Minimalism in Ubiquitous Interface Design

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Minimalism in ubiquitous interface design allows computational augmentations to coexist with unmodified artifacts and the constellations of task behaviors surrounding them. By transparently integrating aspects of the digital world into real artifacts, we strive to provide ubiquitous interfaces to computation that do not obscure or destroy the highly refined interaction modalities of everyday artifacts in the physical world.

We present a system that demonstrates this design philosophy: an augmented *go* board. The game of *go* is an intriguing test case because it is surrounded by a set of behaviors and aesthetic concerns that have been refined over the course of thousands of years. Our system provides a flexible, mode-less augmentation of *go* by adhering to minimalism. Our design philosophy conceives minimalism as a combination of parsimony and transparency.

Minimalism doesn't necessarily imply limited functionality. Transparent design means minimizing cognitive demands on the user by limiting the changes to the pre-existing constellation of behaviors surrounding the artifact being augmented. For example, the augmented *go* system transparently adds game recording and an automatic move clock to traditional face-to-face play with no change to the traditional experience.

Furthermore, parsimony means minimizing the introduction of interface elements and inappropriate metaphors that could lead to clutter. The traditional activities of solitary review, study, and problem solving are enhanced by the addition of minimal visual augmentations that are appropriate to the game context and therefore preserve the game aesthetics. The traditional experience is actually improved because the user is free not only from distractions in the interface, but also from the usual distractions of notes, reference books, and newspapers.

One aspect of this work is the constructive coexistence of the physical and the virtual. In this respect this work is similar to the work of Wellner on the DigitalDesk[1] and is informed by Ishii's pioneering efforts in tangible user interfaces[2]. Another aspect of this work is the desire for transparency and minimal cognitive demands on the user. In this respect it is inspired by work on sympathetic interfaces[3] and supported by the prior literature on perceptual interfaces[4]. In choice of domain, the augmented *go* board is most similar to Underkoffler *et al's* tangible chess board[5]. *Go's* visual affordances provide a simple domain for computer vision techniques. One shortcoming of focusing on *go* as a domain is that the application of minimalism to more complex domains was unexplored. However, after anecdotal experiences augmenting another artifact (a desktop calculator) we think minimalism is applicable to other simple domains.

As the illustrations below show, the *go* system has been implemented. Furthermore, we have conducted an evaluation of the system. An experiment conducted to assess learnability found that subjects not only preferred the minimalist tangible interface when compared to a more traditional GUI, but they also performed tasks significantly more rapidly with this interface[6].

Using minimalism as a guiding design principle suggests learnable methods for interacting with ubiquitous computers. Users of ubiquitous computers will likely have no desire to learn thousands of user interfaces for every conceivable use context. Instead, we propose designers extend a minimal design philosophy to other artifacts, allowing users to interact with them in familiar ways.

[1] P. Wellner. The digitaldesk calculator: Tangible manipulation on a desk top display. In *Proc. ACM SIGGRAPH Symposium on User Interface Software and Technology*, pages 107–115., 1991.

[2] B. Ullmer and H. Ishii. *Human-Computer Interaction in the New Millennium*, chapter Emerging Frameworks for Tangible User Interfaces, pages 579–601. Addison-Wesley, 2001.

[3] M. Johnson, A. Wilson, B. Blumberg, C. Kline, and A. Bobick. Sympathethic interfaces: using a plush toy to direct synthetic characters. In *Proceedings of CHI*. ACM Press, 1999.

[4] C. Wren, F. Sparacino, A. Azarbayejani, T. Darrell, T. Starner, A. Kotani, C. Chao, M. Hlavac, K. Russell, and Pentland A. Perceptive spaces for peformance and entertainment. *Applied Artificial Intelligence*, 11(4):267–284, June 1997.

[5] J. Underkoffler and H. Ishii. Urp: A luminous-tangible workbench for urban planning and design. In *CHI*, pages 386–393, 1999.

[6] C. Wren and C. Reynolds. Parsimony & transparency in ubiquitous interface design. In *Ubiquitous Computing: Adjunct Proceedings*, pages 31–32, 2002.

