Design of Pedagogical Feedbacks in a Learning Environment for Object-Oriented Modeling

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Context of this work

- Project of the LIUM laboratory: « Interaction and knowledge »
- **Participants:** Dominique Py, Mathilde Alonso, Ludovic Auxepaules
- **Goal of the project:** designing models, methods and tools for object-oriented modeling learning environments
  - Interaction design
  - Diagnosis
- **Application:** the Diagram environment

Plan of the presentation

- Context and approach
- The Diagram environment
  - General interaction framework
  - Diagnostic module
- Pedagogical feedbacks
  - Methodology
  - Principles
  - Example

Context and approach
Related work

Two learning environments for object-oriented modeling :

- COLLECT-UML [Baghaei & Mitrovic 06]
  - « Constraint-based » approach (syntactic and semantic constraints)
  - Messages associated with each violated constraint
- CIMEL-ITS [Moritz *et al.* 05]
  - « Curriculum » approach (curriculum model)
  - Predefined solution and typical errors

Metacognitive aspects of the modeling task

- Modeling task with UML
  - Design a class diagram from a textual description
  - Open task, more than one solution

- Metacognitive regulation
  - Control processes about cognitive activities
  - Three functions [Brown 87]
    - **Planning** and **monitoring** the cognitive activities
    - **Checking** the outcomes of these activities

→ Supporting the reflective activity in UML modeling requires to take into account these three aspects

Context and approach

Position of the Diagram project

- Model of the interaction
  - Assistance during the task
  - Specific helps for novice students
  - Metacognitive support
- Diagnostic tool [Auxepaules et al. 08]
- Diagram environment
  - Class diagram editor
  - Implements the interaction model and provides feedback

