A Model of Invention

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This poster investigates the enterprises of invention. We focus on invention goals, which address those enterprises of an inventor resulting in the creation of novel and useful devices. Invention goals provide one way to explain how creative and innovative ideas are generated, evaluated and further pursued by expert reasoners, such as inventors. Our distributed model of invention, ALEC, highlights the role of social and environmental interaction.

In our view, a professional inventor pursues his invention ideas to satisfy his/her curiosity (i.e., learn more) and/or to get social recognition (e.g., to get famous and wealthy). Whenever the inventor comes across a new idea (e.g., through experimentation or social interaction) that is interesting for him and/or for society, the preliminary preconditions for generating an invention goal are met. But the inventor must also estimate his chances of success, before allocating significant cognitive resources for pursuing a new idea. Our exploration is based on a well-documented example: the invention of the telephone by Alexander Graham Bell (Notebooks[1]; US v. Bell, 1908). Concretely, we propose mechanisms to explain: (1) how Bell's early thematic goals gave rise to the new (invention) goals to invent the multiple telegraph and the telephone and (2) how the new goals interacted opportunistically. In particular, invention goals may generate expertise goals (i.e., learning goals to get domain expertise), while the knowledge gained through expertise goals may be used to generate new invention goals.

We started by analyzing Bell's reasoning in terms of goals, plans and themes, according to Schank and Abelson's (1977) computational model of goal generation and refinement. But we realized that some of Bell's thematic goals manifest new properties: (1) they are ill specified, which affords learning new alternative plans for them dynamically, (2) their number is kept low, by making their generation a deliberative process, (3) they are more "active", by looking from background for unexpected opportunities to satisfy them, (4) social interaction plays an important role for satisfying them, and (5) their life cycle is very long, compared with other goals. The above properties distinguish invention goals from other approaches to opportunistic reasoning, such as opportunistic planning (Hammond et al., 1993) or knowledge goals (Ram and Hunter, 1992).

The idiosyncratic sensitivity for invention goals behaved like a kind of "knowledge lens", which helped Bell to deal with large amounts of information, by focusing him only on the relevant parts. The relevant information was constantly reorganized and learned as new cases and models. Consequently, Bell achieved a goal-directed expertise in electricity, very efficient for his goals, but which sometimes ignored the traditional view of the domain. Moses Farmer offered a now famous characterization of Bell's idiosyncratic expertise: "If Bell had known anything about electricity he would never have invented the telephone".

ALEC's architecture evolved from the difficulties encountered with the opportunistic control of IMPROVISER (Simina and Kolodner, 1995), our previous system for modeling creativity in design. We hope to synthesize a computational model of invention by identifying and understanding invariants across different inventions and inventors. Among the possible applications, such a model can be used for building better expert and tutoring systems.

[1]Alexander Graham Bell's Notebooks are available on the WWW at: *http://jefferson.village.virginia.edu/~meg3c/id/albell/homepage.html*

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