Levitron: Combining Ground and Lifted Planning

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In this work, we describe the *Levitron* planner.[1] Levitron is essentially a wrapper around a lifted and a ground planner. It combines the lifted planner *Powerlifted* (Corrêa et al. 2023a) with the ground planner *Scorpion Maidu* (Corrêa et al. 2023b). Both are sequential portfolio planners but they have complementary strengths: Scorpion Maidu is efficient in tasks of moderate size; Powerlifted works well on larger tasks that are challenging to ground.

Levitron uses Scorpion Maidu as a default component, and Powerlifted as a fallback when the translator of Scorpion Maidu fails. It participated in the satisficing and the agile tracks, and Scorpion Maidu's translator is given a different time limit depending on the track. For the satisficing track, this limit is 15 minutes. For the agile track, the limit is 3 minutes. If the translator reaches the time limit or surpasses the memory limit (of 8 GiB for both tracks), Levitron aborts Scorpion Maidu and calls Powerlifted. If the translator finishes correctly, Powerlifted is never used.

We do not describe the details of Scorpion Maidu and Powerlifted here, and instead refer to their planner abstracts for a complete description (Corrêa et al. 2023a; 2023b).

Results

Levitron was the joint winner of the satisficing track together with Scorpion Maidu. The similar performance of both planners is not surprising, as Scorpion Maidu is the main component of Levitron. Nevertheless, the planners differed in a few domains. Our hypothesis was that Levitron would perform better than Scorpion Maidu in domains where Powerlifted also did so. In the best case scenario, Levitron's score and coverage would be the maximum between Maidu and Powerlifted scores and coverage. In the domains used in the competition, our hypothesis seems correct. But things are not so simple.

Table 1 shows the coverage and score comparisons between Levitron and its two component planners, Scorpion Maidu and Powerlifted. These are the official results from the competition. For a few domains, the organizers provided two versions: one using a more expressive fragment of PDDL (e.g., conditional effects, axioms), and another version where these features were compiled away (called "normalized" versions). The final results only considered the best version of each domain. We show results of both for completeness.

	Levitron		Maidu		PWL	
	S	C	S	C	S	C
Folding (20)	**9**	**8.66**	7	6.80	8	7.69
Folding-norm (20)	8	7.53	7	6.37	**10**	**9.69**
Labyrinth (20)	0	0.00	0	0.00	–	–
Quantum-Layout (20)	**20**	**19.63**	**20**	**19.63**	**20**	16.73
Recharging-Robots (20)	**14**	**13.78**	**14**	**13.78**	0	0.00
Recharging-Robots-norm (20)	**14**	**13.94**	**14**	**13.94**	0	0.00
Ricochet-Robots (20)	**17**	**11.44**	**17**	11.36	–	–
Rubiks-Cube (20)	**20**	**14.16**	**20**	13.08	0	0.00
Rubiks-Cube-norm (20)	**20**	13.63	**20**	**14.16**	0	0.00
Slitherlink (20)	**2**	**2.00**	0	0.00	**2**	**2.00**
Slitherlink-norm (20)	4	4.00	**6**	**6.00**	2	2.00
Sum (220)	**128**	**108.77**	125	105.13	42	38.12

Table 1: Coverage (C) and quality score (S) comparison between Levitron, Scorpion Maidu ("Maidu"), and Powerlifted ("PWL"). Best results marked in bold. Entries with a dash use PDDL fragments not supported by Powerlifted.

In the domains where Powerlifted performed better than Maidu (Folding, Folding-norm, Slitherlink), Levitron also did. For example, in the Folding domain Levitron capitalized on the strengths of both planners. However, in Slitherlink-norm, Levitron landed in between Powerlifted and Maidu.

Randomness plays an important role here as well. For example, Levitron scored better than Maidu in the Ricochet-Robots domain. But Powerlifted does not even support the PDDL fragment used in Ricochet-Robots, so it could not possibly have helped Levitron. At closer inspection, we see that the portfolio configuration of Levitron that computed the best plan, only found this plan in the very last seconds. Due to noise, the same configuration of Maidu did not have enough time to find this plan. The same behavior happened in the other direction (e.g., in Rubiks-Cube-norm).

[1] A Levitron is a toy that demonstrates the principles of magnetic levitation, in which a spinning top is *lifted* and suspended above a magnetic base. The spinning top contains a magnet with its north pole facing outward, while the magnetic base has a north pole facing upward. The repelling forces between these two north poles generate the lift required for the top to levitate.

References

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