promote SAGE
für Forschung und Lehre

Thomas Risse
Institut für Informatik & Automation, IIA
Fakultät E-Technik & Informatik, Hochschule Bremen
risse@hs-bremen.de

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Agenda

1. HSB-Kontext
2. MATLAB vs SAGE
   - Lehre
   - Forschung
3. Folgerungen

HSB-Kontext

Alternativen
- die drei großen (proprietären) Ms

MATLAB
- Industrie-Standard für Ingenieur-Mathematik
- MATLAB mit SIMULINK
- ist in Personalabteilungen bekannt

HSB FH mit einigen auch dualen Informatik-Studiengängen: hier technische Informatik, TI

- **Mathe1** lineare Algebra und analytische Geometrie
- **Mathe2** Analysis (Differential- und Integralrechnung, DGl)
- **Mathe3** mehrdimensionale Analysis und Stochastik
- **andere** Simulation und Modellbildung, Regelungstechnik etc

Kompromiss SAGE in Mathe2, MATLAB in Mathe3

MATLAB vs SAGE

	MATLAB	SAGE
Lizenz	proprietär	open source
programming	MATLAB, m-file	Python
erweiterbar	toolboxes	packages
Dokumentation	techdoc	SageStandardDoc
Referenz	/ref/doc.html	4.7.1: 6813p
tutorials	viele	einige, s.a. `www.sagemath.org`
Bücher	viele	'how to learn SAGEmath' 161Mio Python google hits
google: 'how learn * math'	10.5 Mio hits	9 Mio hits
community	s.a. `mathworks.com`	`groups.google.com/groups/sage-support`
oo	nicht performant	built in, performant

MATLAB vs SAGE – Lehre

unterschiedliche Unterstützung der Studis/Anwender

	MATLAB	SAGE
Installation	lokal	lokal www.sagenb.org sage.informatik.hs-bremen.de
Hilfe-System	help helpdesk	command?(?) search
debugging	call sequence	call sequence

Usability beispielhaft bewertet anhand

- MATLAB- und SAGE-Hilfe-System
- MATLAB- und SAGE-debugging info

MATLAB – help backslash

`help \` liefert

```
Operators and special characters.
```

click auf `mldivide` in der Zeile

```
mldivide - Backslash or left matrix divide \
```

liefert

```
\    Back slash or left matrix divide.
     A\B is the matrix division of A into B, which is roughly the
     same as INV(A)*B , except it is computed in a different way.
     If A is an N-by-N matrix and B is a column vector with N
     components, or a matrix with several such columns, then
     X = A\B is the solution to the equation A*X = B computed by
     Gaussian elimination.  A warning message is printed if A is
     badly scaled or nearly singular.  A\EYE(SIZE(A)) produces the
     inverse of A. ......
```

Optionaler weiterer click liefert die ausführliche `helpdesk`-Dokumentation des Backslash-Operators mit Beispielen.

SAGE – help backslash

\? nix; `search_doc('backslash')`, wähle `matrix2.html`, find 'backslash' auf p78 von pp88

`solve_right`(*B*, *check=True*)¶

If self is a matrix A, then this function returns a vector or matrix X such that $AX = B$. If B is a vector then X is a vector and if B is a matrix, then X is a matrix.

Note

In Sage one can also write `A \backslash B` for `A.solve_right(B)`, i.e., Sage implements the "the MATLAB/Octave backslash operator".

INPUT:

- `B` - a matrix or vector
- `check` - bool (default: True) - if False and self is nonsquare, may not raise an error message even if there is no solution. This is faster but more dangerous.

