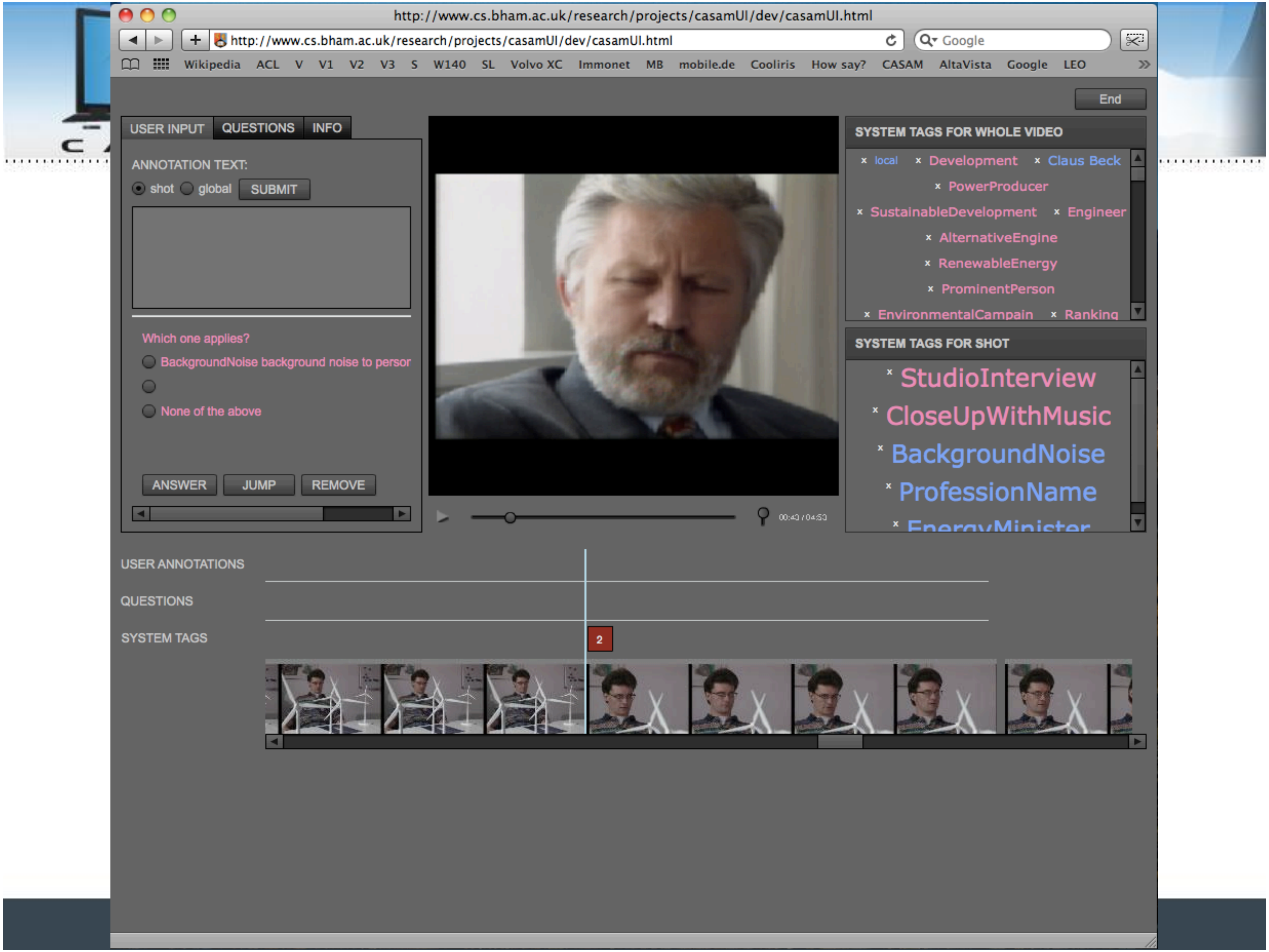
CASAM Schedule

Tasks

- Task 3.1: Optimized reasoning engine for probabilistic first-order structures (Lead TUHH)
  - New approach developed (Paper presented by Oliver at UniDL'10)
- Task 3.2: System supporting probabilistic abduction as a reasoning service (Lead TUHH)
  - Anahita presents paper at RR 2010
  - Michael's presentation
- Task 3.4: Meta-level reasoning component (Lead TUHH)
  - Query generation integrated into second prototype (Michael's pres)
  - See upcoming deliverable D3.4
- Task 6.2: MM Ontology: MESH ontology



http://www.cs.bham.ac.uk/research/projects/casamUI/dev/casamUI.html
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Wikipedia ACL V V1 V2 V3 S W140 SL Volvo XC Immonet MB mobile.de Cooliris How say? CASAM AltaVista Google LEO
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ProfessionName
USER ANNOTATIONS
QUESTIONS
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2

New RMI Implementation

- Overview (I can skip slides on request)
  - Implemented architecture
  - Computation of queries
  - Optimization of abduction
  - Open issues
- CASAM Team @ STS / TUHH
  - Anahita Nafissi
  - Oliver Gries
  - Ralf Möller
  - Maurice Rosenfeld
  - Kamil Sokolski
  - Michael Wessel

What's new in a Nutshell...

- Agenda-based
  - manages RMI interpretations as small individual ABoxes

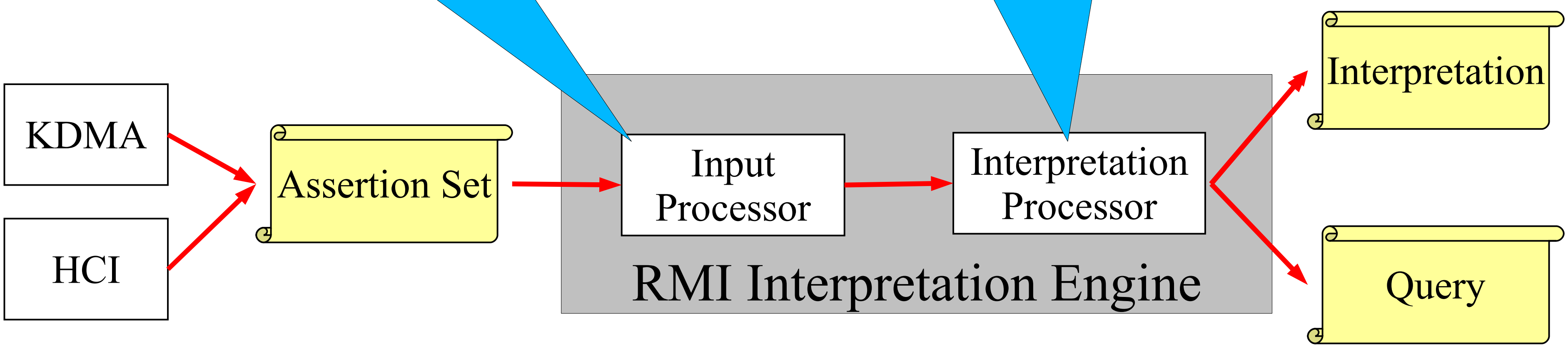
    + big „common part“ ABox CP (segments, EDO/MCO stuff, …)
  - incremental : **only reinterprets what needs to be reinterpreted**
    - uses only the relevant subset of CP (20% of CP) for Fiat rules
    - abduction performed on **subset** of CP + best interpretation