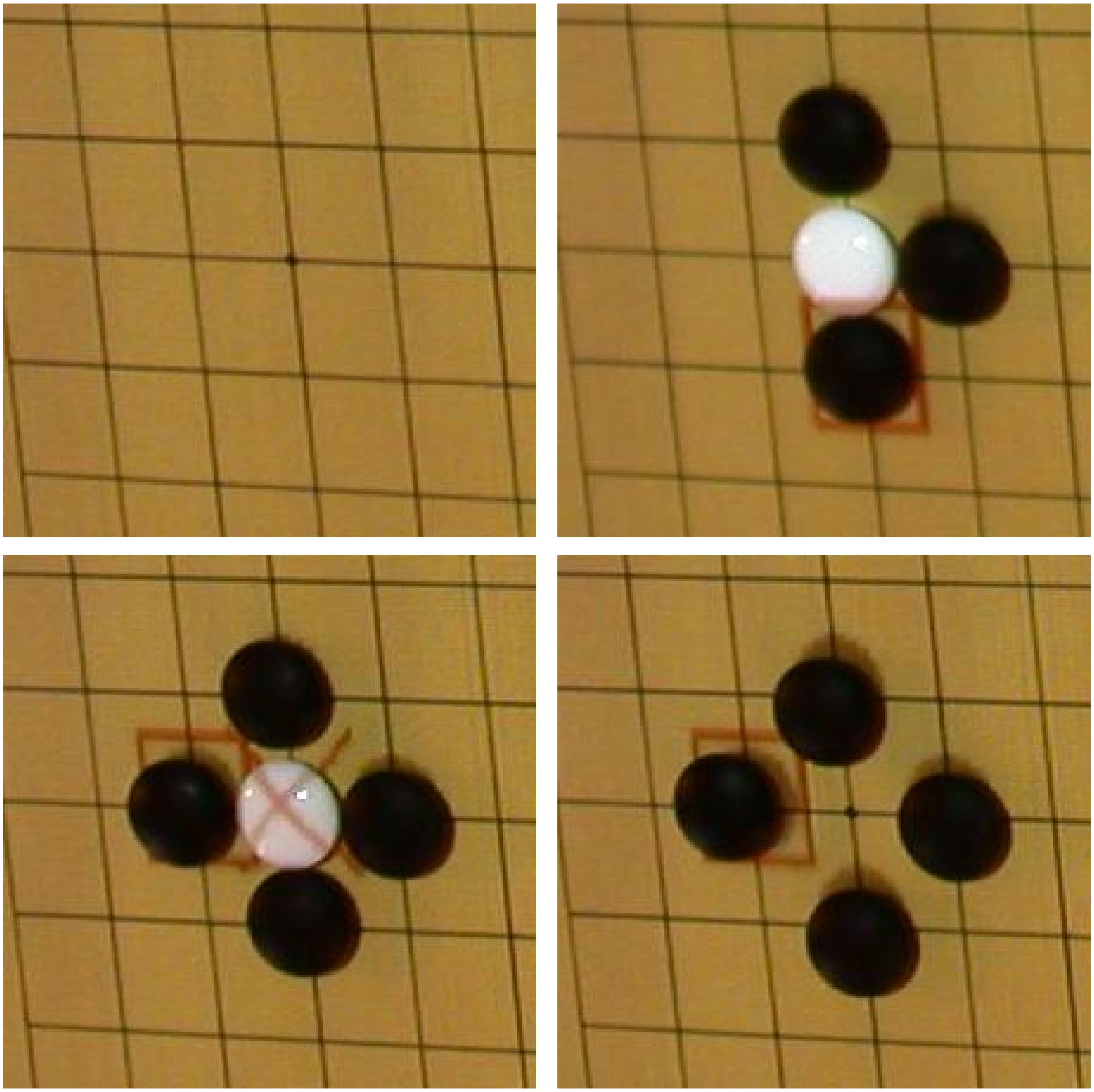

Figure 1: A series of illustrations showing some of the augmentations available to the system. They allow the system to highlight the last move (this is useful for study and remote play), inconsistent board state (useful during study, remote play, and even during live tutoring), and piece confirmation (which provides a subtle cue to the human that there is an additional computational entity that attending to the interaction).

