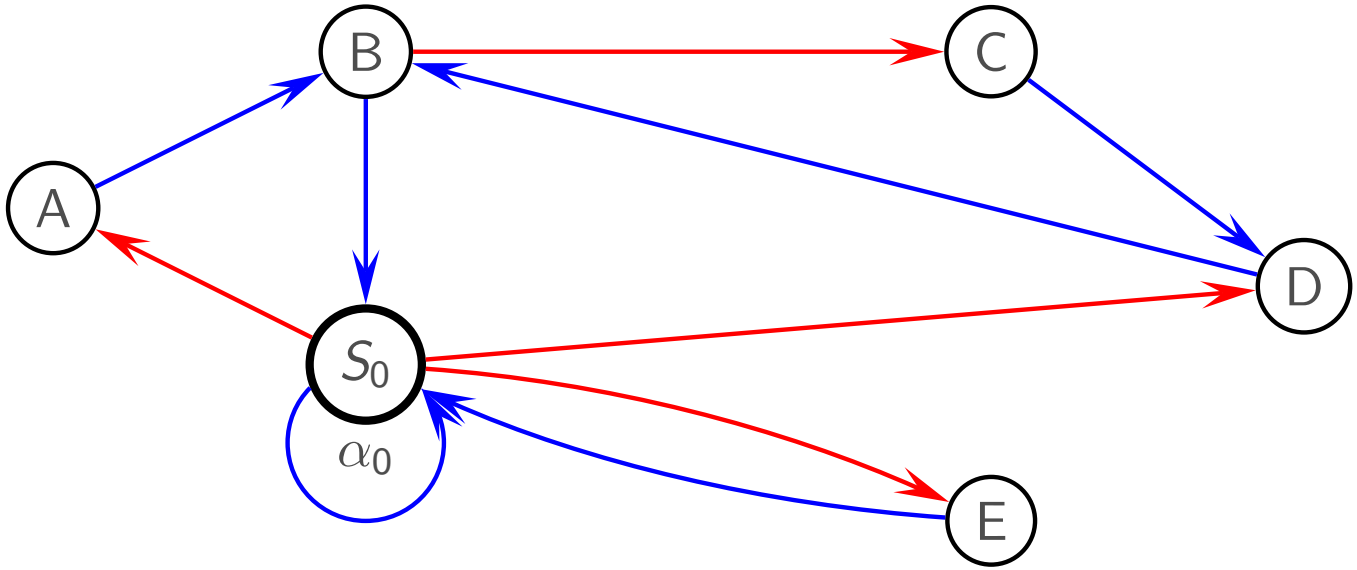

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- Blue edge = decision from the system's controller.

- Every system (i.e., each vertex) is a *constraint optimization problem*, for which every solution has a certain **cost**.
  → example : α_0 is a solution of S_0, and $cost(\alpha_0) = 3$.

