

Graph Drawing Contest Report

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Abstract

This report describes the 32nd Annual Graph Drawing Contest, held in conjunction with the 33rd International Symposium on Graph Drawing and Network Visualization (GD'25) at Linköping University, Norrköping, Sweden. The mission of the Graph Drawing Contest is to monitor and challenge the current state of the art in graph-drawing technology. This year's edition featured two categories, a creative topic in which participants visualized a dataset based on the Netflix show *Dark* and a live challenge held at the conference where participants had to draw a graph on a grid, such that the drawing is k -planar for as low a k as possible. A special feature of this year's contest is that the submissions to the creative topic were exhibited in the "Norrköping Decision Arena", a room with a circular annulus-shaped screen.

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Category Graph Drawing Contest Report

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1 Introduction

This year, the Graph Drawing Contest was again divided into two parts, as was usual for the past years: the *creative topic* and the *live challenge*.

Following the last two editions, this year's creative contest focused on only one dataset. The creative topic was *Dark*: a German sci-fi thriller about time travel, fate, and family secrets. The dataset consists of events in the series, characters involved in each event, and some additional information per event (as described below). The contestant are invited to explore the intricate relationships between events, characters, and timelines in *Dark*. The data set was published about half a year in advance, and contestants submitted their visualizations before the conference started.

The live challenge took place during the conference in a format similar to a typical programming contest. Teams were presented with a collection of *challenge graphs* and had one hour to submit their highest scoring drawings. Since the topic had remained the same for



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the last two years, we introduced a new optimization problem this year: given an undirected simple graph and a grid, find a straight-line drawing with vertices placed on grid points, such that the drawing is k -planar for as low a k as possible.

Overall, we received 34 submissions: 12 submissions for the creative topics and 22 submissions for the live challenge (14 manual and 8 automatic).

2 Creative Topic

The dataset for the Creative Topic represents the events of the Netflix show *Dark*. We provided a directed graph, in which each event forms a vertex and edges represent cause and effect relationships between events.

Each vertex and edge is enriched with some metadata to flesh out the events and the relationships between them. Like last year, we explicitly asked contestants to formulate a question or hypothesis about the data and try to answer or explore it with their visualization.

Vertices have an **ID**, a **Description**, and a **Date**. The date is especially important since time travel plays an important role in *Dark*. Furthermore, we provide a list of **Characters** that are involved in an event. We added some additional metadata about whether a character dies and/or whether an event is a pivotal moment in the story. Finally, as the show progresses, the characters find out there are multiple parallel worlds, so for each event we explicitly state which **World** it takes place in. This lead to the following features for each event:

```
{
  "ID": "Incremental ID for each event",
  "Description": "Textual description of the event",
  "Date": "Date of the event in (dd-mm-yyyy) format",
  "Important Trigger": "Boolean value indicating if the
    event is an important trigger for the series",
  "Death": "Boolean value indicating if the event involves a
    death",
  "Characters": "List of characters involved in the event",
  "World": "World in which the event takes place"
}
```

Edges have a slightly simpler format, with an **ID** and vertex/event IDs for **Source** and **Target** vertices of each directed edge between events. The additional metadata consists of an edge **Type**, which included things such as "Successful time travel" or "World swap". Finally, certain edges have a **Description** if some elaboration on the relation between events was necessary. The features of edges can then be described as:

```
{
  "ID": "Incremental ID for each edge",
  "Source": "ID of the source event",
  "Target": "ID of the target event",
  "Type": "Type of relationship between the events",
  "Description": "Few edges include a description of the
    relationship"
}
```

The total graph had 554 vertices and 628 edges.

The raw data forming the basis of the dataset was extracted from a Reddit post on `r/DarK` by user `u/aldersonloop59`.¹ The Reddit post refers to an interactive Lucidchart, a tool to create diagrams, such as flowcharts and mindmaps. While this Lucidchart document of Dark is very comprehensive, Lucidchart itself is just a visualization tool, and not meant to internally represent complex graph structures with metadata. As such, the XML output generated by Lucidchart could not capture all the relational information and metadata visualized in the document. Hence, the contest committee took on the labor-intensive task of manually extracting all the data into two tables for vertices and edges. In the process some wrong information was corrected and many bits and pieces were refined — using the committee’s knowledge of the Dark plotlines — to create the final dataset.

