Analogy by Abstraction: Theory of Case Retrieval and Adaptation in Inventive Design Problems

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This paper examines the applicability of Case Bases Reasoning for *inventive* design problems and proposes a new reasoning scheme: Analogy by Abstraction (ABA). "Inventive design", in this paper, means designing a new thing based on past similar experience, in which we force to find *some* similarities on the new designed object.

ABA uses use past experience as search control knowledge for heuristic analogical reasoning. To find out *wider* similarities, ABA employs a classified hierarchy of past problems, which forms an *abstract problem space*. The leaf elements of the abstract space are contained in the case base.

The major steps of ABA are summarized as follows (see also Figure 1):
(1) Search: For a given problem, search for similar previous problems using the problem hierarchy;
(2) Abstract: Abstract the associated solution of the previous problem using the generic solution,
(3) Refine: Refine the abstract solution to adjust it to the given problem,
(4) Apply: Apply the refined solution to the given problem,
(5) Verify: Verify the result not to fail because of in adequate analogy.
The architecture of ABA system is shown in Figure 2.

The principles of ABA can be used various task domains. We have carried out the experiments on the following examples. We are now extending both the architecture and applications.
- **Tile Puzzles:** Using problem solving strategy of 5 puzzle to 8 puzzle;
- **Elementary Geometry:** Re-inventing the Pythagorean theorem from properties of triangles.
- **Mechanical Design:** Re-inventing a state-of-the-art car-jack from an old traditional one;

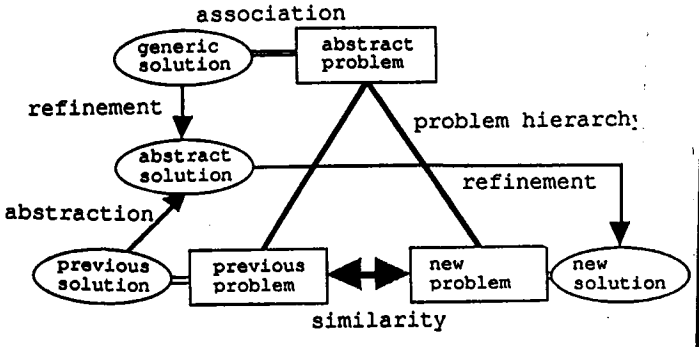

Figure 1: Principle of ABA Scheme

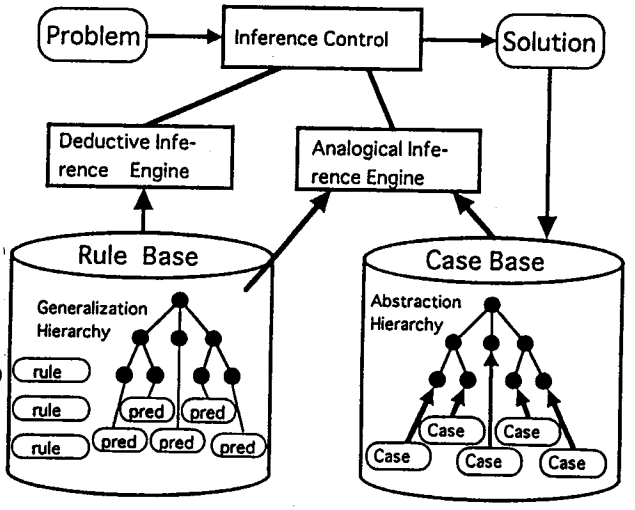

Figure 2: ABA System Architecture