Posets and words in Sage-Combinat

Franco V. Saliola
⟨saliola@gmail.com⟩

Institut Gaspard Monge
Université de Marne-la-Vallée
France

Sage Days 10
11 October 2008

Combinatorics on Words

A *word* is a sequence of elements — called *letters* — from a set A.

Combinatorics on Words

A *word* is a sequence of elements — called *letters* — from a set A.

Thus, words arise in several areas of mathematics and the sciences:

- *word problem* in semigroup and group theory;
- *permutations as words* in combinatorics;
- *automatic sequences* in number theory;
- *DNA* in biology;
- *words* in linguistics;
- *etc.*

Combinatorics on Words

Goal: develop tools for studying words.

Combinatorics on Words

Goal: develop tools for studying words.

Examples: want efficient algorithms and data structures for

- searching text;
- pattern recognition;
- inferring combinatorial, probabilistic and statistical properties;
- counting distinct factors;
- storing and retrieving factors;
- factorizations (Lyndon, Crochemore, . . .);
- . . . .

History

History

- François Bergeron is invited to Sage Days 7, but couldn't go.

History

- François Bergeron is invited to Sage Days 7, but couldn't go.
- Me: "Me! Me! I want to go! Tell them to invite me! Pay for my trip! I promise to give a talk about Sage when I get back!"

History

- François Bergeron is invited to Sage Days 7, but couldn't go.
- Me: "Me! Me! I want to go! Tell them to invite me! Pay for my trip! I promise to give a talk about Sage when I get back!"
- I go to Sage Days 7, and get really excited about what I see.

History

- François Bergeron is invited to Sage Days 7, but couldn't go.
- Me: "Me! Me! I want to go! Tell them to invite me! Pay for my trip! I promise to give a talk about Sage when I get back!"
- I go to Sage Days 7, and get really excited about what I see.
- I give a very enthusiastic talk about it when I get back.

History

- François Bergeron is invited to Sage Days 7, but couldn't go.
- Me: "Me! Me! I want to go! Tell them to invite me! Pay for my trip! I promise to give a talk about Sage when I get back!"
- I go to Sage Days 7, and get really excited about what I see.
- I give a very enthusiastic talk about it when I get back.
- Others get excited too!

History

- Srečko Brlek wants to base a Combinatorics on Words package on Sage.

History

- Srečko Brlek wants to base a Combinatorics on Words package on Sage.
- Reasons: algorithms are useful; much software exists, but it is fragmented, not unified, unmaintained; no nice interface.

History

- Srečko Brlek wants to base a Combinatorics on Words package on Sage.
- Reasons: algorithms are useful; much software exists, but it is fragmented, not unified, unmaintained; no nice interface.
- He puts his (grant) money where his mouth is: hires people to work on it over the summer.

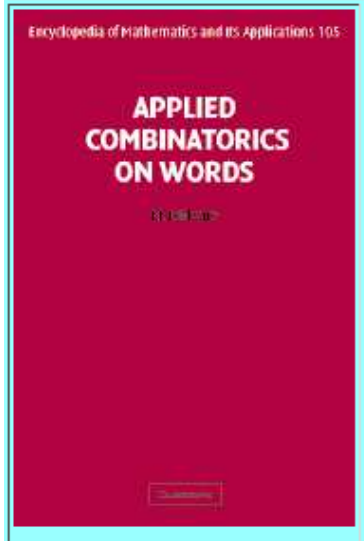
History

- Srečko Brlek wants to base a Combinatorics on Words package on Sage.
- Reasons: algorithms are useful; much software exists, but it is fragmented, not unified, unmaintained; no nice interface.
- He puts his (grant) money where his mouth is: hires people to work on it over the summer.
- May 2008: sage-words is born. Developers: Arnauld Bergeron, Sébastien Labbé, Amy Glen and me.

History

- Srečko Brlek wants to base a Combinatorics on Words package on Sage.
- Reasons: algorithms are useful; much software exists, but it is fragmented, not unified, unmaintained; no nice interface.
- He puts his (grant) money where his mouth is: hires people to work on it over the summer.
- May 2008: sage-words is born. Developers: Arnauld Bergeron, Sébastien Labbé, Amy Glen and me.
- Sept. 2008: People at MLV also want to get in on the action; we'll be discussing more about what should be included soon.

Pre-existing software?

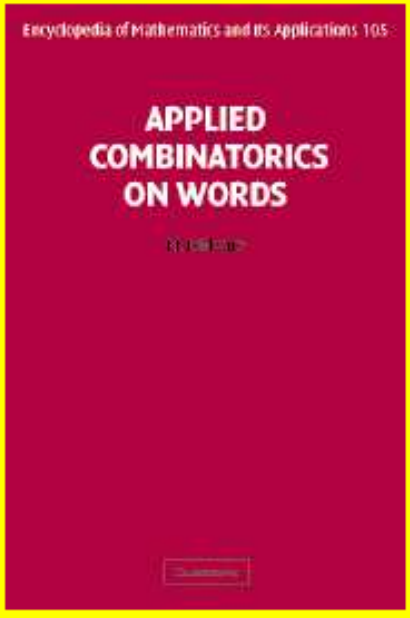


Applied Combinatorics on Words : Contents

Full text (compressed PostScript :2.5 MB)	Last Modification : June 23, 2004
Presentation	
Contents and presentation	
Core algorithms	
Algorithms on words	Jean Berstel and Dominique Perrin
Structures for indexes	Maxime Crochemore
Natural language processing	
Symbolic natural language processing	Eric Laporte
Statistical natural language processing	Mehryar Mohri
Bioinformatics	
Network expression inference	Marie-France Sagot and Nadia Pisanti
Statistics on words with applications to biological sequences	Gesine Reinert, Sophie Schbath and Michael S. Waterman
Algorithms	
Analytic approach to pattern matching	Philippe Jacquet and Wojciech Szpankowski
Periodic structures in words	Roman Kolpakov and Gregory Kucherov
Mathematics	
Counting, coding and sampling with words	Dominique Poulalhon and Gilles Schaeffer
Words in number theory	Jean-Paul Allouche and Valérie Berthé
References	
Bibliography and index	

Pre-existing software?