We received 12 submissions for the creative challenge. Submissions were evaluated according to four criteria:

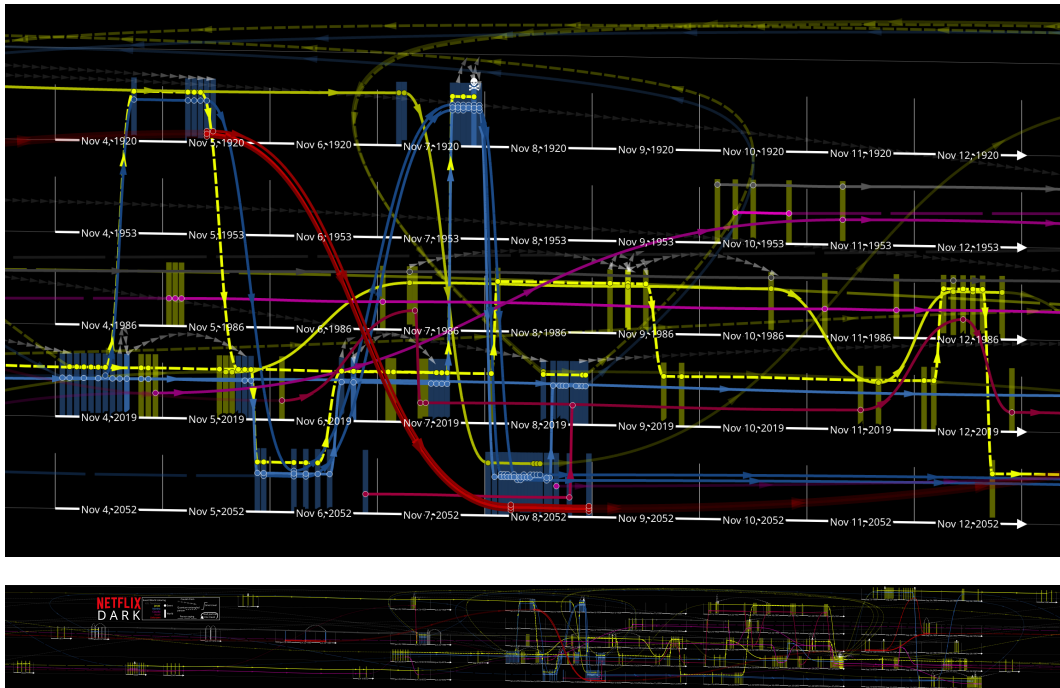
1. readability and clarity of the visualization,
2. aesthetic quality,
3. novelty of the visualization concept, and
4. design quality.

In practice, we asked ourselves the following questions to assess these criteria: **(1)** How much does this submission help you understand (parts of) the data? **(2)** Do the aesthetics fit the theme of Dark? **(3)** Does the submission require (involved) graph drawing techniques? And this year especially: how well is the circular screen utilized? **(4)** How coherent and polished is the submission? As is the case every year, we noticed that it is a difficult decision to choose one submission over the other, and it takes a lot of discussion to weigh all the criteria against each other and come to a definitive top 3. To ease this discussion and to keep the creative topic manageable at the conference, we selected a top six out of all submissions before the conference. This top six was exhibited in the Norrköping Decision Arena during a dedicated session at the Graph Drawing Symposium. We also made all the submissions available on the contest website in the form of a virtual poster exhibition. For a complete list of submissions, refer to <https://www.graphdrawing.org/gdcontest/2025/results/>.

