



# Graph Drawing Contest Report

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**Abstract.** This report describes the 25th Annual Graph Drawing Contest, held in conjunction with the 26th International Symposium on Graph Drawing and Network Visualization (GD'18) in Barcelona, Spain. The mission of the Graph Drawing Contest is to monitor and challenge the current state of the art in graph-drawing technology.

## 1 Introduction

This year, the Graph Drawing Contest was divided into two parts: the *creative topics* and the *live challenge*.

The creative topics had two graphs: the first one was a graph about characters in the Game of Thrones television series, and the second one described adviser-advisee relationships between mathematicians. The data sets were published a year in advance, and contestants submitted their drawings before the conference started. Submissions were evaluated according to aesthetic appeal, domain-specific requirements, and how well the data was visually represented.

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 maximize the smallest crossing angle in a straight-line drawing of a graph with vertex locations restricted to a grid.

Overall, we received 44 submissions: 31 submissions for the creative topics and 13 submissions for the live challenge.

## 2 Creative Topics

The two creative topics for this year were a graph about Game of Thrones and a mathematics genealogy graph. The goal was to visualize each graph with

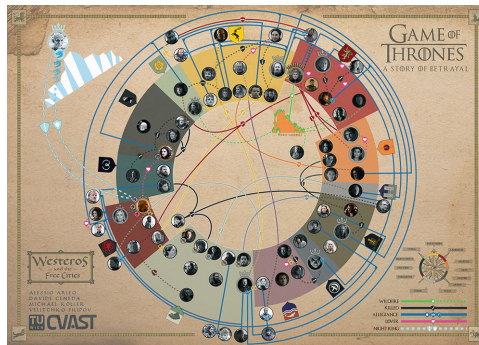
complete artistic freedom, and with the aim of communicating the data in the graph as well as possible.

We received 23 submissions for the first topic, and 8 for the second. For each topic, we selected between 3 and 5 contenders for the prizes, which were printed on large poster boards and presented at the Graph Drawing Symposium. Out of those contenders, we selected the winning submissions. We will now review the top three submissions for each topic (for a complete list of submissions, refer to <http://www.graphdrawing.de/contest2018/results.html>).

## 2.1 Game of Thrones

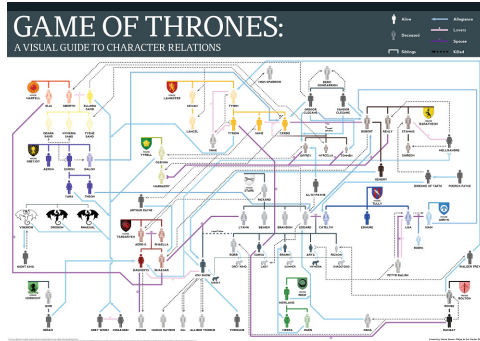
The TV show “Game of Thrones” is based on the book series “A Song of Ice and Fire” by George R. R. Martin and is one of the most popular TV shows in the previous years. For the contest, we extracted the relations between some of the most important characters in the show as of the end of Season 7 from the Game of Thrones Wiki<sup>1</sup>. The graph consists of 84 characters and 216 relations.

**Third Place: Velitchko Filipov, Davide Ceneda, Michael Koller, Alessio Arleo, and Silvia Miksch (TU Vienna).** The committee likes the overall aesthetics of the drawing, and the clever combination of using both the interior and exterior space for routing edges in this radial layout.

