STRUCTURED LOW-RANK APPROXIMATION WITH APPLICATIONS

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Structured low-rank approximation

$$\text{minimize (over } \widehat{w}) \ \|w-\widehat{w}\| \quad \text{subject to} \quad \operatorname{rank}\big(\mathscr{S}(\widehat{w})\big) \leq r$$

w	—	given data
$\mathscr{S}(w)$	—	structured matrix
r	—	rank specification
$\widehat{w}$	—	data approximation (smoothed data)

Example: model order reduction

w	—	impulse response of a high order system
$\mathscr{S}(w)$	—	Hankel matrix
r	—	order of an approximate LTI system
$\widehat{w}$	—	impulse response of the approximate system

Example: approximate GCD

w	—	coefficients of two (degree-d) polynomials
$\mathscr{S}(w)$	—	Sylvester matrix
$d-r$	—	degree of the approximate GCD
$\widehat{w}$	—	coef. of polynomials with degree-$n-r$ GCD

Example: approximate system identification

w	—	observed trajectory (inputs and outputs)
$\mathscr{S}(w)$	—	Hankel matrix
$r = Tm+n$	—	complexity specification
$\widehat{w}$	—	traj. of nth order LTI system with m inputs

Notes:

1. equal treatment of variables
2. abstraction of the model representation

EPSRC proposal aiming at:

- Robust and efficient local optimization methods
- Effective heuristics (subspace and relaxations methods)
- Applications in bioI, biomedical SP, computer algebra

References

- I. Markovsky. Structured low-rank approximation and its applications. *Automatica*, 44(4):891–909, 2007.
- I. Markovsky et al. *Exact and Approximate Modeling of Linear Systems: A Behavioral Approach*, SIAM, 2006.