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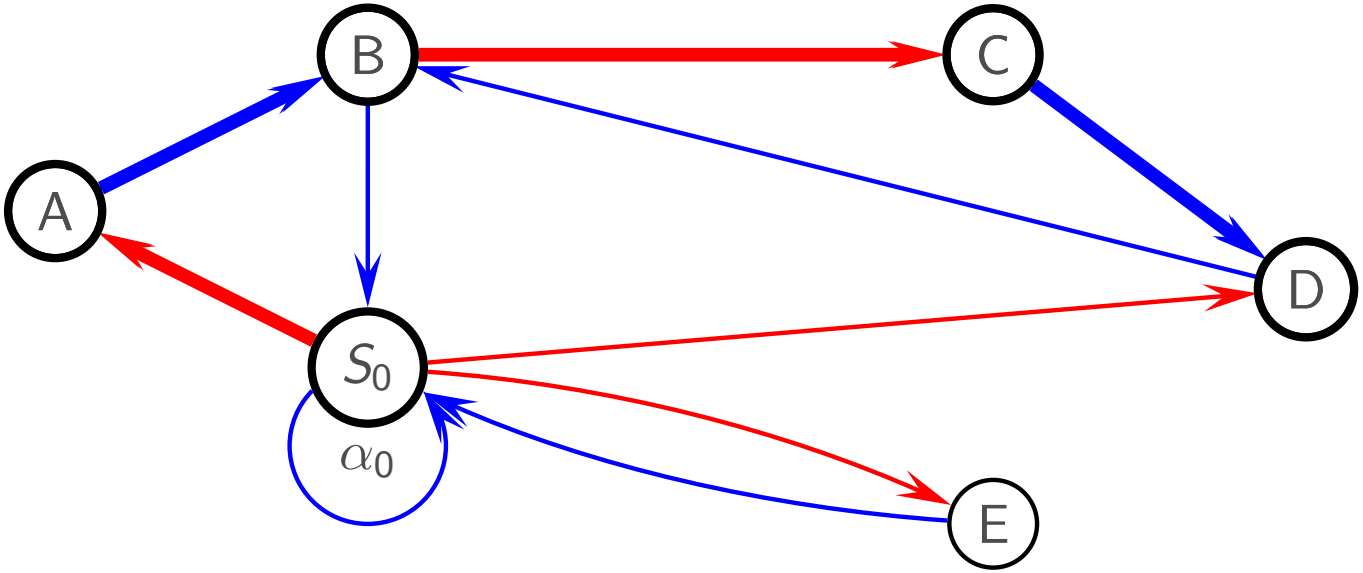

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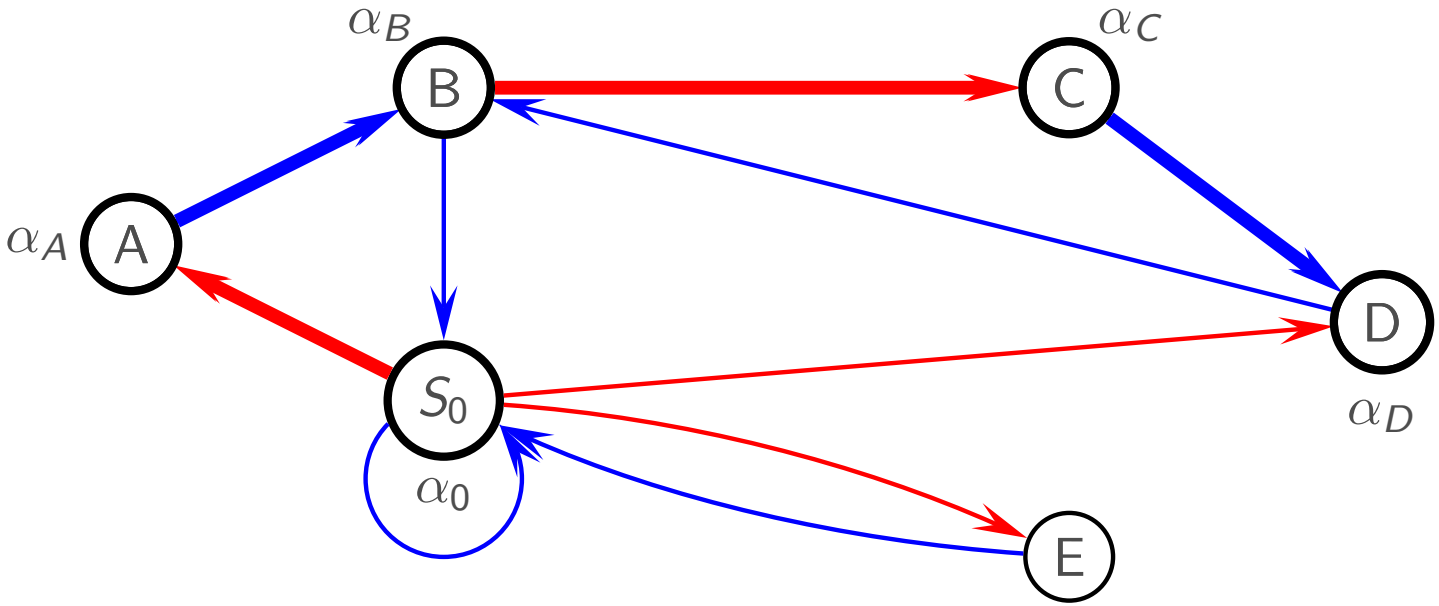

