Graph Drawing Contest Report

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Abstract. This report describes the 28th Annual Graph Drawing Contest, held in conjunction with the 29th International Symposium on Graph Drawing and Network Visualization (GD'21) in Tübingen, Germany. Due to the global COVID-19 pandemic, the conference and thus also the contest was held in a hybrid format, with both on-site and online participants. The mission of the Graph Drawing Contest is to monitor and challenge the current state of the art in graph-drawing technology.

1 Introduction

Following the tradition of the past years, the Graph Drawing Contest was divided into two parts: the *creative topics* and the *live challenge*.

Creative topics were comprised by two data sets. The first data set modeled *Movie Remakes* by different directors. The second data set shows a logical reconstruction of a scientific debate among 19th century geologists, namely the Great Devonian Controversy, as an *Argumentation Network*. The data sets were published about 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. This year's topic was to minimize edge-length ratio in a planar polyline drawing graph with vertex locations restricted to a grid and a maximum number of bends per edge allowed.

Overall, we received 26 submissions: 7 submissions for the creative topics and 19 submissions for the live challenge.

2 Creative Topics

The general goal of the creative topics was to model each data set as a graph and visualize it with complete artistic freedom, and with the aim of communicating

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as much information as possible from the provided data in the most readable and clear way.

We received 7 submissions for the first topic, and 0 for the second. Submissions were evaluated according to four criteria:

(i) Readability and clarity of the visualization,
(ii) aesthetic quality,
(iii) novelty of the visualization concept, and
(iv) design quality.

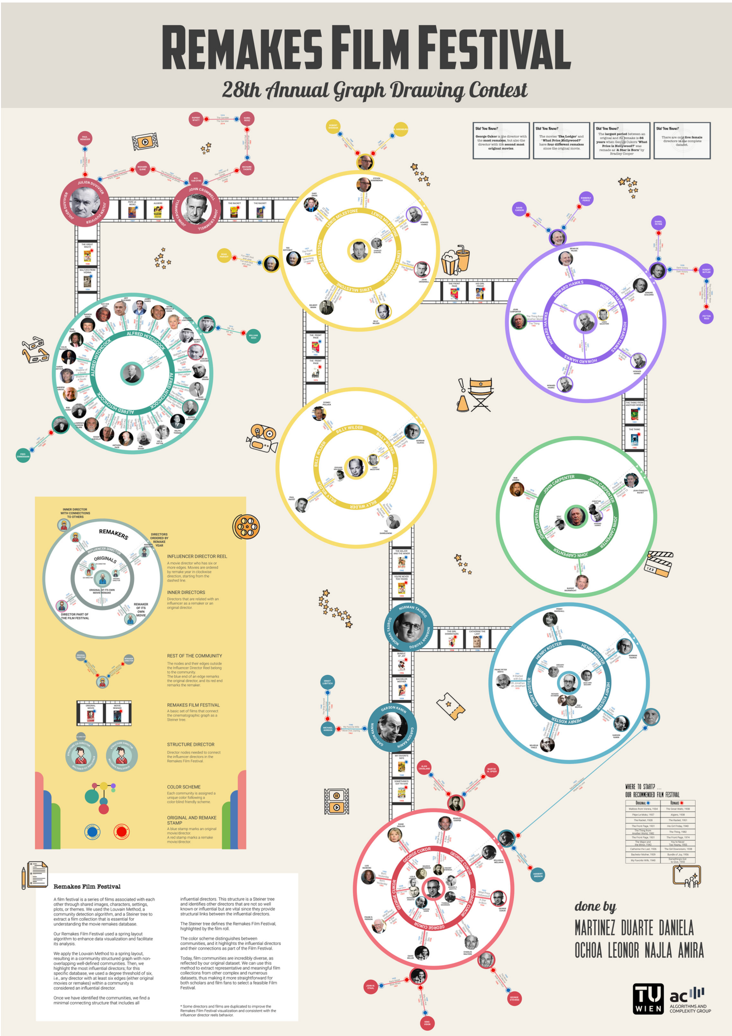
We noticed overall that it is a complex combination of several aspects that make a submission stand out. These aspects include but are not limited to the understanding of the structure of the data, investigation of the additional data sources, applying intuitive and powerful data visual metaphors, careful design choices, combining automatically created visualizations with post-processing by hand, as well as keeping the visualization, especially the text labels, readable. All submissions were printed on large poster boards and presented at the Graph Drawing Symposium. We also made all the submissions available on the contest website in the form of a virtual poster exhibition. During the conference, we presented these submissions and announced the winners. For a complete list of submissions, refer to http://www.graphdrawing.org/gdcontest/contest2021/results.html.

