

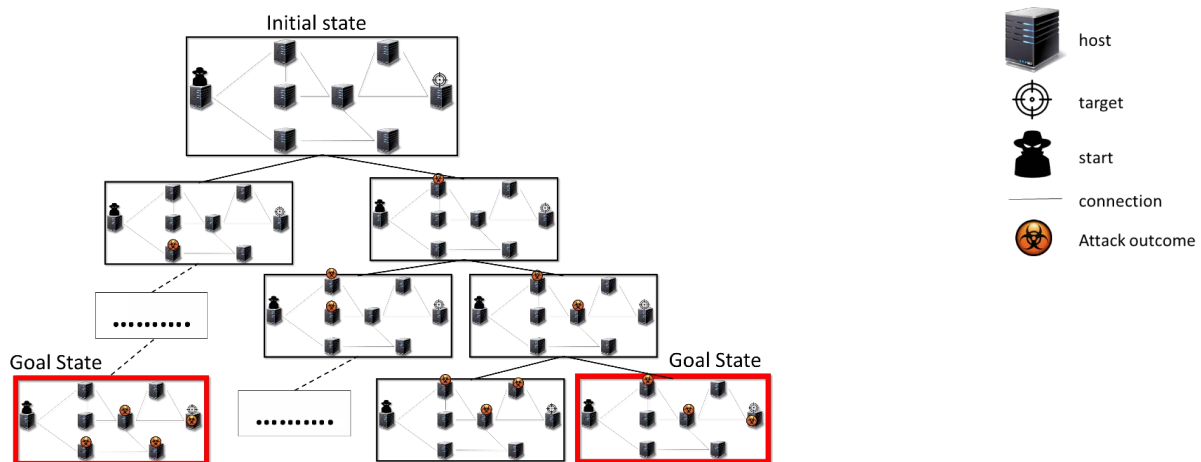
# AI Nanodegree - AI Planning and Search Milestones

## Research Review

In this document we first introduce and define AI Planning and Search then discuss 3 historical developments in the field that give a sense to how it's evolving.

## AI Planning and Search

As described on [Wikipedia](#), AI Planning (also referred to as Automated planning and scheduling) is one of the sub-fields of AI that is concerned with the construction of (ideally, optimum) action sequences to transition from a initial state to a goal state. The below figure shows planning for a cyber security attack.



Illustrated example of planning for computer security described in [4](#)

## STRIPS 1971 - Describing the problem space

To make the problem accessible and computable, you must have a language that describes it in its entirety. A planning problem is described by a collection of actions, each of which are categorised by their preconditions (conditions of the state for the action to be accessible) and postconditions (the consequence on the state when the action is performed). An initial state and

the goal (or target) state. The problem is solved by finding the actions that transition the initial state to the goal state.

[STRIPS \(Stanford Research Institute Problem Solver\)](#) was developed at [SRI](#) as an [action language](#) to efficiently describe these set of **actions** and **states**. It simplified the detail required by introducing the **Strips Assumptions**, a set of assumptions that omitted a great amount of declaration that could be effectively deduced e.g. it is automatically assumed that anything not explicitly referenced during a transition from one state to another remains constant. STRIPS set the foundation for future action languages such as ADL (Action Description Language) and PDDL (Planning Domain Definition Language).

## Graphplan 1995 - Planning the search

In 1995, Avrim Blum and Merrick Furst developed the algorithm [Graphplan](#), the algorithm breaks the searches for the plans into 2 stages. The first is to construct a plan graph, essentially a representation information about what the executive could possibly achieve by executing actions from the initial state. The second stage is to perform a backwards search from the goals to construct a path.

One of the major contributions (and the focal point of this section) of this, to the field of AI Planning, was the **grounding** of all actions. Memory intensive but allowed effective filtering, allowing the planning to avoid actions that conflicted with each other e.g. those that were mutually incompatible.

## Heuristic Guidance Search 1996 - Automatically constructing a heuristic function

At the time, heuristic search was nothing new - a strategy in which the choice between alternatives is made by evaluating each alternative using a heuristic function and then selecting the best approach but the problem prior to McDermott, Geffner and Bonet, was that these heuristic functions were constructed by hand and difficult to generalise. The proposed solution was automatically constructing this heuristic function by analysing the domain. In essence a heuristic value was chosen for a given action based on the estimate of outstanding work remains to accomplish the goal after performing that action (the measure of outstanding work is simply the size of a relaxed plan to achieve the goals).

## Final note

From my reading, the history of AI Planning has been about the balancing of academic research for a generalised approach with industrial applicability. Despite modern developments (such as

probabilistic planning and parallelism), I feel the above encapsulate the essence of this trend. Academic and industrial making planning more accessible by making it easier to describe, making it more efficient for real world problems, and introducing heuristic (automatic and/or domain) to take advantage of the domain knowledge.

## References

1. [https://en.wikipedia.org/wiki/Automated\\_planning\\_and\\_scheduling](https://en.wikipedia.org/wiki/Automated_planning_and_scheduling)
2. [https://www.researchgate.net/publication/242415929\\_Progress\\_in\\_AI\\_Planning\\_Research\\_and\\_Applications](https://www.researchgate.net/publication/242415929_Progress_in_AI_Planning_Research_and_Applications)
3. <https://web.archive.org/web/20131222165824/http://www.eetn.gr:80/index.php/eetn-publications/ai-research-in-greece/planning-and-scheduling>
4. <http://datacyentist.com/artificial-intelligence-and-machine-learning-for-security-data-science/>
5. <https://en.wikipedia.org/wiki/STRIPS>
6. [https://en.wikipedia.org/wiki/SRI\\_International](https://en.wikipedia.org/wiki/SRI_International)
7. [https://en.wikipedia.org/wiki/Action\\_description\\_language](https://en.wikipedia.org/wiki/Action_description_language)
8. <https://en.wikipedia.org/wiki/Graphplan>