Karlsruher Institut für Technologie

Bachelorarbeit

Malleable TOHTN Planning using CrowdHTN and Mallob

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Karlsruhe, den December 25, 2021

Zusammenfassung

Hier die deutsche Zusammenfassung.

Ich bin Blindtext. Von Geburt an. Es hat lange gedauert, bis ich begriffen habe, was es bedeutet, ein blinder Text zu sein: Man macht keinen Sinn. Man wirkt hier und da aus dem Zusammenhang gerissen. Oft wird man gar nicht erst gelesen. Aber bin ich deshalb ein schlechter Text? Ich weiß, dass ich nie die Chance haben werde im Stern zu erscheinen. Aber bin ich darum weniger wichtig? Ich bin blind! Aber ich bin gerne Text. Und sollten Sie mich jetzt tatsächlich zu Ende lesen, dann habe ich etwas geschafft, was den meisten „normalen“ Texten nicht gelingt.

Ich bin Blindtext. Von Geburt an. Es hat lange gedauert, bis ich begriffen habe, was es bedeutet, ein blinder Text zu sein: Man macht keinen Sinn. Man wirkt hier und da aus dem Zusammenhang gerissen. Oft wird man gar nicht erst gelesen. Aber bin ich deshalb ein schlechter Text? Ich weiß, dass ich nie die Chance haben werde im Stern zu erscheinen. Aber bin ich darum weniger wichtig? Ich bin blind! Aber ich bin gerne Text.

Abstract

And here an English translation of the German abstract.

I'm blind text. From birth. It took a long time until I realized what it means to be random text: You make no sense. You stand here and there out of context. Frequently, they do not even read. But I have a bad copy? I know that I will never have the chance of appearing in the. But I'm any less important? I'm blind! But I like to text. And you should see me now actually over, then I have accomplished something that is not possible in most “normal” copies.

I'm blind text. From birth. It took a long time until I realized what it means to be random text: You make no sense. You stand here and there out of context. Frequently, they do not even read. But I have a bad copy? I know that I will never have the chance of appearing in the. But I'm any less important? I'm blind! But I like to text.

Danksagungen

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1.1 TOHTN Formalism

1.2 Malleable Algorithms

2 Improvements to CrowdHTN

2.1 Preceding Plan

In the initial implementation each node stored the full preceding plan as a sequence of all reductions that were applied so far. This leads to roughly quadratic overhead (sum over 1..n, only roughly as not each step increases the length. Wait, is it roughly, then? Probably, as the fraction of steps that increment the preceding plan should be kinda constant) This duplication was not needed. The newer implementation instead stores an optional<reduction> in each node. I.e., the preceding reduction is stored if one exists, nothing if there isn't one. When the preceding plan is needed, either for communication or to extract a plan, the current search path is iterated and all reductions are accumulated.

2.2 Lazy Instantiation of Child Nodes

lazy instantiation works on the basis of finding all free variables of a method and creating Reductions based on all possible combinations

2.3 Using Domain Meta-Information

inspiration taken from HyperTensioN

taking preconditions of tasks and lifting them up into methods Only do this if the precondition is guaranteed to also apply to the method (cannot be achieved before the respective task?) This allows us to stop exploring paths earlier

2.4 Global and Memory Efficient Loop Detection

So far: each worker has a hash set of each node ever encountered (note: we define node equality through the sequence of open tasks and the set of predicates that is the world state. Depth in the graph and preceding plan are ignored) Advantages: allows for perfect local loop detection, as we can always fall back to equality checks in case of hash collisions. Problems: This approach leads to a massive memory overhead, as the world state is duplicated countless times. This also leads to increased run times just to manage the growing hash set. This is also not suited for global loop detection. Global loop detection would need some mechanism to communicate seen nodes. Nodes are too large to communicate all of them, though. If we only communicate some nodes instead of all we run the risk of a node "going pastthat barrier of known nodes and still exploring the swathes of known nodes beyond the "barrierTODO: what about open tasks (memory consumption)? Or was that an ImmutableStack with little overhead?

Idea: drop the precondition of perfect loop detection with no false positives. For loop detection use a bloom filter with a set of hash functions for search nodes. This comes with a fixed, configurable memory overhead per worker. As a result, overall memory consumption should - drop - be more predictable To communicate nodes we can just communicate the bit array that

makes up our filter and combine them via bitwise OR. This ensures that communication volume is also fixed. It is independent of both size of nodes (i.e. length of open tasks sequence) and number of explored nodes (since last round of communication). In addition to communicating the bloom filter we communicate the number of newly added nodes. Then each worker knows an upper bound for the total number of nodes that are part of it's bloom filter (might be an overestimation if two workers insert identical nodes as the node would be counted twice). As bloom filter performance/ false positives degrade with the number of elements inside it, we can restart our work depending on the number of elements in the bloom filter. As we communicate the number of inserted nodes, all workers are in agreement on the absolute number of inserted nodes. As a result, they can independently restart depending on this fact without further synchronization. Restarts are also needed to re-obtain completeness of the algorithm. As we use a random order of graph exploration we may simply restart until we get to a part hidden behind a false positive before we get to the node that blocked it from us. TODO: what if a node has a hash collision with one of its descendants? Impossible to obtain completeness, then!

3 Implementation

3.1 Integration of CrowdHTN and Mallob

4 Experimental Evaluation

5 Future Work

Literatur