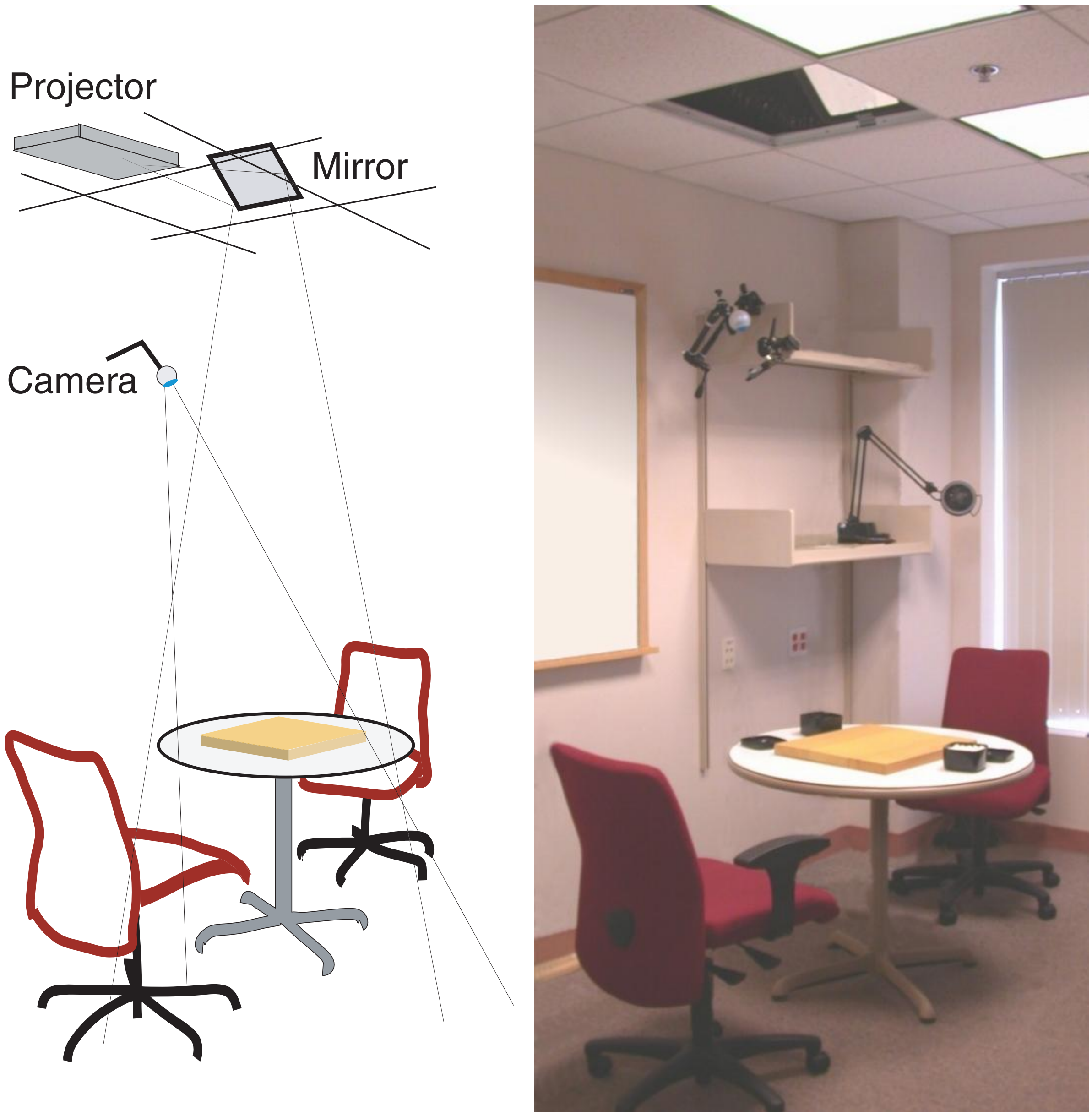

Figure 2: The system we implemented is governed by the design philosophies of parsimony and transparency articulated above. The system itself consists of a light-table comprised of a video camera and projector situated above a *go* board on normal table. The system projects visual annotations that form a superset of the traditional board functionality. The vision system explicitly supports our design philosophy by accommodating the traditional style of game play.

