Multilayer Network Science in Julia
with MultilayerGraphs.jl

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Abstract. MultilayerGraphs.jl is a Julia package for the creation, manipulation and analysis of the structure, dynamics and functions of multilayer graphs.

A multilayer graph consists of multiple subgraphs called layers which can be interconnected through bipartite graphs called interlayers composed of the sets of vertices of two different layers and the edges between them.

In order to formally represent multilayer networks, multiple theoretical paradigms have been proposed and adopted to model a wide spectrum of high-dimensional, multi-scale, time-dependent complex systems including molecular, neuronal, social, ecological and economic networks.

The package features an implementation that maps a standard integer-labelled vertex representation to a more user-friendly framework exporting all the objects a practitioner would expect such as nodes, vertices, layers, interlayers, etc.

MultilayerGraphs.jl has been integrated within the JuliaGraphs[3] and the JuliaDynamics[4] ecosystems through:
  - the extension of Graphs.jl[5] with several methods and metrics including the multilayer eigenvector centrality, the multilayer modularity and the Von Newman entropy;
  - the compatibility with Agents.jl[6] allowing for agent-based modelling on general multilayer networks.

For a comprehensive exploration of the package features and functionalities the reader is invited to consult the README[7] and documentation[8].

Keywords: Discrete Mathematics · Graph Theory · Network Science · Multilayer Graphs · Multilayer Networks · Complex Systems · Computer Science · Julia Language.

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[3] https://github.com/JuliaGraphs.
[4] https://github.com/JuliaDynamics.
[5] https://github.com/JuliaGraphs/Graphs.jl.
[6] https://github.com/JuliaDynamics/Agents.jl.
[7] https://github.com/JuliaGraphs/MultilayerGraphs.jl/blob/main/README.md.
[8] https://juliagraphs.org/MultilayerGraphs.jl.

1   First Section

1.1   A Subsection Sample

Please note that the first paragraph of a section or subsection is not indented. The first paragraph that follows a table, figure, equation etc. does not need an indent, either.

Subsequent paragraphs, however, are indented.

Sample Heading (Third Level) Only two levels of headings should be numbered. Lower level headings remain unnumbered; they are formatted as run-in headings.

Sample Heading (Fourth Level) The contribution should contain no more than four levels of headings. Table 1 gives a summary of all heading levels.

Table 1. Table captions should be placed above the tables.

Heading level	Example	Font size and style
Title (centered)	**Lecture Notes**	14 point, bold
1st-level heading	**1 Introduction**	12 point, bold
2nd-level heading	**2.1 Printing Area**	10 point, bold
3rd-level heading	**Run-in Heading in Bold.** Text follows	10 point, bold
4th-level heading	*Lowest Level Heading.* Text follows	10 point, italic

Displayed equations are centered and set on a separate line.

$$x + y = z \tag{1}$$

Please try to avoid rasterized images for line-art diagrams and schemas. Whenever possible, use vector graphics instead (see Fig. 1).

Theorem 1. *This is a sample theorem. The run-in heading is set in bold, while the following text appears in italics. Definitions, lemmas, propositions, and corollaries are styled the same way.*
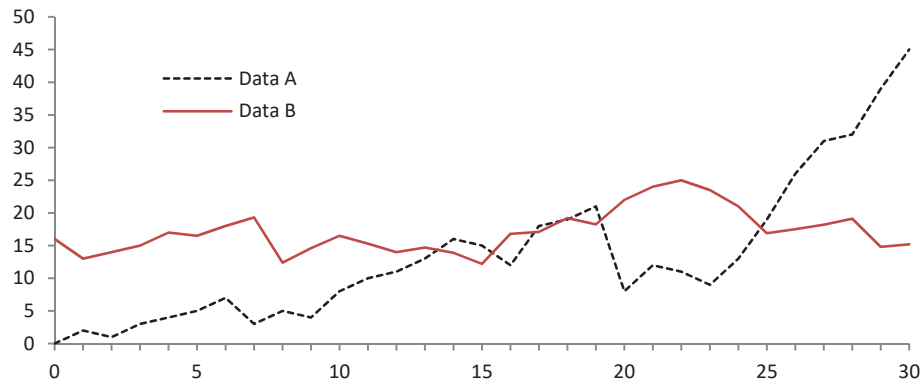
Proof. Proofs, examples, and remarks have the initial word in italics, while the following text appears in normal font.

For citations of references, we prefer the use of square brackets and consecutive numbers. Citations using labels or the author/year convention are also acceptable.

[2, 3, 1]

Fig. 1. A figure caption is always placed below the illustration. Please note that short captions are centered, while long ones are justified by the macro package automatically.

References

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3. Kivela, M., Arenas, A., Barthelemy, M., Gleeson, J.P., Moreno, Y., Porter, M.A.: Multilayer networks. Journal of Complex Networks **2**(3), 203–271 (Jul 2014), https://doi.org/10.1093/comnet/cnu016