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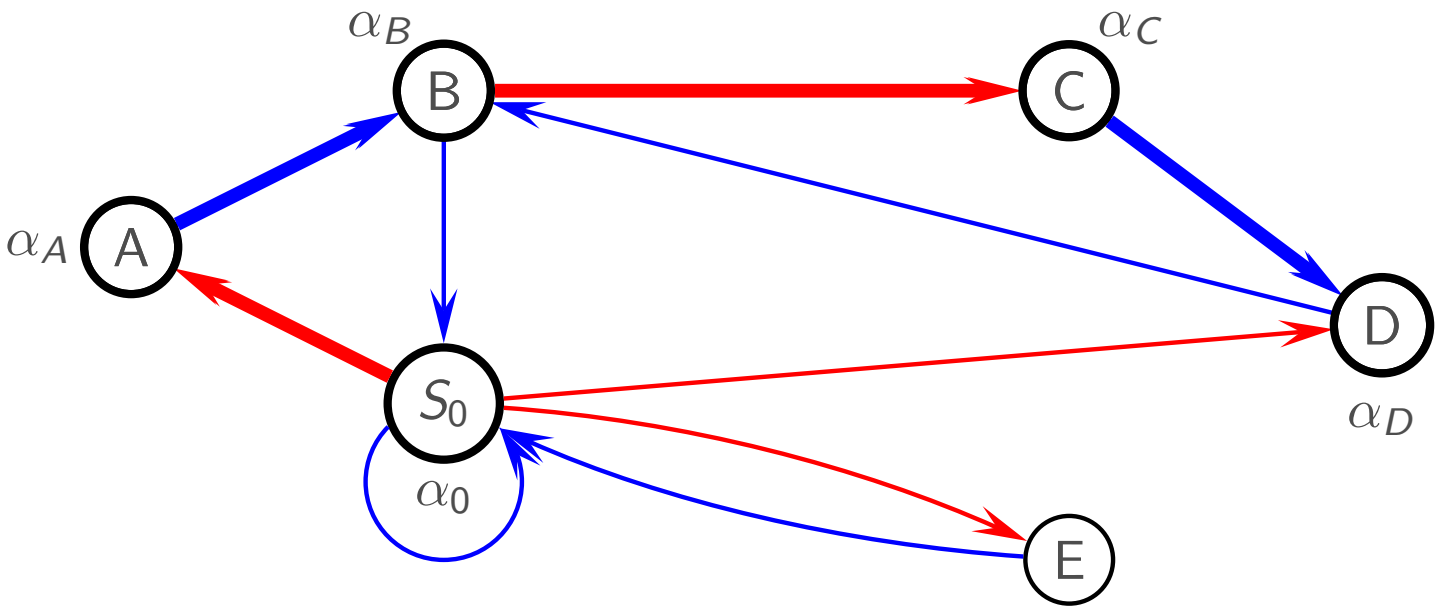
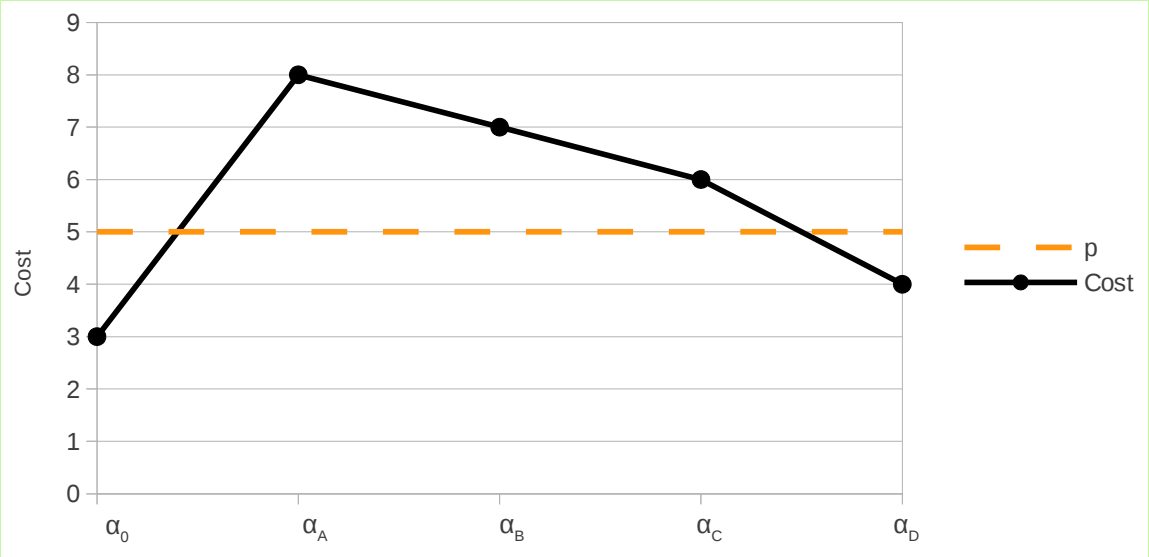