2.1 Movie Remakes

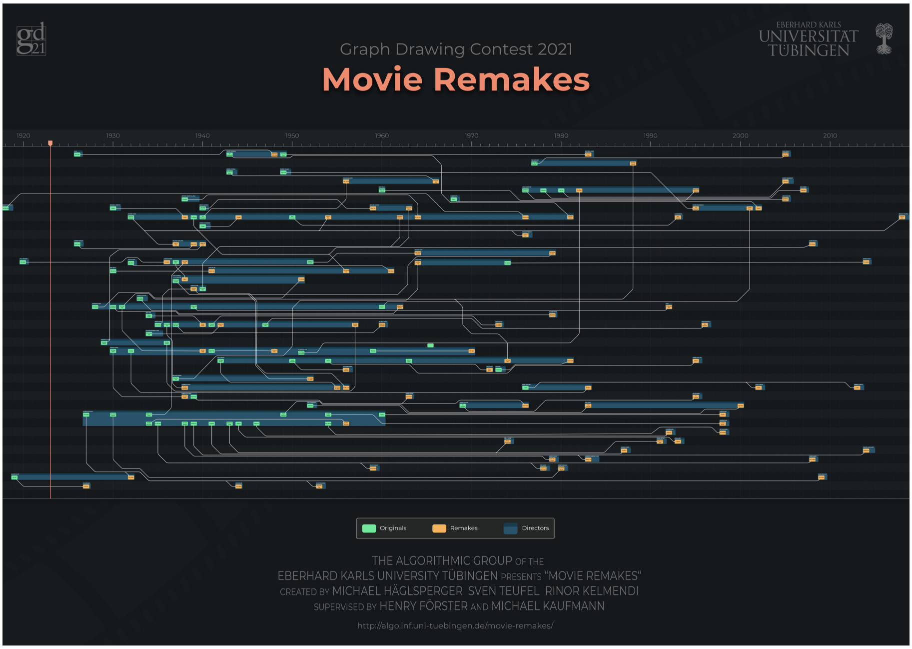
A movie remake is a production of a film that is based upon an earlier production. A remake tells the same story as the original but uses a different cast and may alter the theme or target audience. See Tang et al. [1] for related work on this topic.

For this topic, the task was to visualize a graph of movie remakes by different directors. The data contains a list of directors, and pairs of movies: the original and the remake (both with title, year, and directors). The data has been crawled from Wikipedia and consists of 91 directors and 102 pairs of movies. The participants were free to decide which parts of the data to visualize and how to visualize it.

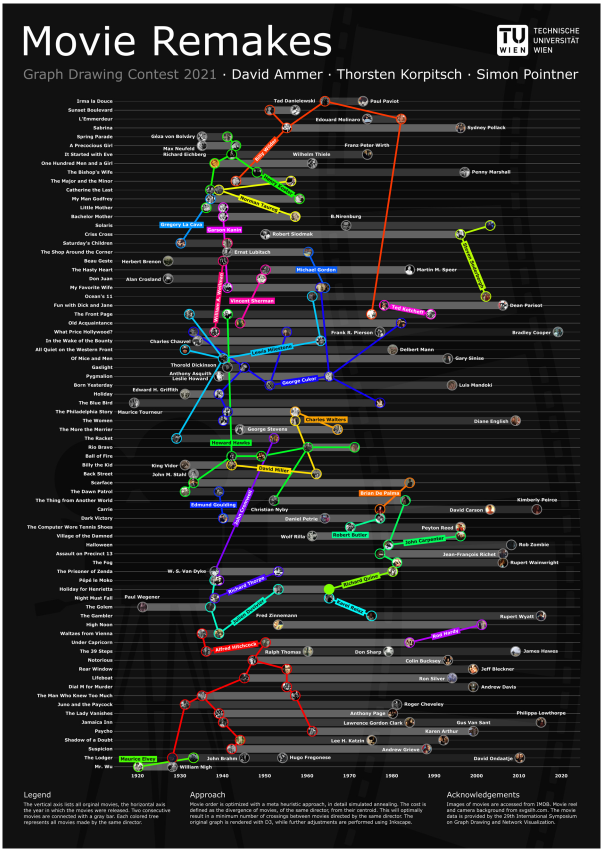
Shared 2nd Place: Najla Amira Ochoa Leonor and Daniela Martinez Duarte (TU Wien). The authors used Louvain's method for community detection. Within each community, they identified film directors related to six or more directors as the most influential movie directors. Using these directors as the backbone for the visualization, they extracted a Steiner tree from the cinematographic graph. Then they used a spring layout for the visualization, where each influential director is shown in a radial drawing resembling a film reel. The authors also added context information for the data set, addressing common questions a reader could ask of the data set, such as the largest time span between a movie and its remake or the proportion of female directors. This was probably the prettiest submission and the committee appreciated the aesthetics and the design quality of the visualization.



