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Topic Maps Self-Control

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Sorry!

- No TM introduction
- No extensive motivation of concepts covered in this talk

- But: Extreme Topic Maps

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Quine's criterion:

What is there?

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Everything!

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Overview

- Ontologies and TM templates
  - Purpose, concept, application
- Type hierarchies
  - Super-subclassing of types
- Association properties
  - Transitivity
- Inference rules
  - Deducing implicit knowledge
- Consistency checking
  - Rule-based constraints

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Ontologies and TM Templates

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TM Ontology

- John F. Sowa:

  "*Ontology* defines the kinds of things that exist in the application domain."

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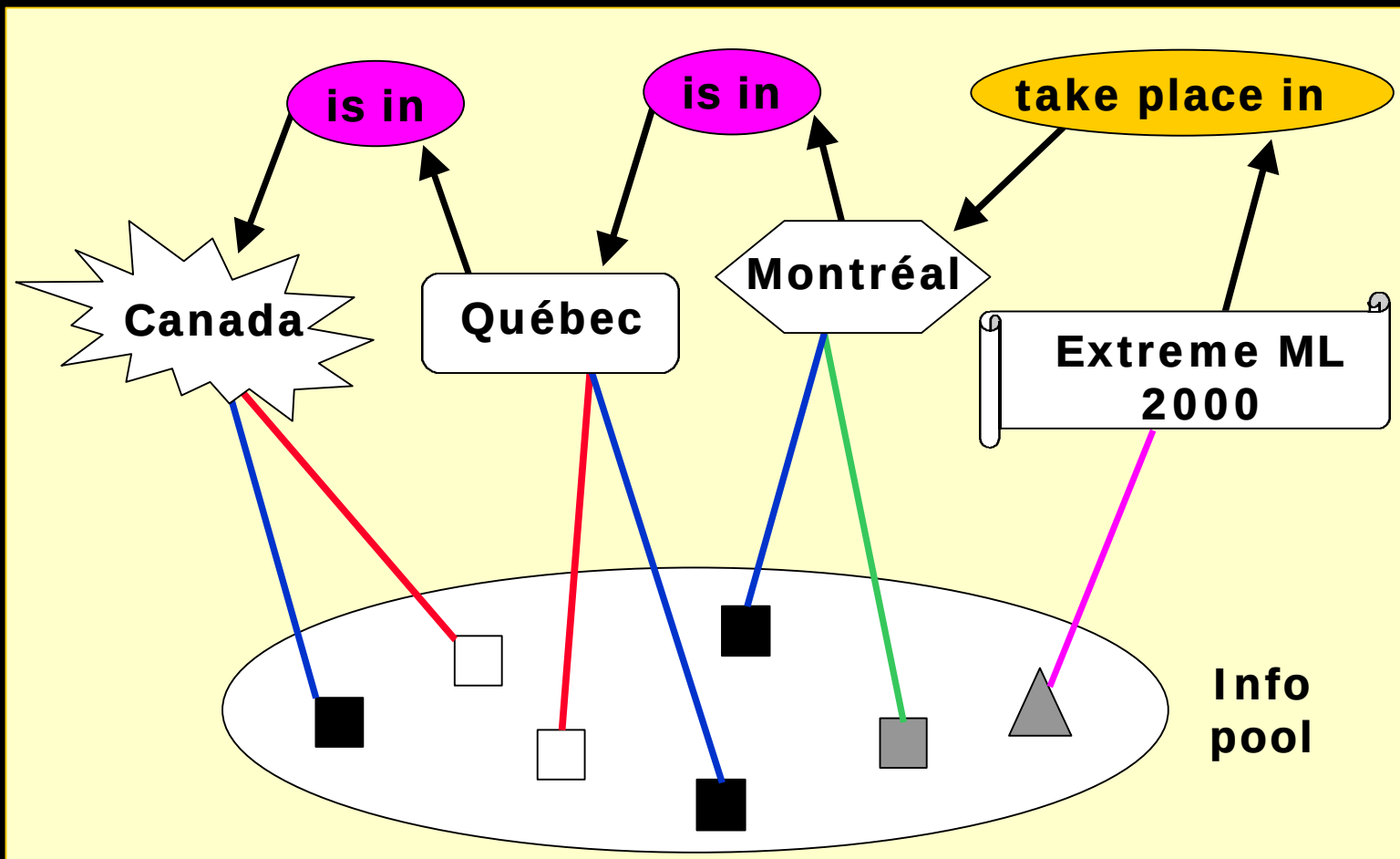
“Real” TM