¹ https://www.reddit.com/r/DarK/comments/hqnzgf/spoilers_s3_d_a_r_k_the_complete_visual_timeline/

3rd Place: Tom Baumgartl, Luke Watkin, George Bell, Daniel Archambault, Alma Cantu and Tatiana von Landesberger – Visualizing Time Travelling, Worlds, and Quantum Variants: A Storyline-Spiral Layout of Netflix Dark

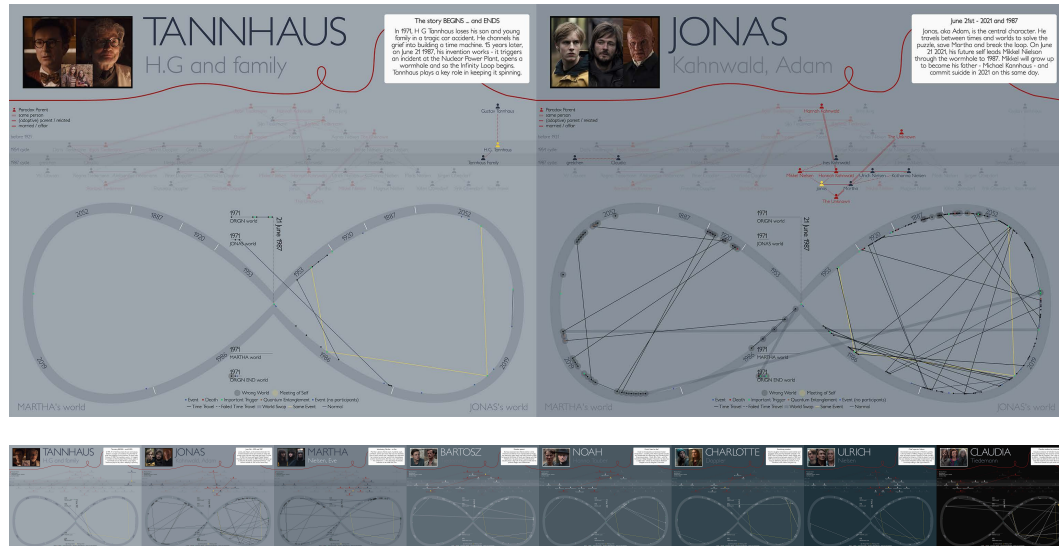
The team submitted a storyline visualization that made excellent use of the circular screen — a stand-out feature for this year’s contest.



“ Our visualization tackles the complex narrative of Dark, where characters exist across parallel worlds, multiple ages, and quantum variants connected by time travel. We designed a static storyline spiral layout, splitting time into 33-year increments stacked on a sloped spiral to emphasize the cyclic theme. Character variants are shown as identity-colored continuous lines with fixed vertical ordering to reduce crossings. Scenes from different worlds appear as colored vertical bars, with dots marking participation and saturation encoding event importance. Time travel arcs, quantum entanglements, and uncertainty between events are encoded through curves, dashed lines, and opacity, revealing both local detail and the global narrative structure. ”

2nd Place: Bryony Miles – Dark Contest – Paradox Tree and Infinity Loop

The submission by Bryony had outstanding aesthetic and design quality; the use of the infinity sign was fitting, since it plays a central role in Dark, and the recurring design looked stunning on the circular screen.



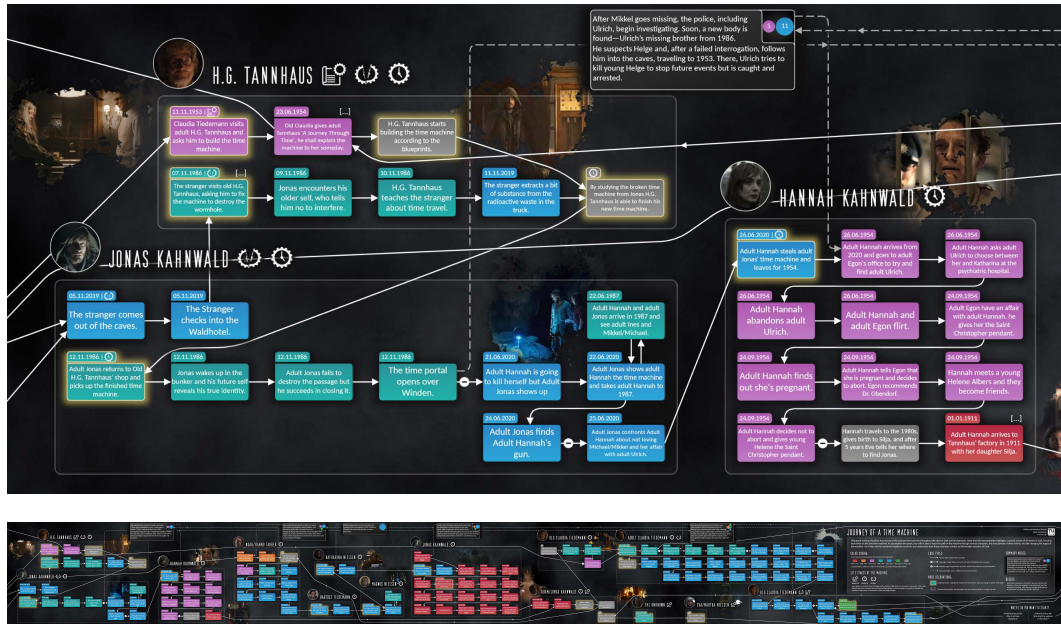
“ My final design aimed to fulfil four goals:

1. Show the main story arc across the four worlds (ORIGIN world -> stuck in the Infinity Loop (JONAS + MARTHA world) -> ORIGIN END world)
2. Tell the story through 8 key characters and their nodes + edges
3. Use the unique 360 degree viewing platform to connect the characters and compare interactions
4. Build a family tree to visually illustrate the many Parent Paradoxes in the plot

I also wanted to use a colour palette and imagery drawn from the Netflix series - character photos, Infinity Loop, red thread connecting the characters. D3.js was always going to be my tool of choice. The trickiest technical challenges were running the nodes along the SVG path and syncing the animations on the interactive version. ”

1st Place: Florian Saß, Jakob Speitkamp and Guilherme Monteiro Oliveira – Journey of a Time Machine.

This team gave a unique twist to their exposition of the data, choosing to follow the time machine throughout the story. This idea was well-executed and resulted in an exciting and polished submission.



The comments of the authors of this submission are included as a separate report.

3 Live Challenge

As always, the live challenge took place during the conference and lasted exactly one hour. During this hour, participants of the conference could take part in the manual category (in which they could attempt to draw the graphs using a supplied tool: <http://graphdrawing.org/gdcontest/tool/>), or in the automatic category (in which they could use their own software to draw the graphs).

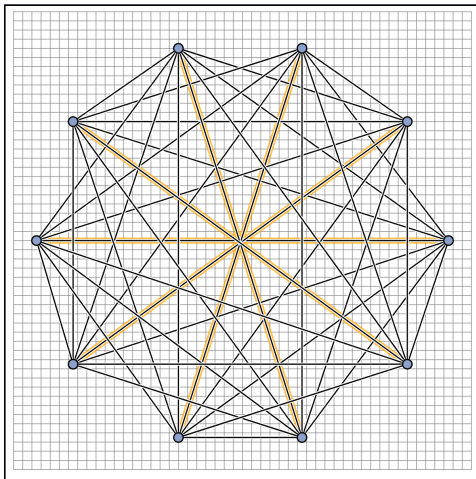
We introduced a new rule this year, allowing teams to participate only if they have a representative attending the conference. This representative can be a team member, or another (closely related) member of the GD community, such as a supervisor (of student team), collaborator, or friend. The contest is organized for the GD community, and hence we think it is important that the participants interact with each other and with the community, to share knowledge about how to efficiently solve the challenges in the contest.

To coordinate the contest, we gave a brief introduction, answered questions, and gave participants the possibility to form teams. We were kindly provided with both a room in the conference building, and laptop facilities, to accommodate to the needs of the participating teams. The largest automatic contest instance gave some teams technical issues, as the server would sometimes have problems storing the solutions sent in by teams. Luckily resending the solutions would resolve this issue, and the contest was otherwise uneventful in terms of technical issues.

The challenge of this year's contest was to draw a given undirected graph on a given grid, while ensuring that the straight-line drawing was k -planar for as small a k as possible. We did not allow for points to lie on (the interior of) edges. For each edge we count the number of crossings, and the edge with the largest number of crossings for a single edge determines the quality metric k of a drawing. The study of k -planarity and k -planar graphs is an active field of research within graph drawing, and hence this contest topic forms a timely challenge to the community to put the obtained knowledge into practice.