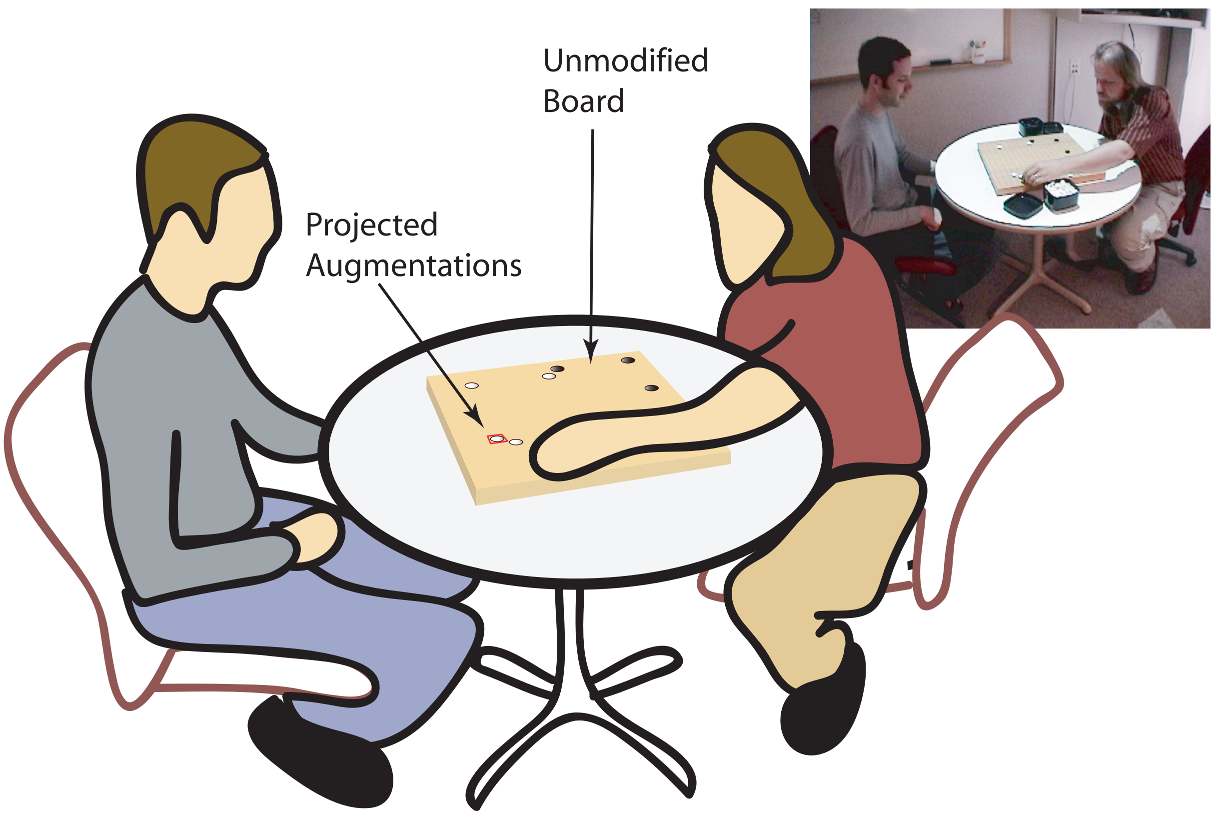

Figure 3: The players utilize the board as they always have, playing a game without having to wear any special markers, or explicitly interacting with computers, or other devices. The environment is not cluttered with virtual buttons, or menus, or other inappropriate carry-overs from the GUI domain.