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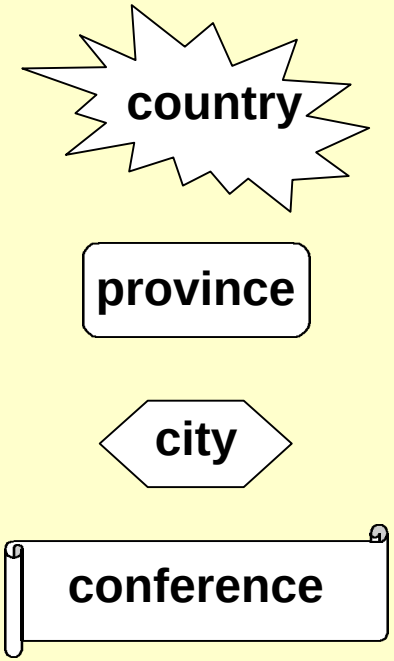
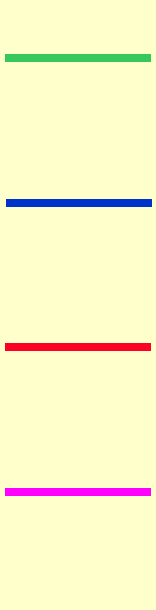
The ontology TM

Topic types

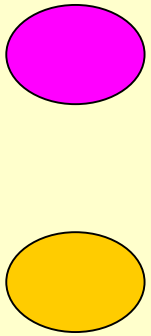


Occurrence role types



- city map
- article
- video
- call f. papers

Association types



- is in
- takes place in

Others:
Assoc. role types, themes

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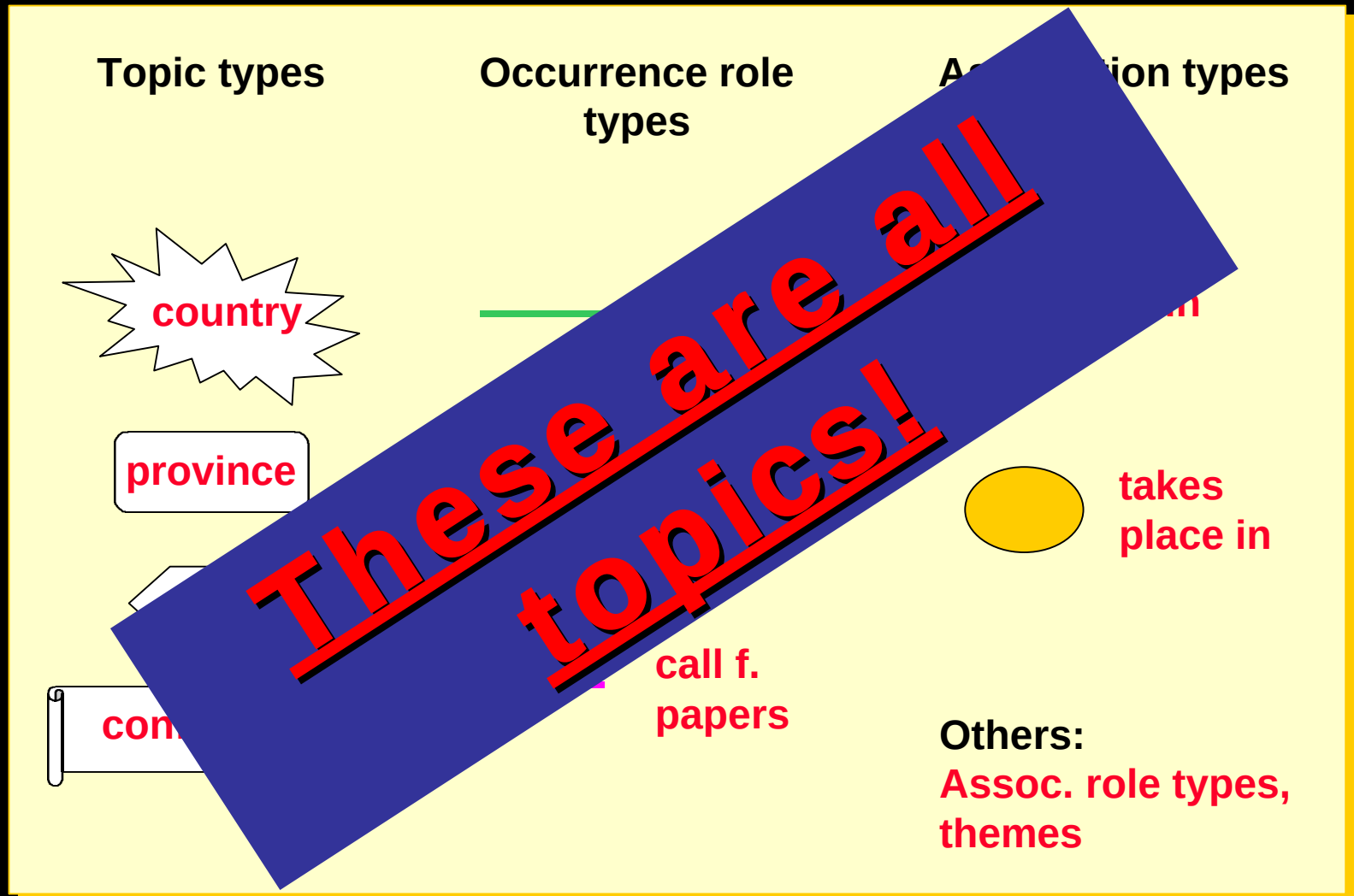
The ontology TM



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The solution

- Term "TM template" informally defined by ISO working group
- A topic map template is a topic map
- Consists of all constructs which have a declarative meaning for a map
  - Topics which are candidates for themes and types
  - Inference rules (see later)
  - Constraints (see later)

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The technique

- Define Public Subject Identifiers (PSIs) for the basic typing/theming topic types
  - theme
  - topic type
  - occurrence role type
  - association type
  - association role type
  - facet type
  - facet value type

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The technique (real map)

```
<topic id="canada" types="country">
  <topname>
    <basename>Canada</basename>
  </topname>
</topic>
<topic id="montreal" types="city">
  <topname>
    <basename>Montréal</basename>
  </topname>
</topic>
```

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The technique (template)

```
<topic id="country">
  <topname>
    <basename>country</basename>
  </topname>
</topic>
<topic id="city">