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The Diagram environment

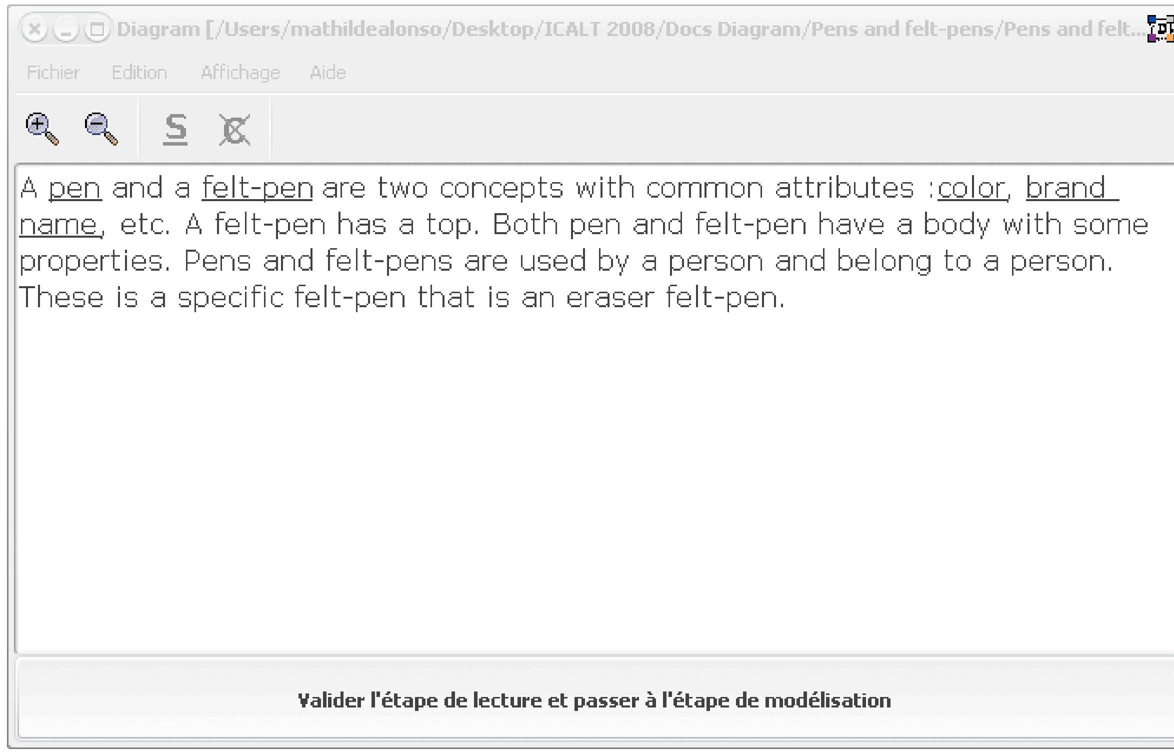
Specific interaction modes

- Diagram
  - A class diagram editor providing a subset of classic editors functions
- Facilitation of visual control
  - Problem text displayed on the interface
  - Underlining function for relevant expressions
  - Creation of diagram elements from text expressions
    - The element and the corresponding expression are displayed in the same color

The Diagram environment

Task organization

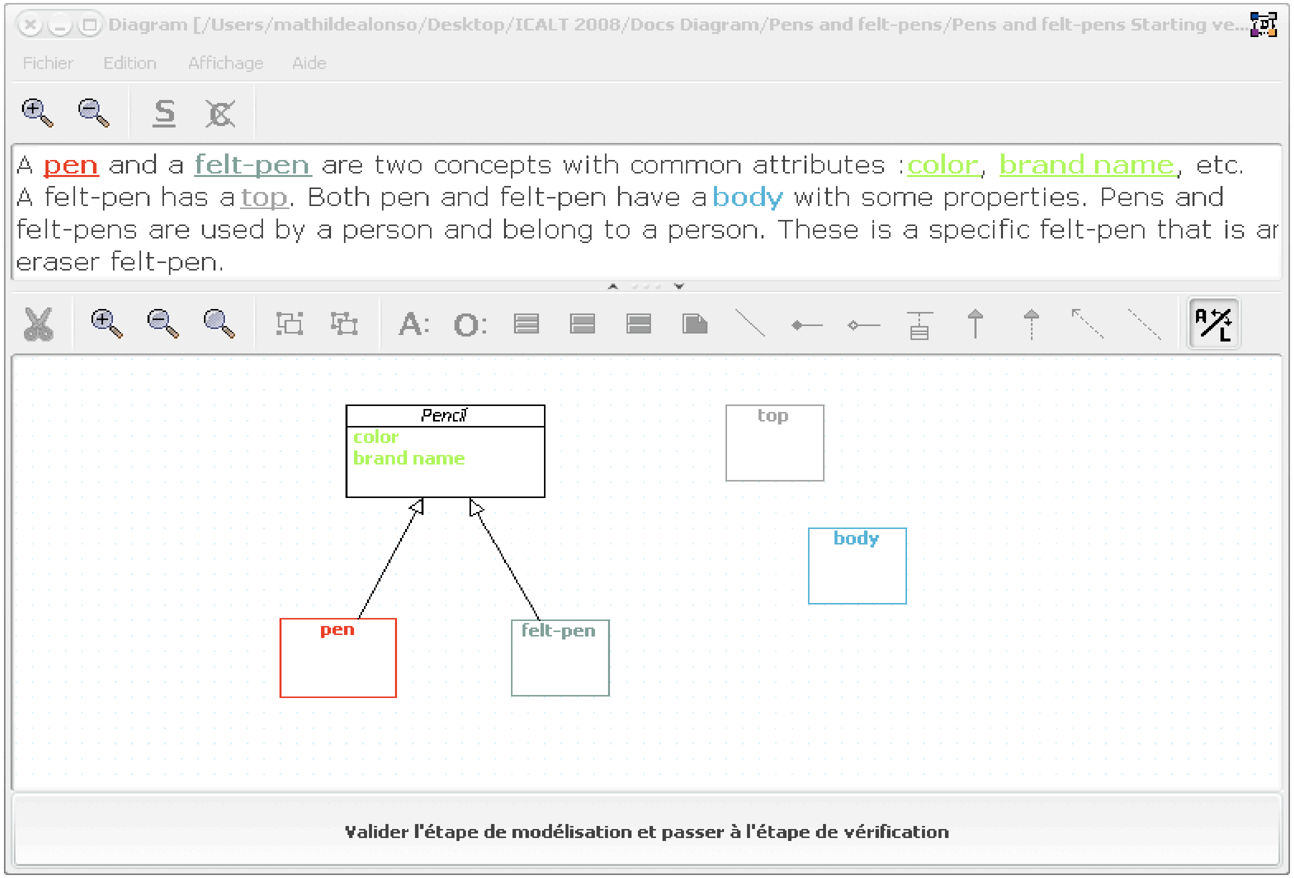
- **First step**
  - Reading the text
  - Underlining the expressions