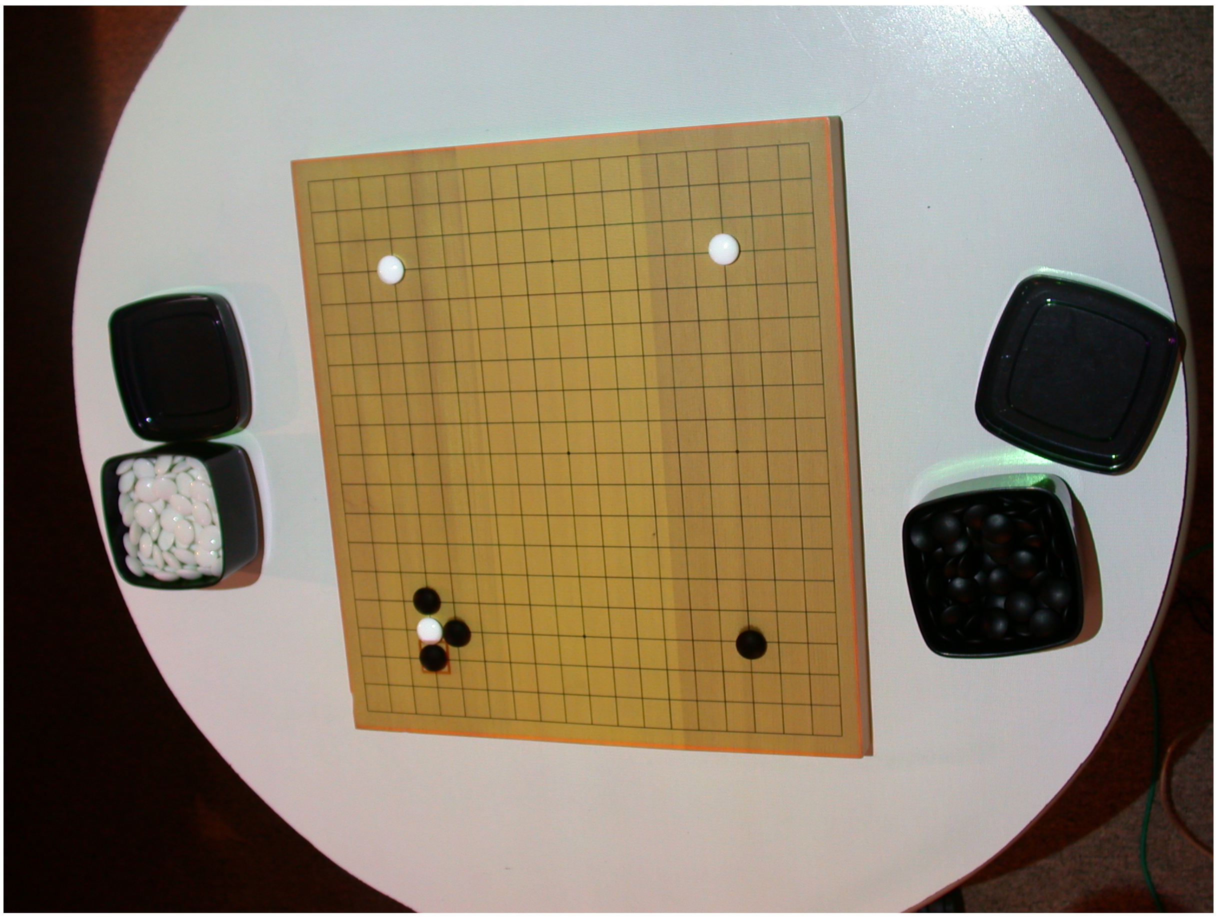

Figure 4: The view from the camera while a game is being played, between moves. The system employs well-understood computer vision techniques to recover the state of the world. A rich domain model allows the perceptual system to react intelligently to human actions, without introducing onerous constraints or confusing modal behavior. The system does not control the interaction: it only provides helpful information in response to free-form human activity.