OUTPUT: a matrix or vector

See also

`solve_left()`

EXAMPLES:

```
A = matrix(QQ, 3, [1,2,3,-1,2,5,2,3,1])
b = vector(QQ,[1,2,3])
x = A \ b; x
```

```
(-13/12, 23/12, -7/12)
```

MATLAB vs SAGE – debug info

```
» A = [1 2;3 4]; x = A\1
??? Error using ==> mldivide
Matrix dimensions must agree.
```

```
A = matrix(RR,2,[1,2,3,4]); x = A\1;
```

evaluate

```
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
  File "_sage_input_18.py", line 10, in <module>
    exec compile(u'open("___code___.py","w").write("# -*- coding: utf-8 -*-\\n" +
  File "", line 1, in <module>

  File "/tmp/tmp4mdInE/___code___.py", line 3, in <module>
    exec compile(u'A = matrix(RR,_sage_const_2 ,[_sage_const_1 ,_sage_const_2 ,_s
  File "", line 1, in <module>

  File "/home/sage/sage/local/lib/python2.6/site-packages/sage/misc/preparser.py'
    return self.left._backslash_(right)
  File "matrix2.pyx", line 73, in sage.matrix.matrix2.Matrix._backslash_ (sage/ma
  File "matrix2.pyx", line 276, in sage.matrix.matrix2.Matrix.solve_right (sage/m
  File "element.pyx", line 306, in sage.structure.element.Element.__getattr__ (sa
  File "parent.pyx", line 268, in sage.structure.parent.getattr_from_other_class
  File "parent.pyx", line 170, in sage.structure.parent.raise_attribute_error (sa
AttributeError: 'sage.rings.integer.Integer' object has no attribute 'nrows'
```

SAGE – weitere Beispiele

- `plot?`, aber was sind matplotlib line options?
- Unterschied `type(obj)` und `obj.parent()`
- Graphen mit ettikettierten Knoten
- ```
  R.<x> = PolynomialRing(GF(2^m));
  var('z');
  Q.<z> = QuotientRing(R,GoppaPolynomial);
  ```
  ```

MATLAB vs SAGE – Forschung

unterschiedliche Unterstützung der Forscher

SAGE überragendes Potential in Algebra und in diskreter Mathematik, z.B. post quantum cryptography [1], diskreter Mathematik [2]

Symbolic Calculus, 2D Graphics, 3D Graphics, Games, Graph Theory, Basic Structures, Cryptography, Combinatorics, Category Theory, Monoids, Groups, General Rings, Ideals, and Morphisms, Standard Commutative Rings, Algebraic Number Fields, p-Adics, Polynomial Rings, Power Series Rings, Algebras, Quaternion Algebras, Matrices and Spaces of Matrices, Modules, Combinatorial Geometry, Homology of Simplicial Complexes, L-Functions, Schemes, Elliptic and Plane Curves, Hyperelliptic Curves, Coding Theory, Arithmetic Subgroups of SL2(Z), General Hecke Algebras and Hecke Modules, Modular Symbols, Modular Forms, Modular Abelian Varieties, Miscellaneous Modular-Form-Related Modules etc

MATLAB bietet Simulink
etwa (J)modelica in SAGE integrieren

Folgerungen

SAGE zu einem breiten Einsatz zu verhelfen bedeutet

usability

- Lehr-/Lernmaterial auf Deutsch bereitstellen
- Hilfe-System benutzerorientiert verbessern
- Darstellung der debugging-Information verbessern

utility

- Modularisierung unterstützen
- hierarchisierbare, sichere Ablage von worksheets, vgl. `sage-support`
- Import und Export formatierter Daten, R
- Integration weiterer Pakete

Referenzen

[1] Thomas Risse: How SAGE helps to implement Goppa Codes and the McEliece Public Key Crypto System; Ubiquitous Computing and Communication Journal, UbiCC, ISSN 1992-8424, Special Issue on 5th International Conference on Information Technology (ICIT'11) `www.weblearn.hs-bremen.de/risse/papers/UbiCC2011`

[2] Thomas Risse: SAGE, ein open source CAS vor allem auch für die diskrete Mathematik; Wismarer Frege-Reihe, ISSN 1862-1767, Heft 03/2010, S.34-40 `www.weblearn.hs-bremen.de/risse/papers/Frege2010_03`

[3] William A. Stein et al.: Sage Mathematics Software (Version 4.7.1); The Sage Development Team, 2011, `www.sagemath.org`