Topic: Write a one-page report on three of the important historical developments in the field of AI planning and search, highlighting the relationships between the developments and their impact on the field of AI as a whole.

Historical developments selected: Total Order Planning, Partial Order Planning, Post-Partial Order Planning (Heuristic Search)

Planning and search are both key areas within the field of Artificial Intelligence. The two areas have evolved and expanded as available computational resources and problem complexity have also increased. Starting from the most basic linear planning techniques, partial order planning techniques became popular from the 1970s through mid-1990s, then heuristic search technique became popular from the 2000s on forward. Many of today's best performing planning techniques rely on heuristic search techniques.

Total order planner searches for a solution within a set of totally ordered states, where every state of the plan is ordered with respect to other states. In a total order plan, every state knows exactly which state comes before and after itself. This method is a naïve search method in that we strictly consider state transitions from initial to goal. However, for complex problems or problems with repeated set of state transitions, partial order planning is deemed more efficient. Partial order planner allows steps to be unordered. Partial order planner can search for multiple plans that satisfy sub-goals, which is combined later. Since TO planner must search for all possible state combinations while PO planner need to search for subplan combinations, reducing the search space.

As the application of planning techniques increased, new planners that outperform partial order planner have also been proposed. Graphplan algorithm, for example, uses reachability information for reducing the search space while increasing the cost of searching each node. Distance heuristics have been found to be most successful with finding non-optimal solutions to computationally cheap planning problems with very large search space. More modern planners include Fast Downward planner which use domain transition graphs and causal graphs and the hierarchical information contained within them to further reduce the search space.

In conclusion, the planners have evolved over time from a naïve search that explored the entire search space, to breaking down the search spaces into smaller pieces, and to reduce the search space itself using heuristics. This advancement is allowing the AI to search through larger space with increased efficiency, further expanding its applications.

References

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[2] J. Rintanen, J. Hoffmann. An Overview of Recent Algorithms for AI Planning. Künstliche Intelligenz, 2(1), 2001, pp. 5-11.