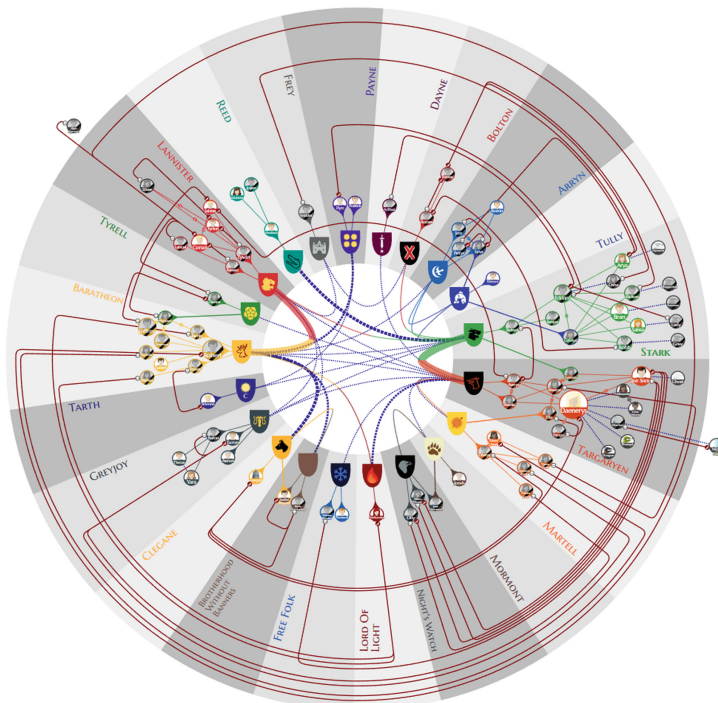


**Second Place: Marian Amann, Philipp de Col, and Markus Wallinger (TU Vienna).** The committee likes the clarity of this layout, with a good global overview of the graph structure, as well as showing lower-level connections between different individual characters.

<sup>1</sup> [http://gameofthrones.wikia.com/wiki/Game\\_of\\_Thrones\\_Wiki](http://gameofthrones.wikia.com/wiki/Game_of_Thrones_Wiki).



**Winner: Evmorfia Argyriou, Michael Baur, Anne Eberle, and Armin Gufler (yWorks).** The committee likes the overall clarity of this drawing, and the use of symbols representing houses and individuals. It is a nice idea to use different drawing styles to visualize clusters of family relations, “peaceful” relations, and killings, allowing the viewer to focus on each of these as almost separate subgraphs. The visualization and an explanation of the drawing process is available online: <http://yworks.com/got>.



“ In our Game of Thrones visualization we grouped the characters according to their house and placed them on radial layers that depict generations. In each house, solid edges between characters show marriages, love interests and parenthood. Loyalty and family ties of characters of different houses are condensed into dotted and solid edges between the new house nodes in the central circle, while the blood-red edges on radial paths in the outskirts represent killings. ”

*Evmorfia Argyriou*

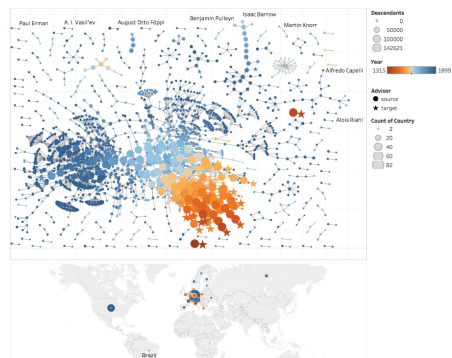
## 2.2 Mathematics Genealogy

The Mathematics Genealogy Project<sup>2</sup> is an initiative of the North Dakota State University to track all advisor-advisee relationships in the broader field of mathematics since the earliest records that are available. The database has 222,360 scientists on record as of today.

In 2016, Cosmin Ionita and Pat Quillen of MathWorks analyzed the graph. The main component had 7323 root vertices and 137,155 leaves, and contained 90% of the vertices. There were 7639 isolated vertices and 1962 components of size two. The graph has some cycles, but is generally very tree-like.

For the contest, we have selected the subgraph containing only the 2277 scientists who graduated before the year 1900, but retaining the number of descendants in the full graph. We also kept the year and country of each graduation.

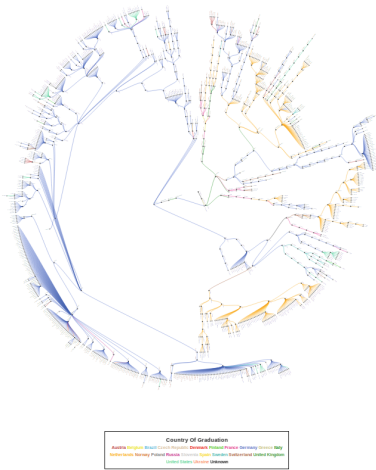
**Third Place: Yixuan Wang (University of Sydney).** The committee really likes the idea of drawing this graph with approximately geo-located nodes, which allows the user to interpret vertex locations while still allowing sufficient freedom in the vertex placement to see the actual graph structure. The use of a color gradient for the year of graduation nicely complements this choice, as well as using vertex size to visualize the number of descendants.



<sup>2</sup> <https://www.genealogy.math.ndsu.nodak.edu>.

