# 囲碁と数学の知識の伝達

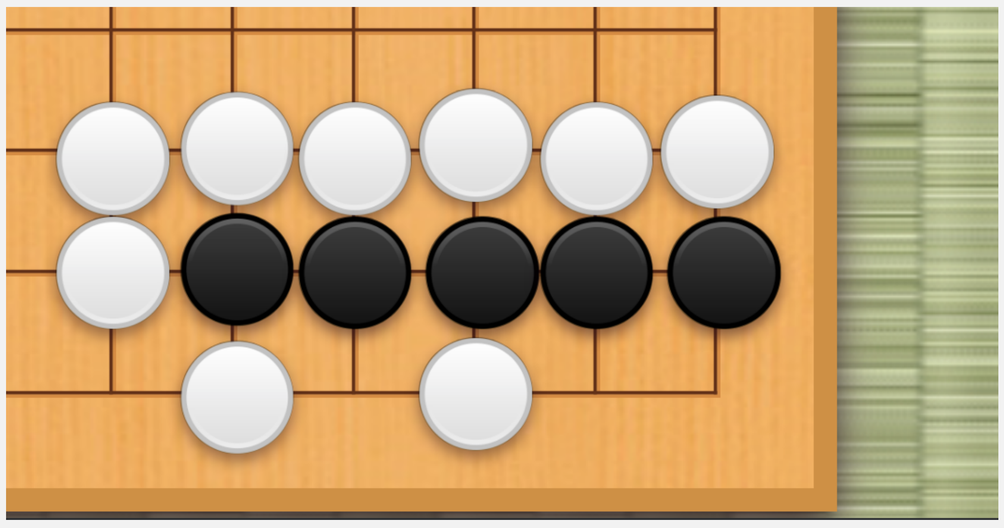
# Knowledge Transfer Between the Game of Go and Mathematics

Attila Egri-Nagy — Akita International University — www.egri-nagy.hu — @EgriNagy

## Research Problem

"Learning the game is worth an advanced mathematics course. " – is often stated about Go (围棋 weiqi, 바둑 baduk, 囲碁 igo). *How can we turn this observation into some tangible benefit in education? How can expertise in a game help in other fields?*

## Tsumego (Go puzzle) black to play & live



## A math problem

Simplify the expression

$$\frac{1}{2}\log_3(x-1) - \log_3 y - 3\log_3(z+1)$$

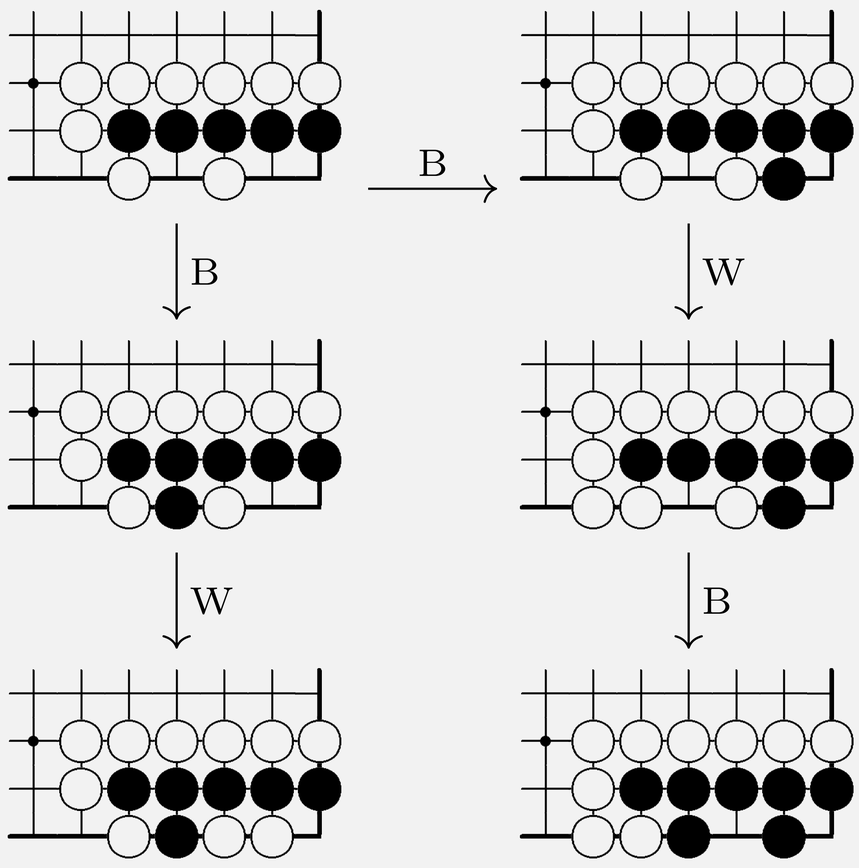
into a single logarithm by using the laws of logarithm

$$\text{(L1)}\ \log_a(xy) = \log_a x + \log_a y,$$

$$\text{(L2)}\ \log_a\left(\frac{x}{y}\right) = \log_a x - \log_a y,$$

$$\text{(L3)}\ \log_a x^y = y\log_a x.$$

## What is common in these problems? Both are examples of graph search algorithms.




$$\frac{1}{2}\log_3(x-1) - \log_3 y - 3\log_3(z+1) \xrightarrow{L3} \log_3(x-1)^{\frac{1}{2}} - \log_3 y - \log_3(z+1)^3$$

$$\downarrow L3 \qquad\qquad \downarrow \text{extract -1}$$

$$\log_3(x-1)^{\frac{1}{2}} - \log_3 y - 3\log_3(z+1) \qquad \log_3(x-1)^{\frac{1}{2}} - \left(\log_3 y + \log_3(z+1)^3\right)$$

$$\downarrow L2 \qquad\qquad \downarrow L1$$

$$\log_3 \frac{(x-1)^{\frac{1}{2}}}{y} - 3\log_3(z+1) \qquad \log_3(x-1)^{\frac{1}{2}} - \log_3 y(z+1)^3$$

**Classical AI search algorithms and calculating logic.** We choose from a finite set of operations repeatedly in order to get closer to a solution. Arrows indicate the action we take to move between the partial results. Humans do this when faced with unfamiliar problems. Systematic, step-by-step thinking.

**Deep learning and intuition.** After practise, we just 'see' the right way to the solution. Knowledge encoded in the weights of a neural network. There is no immediate explanation for the chosen solution.

## Conclusion

Several AI techniques are modeled after our thought processes. Introspection improves our thinking, therefore learning about AI methods can sharpen the mind. Technical study could be used as metacognition.


The game of Go is a self-contained topic for demonstrating different AI techniques. It also allows breaking out from traditional lecturing style of mathematics. Metacognition techniques transfer to other fields of study.

## Further Information

1. **"How to solve it?" - The tsumego session** *Annales Mathematicae et Informaticae*, Vol 38 2011, pp 137-145, classic mathematical heuristics applied to Go puzzles with the purpose of improving problem solving skills in general, http://ami.ektf.hu/uploads/papers/finalpdf/AMI_38_from137to145.pdf
2. **Igo Math – Natural and Artificial Intelligence and the Game of Go**, an integrated course combining technical and philosophical ideas, developed for the Liberal Arts curriculum reform, 2018 https://egri-nagy.github.io/igomath/