      → even „higher levels“ of interpretation possible
  - more control on interpretation process, by looking at the agenda (more information explicitly available) → **meta level reasoning**
- Queries computed for interpretations on agenda
- Lisp-based & multi-core ready
  - shares memory structures with RacerPro (no more OWL-in-out)

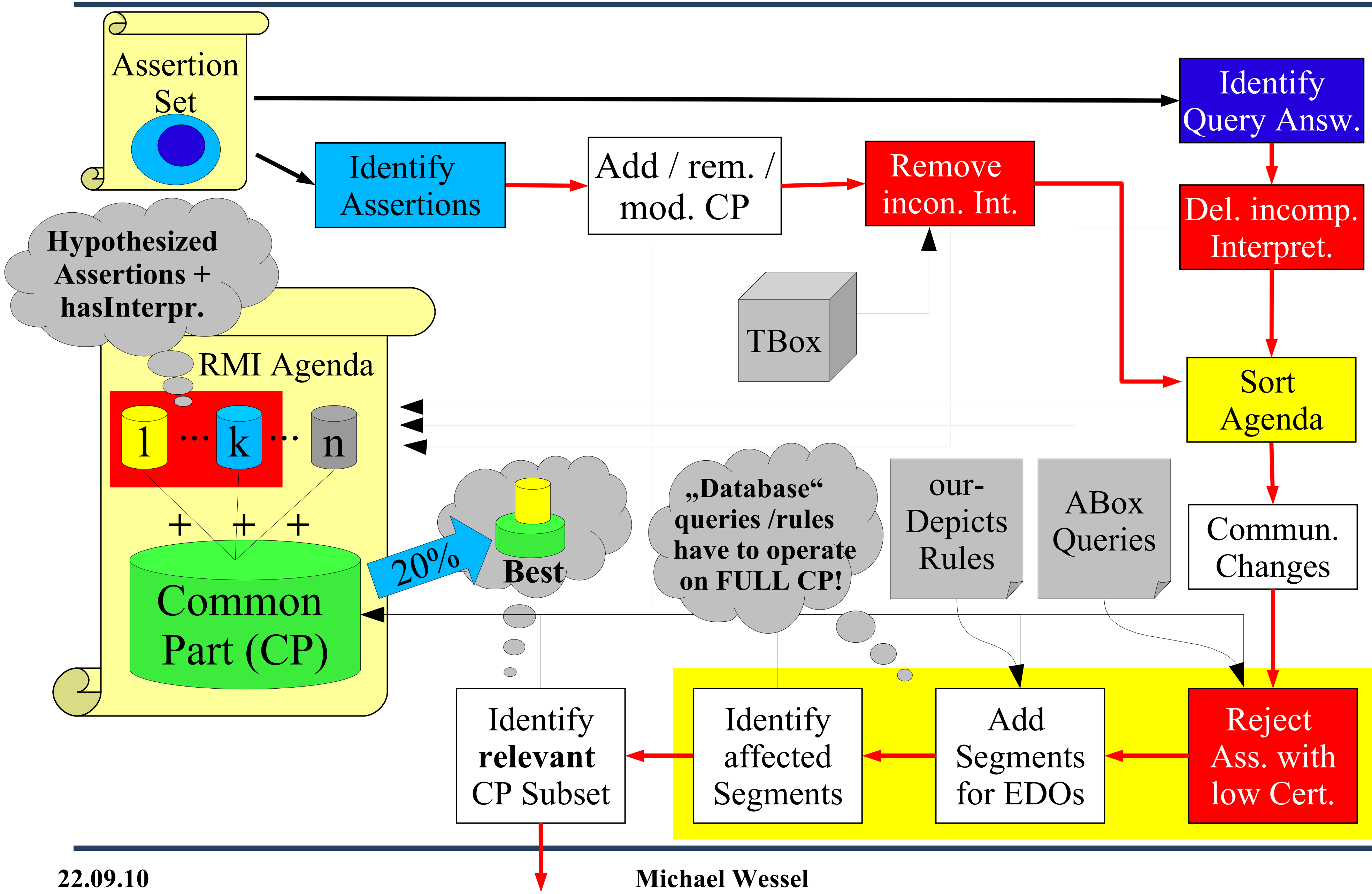
RMI Implementation of `receiveAssertions`

- Manage agenda (updates, query answers, ...)
- Abox augmentation
- Determine focus, compute relevant part of CP ABox