Example : **recoverability**



(#1) Summary and Perspectives

- Summary :
  - Several properties : Resilience (= Resistance + Recoverability), Functionality, Stability, Stabilizability.
  - A step forward in the design of "robust" dynamic systems (applicable in many fields).
  - 3rd Prize in the Special Track of Challenges and Vision Papers of the 12th International Conference on Autonomous Agents and Multiagent Systems (AAMAS'13).

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- Perspectives :
  - Many problems are now open, e.g., computational complexity problems and optimization problems.
  - Introducing probabilities (on going work, Zeltner, Schwind, Inoue).

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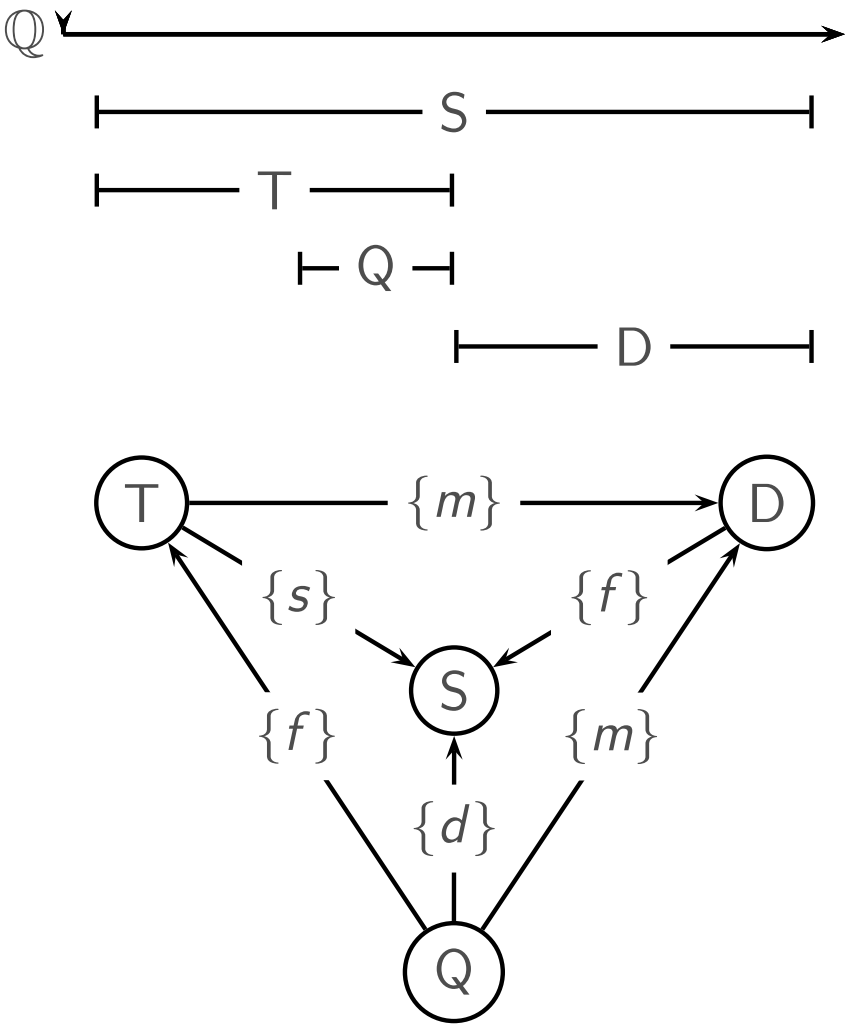
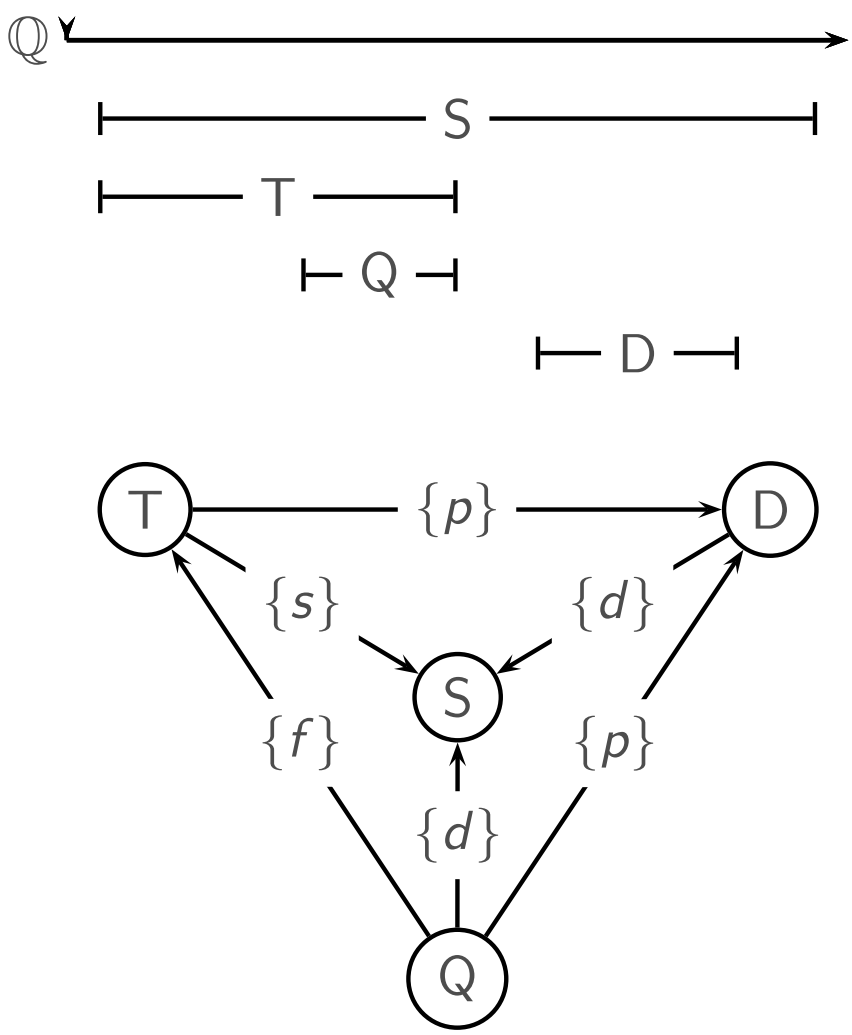