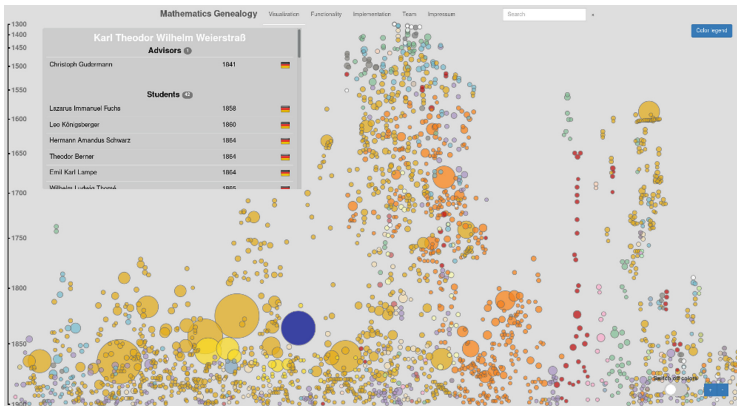
**Mathematical Genealogy**

A visualisation of advisor-advisee relations in science preceding the year 1900



**Second Place: Gesa Behrends, Maria Hartmann, Johannes Janssen, Artsem Kavaleuski, Andre Mazal Krauss, Duc Do Minh, Alexander Zachrau, Hong Zhu, and Günter Rote (FU Berlin).** The committee was impressed by the clarity of this drawing, given the large data size and the authors' decision to include all individual names on a single poster. The use of large empty regions help the viewer to see the global graph structure at a glance, while individual clusters and relationships can still be distinguished.

**Winner: Florian Grötschla, Tamar Mirbach, Christian Ortlieb, Tamara Mchedlidze, and Marcel Radermacher (KIT).** The committee was impressed by this interactive visualization. The website has some nice functionality; especially the highlighting of advisors and students and the additional information display on hovering over a node should be emphasized. This makes it a great way to explore the data. The drawing can be explored here: <https://mathematics-genealogy.de>.



“The large size of the genealogy graph, and the fact that it is denser than a tree, defeated our tries to create a readable standalone node-link diagram. Thus, we decided to avoid the display of the edges and instead design an interactive visualization tool where one can focus on smaller portions of the visualization using zooming operation, investigate the relations between mathematicians using an interactive highlight tool and still obtain a big picture of the data, which is enhanced by the coloring of the nodes according to the country of graduation. To keep the node proximity meaningful (connected nodes are close and non-connected far apart) and to express the time of graduation, we employed the Sugiyama framework for the node positions, where horizontal layers correspond to the graduation date.”

*Florian Grötschla*

### 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 solve the graphs using a supplied tool<sup>3</sup>), or in the automatic category (in which they could use their own software to solve the graphs). At the same time, remote participants could also take part in the automatic category.

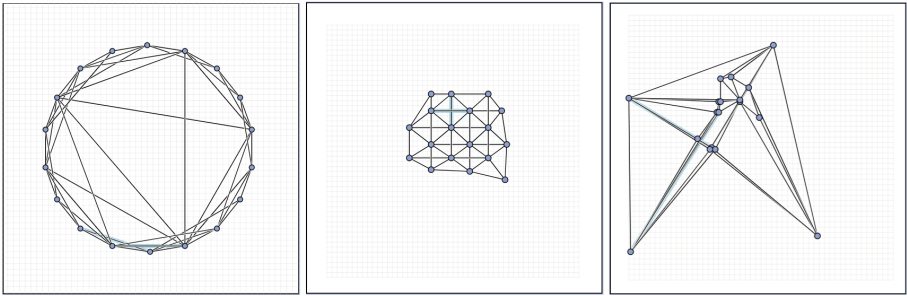
The challenge focused on maximizing the minimum crossing angle in a straight-line embedding of a given graph, with vertex locations restricted to a grid. The results were judged solely with respect to the minimum crossing angle; other aesthetic criteria were not taken into account. This allows an objective way to evaluate each drawing.

#### 3.1 The Graphs

In the manual category, participants were presented with seven graphs. These were arranged from small to large and chosen to highlight different types of graphs and graph structures. In the automatic category, participants had to solve the same seven 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 third graph in its initial state, the best manual solution we received (by team ToBeDecided), and the best automatic solution we received (by team TübingenColdShower).

<sup>3</sup> <http://graphdrawing.de/tool>.



For the complete set of graphs and submissions, refer to the contest website at <http://www.graphdrawing.de/contest2018/results.html>.