The Diagram environment

Task organization

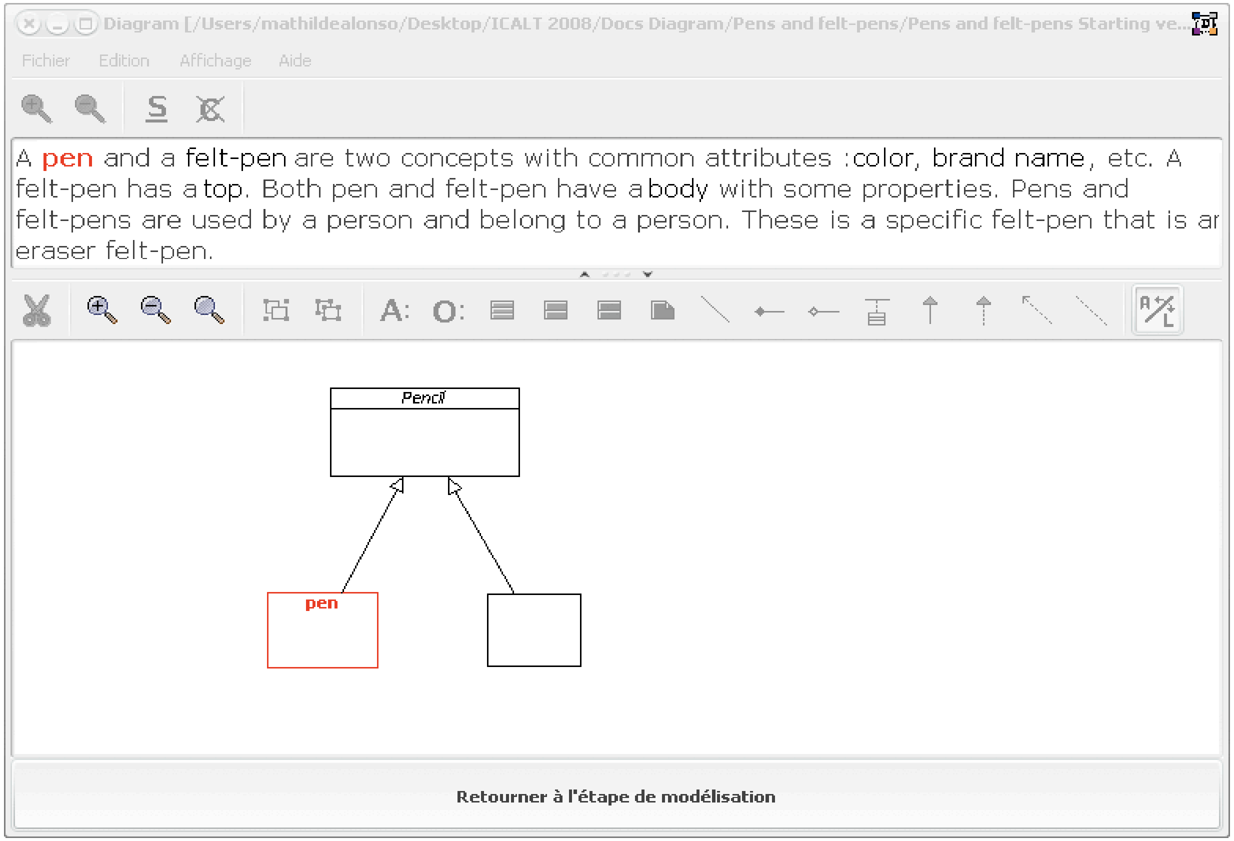
- **Second step**
  - Designing the class diagram
  - Underlining and highlighting functions