Proposed schedule



Final schedule

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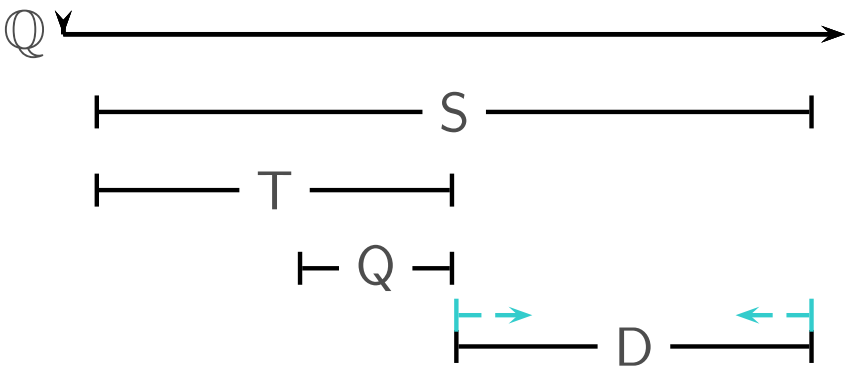

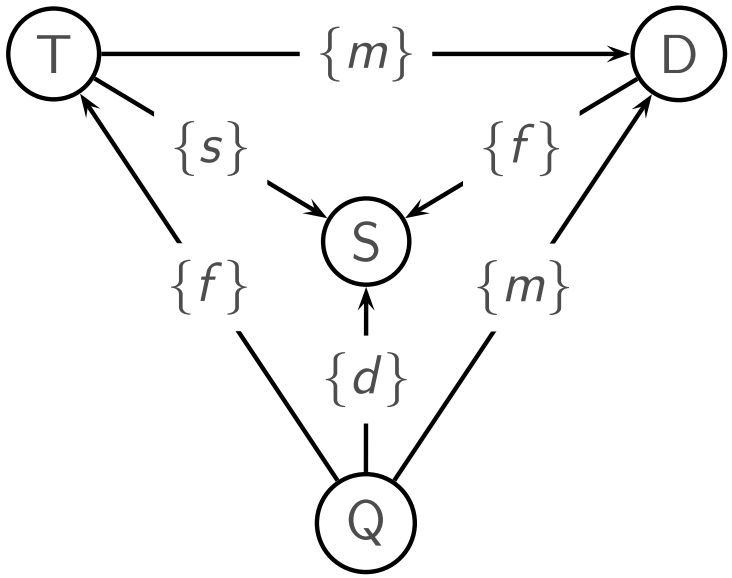

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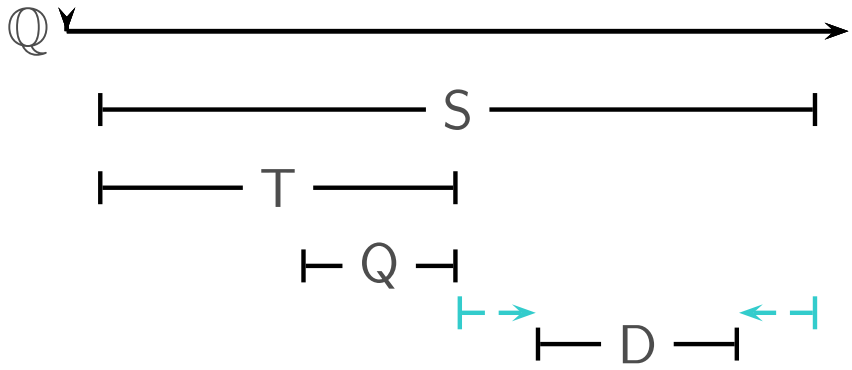