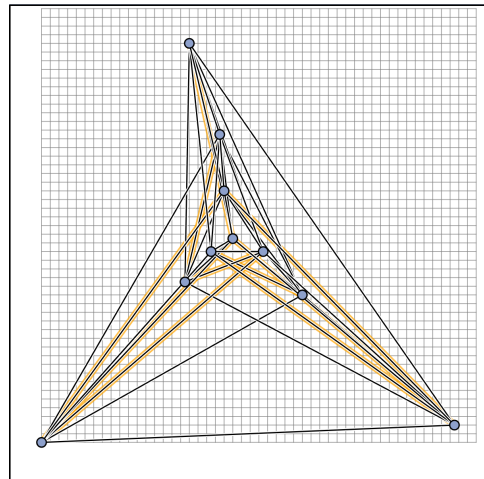
3.1 The Graphs

In the manual category, participants were presented with seven graphs. While the graphs are usually arranged (roughly) from small to large, this year there are quite some smaller graphs in the later half of the manual category. Instead the graphs are ordered such that it is increasingly less obvious what the underlying structure is of the graph, such that it becomes harder to minimize k . The automatic category has an entirely different set of nice instances, as opposed to last years, where they solve the manual category instances and in addition another eight larger graphs. To counteract the decrease in number of instances, the size of the final few instances has increased significantly. The graphs were constructed to have different structures, and for the automatic category, they are roughly ordered from small to large.



Provided drawing in manual category

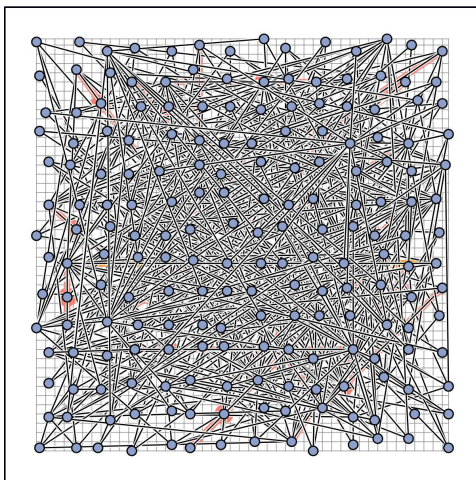
16-planar



Best manual solution

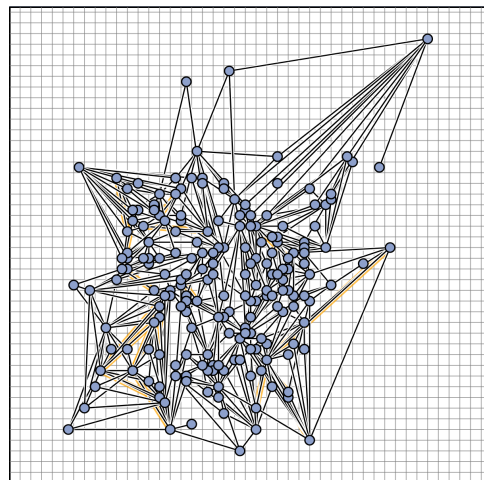
The Untanglers

5-planar



Provided drawing in automatic category

Invalid drawing



Best automatic solution

OMEGA

6-planar

For illustration, we include one graph of each category, showing both the initial drawing as well as the best solution found by one of the participating teams. These instances show both strengths and weaknesses of optimizing k -planarity. For the manual contest instance, the initial drawing shows the symmetry of the graph, and all crossings are easily recognized because the drawing has few small and/or thin faces. The drawing with lower k -planarity loses all these features. However, for the automatic category, the initial drawing is a big hairball, and the best solution clearly shows more structure in the graph. While in previous years, the committee saw repeatedly that manual (human) drawings of graphs display a deeper understanding of the underlying graph structure than automatic and therefore have better readability. For this year's contest that is not always the case, as becomes clear from the examples above. Still, the committee is curious to see how this evolves in the next year, as the live contest topic remains the same for a second year, as is common for the contest.

For the complete set of graphs and submissions, refer to the contest website at <https://www.graphdrawing.org/gdcontest/2025/results/>. The graphs are still available for exploration and solving on the Graph Drawing Contest Submission System: <https://www.graphdrawing.org/gdcontest/tool/>.

