CS433 Assignment 2

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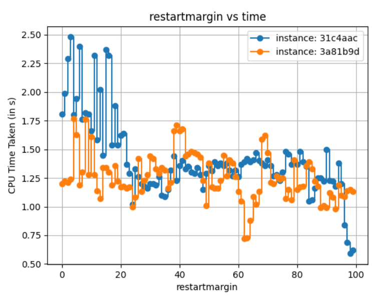
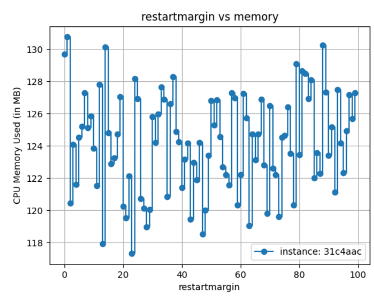
Here we present the plots we have generated and our understanding of why they were so:

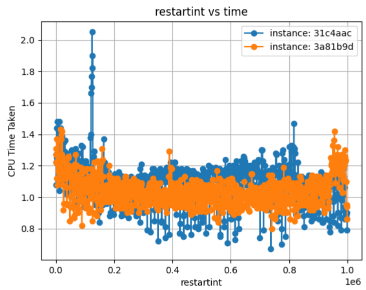
`restartmargin`

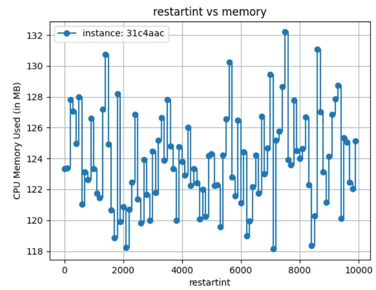




As we can see from these figures there are sudden **drops** in time taken at few discrete values of `restartmargin`. This parameter relates with the frequency of restarts. This is done using something known as **glucose level**. Glucose level of a learned clause is based on how many of its literals appear in recent conflicts. Thus a newly learned clause which is getting involved in multiple conflicts has a high glucose level. If the average glucose level gets more than initial glucose * `restartmargin`, then there's a restart. This can be seen in `src/restart.cpp`. Small changes in this don't change timing much. But at certain threshold valuees as seen here, restart frequency aligns optimally with the problem structure, allowing solver to escape inefficient search regions at the right moment.

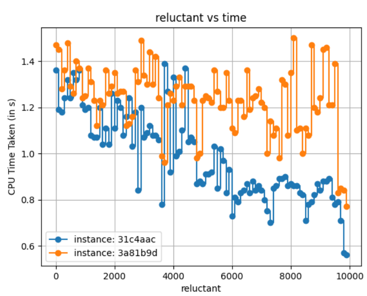
restartint

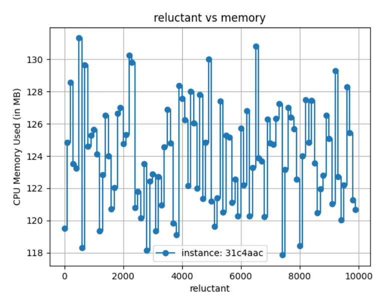




As we can see from the figures, with an increase in **`restartint`**, the time taken is expected to initially decrease, but after a certain point, it may start to increase again. **`restartint`** controls the interval between restarts, and increasing it delays restarts, allowing the solver to explore the search space more deeply before resetting. This can be beneficial by reducing unnecessary restarts and improving the solver's progress with learned clauses. However, if the interval becomes too long, the solver might get stuck in unproductive areas of the search space, leading to longer solving times. So, while increasing **`restartint`** generally improves performance, there's a balance, and beyond a certain threshold, it might have diminishing returns or even negative effects

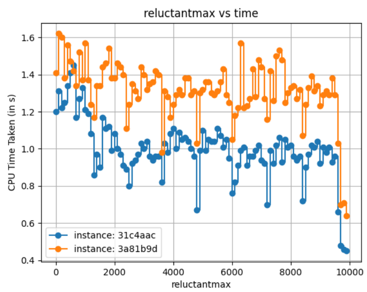
reluctant

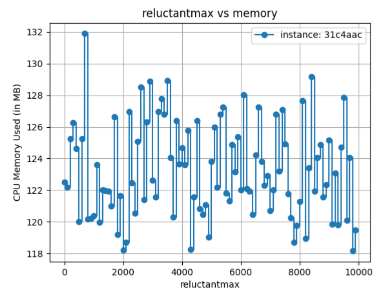




As we can see from the figures, with an increase in **`reluctant`**, the time taken decreases. This might be because a higher **`reluctant`** causes the solver to delay restarts for a longer period, allowing it to explore the search space more deeply before resetting. By doing so, it can often make better decisions based on the learned clauses, avoiding unnecessary backtracking. As a result, the solver can find solutions more efficiently, reducing the overall time. This behavior is particularly noticeable when the solver benefits from not restarting too soon and is able to capitalize on previously learned information to make progress.