  <topname>
    <basename>city</basename>
  </topname>
</topic>
```

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The technique (template)

```
<topic id="country" types="tt">
  <topname>
    <basename>country</basename>
  </topname>
</topic>
<topic id="city" types="tt">
  <topname>
    <basename>city</basename>
  </topname>
</topic>
```

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The technique (template)

```
<topic id="tt"
 identity="http://www.topicmaps.com/
xtm/1.0/psi/topic-type">
  <topname>
    <basename>topic type</basename>
  </topname>
</topic>
```

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Some remarks

- PSI should be somehow standardized (ISO, XTM) and publicly registered (ISO, OASIS)
- A typing topic type could be candidate for more than one basic type (e.g. topic type and theme)
- Naming of basic type topics is up to the application, only PSIs are fix

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Type Hierarchies

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The challenge

- ISO 13250 defines type-instance relationship with its "type" concept
- Knowledge representation and advanced inferencing techniques require type hierarchies defined by supertype-subtype relationship

The challenge

- The difference between type-instance and supertype-subtype relationships:
  - Graham is-of-type human
  - Human is-of-type species
  - Human is-subtype-of mammal
  - Implies: Graham is-of-type mammal
  - Implies not: Graham is-of-type species
  - Supertype-subtype relationship is transitive, type-instance is not

