

What makes a graph interesting ?

An analysis of The House of Graphs

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Outline

- 1 Introduction
- 2 Instance-space Analysis
- 3 Statistical Analysis of the Features
- 4 Conclusion

Which set of graphs are we considering?

The House of Graphs:

- ▶ www.houseofgraphs.org
- ▶ A searchable database of "interesting" graphs
- ▶ Over 600 registered users
- ▶ 28047 uploaded graphs (on 17/11/25)
- ▶ 161683 total views (on 17/11/25)
- ▶ 56 features per graph
 - 51 graph invariants



House of Graphs

Search

Draw Graph

Meta-directory

Publications

Help

Database of Interesting Graphs

Most graph theorists will agree that among the vast number of graphs that exist, there are only a few thousand that can be considered really *interesting*.

It is the aim of this House of Graphs project to find a workable definition of 'interesting' and provide a [searchable database](#) of graphs that conform to this definition. Note that the searchable database does *not* contain all graphs of a given order, but only the ones which are considered 'interesting' by at least one of the users. We also allow users to add additional graphs which they find interesting. In order to avoid abuse, only [registered](#) users can add new graphs.

Lists of Graphs and Generators

We would also like to serve as a central repository for complete lists of graphs (which can be downloaded in several formats) of various graphs classes and the generators which can be used to generate these graphs. These lists of graphs and generators can be found in the [graph meta-directory](#).



Search Graphs

Browse and filter the database of interesting graphs



Draw a Graph

Create and visualize graphs with our interactive drawing tool



Meta-directory

Access complete lists of graphs and generators by graph class

Figure: Homepage of the House of Graphs

What do we mean by interesting?

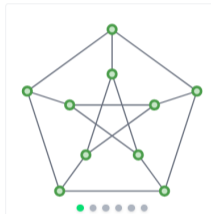
User interaction metrics:

- ▶ Has a complement graph in the database
- ▶ Has a line graph in the database
- ▶ Number of comments
- ▶ Number of drawings
- ▶ Number of views

Graph 660

Name: Petersen Graph

Submitted by GraPHedron



Edit / export drawing

Download this graph in the selected format: ?

Graph6

Download

See also: [supported formats](#)

Related graphs

- [Complement graph](#)
- [Line graph](#)

Figure: An example of a graph on House of Graphs

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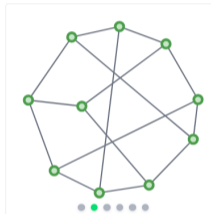
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Distribution of views

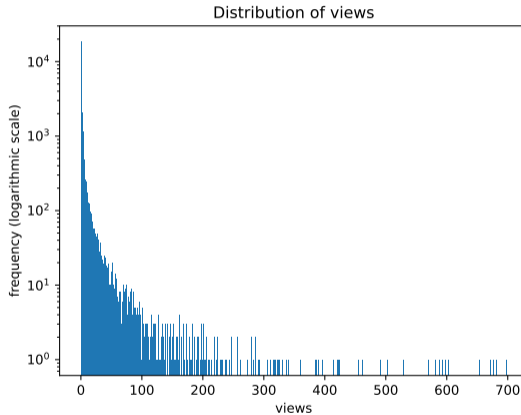
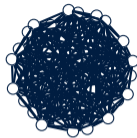
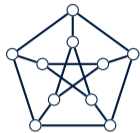
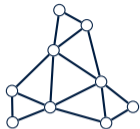


Figure: Distribution of views on the website without the top 10

Top 10 most viewed graphs



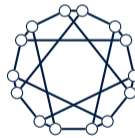
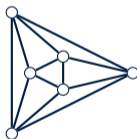
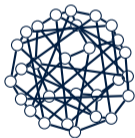
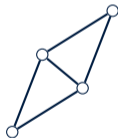
Smallest Cyclic
Group Graph

Petersen Graph

$C_5 + K_2$

Edge-Girth-
Regular Graph

Wagner graph M_8



Tri-Hex

Diamond Graph

JESK56

Octahedron

Heawood graph

$K_{2,2,2}$

JESK56

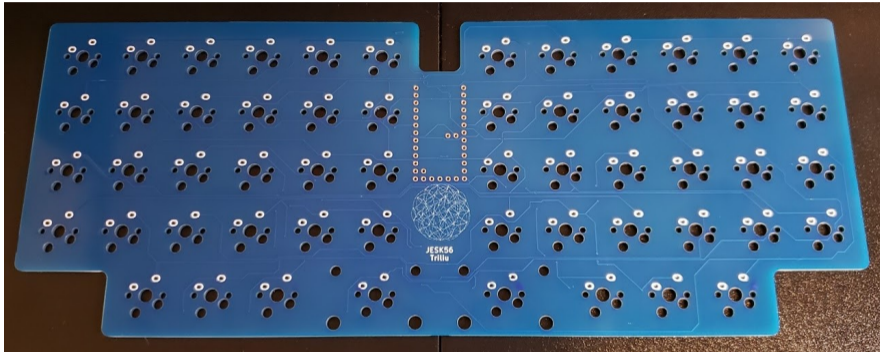


Figure: The diodeless keyboard based on JESK56

Correlation of metrics

How is views correlated to the other metrics:

