

### **The Modern Marriage of Integer Programs and Artificial Intelligence**

In their 1976 paper titled “Computer Science as an Empirical Inquiry: Symbols and Search”, Allen Newell and Herbert Simon dive deep into a variety of topics, most notably their references to the impact of artificial intelligence upon the rise operations research fields such as integer programming. However, innovations in integer programming following their publication have led to a far more symbiotic relationship in which both sciences benefit. A decade after Newell and Simon’s publication, Dr. Fred Glover has built upon this mutually beneficial marriage.

A prominent example of this is the development of “simulated annealing” (Glover 535) in the sector of controlled randomization, which was a methodology developed to prune the search base through incremental changes to the objective function. A moving probability function is paired with a heuristic to re-evaluate the objective at each step, through which moves with objective “improvement” are “automatically accepted” (Glover 535). Along with this new form of randomness providing benefits over the traditional branch and bound methods (as well as random restart and shakeup practices), simulated annealing opened a new door in the understanding of artificial intelligence and cognition. As a patron of cognitive studies, Glover highlights that that simulated annealing was in fact a “reflection on the way a human might proceed” in intelligent decision making. A human mind does in fact tend to reflect on the effects of decisions, similar to annealing, and make probabilistic (albeit more qualitative than quantitative) assessments, most often favoring positive outcomes. It is through this that Glover has highlighted the potential for artificial intelligence to utilize annealing in its path towards building “intelligent behavior”.

The potential going forward for operations research and artificial intelligence problems to intermingle is truly exciting, including topics ranging from learning strategies to induced decomposition.