Experimenting with finite state automata in GAP

Ruth Hoffmann

University of St Andrews, School of Computer Science

FSMNLP 2013
University of St Andrews
15th July 2013
1988  GAP is published in Aachen
1988  GAP is published in Aachen
1997  GAP HQ moves to St Andrews
History

1988  GAP is published in Aachen
1997  GAP HQ moves to St Andrews
2013  Most recent version (4.6.4) is released
C Kernel
C Kernel
Algebraic Library
C Kernel
Algebraic Library
Groups Library
C Kernel
Algebraic Library
Groups Library
Documentation
Interactive Environment
GAP System

- C Kernel
- Algebraic Library
- Groups Library
- Documentation
- Interactive Environment
- Programming Language
Experimenting with finite state automata in GAP
Automata
General Information

Authors  Manuel Delgado, Steve Linton, José João Morais

Dates  Started – 1998;
       Official package acceptance – 2004;
       Most recent version (1.13) – 2011
Automata
Some notation, expressions, reminders

Automaton \( A = (Q, \Sigma, \delta, Q_0, F) \)

Types of automata:

**Deterministic**  Exactly one transition per letter per state

**Nondeterministic**  Allowing for no or multiple transitions per letter per state

**Epsilon**  Allowing for \( \varepsilon \) transitions
Automata
Some notation, expressions, reminders

Transition function forms:

- Function
- Diagram
- Table
Automata
Some notation, expressions, reminders

- Regular Expression $=$ Rational Expression
- Permutation Automaton
- Reversible Automaton
Demonstration

Let's see what we can do with this package.
Demonstration
Investigation of a given automaton and its reverse

▶ What is the reverse?
▶ How does the diagram look?
▶ What regular language is accepted?
▶ Are the languages equal?
▶ What is a permutation of the given automaton?
▶ Does the permutation really have the same language?
▶ Is the language of the given automaton finite?
Demonstration
Investigation of a random non-deterministic automaton

- How big is the non-deterministic equivalent automaton?
- Can the NDA be reduced?
- What is the deterministic equivalent?
- Can the DA be reduced?
- What properties does the DA have?
- What is the diagram of the DA?
Demonstration
Creating new automata from existing ones

- What is the union of two automata?
- What is the product of two automata?
Demonstration
Investigation of a rational expression

- How can new expressions be created?
- Which automaton accepts this expression?
Demonstration
Investigation of a random rational expression

- How long is the expression?
- Which automaton accepts the expression?
- Is the word $abc$ in the language?
Demonstration
Investigating two rational expressions

- Is the concatenation finite?
- What are all the words of the language?
- Which automaton accepts all these words?
- Which automaton accepts the expression?
GAP Webpage
www.gap-system.org

Automata Webpage
cmup.fc.up.pt/cmup/mdelgado/automata/

Forum Email
forum@gap-system.org

My Email
rh347@st-andrews.ac.uk