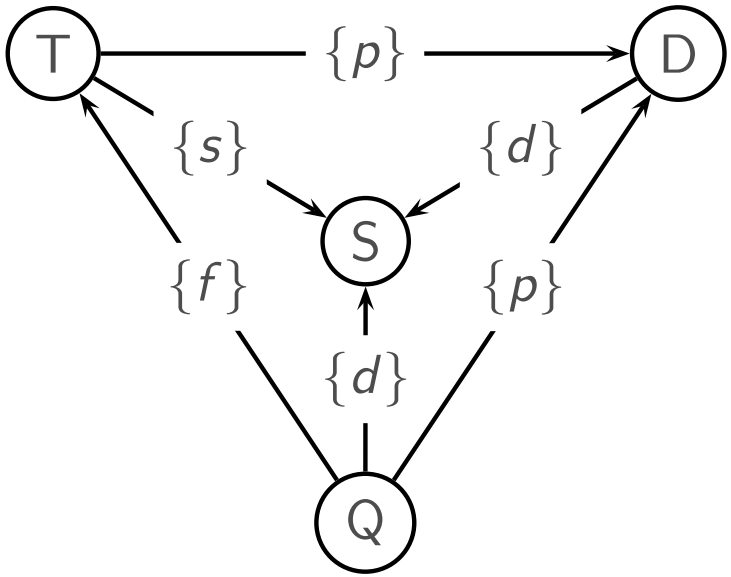

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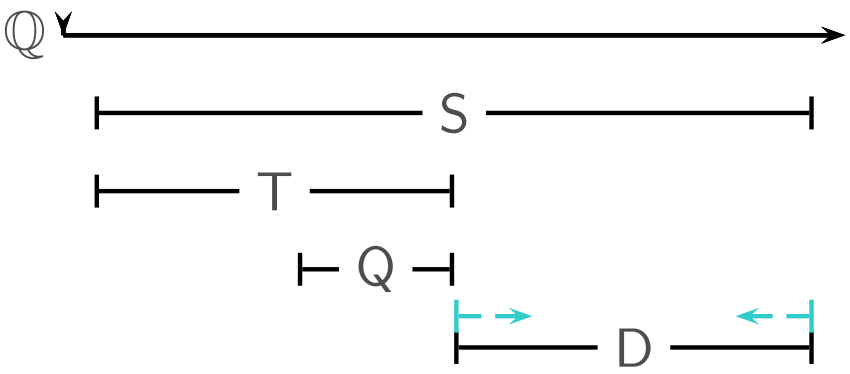

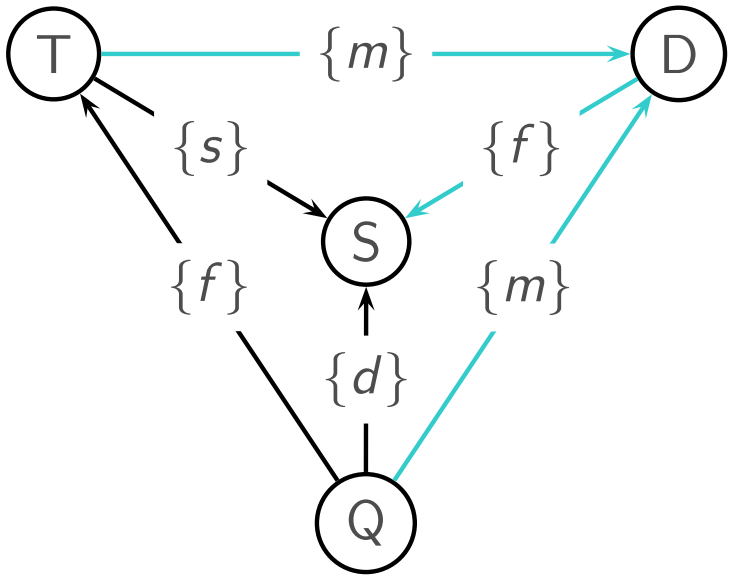

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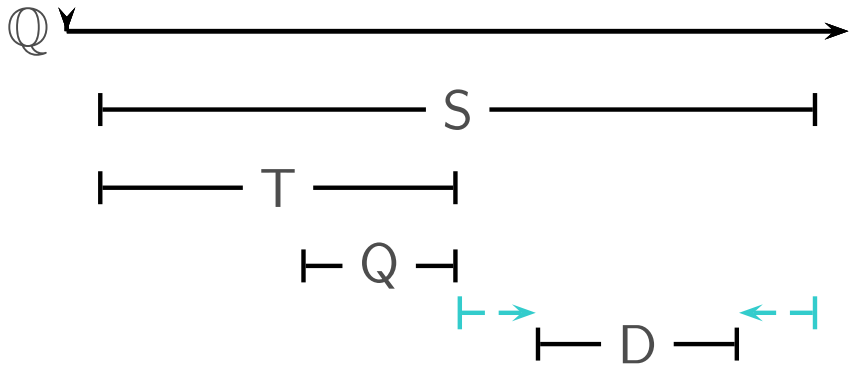