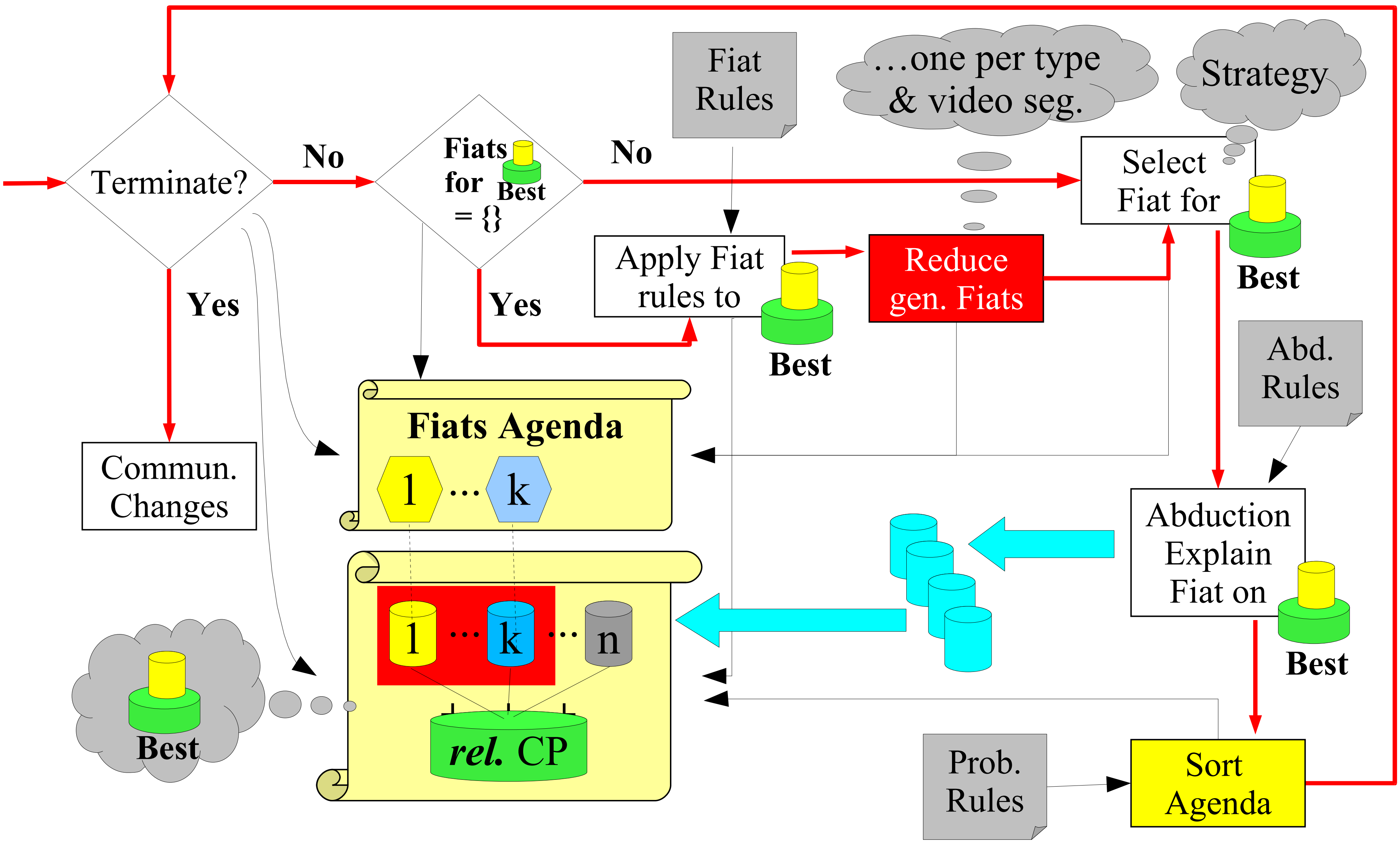
Perform the abduction in a loop until termination criterion met (max. # fiats, no more fiats, no probability increase, ...)