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The technique

- Define supertype-subtype association type and supertype and subtype association role types
- Define according PSIs:
  - .../psi/association-type/supertype-subtype
  - .../psi/association-role-type/supertype
  - .../psi/association-role-type/subtype

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The technique

- Define topics for assoc. type, assoc. role types which use these PSIs
- Assign transitivity property to this association type (see later)
- Connect typing topics by this association and assign roles accordingly

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The technique

- Example:

```
<assoc type="supertype-subtype">
  <assocrl type="supertype">mammal
  </assocrl>
  <assocrl type="subtype">human
  </assocrl>
</assoc>
```

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Some remarks

- ISO will add supertypes attr. to topic link as shorthand for association
- The class-instance relationship expressed by the "types" attribute will also be defined as predefined association. Why?
  - Symmetry reasons
  - Attributes are shortcuts for assocs which could carry scopes
  - Cannot delete attribute from standard

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Association Properties

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Theoretical backgrounds

- Knowledge representation, AI, mathematics, linguistics, philosophy
- Association properties:
  - Reflexive
  - Symmetric
  - Transitive
  - Anti-reflexive
  - Anti-symmetric
- Enable automatic derivation of implicit knowledge from the map (inferencing mechanisms)

The technique

- The association type topic:

```
<topic id="is-in" types="at">
  <topname>
    <basename>is in</basename>
  </topname>
</topic>
```

The technique

- Assign property by facet:

```
<topic id="is-in" types="at">
  <topname>
    <basename>is in</basename>
  </topname>
</topic>

<facet type="association-property">
  <fvalue type="transitive">is-in
  </fvalue>
</facet>
```

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The technique

- Assign property by facet:

```
<topic id="is-in" types="at">
  <topname>
    <basename>is in</basename>
  </topname>
</topic>

<facet type="association-property">
  <fvalue type="transitive">is-in
  </fvalue>
</facet>
```

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The technique

- Define facet type topics using PSI as identifier:

```
<topic id="association-property"
 types="ft"
 identity="http://www.topicmaps.com/
xtm/1.0/psi/facet-type/property">
  <topname>
    <basename>association property
    </basename>
  </topname>
</topic>
```

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The technique

- Define facet value type topics using PSI as identifier:

```
<topic id="transitive"
 types="fvt"
 identity="http://www.topicmaps.com/
xtm/1.0/psi/facet-value-type/
transitive">
  <topname>
    <basename>transitive</basename>
  </topname>
</topic>
```

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Some remarks

- Other assoc props could be useful hints when serializing TMs as natural language or when validating TMs
- Transitivity could be used in queries to increase or decrease the result list (e.g. up or down in type hierarchy)

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Consistency Checking

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The needs

- Manual checking of large maps is impossible but validation is a requirement
- TM software should validate during design and creation
  - Permanently or on demand
  - Like structure validation in SGML/XML editors/parsers
- Constraints control validation process

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The techniques

- Set of topic, occurrence, and association "patterns" declared in the template
- Programming language using an API of the topic map editor/engine
- API gives more freedom, but for the price of rather big effort
- Patterns fulfill the 80/20 rule and might be sufficient for most applications

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The techniques – constraint pattern

- Rule-based "patterns" for topics, occurrences, and associations
- Patterns "declare" the possible parameters and their combinations
- "Wildcard" for "any topic"
- Theme signalling if a topic must participate (playing the specified role) in an association

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An example

```
<topic id="X"
 types="country" scope="schema">
  <topname min="1" scope="english">
    <basename>X</basename>
  </topname>
  <topname max="1" scope="french">
    <basename>X</basename>
  </topname>
  <occurs type="map" min="1"></occurs>
  <occurs type="description"
   scope="english"></occurs>
  <occurs type="description"
   scope="french"></occurs>
</topic>
```