3.2 Results: Manual Category

Below we present the full list of scores for all teams. The numbers listed are the k values for the lowest k -planarity achieved by the drawings; the horizontal bars visualize the corresponding scores, where lower scores correspond to larger bars.

graph	1	2	3	4	5	6	7
The Untanglers	1.0	4.0	2.0	5.0	2.0	2.0	5.0
Spider-Barbies	1.0	4.0	2.0	6.0	2.0	1.0	4.0
notadmin	1.0	6.0	2.0	7.0	4.0	2.0	8.0
Bryony Miles	1.0	6.0	2.0	8.0	5.0	7.0	17.0
Tasmanian Devils	1.0	4.0	2.0	5.0	3.0	2.0	9.0
hot potato	1.0	4.0	3.0	6.0	4.0	5.0	9.0
disaro	1.0	4.0	2.0	5.0	3.0	2.0	9.0
94.3333-planar	1.0	4.0	2.0	7.0	3.0	2.0	6.0
TUW-Team-2	1.0	11.0	3.0	10.0	5.0	4.0	6.0
Platypus	1.0	9.0	2.0	7.0	3.0	2.0	14.0
Simple Straight-Line Controversy	1.0	4.0	2.0	6.0	4.0	2.0	6.0
?id you fix your Encodin??	1.0	4.0	2.0	6.0	2.0	2.0	6.0
Power Graph Girls	1.0	4.0	2.0	6.0	4.0	2.0	6.0
YouShallNotCross!	1.0	5.0	2.0	7.0	3.0	2.0	12.0

Third place: **Did you fix your Encoding?**, consisting of Soeren Terziadis and Birgit Vogtenhuber.

“Creating an entirely new embedding from scratch appeared to be hard. Instead we mostly focussed on iteratively resolving crossings on the crossing-heaviest edges. Long edges all pointing in roughly the same direction seemed suboptimal but the solution of placing them more central tended to crowd the center. So we focussed on creating sufficient space on the inside to realize small moves. Whenever a heavy edge was part of a long subdivided path of degree 2 nodes we often did not change the actual routing of the path but instead equally distributed the crossings along the path.”
Soeren Terziadis and Birgit Vogtenhuber

Second place: **The Untanglers**, Joseph Dorfer, Ly Orgo, and Benedikt Hahn.

“To untangle the instances, we started by getting a grasp on the structure of the graph. For example, one of the instances was a near-complete graph, so we tried to mimic a crossing-optimal straight-line drawing of the complete graph (i.e., tripod-like). Then, the person in charge of the mouse could focus on minor local improvements, while the other two suggested more substantial local changes, involving redrawing multiple vertices. At the same time, we tried to redraw areas that seemed too crowded. Unfortunately, just as the timer dropped to zero, we missed a further improvement by a few seconds.”
Joseph Dorfer, Ly Orgo, and Benedikt Hahn

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Winner: **Spider-Barbies**, consisting of Giordano Andreolna, Philipp Kindermann, and Allegra Strippoli.

“ Before the contest even began, the toughest challenge was finding a team name. In the end, we combined our favorite superheroes; and thus, the Spider-Barbies were born. Inspired by the beautiful waterfall of Norrköping, our team of two rookies and one man freshly out of retirement faced seven graphs, each edge demanding fewer crossings than a catwalk runway. We modeled the problem through spider webs, aiming to maximize the mosquitos caught, a well-known natural reduction. Fueled by coffee, quick sketches, and a bit of spider silk magic, we tangled our way through layouts. When the clock struck, our graphs stood polished, strutting like Barbies on stage – and so did we. ”

T. Hegemann and J. Zink

3.3 Results: Automatic Category

In the following we present the full list of scores for all teams that participated in the automatic category. The numbers listed are again the k values for the lowest k -planarity achieved by the drawings; the horizontal bars visualize the corresponding scores (lower scores lead to longer bars).