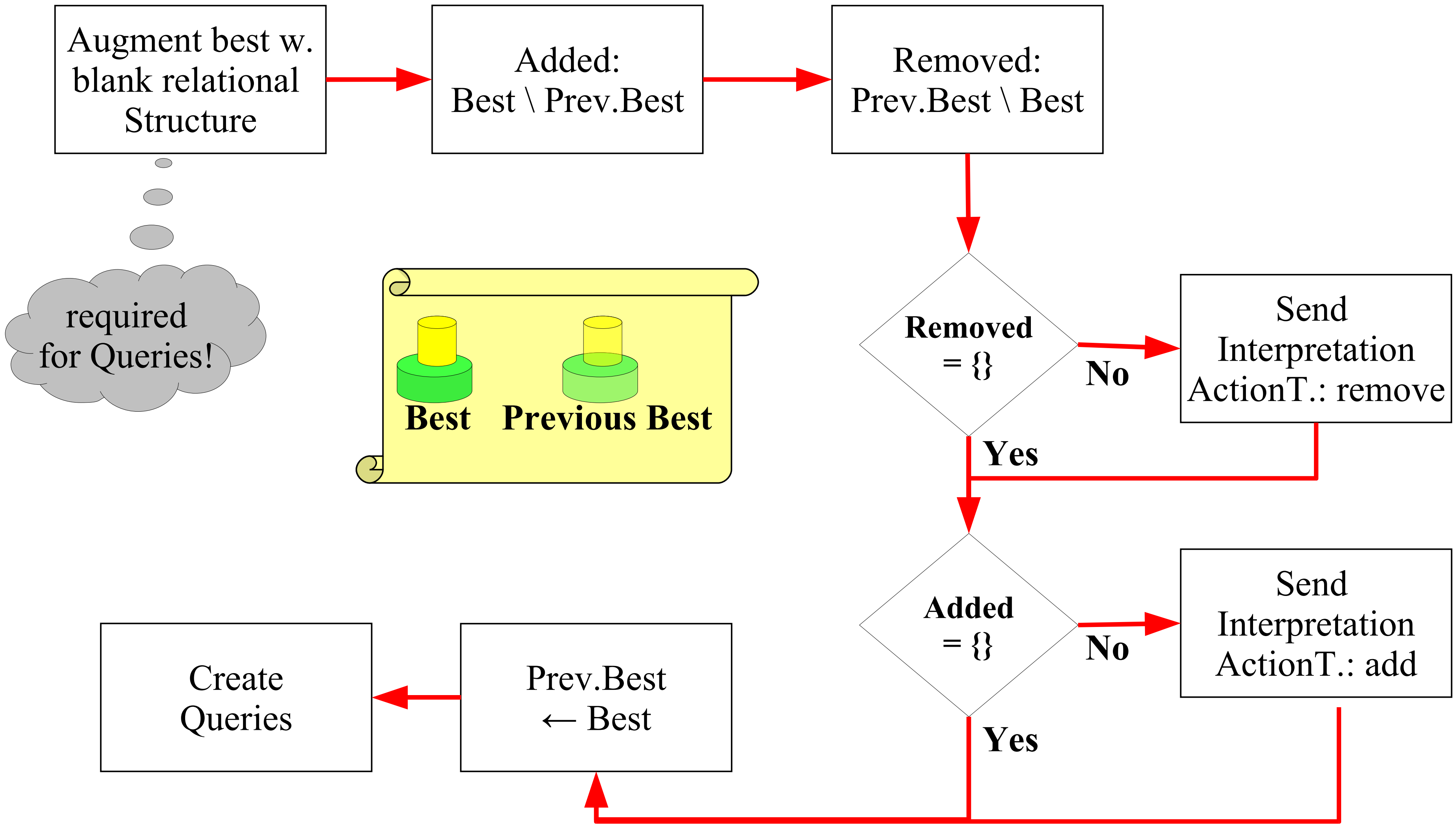
RMI Input Processor



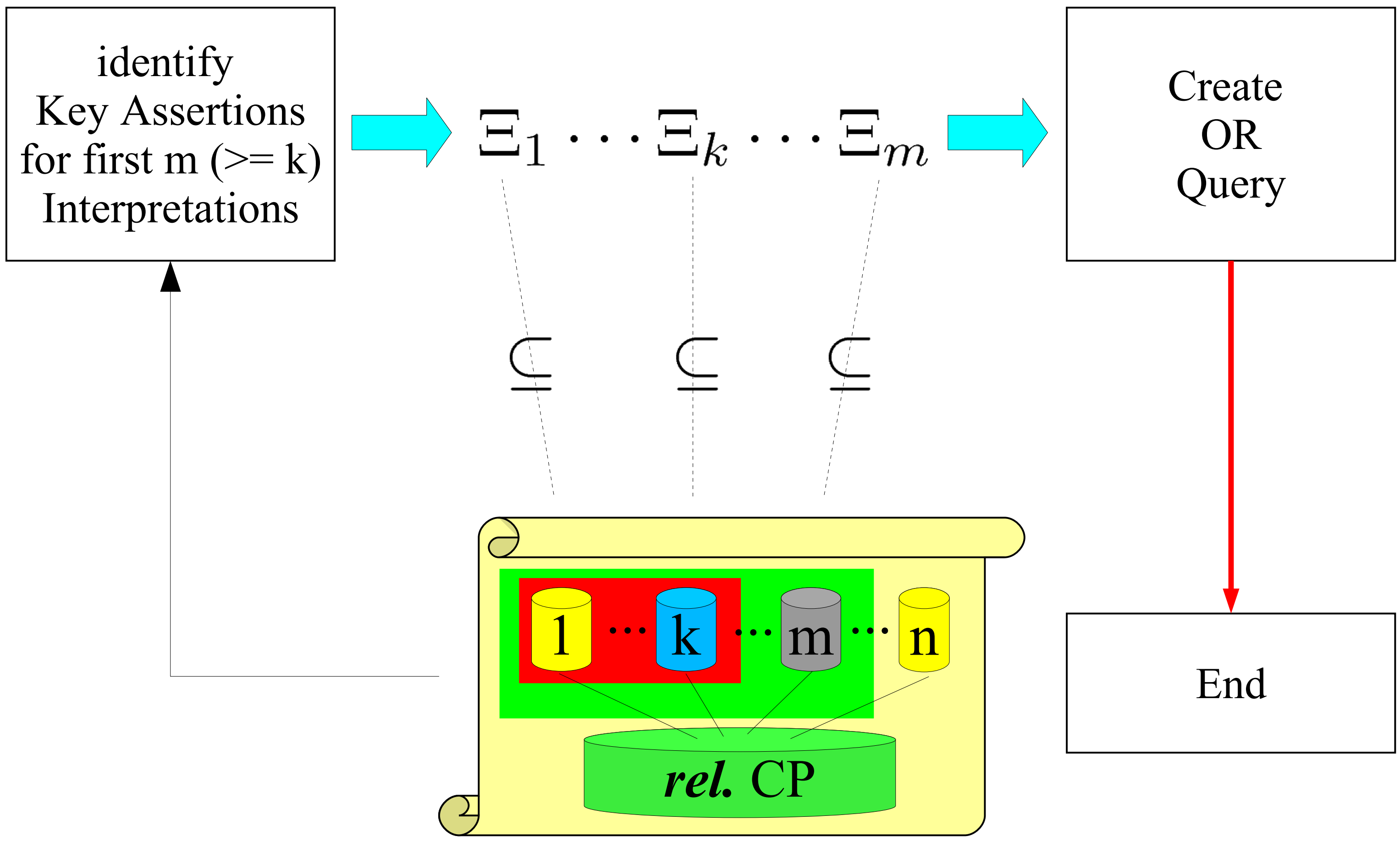
RMI Interpretation Processor



RMI Communicate Changes



RMI Create Queries



Computation of Queries

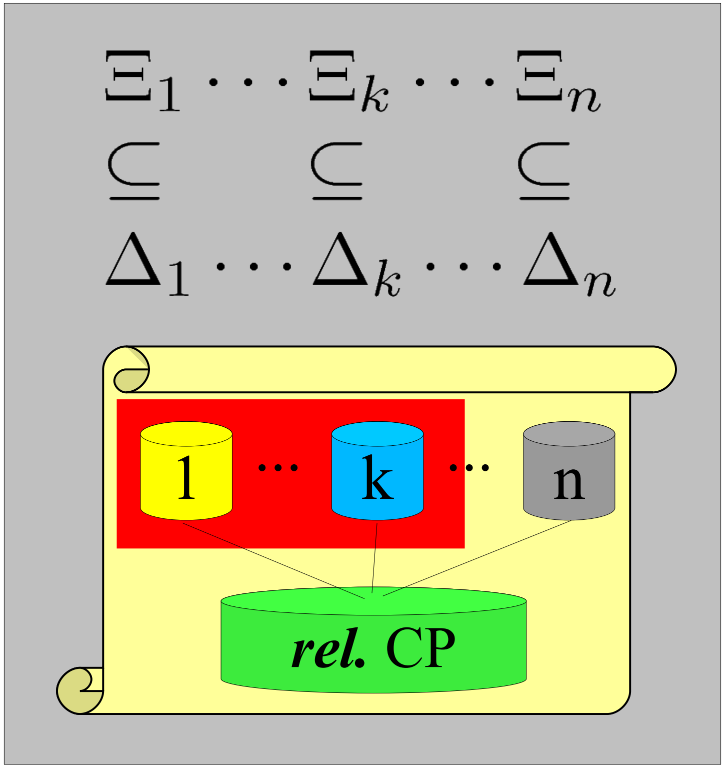
- Computation of characteristic („key“) assertions Ξ_i for $\Delta_i, 1 \leq i \leq n$
- Compute the „common differences“ by intersecting all differences to all other Δ_j

$$\Xi_i = \bigcap_{i \neq j, 1 \leq j \leq n} \Delta_i \setminus \Delta_j$$

- From each Ξ_i select an assertion (preferable an instance assertion)