The Diagram environment

Task organization

- **Third step**
  - Checking the diagram correctness and completeness



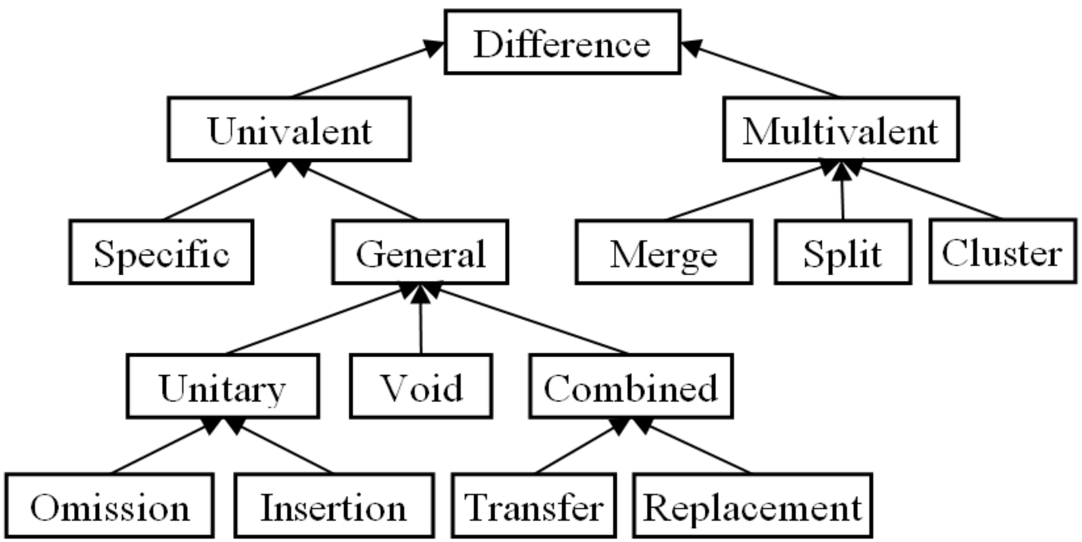
The Diagram environment

Diagnostic of the student’s diagram

- The student’s diagram is compared with an « ideal solution »
- The algorithm is adapted from generic algorithms of graphs comparison and matching [Auxepaules 2008]
- ***Output:*** a list of « differences » between the two diagrams, according to our Structural Differences Taxonomy (SDT)

Structural Differences Taxonomy

- **Univalent** difference : partial match of one pattern with another one
  - **Specific** difference related to pattern properties and semantic
  - **General** difference related to patterns organization in the diagrams
- **Multivalent** difference : partial match of several patterns with one pattern



Plan of the presentation

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Pedagogical feedbacks

Methodology

- Comprehensive study of errors found in diagrams built by students during previous experiments with Diagram
- Design of a Pedagogical Differences Taxonomy (PDT)
- Correspondence established between SDT and PDT taxonomies
- Messages associated with each PDT difference (three modes: *notify*, *question*, *suggest*)
- Implementation and test

Pedagogical feedbacks

Pedagogical Differences Taxonomy

Eight categories of differences between class diagrams :