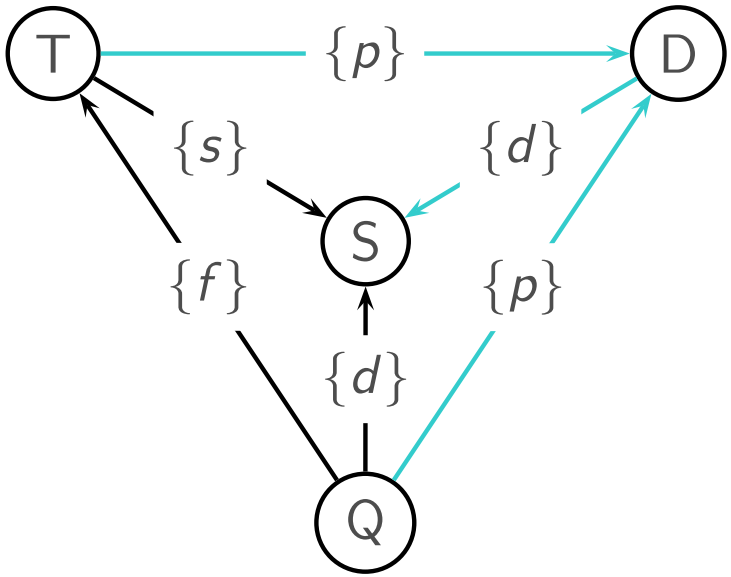

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- Summary :
  - We formalized the notion of “distortion” of an entity.
  - We derived from it a “distance” between qualitative configurations.
  - Contribution published to the International Workshop on Spatio-Temporal Dynamics (STeDy'12), co-located with the Twentieth European Conference on Artificial Intelligence (ECAI'12).

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- This work has many important applications :
  - For spatial formalisms, given two snapshots of a scene, try to rebuild the scenario of what happened in between.
  - Evaluation of the distance between two partitions over the same universe (To what extend a coalition structure has been changed ?)
  - Evaluation of the distance between two preference orderings $\rightarrow$ very important in Social Choice Theory.
  - Important perspectives for several existing real-world applications in spatial reasoning (e.g., fingerprint recognition, sketch maps processing.)

(#3) Revision of Logic Programs under Answer Set Semantics

- Logic programming is one of the main paradigms in Knowledge Representation and Reasoning.
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- Rational behaviour of a revision operator $\star$ [Delgrande *et al.*, 2008, 2013] :

  (RA1) $P \star Q \subseteq_s Q$;
  (RA2) If $P + Q$ is consistent, then $P \star Q \equiv_s P + Q$;
  (RA3) If Q is consistent, then $P \star Q$ is consistent ;
  (RA4) If $P_1 \equiv_s P_2$ and $Q_1 \equiv_s Q_2$, then $P_1 \star Q_1 \equiv P_2 \star Q_2$;
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→ **We provided representation theorems for revision operators of generalized logic programs, i.e., sound and complete procedures to build the corresponding revision operators. [LPNMR'13].**

Three topics for a unified motivation

Our world is always subject to **change**, so are our systems.

1. development of our work about the resilience of dynamic systems (*change* = occurence of a disaster.)
2. application of the distance between qualitative configurations in spatial reasoning (*change* is used to compute a "rational distance".)
3. development of specific revision operators for logic programs, and investigation of other belief change operators (for revision, *change* = new knowledge about the represented world.)

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