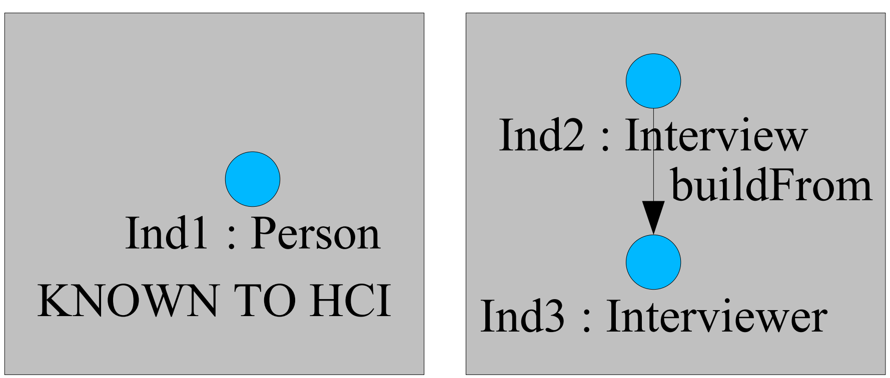
  → n disjuncts for OR query
  → simple score: 1 – 1 / *n*

- „\“ may be ABox difference, but...

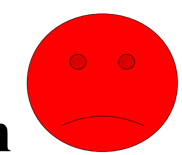


What is the blank relational structure and why is it required?

- Problem:
  - queries can only be formulated against the communicated „best“ interpretation: Δ_i
  - However, all but one query disjuncts come from $\Xi_j \subseteq \Delta_j$
  - the relational structures may be completely different
    - different hypothesized **RMI INDs**, different edges, etc.
- Example: how to communicate the difference between



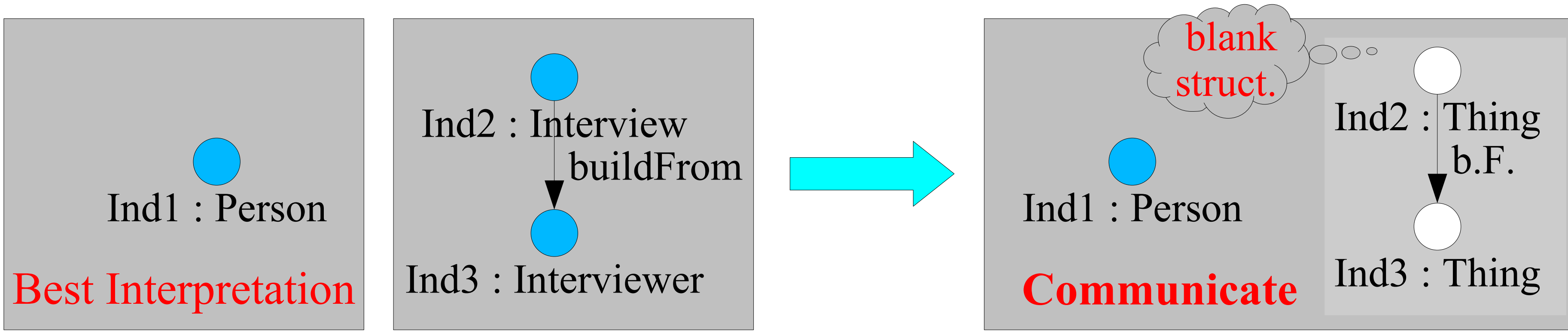
- HCI only knows **Ind1**!
- Q-Disjunct1: **Ind1 : Person**
- Q-Disjunct2: **Ind1 : Interview** ??
  Ind1 : Interviewer ??
- **Solution: avoid the problem in the first place!**

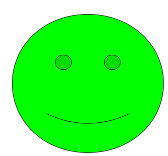


What is the blank relational structure and why is it required? (2)

- Instead of only sending the best interpretation, we also include the „blank relational structure“ of ALL other interpretations

→ relational structure and all hypothesized INDs known to HCI





- HCI knows **Ind1, Ind2, Ind3**!
- Q-Disjunct1: **Ind1 : Person**
- Q-Disjunct2: **Ind2 : Interview**
  [Ind3 : Interviewer]
  [(Ind2, Ind3) : b.F.]
- **No „new-ind mapping“ needed**