1. Omission of an element
2. Addition of an element
3. Transfer of an element
4. Duplication of an element
5. Merging of several elements
6. Misrepresentation of an element (wrong type…)
7. Reversion of the direction of a relationship
8. Wrong multiplicity in a relationship

Pedagogical feedbacks

Pedagogical Differences Taxonomy

- Simple differences : a single difference
- Complex differences
  - Groups of simple differences that usually occur together
  - ***Example****:* « class omission » implies « relation omission » or « relation transfer »
- Complex differences have priority on simple differences and are associated with specific feedback messages

Pedagogical feedbacks

Correspondance SDT → PDT

- **Motivation:** independance of taxonomies, modularity, genericity

Structural DT	Pedagogical DT
Univalent – specific	Misrepresentation, reversion, …
Univalent – Insertion	Addition
Univalent - Replacement	*no match*
…	…

Pedagogical feedbacks

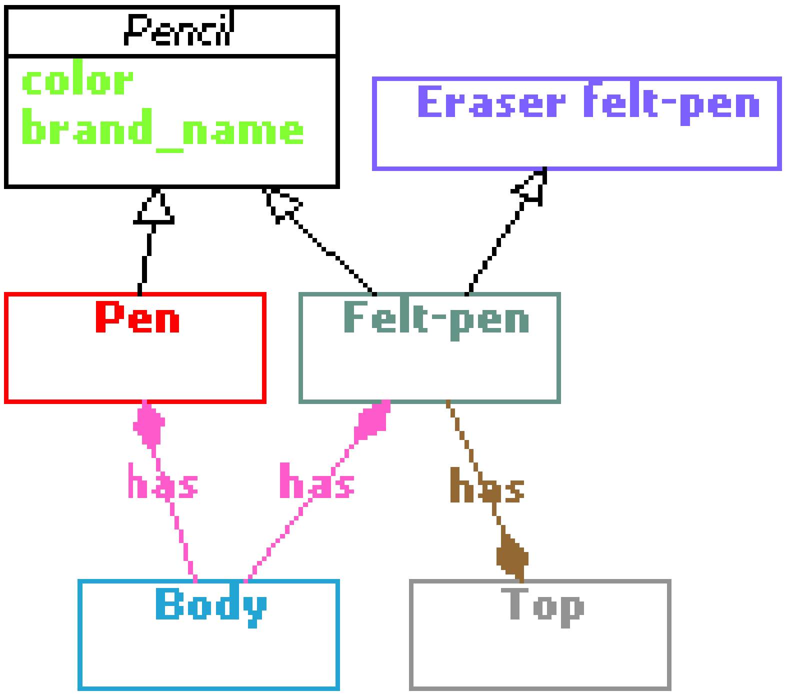
Feedbacks formulation

- **Goal :** Soliciting the metacognitive regulation (*checking* function)

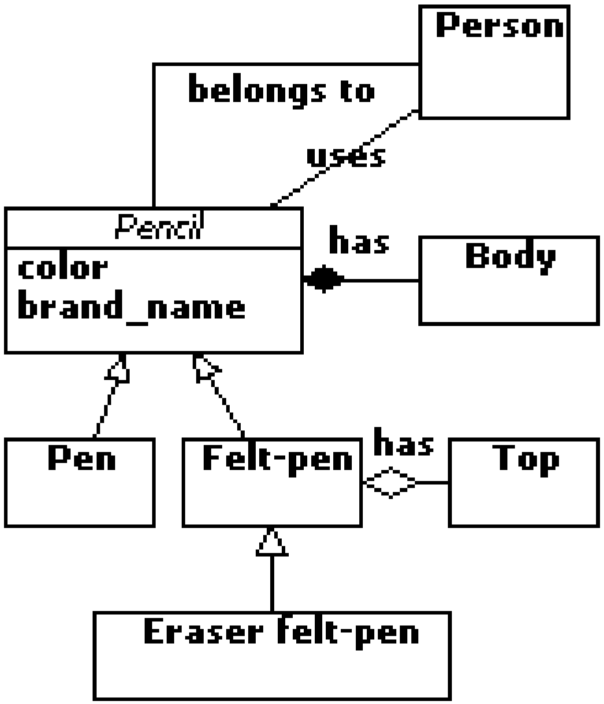
- Three kinds of messages
  - ***Notify****:* point out a diagram part « *you say that…* »
  - ***Question****:* ask whether a representation is correct « *does x has y?* »
  - ***Propose****:* suggest another way « *I would rather say…* »