Shared 2nd Place: Michael Häglsperger, Sven Teufel, Rinor Kelmendi, and Henry Förster (Universität Tübingen). The authors arranged the original movies together with their remakes on a timeline where movies of the same director are grouped together. The dependency of movies is illustrated by edges pointing from the original to their remakes. The visualization mimics a video editor program, for this the movies of one director are arranged on the same height, so the grouped nodes look similar to tracks in an editing software. The authors also created an interactive version of the graph where it is possible to highlight dependencies by clicking on a movie, remake, director, or year. The interactive graph can be accessed at https://algo.inf.uni-tuebingen.de/movie-remakes. The committee liked the approach and the design quality of the submission, which made it easy to explore the data and explore interesting structures.



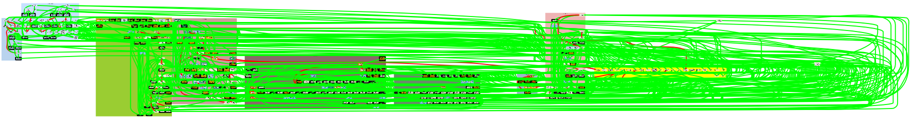
Winner: Simon Pointner, David Ammer and Thorsten Korpitsch (TU Wien). The authors show the movies along the vertical axis and their release dates on the horizontal axis. Colored trees connect movies made by the same director. To avoid overlaps of the trees, the authors computed an order of the movies by optimizing the distance from the centroid of each node in a tree. The committee was impressed by the aesthetics and the clarity of the visualization. We especially liked the idea to connect movies by the same director by a tree, which turns out to reveal a lot of information and structure in the data that otherwise cannot be seen.



> “Our main focus point was putting the movies as the central piece of information and therefore putting them on the horizontal axis while connecting the movies created by the same director mostly on the vertical axis. To minimize the number of crossings and the area for each director tree we optimized the order using a metaheuristic approach, in detail simulated annealing. The cost is defined as the divergence of movies, of the same director, from their centroid.”
> *Simon Pointner*

2.2 Argumentation Network

The network shows a logical reconstruction of a scientific debate among 19th century geologists, namely the Great Devonian Controversy. The network contains 335 vertices which are of two types: statements and arguments. Each argument has one or more sentences as premises and one sentence as a conclusion. Vertices are grouped into 12 thematic clusters. The 1016 edges connect statements to statements and statements to arguments. Each edge has an associated type that describes the logical relation between vertices: `contrary`, `contradictory`, or `entails`.



Unfortunately, we have received no submission for this topic. During the conference, we conducted a brief survey to find the reasons why nobody submitted a drawing for this graph. The main reason seemed to be that the topic of the argumentation, the Great Devonian Controversy, is largely unknown and that it is difficult to find additional information on it. Most submissions have been done by students (supervised by more experienced researchers), when given the choice they all found the Movie Remakes graph to be more interesting and chose to work on that one instead. Overall, it was not the graph itself, but the topic that was not appealing enough for the participants. Based on the results of the survey, we decided not to pose the same graph again and will instead hand out two new topics for the Graph Drawing Contest 2022.