Augment best w. blank relational Structure

Abductive Query Answering

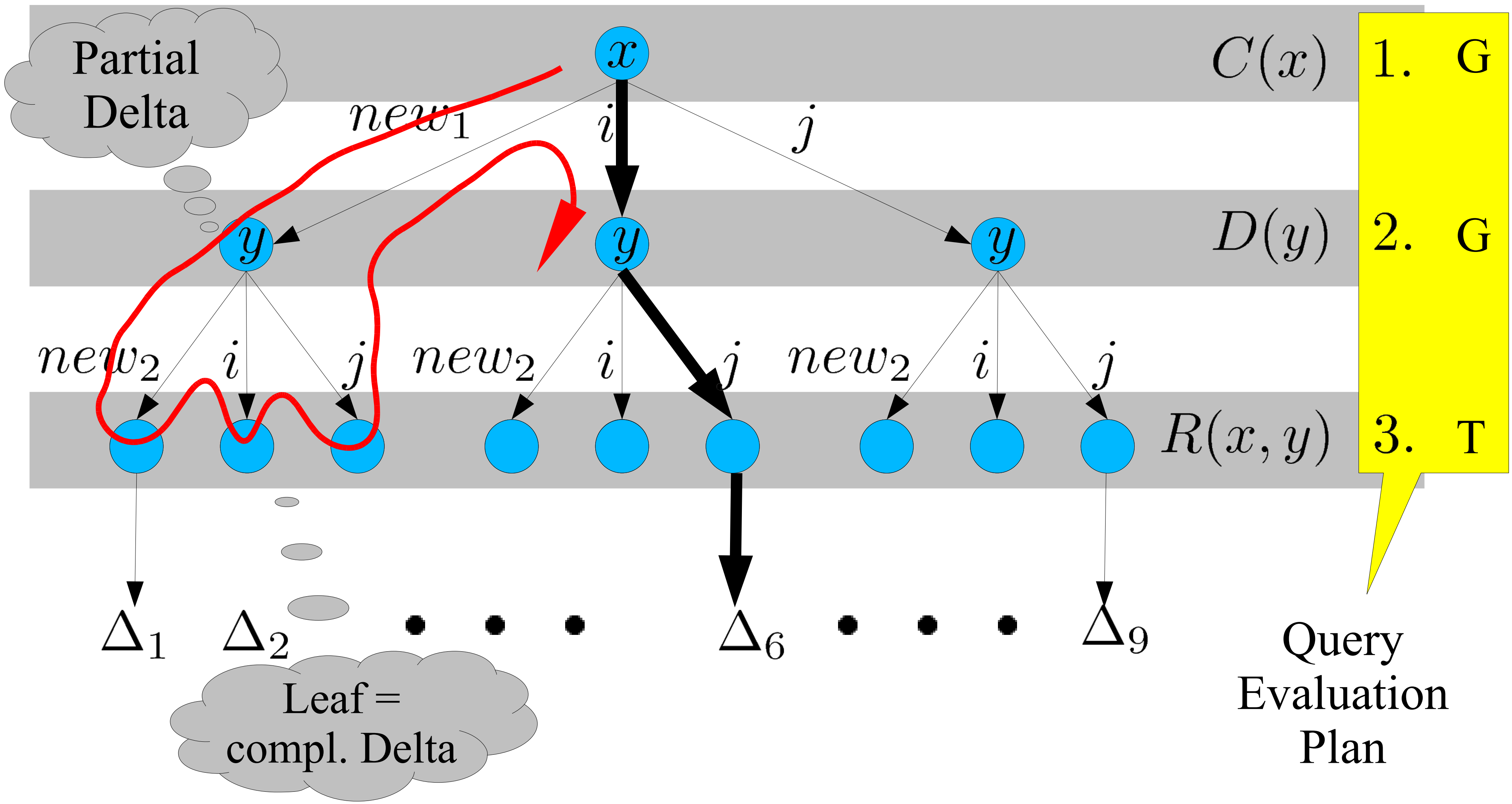
- Simple example
  - Query: $ans() \leftarrow C(x), D(y), R(x,y)$
  - Abox: $\{(i,j) : R, i : C\}$
  - **Preferred** solution (optimal, according to score defined below)

    $x \leftarrow i, y \rightarrow j :$
    $\Delta = \{j : D\}$
  - **Other** solution (plus 7 more, $3^2 = 9$), e.g.

    $x \leftarrow new1, y \leftarrow new_2 :$
    $\Delta = \{new_1 : C, new_2 : D, (new_1, new_2) : R\}$
- Exponential number of solutions has to be computed to find „the best“
  - **optimization idea:** early dynamic cutoff of search space based on score evaluation on partially computed explanations (deltas)

„Depth First“ Abductive Query Evaluation

$$\mathcal{A} = \{(i,j) : R, i : C\}$$



CASAM Preference Score

Very simple:

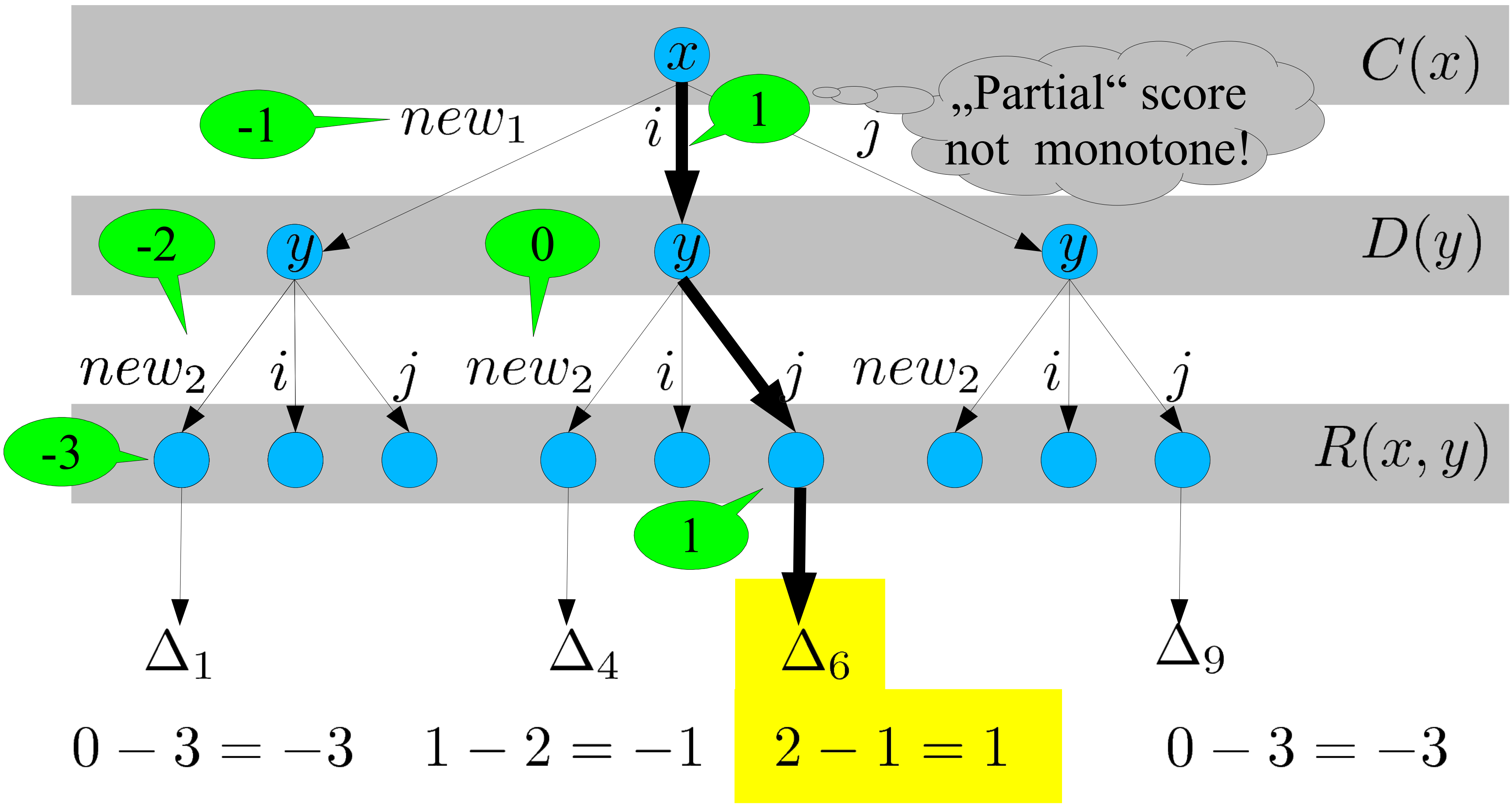
entailed Assertions minus hypothesized Assertions

$$\mathsf{score}(\Delta) =_{def} |\Delta^+| - |\Delta^-| \rightarrow \text{ maximize}$$