Pedagogical feedbacks

Example



Student diagram

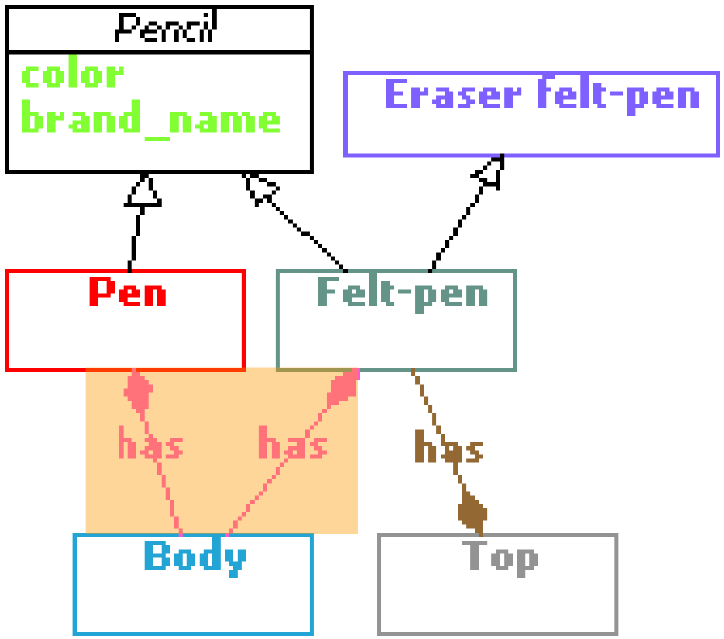


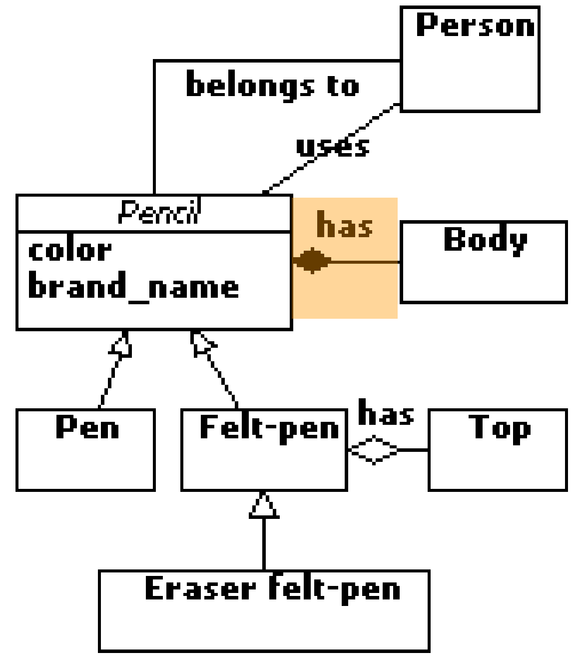
Reference diagram

- *9 simple differences*
- *3 compound differences*

Pedagogical feedbacks

Example





- **Compound difference #1**
  - Duplication and transfer of « has » relationship between « Pencil » and « Body » classes

