Package in development: Graphs

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What is Graphs?

Graphs is a GAP package in development by J, J. D. Mitchell, M. Torpey and W. Wilson.

The package is aiming to provide the functionality of dealing with directed graphs with possibly multiple edges (multigraphs).

How did we start?

- Semigroups package;
- Michael Torpey;
- Wilf Wilson.

Design goals

Our main goal was to create a package for dealing with directed multigraphs which is

- time efficient;
- contains GAP kernel code;
- has a clear separation between data structures and algorithms.

What can we do with Graphs?

- ▶ create and manipulate directed multigraphs in all/most of the way one might reasonably want to do;
- ▶ find weakly/strongly connected components;
- ▶ **Floyd - Warshall** algorithm and transitive closure of a graph;
- ▶ use **bliss** to compute automorphism groups of graphs;
- ▶ etc.

Storing graphs

We wanted to have a way of storing directed multigraphs in a compressed way, in a similar fashion as **graph6** and **sparse6** do in **numpy**.

We implemented two generalizations:

- ▶ digraph6 - suitable for edge-dense directed graphs without multiple edges;
- ▶ disparse6 - suitable for edge-sparse directed multigraphs.

Endomorphisms of graphs

Coming from semigroups background, we wanted to be able to use this Graphs to produce interesting examples of semigroups.

We have an algorithm (based on previous work by M. Neunhoeffer and A. Schaefer) for computing endomorphism monoids of graphs.

The algorithm makes use of the knowledge of the automorphism group the graph to reduce the search tree. As well as some heuristics, which helped us in some examples to decrease runtime from days to hundreds of milliseconds.

What's next?

Plans for the future:

- more functionality, such as maximal cliques, maximal matchings, etc.
- release!

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Thank you.