`reluctantmax`

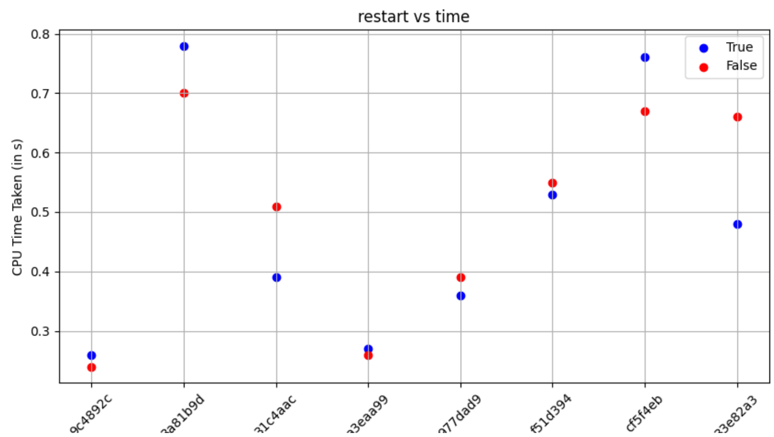


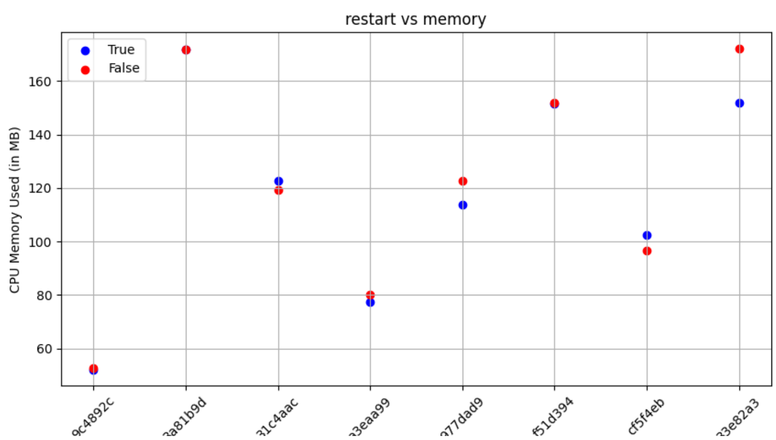


As we can see from these figures, there are sudden **drops** in time taken at a few discrete values of `reluctantmax`. This parameter controls the solver's **reluctant doubling** restart strategy, where restart intervals grow progressively longer. Unlike `restartmargin`, which reacts to glucose levels, this method follows a structured sequence based on an internal counter. The implementation can be found in `src/restart.cpp`.

The sudden drops occur because `reluctantmax` defines restart timing in a **discrete, exponential manner**. At most values, changes in `reluctantmax` do not significantly affect when restarts happen, keeping the solving time stable. However, at certain points, the adjusted restart schedule aligns better with conflict patterns, allowing the solver to escape inefficient search paths earlier, leading to a sharp decrease in time taken.

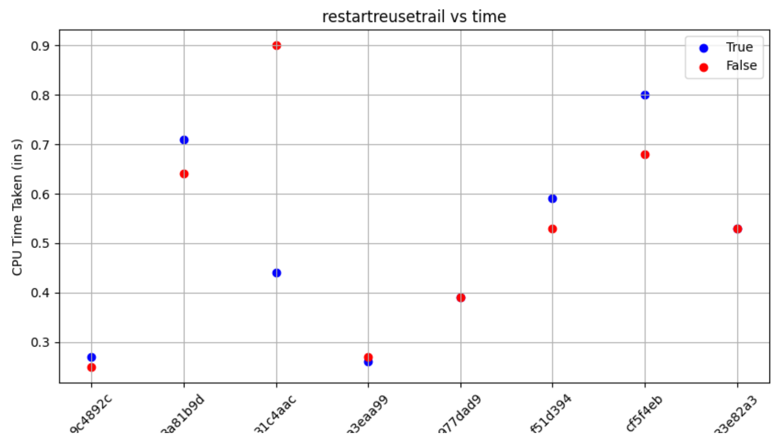
restart

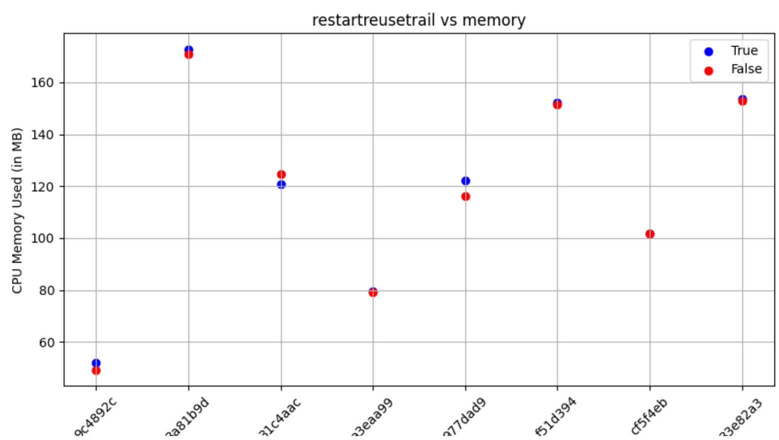




From the results, we can see that keeping `restart` = True is sometimes better, sometimes worse, and in some cases, nearly the same as False. This might be happening because the impact of restarts depends on the problem structure. When restarts help escape difficult search regions, they improve performance, but if they occur too frequently, they might disrupt useful clause learning, leading to slower solving. In cases where the search space is naturally well-guided, restarts make little difference, resulting in similar solving times. This explains why the trend varies instead of showing a clear preference.

restartreusetrail





From the results, setting `restartreusetrail` = True is just as often better as it is worse compared to False. This happens because reusing the trail after a restart can sometimes preserve useful decisions, making solving faster, but other times it keeps bad assignments, leading to more conflicts. If the problem benefits from continuity, it helps, but if a clean slate is better, it hurts. Since this entirely depends on the problem, neither setting is consistently the best.