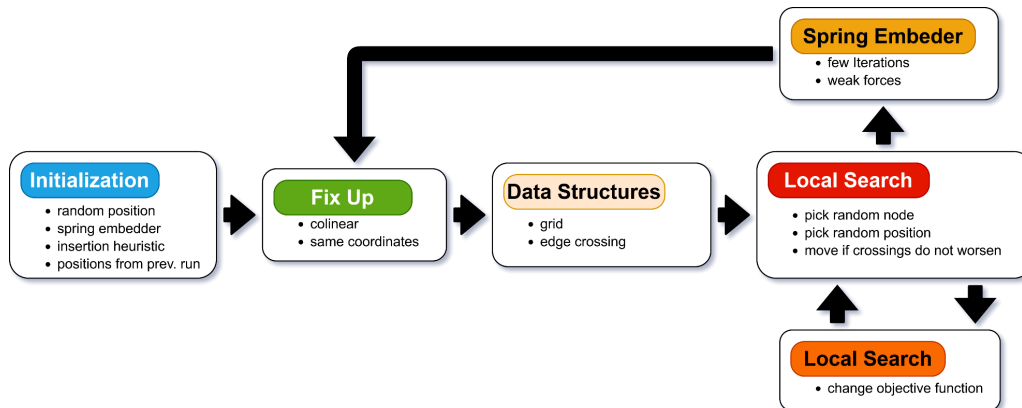
graph	1	2	3	4	5	6	7	8	9
ChadGPT	10.0	5.0	53.0	11.0	128.0	1089.0	116.0	2524.0	
HN	16.0	5.0	82.0	13.0	129.0	1186.0	118.0	23.0	
TUW-Team-3	26.0	6.0	76.0	15.0	547.0	1394.0	160.0	770.0	32.0
Christoph	9.0	3.0	40.0	7.0	81.0	560.0	32.0	-3.0	21.0
TUW-Team-2	15.0	6.0	93.0	17.0	114.0	1291.0	75.0	20.0	22.0
randomteam	9.0	3.0	43.0	8.0	85.0	1081.0	40.0	-3.0	26.0
Vienna-Team-4	27.0	5.0	80.0	28.0	146.0	1220.0	62.0	29.0	16.0
OMEGA	9.0	3.0	34.0	6.0	76.0	568.0	31.0	15.0	12.0

Third place: **randomteam**, consisting of Stefan Brandmair and Luca Marius Cobzaru.

“ For this contest, we employed a simple pipeline of initialization, followed by local optimisation. It turns out that spring embedders are king. For local optimisation, we chose the simplest possible "move node" heuristics. To make it fast, we coupled it with a few heuristics for early exiting, such as the order in which we count edges after moving. For the graph, we made sure to write our own specialized array-based type, instead of using a general Julia library. After implementing an incremental crossing computation, we also added a grid for quickly finding nearby nodes. Finally, we created an [open testing tool](#) to compare our implementations. ”

Stefan Brandmair and Luca Marius Cobzaru

Randomteam also provided a schema to explain their process:



Second place: **Christoph**, consisting of Christoph Weber.

“My most effective strategy was to first generate a solid starting point using multiple force-based algorithm runs. From there, I iteratively improved the layout with a local search approach. I found that incorporating randomization for node selection and positioning during this search generally produced the best results. The main challenge was making my program efficient enough to test a sufficient number of positions in a reasonable time. I achieved this with a grid indexing system and cross-computation strategies that abandoned unpromising moves early. My local search normally rejected any move that increased k-planarity. To escape local minima, the search would temporarily accept a controlled worsening of the solution before resuming.”

Christoph Weber

Winner: **OMEGA**, consisting of Julien Bianchetti and Laurent Moalic.

The report from team OMEGA is attached to this report as its own standalone report.

4 Conclusion

The 2025 edition of the Graph Drawing Contest was another success in both participation and result. While the attendance to the GD conference was a bit lower than in Vienna (2024), the total number of creative topic submissions and participating teams in the live challenge went up. The participation in the live challenge remained strong, even though the committee introduced a new rule that requires each team to have a representative at the conference. This is a good sign, as it shows that there are enough participants in the community, or the participants from outside the community are willing to attend to conference. As such, this new rule achieves exactly the intended outcome: it creates engagement and discourse within the Graph Drawing community and attracts outsiders to participate in our community. The opportunity to use the Decision Arena in Norrköping was also a highlight of this year's contest. Participants loved seeing the submissions in an entirely new and unusual format, and the committee is really grateful to the organizers for helping us to make this happen. The committee will look out for more such opportunities in the future.