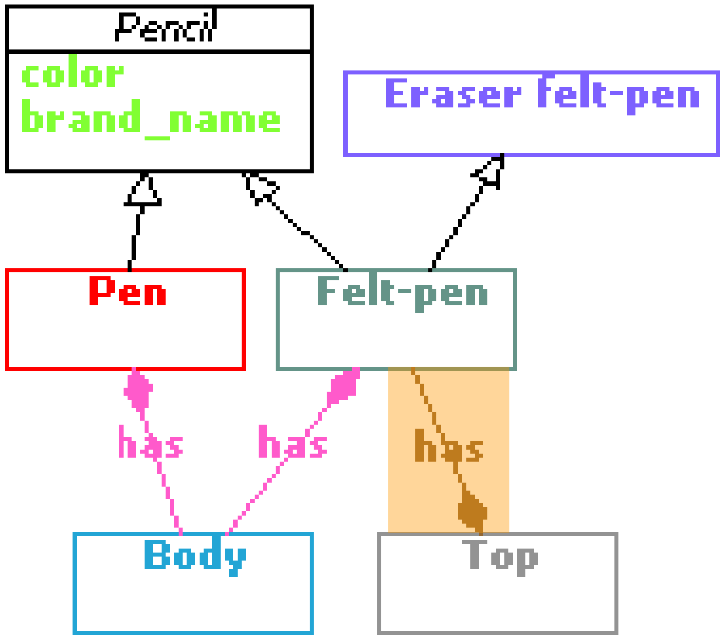
Example

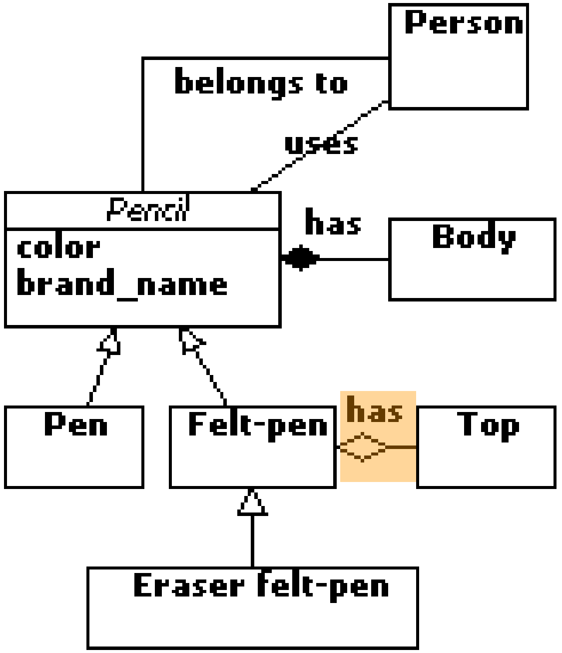
- **Compound difference #1**
  - Duplication and transfer of « has » relationship between « Pencil » and « Body » classes

- Feedbacks
  - ***Notify***: You say ‘Pen has Body’ and ‘Felt-pen has Body’.
  - ***Question***: Do the relationships ‘Pen-Body’ et ‘Felt-pen - Body’ represent the same relationship?
  - ***Propose***: You must merge them into one single relationship, using the “Pencil” and “Body” classes.

Pedagogical feedbacks

Example





- **Compound difference #2**
  - Misrepresentation of a relationship and reverse direction (between « Top » and « Felt-pen » classes)

Pedagogical feedbacks

Example

- **Compound difference #2**
  - Misrepresentation of a relationship and reverse direction (between « Top » and « Felt-pen » classes)

- Feedbacks
  - ***Notify***: You say ‘Top has Felt-pen’.
  - ***Question***: Does Top have Felt-pen?
  - ***Propose***: I would rather say ‘Felt-pen has Top’.

Conclusion

- Pedagogical feedbacks specific to each learner's diagram
- Independence of diagnostic module and feedback module
- Experimentations with students (sept-nov 2008)
- Limits and perspectives
  - Relies on a single reference diagram → include alternative solutions
  - Rocal diagnosis → memorize successive diagnosis to avoid repetitions