3 Live Challenge

The live challenge took place during the conference and lasted exactly one hour. During this hour, local 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). Because of the global COVID-19 pandemic, we allowed everybody in both categories to participate remotely. To coordinate the contest, give a brief introduction, answering questions, and giving participants the possibility to form teams, we were kindly provided with both a room in the conference building, and a dedicated room in the gather.town of the conference.

The challenge focused on minimizing the planar polyline edge-length ratio on a fixed grid. The *planar edge-length ratio* of a straight-line drawing is defined as the ratio between the length of longest edge and the length of the shortest edge. There has been recent attention to this topic with several publications. The *planar polyline edge-length ratio* is a generalization of the planar edge-length ratio where edges do not have to be straight-line segments, but can be polylines with a maximum number of bends per edge defined by the input.

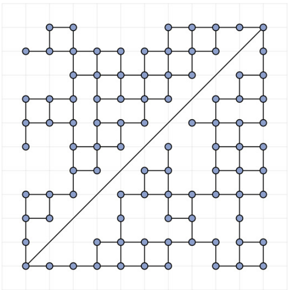
The input graphs were planar undirected graphs. For the manual category, each graph came already with a planar drawing.

The results were judged solely with respect to the edge-length ratio; other aesthetic criteria were not taken into account. This allows an objective way to evaluate each drawing.

3.1 The Graphs

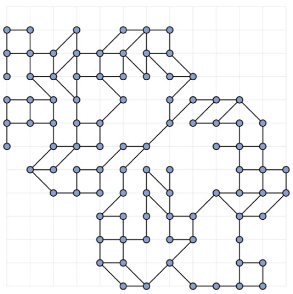
In the manual category, participants were presented with six graphs. These were arranged from small to large and chosen to contain different types of graph structures. In the automatic category, participants had to draw the same six graphs as in the manual category, and in addition another seven larger graphs. Again, the graphs were constructed to have different structure.

For illustration, we include the fourth graph, which was given with a drawing where every edge has length 1, except one long diagonal edge with length $10\sqrt{2} \approx 14.14$, in its initial state with vertices moved around randomly, the best manual solution we received (by team *New keyboard, who dis?*), and the best automatic solution we received (by team *TheWorstLayoutProducers*).

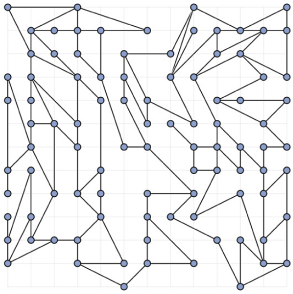


Provided drawing

edge-length ratio 14.14



Best manual solution
New keyboard, who dis?
edge-length ratio 1.41



Best automatic solution
TheWorstLayoutProducers
edge-length ratio 3.16

For the complete set of graphs and submissions, refer to the contest website at http://www.graphdrawing.org/gdcontest/contest2021/results.html. The graphs are still available for exploration and solving Graph Drawing Contest Submission System: https://graphdrawingcontest.appspot.com.

Similarly to the past years, the committee observed that manual (human) drawings of graphs often display a deeper understanding of the underlying graph structure than automatic and therefore gain in readability. The committee was also impressed by the fact that for all of the six small graphs the manual drawings were better than the automatic drawings. For the larger graphs, it turned out that the allowed grid sizes of the input were too restrictive and it was hard to get any planar drawing at all. Only for two of the seven large graphs, a feasible solution has been submitted.

3.2 Results: Manual Category

Below we present the full list of scores for all teams. The numbers listed are the edge-length ratios of the drawings; the horizontal bars visualize the corresponding scores.