Applied Combinatorics on Words: Implementation of algorithms



Algorithms on words

A set of computer programs in Java for the algorithms of Chapter 1 is available in a preliminary form. They can be freely copied and used with the mention of their origin. The idea is to present an illustration of a possible effective implementation rather than fine tuned optimal software. No guarantee at all is given for correctness. A documentation is in progress.

Structures for indexes

Computer programs in Java and C for the algorithms of Chapter 2 and for other text processing algorithms are available.

Statistical natural language processing

Programs for the algorithms of this chapter are available at:

http://www.research.att.com/sw/tools/fsm
http://www.research.att.com/sw/tools/grm
http://www.research.att.com/sw/tools/dcd

Statistics on words with applications to biological sequences

Computations of words with exceptional frequency in DNA were performed with programs available at: http://www-mig.jouy.inra.fr/ssb/rmes/

Periodic structures in words

Concerning this chapter, principal algorithms have been implemented in the mreps software http://www.loria.fr/mreps/.

What does sage-words do?

Demo

What's next for sage-words?

What's next for sage-words?

- Current version: 0.3. Before 1.0 design may change drastically.

What's next for sage-words?

- Current version: 0.3. Before 1.0 design may change drastically.
- Want to merge into sage-combinat; I want to use CombinatorialClass, Streams, etc.

What's next for sage-words?

- Current version: 0.3. Before 1.0 design may change drastically.
- Want to merge into sage-combinat; I want to use CombinatorialClass, Streams, etc.
- New features need to be added.

What's next for sage-words?

- Current version: 0.3. Before 1.0 design may change drastically.
- Want to merge into sage-combinat; I want to use CombinatorialClass, Streams, etc.
- New features need to be added.
- Morphisms should be able to map into other monoids.

What's next for sage-words?

- Current version: 0.3. Before 1.0 design may change drastically.
- Want to merge into sage-combinat; I want to use CombinatorialClass, Streams, etc.
- New features need to be added.
- Morphisms should be able to map into other monoids.
- Better algorithms need to be implemented.

What's next for sage-words?

- Current version: 0.3. Before 1.0 design may change drastically.
- Want to merge into sage-combinat; I want to use CombinatorialClass, Streams, etc.
- New features need to be added.
- Morphisms should be able to map into other monoids.
- Better algorithms need to be implemented.
- Need to decide an best backend: suffix trees? other?

What's next for sage-words?

- Current version: 0.3. Before 1.0 design may change drastically.
- Want to merge into sage-combinat; I want to use CombinatorialClass, Streams, etc.
- New features need to be added.
- Morphisms should be able to map into other monoids.
- Better algorithms need to be implemented.
- Need to decide an best backend: suffix trees? other?
- Cythonize!

Posets in sage-combinat

Posets in sage-combinat

- A *poset* is a set with a *partial-order*.

Posets in sage-combinat

- A *poset* is a set with a *partial-order*.
- Current code is for working with finite posets via the Hasse diagram (that is, it uses DiGraphs as the backend).

Posets in sage-combinat

- A *poset* is a set with a *partial-order*.
- Current code is for working with finite posets via the Hasse diagram (that is, it uses DiGraphs as the backend).

DEMO

Posets in sage-combinat

Lots to do here:

Posets in sage-combinat

Lots to do here:

- Improve the current code: finite poset generator; additional input methods; fix bugs & docstrings; ....

Posets in sage-combinat

Lots to do here:

- Improve the current code: finite poset generator; additional input methods; fix bugs & docstrings; ....
- Rethink the design.

Posets in sage-combinat

Lots to do here:

- Improve the current code: finite poset generator; additional input methods; fix bugs & docstrings; . . . .
- Rethink the design.
- Want to be able to work with posets without storing the Hasse diagram (with very big, like infinite, posets).

Posets in sage-combinat

Lots to do here:

- Improve the current code: finite poset generator; additional input methods; fix bugs & docstrings; . . . .
- Rethink the design.
- Want to be able to work with posets without storing the Hasse diagram (with very big, like infinite, posets).
- Posets with EL-labellings.

Posets in sage-combinat

Lots to do here:

- Improve the current code: finite poset generator; additional input methods; fix bugs & docstrings; ....
- Rethink the design.
- Want to be able to work with posets without storing the Hasse diagram (with very big, like infinite, posets).
- Posets with EL-labellings.
- Want to have operations defined on posets: $*$, $+$, $/$, ...

Posets in sage-combinat

Lots to do here:

- Improve the current code: finite poset generator; additional input methods; fix bugs & docstrings; ....
- Rethink the design.
- Want to be able to work with posets without storing the Hasse diagram (with very big, like infinite, posets).
- Posets with EL-labellings.
- Want to have operations defined on posets: $*$, $+$, $/$, ...
- Very important: Need to be able to take objects (say, permutations) and turn them into posets *easily*.