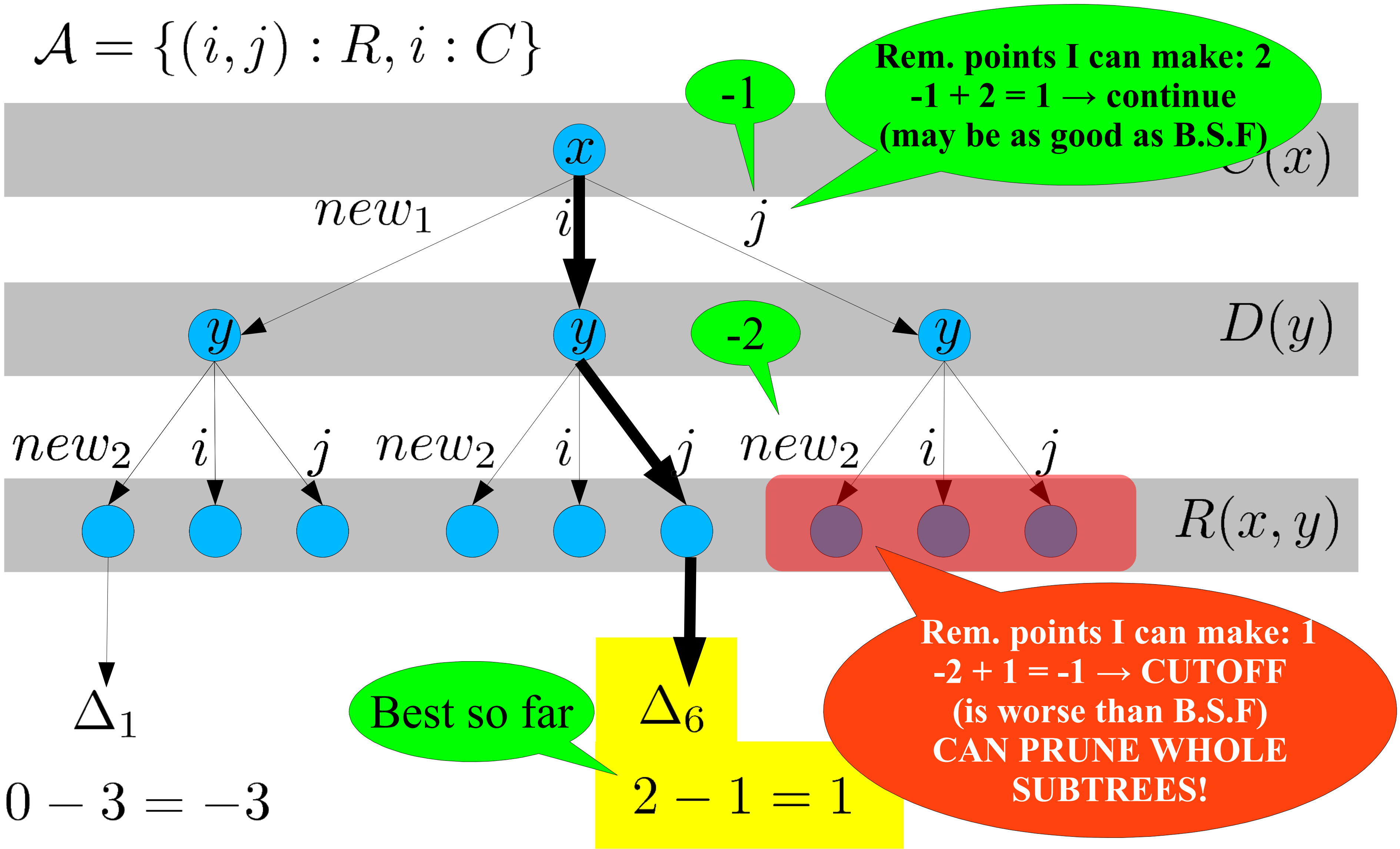
$$\Delta = \Delta^+ \cup \Delta^- \text{ (entailed, hypothesized)}$$

Illustrations of (Partial) Scores

$\mathcal{A} = \{(i,j) : R, i : C\}$ $\qquad |\Delta^+| - |\Delta^-| = score \rightarrow max.$



Score-Based Cutoff of Search Space



More formally...

$n = |\Delta^+| + |\Delta^-|$ (n const. for each rule body)

$\mathsf{score}(\Delta) =_{def} |\Delta^+| - |\Delta^-| \rightarrow$ maximize (not monotone)

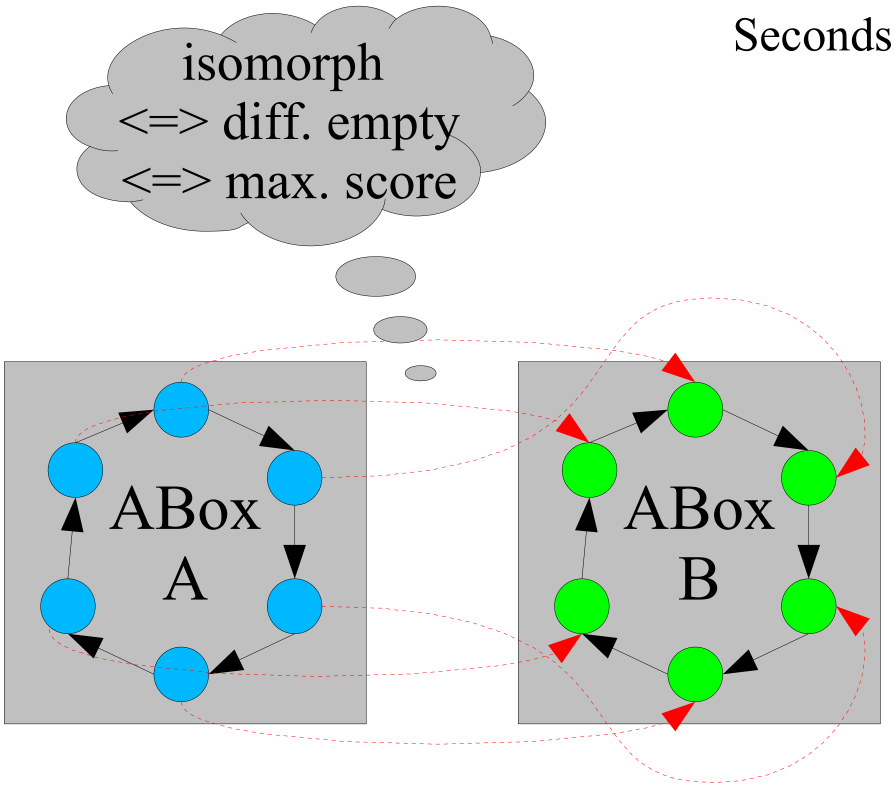
$n + \mathsf{score}(\Delta) = 2|\Delta^+|$

