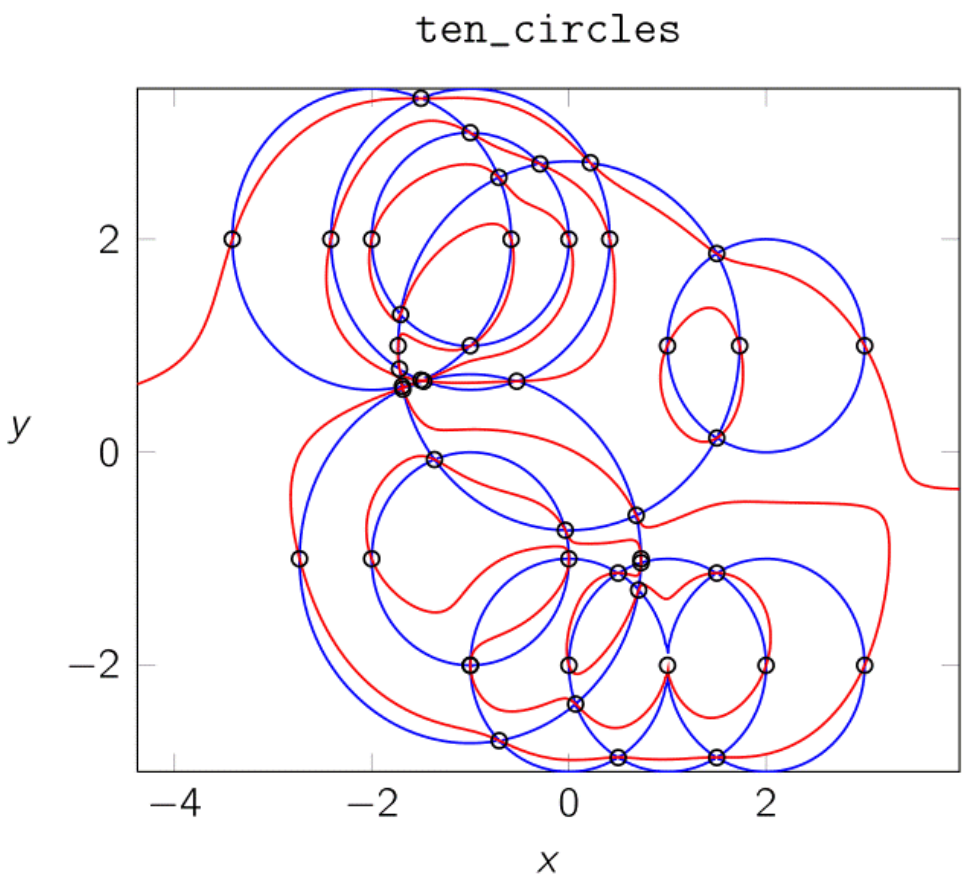
SUPERVISOR MODULE

TENSOR-BASED ALGORITHMS FOR SETS OF POLYNOMIAL EQUATIONS

Sets of polynomial equations can in principle be solved by constructing the so-called Macaulay matrix of equation coefficients and by exploiting shift-invariance structure in its null space via an eigenvalue decomposition.

Canonical Polyadic Decomposition (CPD) of a *higher-order tensor* is its decomposition in a minimal number of rank-1 terms. Higher-order tensors are “matrices in more than two dimensions". Tensors are becoming increasingly important in signal processing, data mining, machine learning, scientific computing and many other fields, where they open up remarkable new opportunities.

The null space of the Macaulay matrix turns out to be structured like a higher-order tensor of which the CPD reveals the unknown roots. In a previous WIT thesis, this has led to a new conceptual approach for the numerical computation of the solutions of sets of polynomial equations that relies on numerical CPD algorithms. This way of working has some important advantages over alternative algorithmic approaches.



The size of the Macaulay matrix limits its use to small-scale problems. However, it is very sparse and has a block-Toeplitz structure. These features should be exploited in the computation of the Macaulay null space. We can envisage handling much larger sets of equations if this null space is computed by means of iterative structure-exploiting methods. Further scaling may be achieved by computing the CPD in a single-step approach, instead of the current two-step procedure (i.e. computation of a null space followed by computation of a CPD).

The first goal of the thesis is to integrate, along the above lines, relevant insights from numerical linear algebra and numerical optimization in new algorithms for solving sets of polynomial equations. The second goal is to develop algorithms that work in the Chebyshev basis instead of the numerically disadvantageous monomial basis, as is currently done. The sets of equations are possibly overdetermined, in which case they need to be solved in least-squares sense.

Conceptually we aim at solving fairly large sets of polynomial equations by means of numerical multilinear algebra in a similar spirit as sets of over-determined sets of linear equations are currently solved by means of numerical linear algebra. This is expected to enable the integration of sets of polynomial equations (as a natural extension of sets of linear equations) in a variety of signal processing, data analysis and machine learning applications. In other words, the overall goal is the construction of new tools for broad use in engineering.

Bijlagen

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VOEG TOE

Promotoren	Co-promotoren	Mentors	Assessoren
Lieven De Lathauwer			

Project URL

(leeg)

Naam organisatie / URL

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Opmerkingen

First the required know-how is acquired through discussions, attending a few lectures on tensor methods and a limited, guided study of the literature. For tensor methods a concise course text is available. New algorithms are developed with attention for numerical aspects. The algorithms are validated on practical examples.

Depending on the interest, the emphasis can be put less or more on applications, numerical aspects or implementation.
Wiskundige ingenieurstechnieken
Mathematical Engineering

Status

ontwerp

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Laatst gewijzigd door

Lieven De Lathauwer

Disciplines

NUMA

STADIUS

Embargo

Aantal studenten

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‹ **OVERZICHT ONDERWERPEN**