From the resulting drawings, the committee reinforces its conclusion from the previous year; namely that, if the minimum crossing angle is an indicator of the legibility of a graph visualization, it must be so only when combined with other criteria; for instance, penalizing low distances between vertices. The committee also observed that manual (human) drawings of graphs often display a deeper understanding of the underlying graph structure than automatic drawings of the same graph, even when the automatic drawing scores equally high or higher.

### 3.2 Results: Manual Category

We are happy to present the full list of scores for all teams. The numbers listed are the smallest crossing angle in degrees in each graph; the horizontal bars visualize the corresponding scores.

graph	1	2	3	4	5	6	7
OFMO	47°	90°	74°	53°	39°	31°	23°
MaLaRa	56°	89°	71°	62°	33°	57°	22°
PUK	58°	90°	90°	50°	43°	40°	28°
To Be Decided	33°	90°	90°	40°	36°	35°	21°
Over-Aged	46°	90°	78°	48°	29°	28°	33°
NonAustrians	43°	90°	71°	57°	49°	55°	37°
Scho	59°	90°	90°	63°	39°	71°	21°
Rotes Minions	42°	89°	88°	39°	42°	45°	40°
AFT	45°	90°	90°	47°	32°	27°	23°

The runner-up teams are team PUK (3rd place), consisting of Paul Jungeblut, Jérôme Urhausen, and Peter Stumpf; and team NonAustrianAustrians (2nd

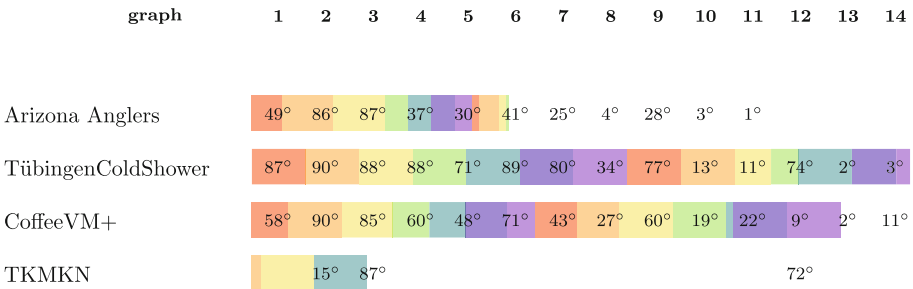
place), consisting of Fabian Klute and Irene Parada. The winning team is team Scho, consisting of Myroslav Kryven and Johannes Zink.

“Our strategy was as follows: we started by trying to reduce the number of crossings (and thinning dense areas) as best as we could. While doing so we rather ignored the current worst angle. After this first phase, we were pursuing the seemingly obvious strategy of iteratively improving the current worst crossing angle locally. In one of the given instances, we were also trying to orient all edges either horizontally or vertically such that the crossings occurred only between these types of edges. Besides competing against strong and experienced other teams, we faced another tough opponent: the time. Since we spent much of it on the first graphs, we had to give up our aforementioned strategy towards the end. On the last graph, we had only spent a few moments to improve the worst angles locally before we submitted it some seconds before the end of the time. In spite of this last bad result, it turned out that we managed to keep our lead barely. Finally, if you are wondering about our team name it is both the Ukrainian word for “what?” and the Franconian-German word for “indeed”.

*Johannes Zink*

### 3.3 Results: Automatic Category

We are happy to present the full list of scores for all teams. The numbers listed are the smallest crossing angle in degrees in each graph; the horizontal bars visualize the corresponding scores.



The runner-up teams are team Arizona Anglers (3rd place), consisting of Reyan Ahmed and Sabin Devkota; and team CoffeeVM+ (2nd place), consisting of Almut Demel, Dominik Dürschnabel, Lasse Wulf, Tamara Mchedlidze, and Marcel adermacher. The winning team is team TübingenColdShower, consisting of Amadäus Spallek, Christian Geckeler, Henry Förster, and Michalis Bekos!



“ After our last year’s failure on the exact same topic, we decided to completely change our approach to become more competitive. It turned out that our new probabilistic hill climbing approach performed way better than our previous force-directed algorithm, and thus the result for the TübingenColdShower team was not of the same kind as the water in the shower earlier the same day. ”

*Christian Geckeler*

**Acknowledgments.** The contest committee would like to thank the organizing committee of the conference for printing the posters and providing a room with hardware for the live challenge; the generous sponsors of the symposium, in particular Springer for contributing prizes; and all the contestants for their participation. Further details including all submitted drawings and challenge graphs can be found at the contest website:

<http://www.graphdrawing.de/contest2018/results.html>