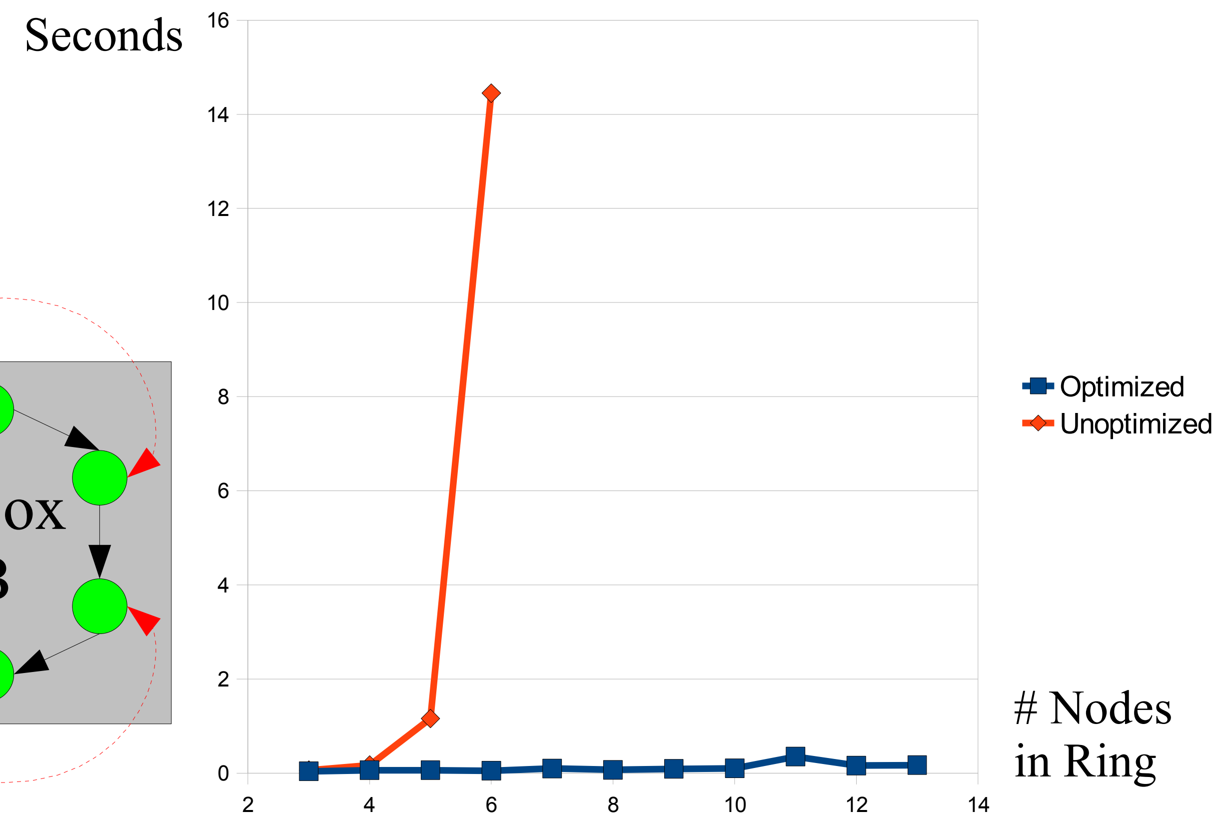
$\mathsf{score}(\Delta) = 2|\Delta^+| - n \rightarrow$ maximize (and monotone!)

- Let $\Delta_p \subseteq \Delta, m_p = n - |\Delta_p|$ (remaining conjuncts)
  - If $\mathsf{score}(\Delta_p) + (n - |\Delta_p|) < \mathsf{score}(\Delta_{best\_so\_far})$
    $\mathsf{score}(\Delta_{best\_so\_far}) - \mathsf{score}(\Delta_p) > (n - |\Delta_p|)$
    reject Δ_p

How Effective is this?

- Synthetic benchmark: finding graph isomorphisms (n nodes)
- Problem reductions:
  Graph Isomorphism → ABox Difference → Abduction





Appreciation of Complexity

- Some numbers
  - video 6, after bunch 3: 283 Fiats (new rule set)
    - potential quadratic number of Fiats (in terms of inds in the Abox)
    - after reduction „only one Fiat per type and shot“: 46 Fiats

Reduce gen. Fiats

  - „external complexity“ of interpretation loop
    - each Fiat may generate 2 to 3 explanations
    - branching will easily kill the system
  - „internal complexity“ of abduction (hidden in RacerPro)
    - in order to find these 2 to 3 best explanations PER FIAT, yet another exponential number of explanations has to be considered!
    - exponential in the number of indiviuals in the ABox

→ RMI handles **serious complex problems, more must be done for meta reasoning** (we stop after 30 Fiats per bunch)

Open Issues

- Reimplementation of probabilistic valuation and **Sort Agenda**
- React to removed / confirmed tags
- React to „negative“ query answers
  - only positive query answers considered so far
  - „shuffle“ the interpretations containing the answer assertions to the front of the agenda
- More specific Fiat generation rules
- Anytime / meta reasoning
  - reduce set of assertions if timeout occurs, etc.
  - some dumb strategies already implemented
- Q: do we really have to keep all interpretations on the agenda?