Correlation of metrics

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	comp.	line	comm.	draw.	views
comp.		0.39	0.31	0.10	0.27
line	0.39		0.29	0.06	0.24
comm.	0.31	0.29		0.28	0.47
draw.	0.10	0.06	0.28		0.16
views	0.27	0.24	0.47	0.16	

Table: Spearman rank correlation of the user metric

Are there more interesting graphs?

Instance-space analysis

- ▶ Developed for analysing problem instances for algorithms
- ▶ Comparing performance of algorithms on different problem instances
- ▶ Identifying hard instances of problems

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In our case:

- ▶ Graphs: instances of interesting objects
- ▶ Views: performance metric

Analysing the instance-space

Using the MATILDA framework

- ▶ Developed by Smith-Miles and Muñoz [1] in 2020
- ▶ <https://matilda.unimelb.edu.au/>
- ▶ 2D projection of instances

Feature selection

- ▶ SIFTED: Selection of Instance Features to Explain Difficulty.
- ▶ PILOT: Projecting Instances with Linearly Observable Trends.

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Figure: The homepage of the MATILDA website

Projection of the graph instance-space

$$\begin{bmatrix} z_1 \\ z_2 \end{bmatrix} = \begin{bmatrix} 0.9577 & 0.5302 \\ -1.1434 & 1.138 \\ 0.4999 & 0.6035 \\ 0.6343 & 0.5792 \\ 0.7192 & -1.0993 \\ 0.0843 & -0.5482 \\ 0.4771 & 0.7123 \end{bmatrix}^T \begin{bmatrix} \text{Independence Number} \\ \text{Laplacian Largest Eigenvalue} \\ \text{Number of Edges} \\ \text{Number of Spanning Trees} \\ \text{Smallest Eigenvalue} \\ \textit{Has complement id} \\ \textit{Number of timed out invariants} \end{bmatrix}$$

Projected space

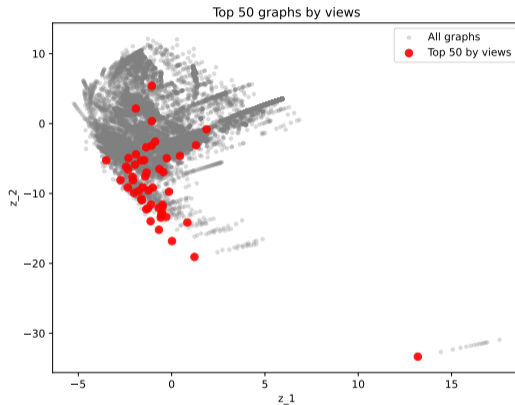


Figure: Top 50 graphs by views as projected by MATILDA

Projected space

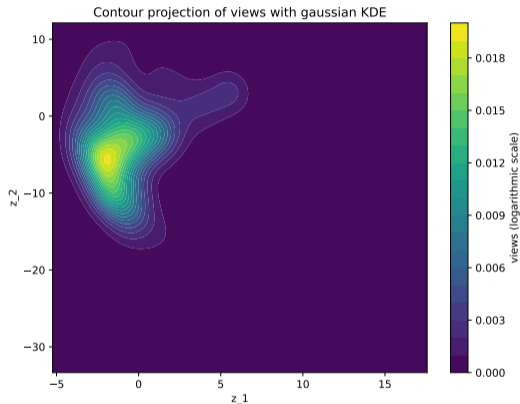


Figure: Contour projection of views (logarithmic scale)

Interpretation of projected space

Spatial clustering → features related to being "interesting"

To confirm the results observed in the projections:

- ▶ Perform correlation test on features
- ▶ Compare feature correlation to automated feature selection
- ▶ Analyse selected features

Performing correlation tests

feature	correlation
Smallest Eigenvalue	0.41
Number of Spanning Trees	-0.39
Number of Edges	-0.38
Second Largest Eigenvalue	-0.34
<i>Number of timed out invariants</i>	-0.32
Independence Number	-0.32
Number of Vertices	-0.31
Feedback Vertex Set Number	-0.31
Treewidth	-0.31
Length of Longest Path	-0.31
Clique Number	0.30

Table: Correlation of features with views, where $\text{abs}(\text{spearman rank coefficient}) \geq 0.3$:

Interdependent features

An important point to be made here is that some features in that set are heavily dependent on each other:

- ▶ Graphs with lower number of vertices will often have a lower number of edges, Treewidth, Longest Path and Clique Number

feature	correlation
Smallest Eigenvalue	0.41
Number of Spanning Trees	-0.39
Second Largest Eigenvalue	-0.34
Number of timed out invariants	-0.32
Number of Vertices	-0.31