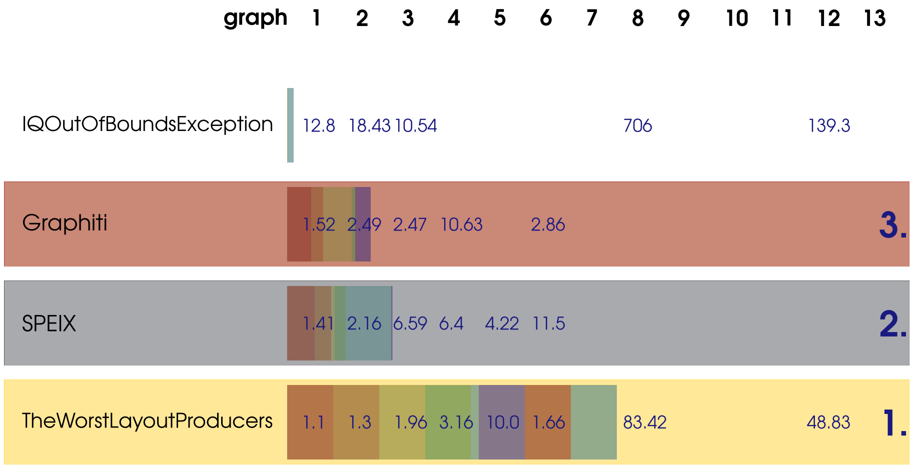
graph	1	2	3	4	5	6	
Mina et al.	1.11	2.23	5.06	2.82	6.72	6.0	
Zinklos	1.0	1.67	1.27	1.41	1.86	1.0	1.
funnygame	1.22	2.3	2.77	2.23	4.25	2.51	
Team Golden Ratio	1.19	1.58	3.28	2.23	5.71	3.55	
WinterIsComing	1.16	1.21	1.38	2.23	3.75	4.5	
Bako	1.09	1.25	2.76	2.23	5.06	2.63	
Team perpendicular table	1.14	1.21	1.32	1.41	2.06	3.6	2.
Quickdraw	1.17	1.3	1.82	2.0	3.39	2.0	
ℚ	1.0	2.64	1.18	2.23	2.54	2.4	
unbowed, unbent, uncrossed	1.0	1.37	1.71	2.82	6.0	2.0	
New keyboard, who dis?	1.11	1.17	1.75	1.41	2.68	1.94	3.
Cobbie	1.37	2.28	2.84	2.82	3.41	6.65	
PG-team	1.2	1.49	2.78	2.82	6.4	5.0	
Mihir Neve	1.13	1.19					
Fabri	1.41	2.23	6.47	2.23	7.07	4.24	

Third place: **New keyboard, who dis?**, consisting of Soeren Nickel, Anaïs Villedieu, and Jules Wulms.
Second place: **Team perpendicular table**, consisting of Fouli Argyriou, Henry Förster, and Martin Gronemann
Winner: **Zinklos**, consisting of Jonathan Klawitter and Felix Klesen.

> “After the shocking event that gave our team its name, namely, a person with the name Zink leaving our team just minutes before the event started, we picked ourselves up again and got the adrenalin flowing. We then attacked each instance with the following steps. First, we checked if there is some structure in the graph that we can use such as a grid structure or other regularities. Second, since a good planar embedding is important for a good score, it was often worthwhile to search for a suitable one. In particular for the last instance, we made a timewise heavy investment to change the whole embedding such that a perfect edge length ratio could be achieved. Third, when the longest edges could not be shorted anymore, we iteratively extended the shortest edge by adding bends and drawing them zigzagily.”
> *Jonathan Klawitter*

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 the edge-length ratios of the drawings; the horizontal bars visualize the corresponding scores.



Third place: **Graphiti**, consisting of Lukas Schmitt and David Rumpf.
Second place: **SPEIX**, consisting of Haolin Pan, Yiming Qin, and Kunhao Zheng.
Winner: **TheWorstLayoutProducers**, consisting of Moritz Greiner, Axel Kuckuk, Michael Bekos, and Maximilian Pfister.

> “While working on this task, we quickly realized that the drawings that optimize the given quality metric are far from nice. Hence, our team WorstLayoutProducers focused on producing the worst such layouts, which was enough to give us the first place. To be more precise, as a first step we compute a valid drawing of the (abstract) graph, and afterwards we used an iterative scheme that tries to improve the current solution by slightly modifying the current drawing without changing its embedding, as this turned out to be more efficient for larger graphs.”
> *Maximilian Pfister*

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Reference

1. Tang, Y., Yu, J., Li, C., Fan, J.: Visual analysis of multimodal movie network data based on the double-layered view. Int. J. Distributed Sens. Netw. 11, 906316:1–906316:16 (2015)