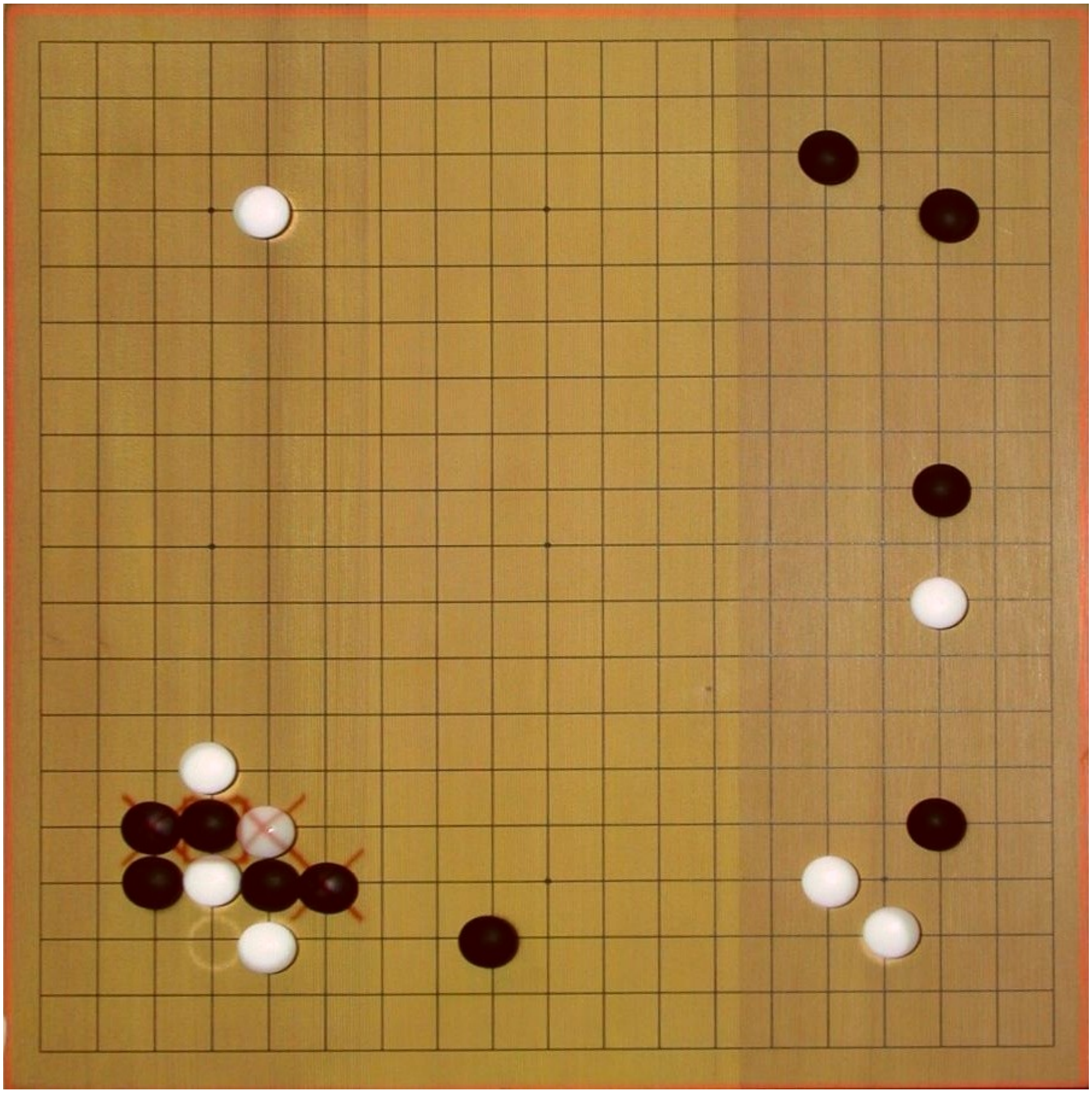

Figure 5: An illustration of the roll-back interface. The student has explored a variation on a recorded game and is attempting to go back to the primary task. The system highlights the student's options in the lower-left. This is a form of cognitive aid that is essential to novice study, and it is provided by every GUI *go* client that we surveyed, but until now, was lacking from the physical interface.