Table: Correlation of features with views

Smallest eigenvalue

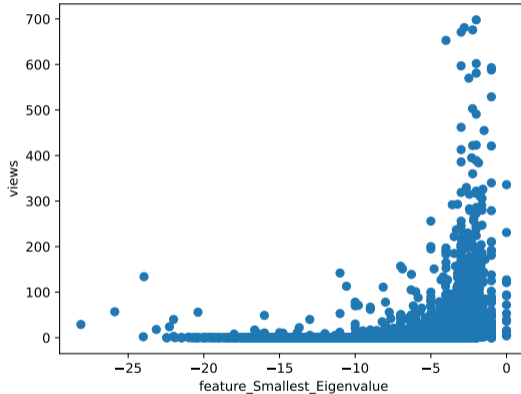


Figure: The number of views in function of the smallest eigenvalue

Number of spanning trees

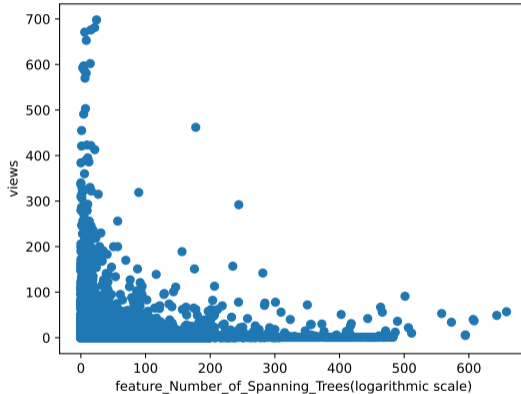


Figure: The number of views in function of the number of spanning trees

Second largest eigenvalue

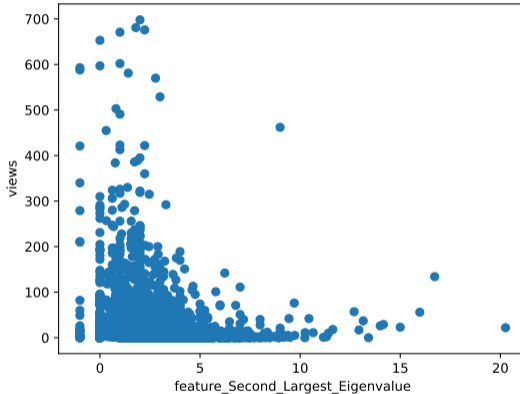
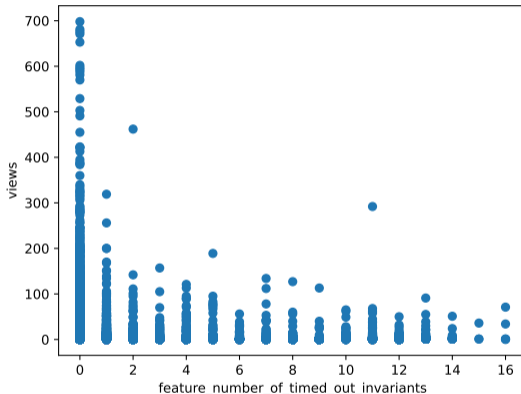


Figure: The number of views in function of the second largest eigenvalue

Number of timed-out invariants



Number of vertices

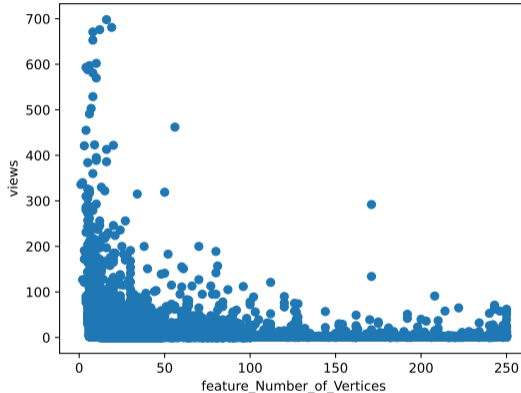


Figure: The number of views in function of the number of vertices

Conclusion

We observed that The House of Graphs database contains a large set of "interesting" graphs.

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When asking what makes a graph "interesting", we observed that it is important to look for the following characteristics:

- ▶ Eigenvalues: small spectral footprint
- ▶ Smaller number of spanning trees
- ▶ Smaller number of edges and vertices
- ▶ Smaller number of timed-out invariants

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We observed that The House of Graphs database contains a large set of "interesting" graphs.

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Perhaps this last feature could also indicate that there is no immediate need for more compute power.

Thank you! Questions?

References



SMITH-MILES, K., AND MUÑOZ, M. A.

Instance space analysis for algorithm & testing: Methodology and software tools.

ACM Comput. Surv. 55, 12 (Mar. 2023).