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Homework due on 07.01.2026 at 16:00

## Possible solution for Exercise Sheet 10 in Scientific and Technical English for Computer Scientists

The exercise sheets consist of in-class exercises and homework. The in-class exercises take place during the second half of the lecture time slots. The homework, which is optional and ungraded, can be submitted via the “Homework” section in Moodle. The homework is subject to peer review.

Unless indicated otherwise, generative artificial intelligence assistants such as Chat-GPT may be used, as long as you acknowledge how you use them as specified by the Institute’s policy on plagiarism.<sup>1</sup> However, you may not use such tools to generate peer reviews for you. In addition, we strongly recommend that you do not use them to generate entire solutions, since that would defeat the purpose of the exercises.

**In-class exercise 10-1 *Shortening an Abstract***     The following 344-word abstract<sup>2</sup> is long and verbose.

We identify a tradeoff curve between the number of wheels on a train car, and the amount of track that must be installed in order to ensure that the train car is supported by the track at all times. The goal is to build an elevated track that covers some large distance  $\ell$ , but that consists primarily of gaps, so that the total amount of feet of train track that is actually installed is only a small fraction of  $\ell$ . In order so that the train track can support the train at all points, the requirement is that as the train drives across the track, at least one set of wheels from the rear quarter and at least one set of wheels from the front quarter of the train must be touching the track at all times.

We show that, if a train car has  $n$  sets of wheels evenly spaced apart in its rear and  $n$  sets of wheels evenly spaced apart in its front, then it is possible to build a train track that supports the train car but uses only  $O(\frac{\ell}{n})$  feet of track. We then consider what happens if the wheels on the train car are not evenly spaced (and may even be configured adversarially). We show that for any configuration of the train car, with  $n$  wheels in each of the front and rear quarters of the car, it is possible to build a track that supports the car

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<sup>1</sup><https://www.medien.ifi.lmu.de/lehre/Plagiate-IfI.pdf>

<sup>2</sup>William Kuszmaul, “Train Tracks with Gaps: Applying the Probabilistic Method to Trains,” *Theoretical Computer Science* 899, pp. 39–47, 2020.

for distance  $\ell$  and uses only  $O(\frac{\ell \log n}{n})$  feet of track. Additionally, we show that there exist configurations of the train car for which this tradeoff curve is asymptotically optimal. Both the upper and lower bounds are achieved via applications of the probabilistic method.

The algorithms and lower bounds in this paper provide simple illustrative examples of many of the core techniques in probabilistic combinatorics and randomized algorithms. These include the probabilistic method with alterations, the use of McDiarmid's inequality within the probabilistic method, the algorithmic Lovász Local Lemma, the min-hash technique, and the method of conditional probabilities.

- a) Shorten the abstract by at least 25% using the haircut and amputation approaches while preserving its essence, without using generative artificial intelligence assistants.

**POSSIBLE SOLUTION:**

We identify a tradeoff curve between the number of wheels on a train car and the amount of track to support the car at all times. The goal is to cover some large distance  $\ell$  by a track that is primarily composed of gaps so that the total amount of track is only a small fraction of  $\ell$ . To guarantee that the track can support the train during the whole drive, at least one set of wheels from the rear quarter and one from the front quarter of the train must always be touching the track.

We show that, if a train car has  $n$  sets of wheels evenly spaced apart in its rear and  $n$  sets of wheels evenly spaced apart in its front, then a supporting track is possible that uses only  $O(\frac{\ell}{n})$  feet of track. We then consider wheels that are unevenly or adversarially spaced. We show that for any configuration of the car with  $n$  wheels each in the front and the rear quarter, it is possible to build a track that uses only  $O(\frac{\ell \log n}{n})$  feet of track and that supports the car for distance  $\ell$ . Additionally, we show that there exist train car configurations where this tradeoff curve is asymptotically optimal, using the probabilistic method.

Our algorithms and lower bounds illustrate many of the core techniques in probabilistic combinatorics and randomized algorithms, including the probabilistic method with alterations, McDiarmid's inequality, the Lovász Local Lemma, the min-hash technique, and conditional probabilities.

- b) Now use artificial intelligence to do the same for you. What is your prompt?

**POSSIBLE SOLUTION:**

We identify a tradeoff between the number of wheels on a train car and the

amount of track needed to ensure it is always supported. The goal is to span a distance  $\ell$  using an elevated track composed mostly of gaps, with only a small fraction of the total length consisting of actual track. The constraint is that at all times, at least one set of wheels from both the front and rear quarters of the train must touch the track.

We show that if a train car has  $n$  evenly spaced sets of wheels in each of its front and rear quarters, it is possible to construct a supporting track using only  $O(\frac{\ell}{n})$  feet of rail. For arbitrary or adversarial wheel placements, we prove that  $O(\frac{\ell \log n}{n})$  feet of track suffice. Moreover, this bound is tight: there exist configurations for which this tradeoff is asymptotically optimal. Both bounds are obtained using the probabilistic method.

Our results serve as illustrative examples of techniques in probabilistic combinatorics and randomized algorithms, including the probabilistic method with alterations, McDiarmid's inequality, the algorithmic Lovász Local Lemma, min-hashing, and the method of conditional probabilities.

#### ChatGPT Prompt

I have an abstract that is too long and verbose, and I would ask you to reduce it to 75% of the original. Here is the abstract: [original abstract]

- c) Compare your solutions for tasks (a) and (b).

#### POSSIBLE SOLUTION:

While the solution to (a) is more explanatory and structured, it still has 248 words. The solution to (b) has only 191 words and is arguably more polished in some respects. However, the sentence "Both bounds are ..." is cryptic, since the upper bound is no longer mentioned. Moreover, the conclusion that the lower bound is tight might be too strong.

- d) Prepare a unified abstract that combines the best ideas from both versions.

#### POSSIBLE SOLUTION:

We identify a tradeoff between the number of wheels on a train car and the amount of track to support the car at all times. The goal is to cover some large distance  $\ell$  by a track that is primarily composed of gaps so that the total amount of track is only a small fraction of  $\ell$ . To guarantee that the track can support the train during the whole drive, at least one set of wheels from both the front and rear quarters of the train must always touch the track.

We show that if a train car has  $n$  evenly spaced sets of wheels in each of

its front and rear quarters, then a supporting track is possible that uses only  $O(\frac{\ell}{n})$  feet of track and  $O(\frac{\ell \log n}{n})$  feet of track for arbitrary, possibly adversarial wheel placements. Moreover, using the probabilistic method, we show that there exist train car configurations where this tradeoff curve is asymptotically optimal.

Our algorithms and lower bounds are illustrative examples of probabilistic combinatorics and randomized algorithms, for instance the probabilistic method with alterations, McDiarmid's inequality, the Lovász Local Lemma, min-hashing, and conditional probabilities.