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Another example

```
<assoc type="is-in" scope="schema">
  <assocrl type="container">city
  </assocrl>
  <assocrl type="containee">street
  </assocrl>
</assoc>
<assoc type="born-in"
 scope="schema topic-assocrole-
requirement">
  <assocrl type="person">person
  </assocrl>
  <assocrl type="place">place
  </assocrl>
</assoc>
```

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Some remarks

- Constraint patterns are simple but powerful
- Smart integration of validating API functions has to be investigated (has to be checked if SAF idea could help)

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Inference Rules

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Background

- Type hierarchies and of transitivity allow powerful inferencing of knowledge not coded in the topic map
- But a map may contain further knowledge which could be inferred
- Inference rules define on the ontology level how to derive implicit knowledge

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Example

If $topic1 is a sibling of $topic2
and $topic1 is a male

then $topic1 is a brother

(Eric Freese, XML Europe 2000, Paris)

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Rule components

- "if <condition> then <inference>" defines the inference rule
- "$topic1" and "$topic2" are variables which have to be instantiated when the rule is evaluated
- "is a sibling of" and "is a male" are the assoc. types in question
- "is a brother" is the inferred assoc. type

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Rule components – inference rule

- Association with predefined type in predefined scope:

```
<assoc
 type="inference-rule"
 scope="ir-schema">
...
</assoc>
```

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Rule components – variables

- Topic with predefined type:

```
<topic
 id="ir-topic-A-PERSON"
 types="ir-topvar"
 scope="ir-schema">
  <topname><basename>A PERSON</></></>
</topic>
```

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Rule components – assoc types

- Predefined association role types with condition number:

```
<assocrl type="ir-cond-t1" no="2">
ir-topic-A-PERSON</assocrl>
<assocrl type="ir-cond-art1" no="2">
instance</assocrl>
<assocrl type="ir-cond-at" no="2">
class-instance</assocrl>
<assocrl type="ir-cond-art2" no="2">
class</assocrl>
<assocrl type="ir-cond-t2" no="2">
male</assocrl>
```

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Rule components – inferred assoc. type

- Predefined association role types:

```
<assocrl type="ir-then-t1">
ir-topic-A-PERSON</assocrl>
<assocrl type="ir-then-art1">
instance</assocrl>
<assocrl type="ir-then-at">
class-instance</assocrl>
<assocrl type="ir-then-art2">
class</assocrl>
<assocrl type="ir-then-t2">
brother</assocrl>
```

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Shortcomings of straight forward solution

- Looks clumsy
- Restricted to binary associations

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Elegant solution

- Association gets id attribute to be associated with/by other associations
- Association patterns model the association types in question

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Elegant solution

```
...
<assoc id="ir-male"
 type="class-instance"
 scope="ir-schema">
  <assocrl type="instance">
    ir-topic-A-PERSON</assocrl>
  <assocrl type="class">
    male</assocrl>
</assoc>
...
```

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Elegant solution

```
<assoc type="inference-rule"
 scope="ir-schema">
  <assocrl type="ir-cond">
    ir-sibling</assocrl>
  <assocrl type="ir-cond">
    ir-male</assocrl>
  <assocrl type="ir-then">
    ir-brother</assocrl>
</assoc>
```

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Some remarks

- Elegant solutions follows idea of constraints
- Defines TM representation of TMQL queries (variable topics and conditions are "select" and "from" part of TMQL)

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Conclusions

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Conclusions

- Topic map templates
  - Logical container for the “schema” part of a map
    - type/theme declarations
    - Constraints
    - Inference rules
  - Modularization and re-use
  - Standardization of templates
- Association properties
  - Transitivity
  - Reduce map size, minimize creation efforts, support inferencing capabilities

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Conclusions cont'd

- Type hierarchies
  - Super-subclassing
  - Powerful inferencing
- Consistency checking with constraints
  - Rule-based constraints control validation process
  - Constraint patterns
- Inference rules
  - Deduce additional knowledge
  - Inference patterns

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Conclusions cont'd

- PSIs define all necessary concepts (semantic)
- All presented features can be modeled with TM concepts in a very elegant way
- The TM control their own structure and content

=> Topic Maps self-control

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<end>

See you at

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Questions?

</end>

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