LAUDATIO

2004 Johann Bernoulli Lecture

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Biography

Biography

- ° Halle, Vlaams Brabant, Belgium, in 1960
- Studied engineering, Ph.D., at K.U. Leuven
- Post-doc at Stanford University
- Presently, Professor and head of the research group SISTA, K.U. Leuven

Biography

- 1991-92 Chief of Staff of Wivina De Meester, Belgian minister of Science and Education
- 1992-94 Chief of Staff of Wilfried Martens, Belgian prime minister
- 1994-98 Science Advisor, Government of Flanders

Research

- Applications of SVD, numerical analysis
- Subspace Identification
- MPC, etc.
- Quantum control and information theory
- Learning algorithms
- Bio-informatics

System identification

Observed data $\mapsto$ System model

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Case on interest:

Data = a finite vector time-series record

$$\boxed{\tilde{w}(1), \tilde{w}(2), \ldots, \tilde{w}(T)} \qquad w(t) \in \mathbb{R}^{\mathtt{w}}$$

Model:

a dynamical system that 'explains' this time-series

Subspace Identification

subspace algorithms (oblique projection of 'future' on 'past') pass directly from

$$\boxed{\tilde{w}(1), \ldots, \tilde{w}(t), \ldots}$$

$\downarrow\downarrow$ **to** $\downarrow\downarrow$

$$\boxed{\tilde{x}(1), \ldots, \tilde{x}(t), \ldots}$$

a state trajectory of the system that produced the data.

Subspace Identification

$\leadsto$ Reduce the state dimension, split $w = (u, y)$ into inputs and outputs, and solve by least squares, using the reduced $\tilde{x}$,

$$\begin{bmatrix} \tilde{x}(t_1+1) & \cdots & \tilde{x}(t_2) \\ \tilde{y}(t_1) & \cdots & \tilde{y}(t_2-1) \end{bmatrix} = \begin{bmatrix} A & B \\ C & D \end{bmatrix} \begin{bmatrix} \tilde{x}(t_1) & \cdots & \tilde{x}(t_2-1) \\ \tilde{u}(t_1) & \cdots & \tilde{u}(t_2-1) \end{bmatrix}$$

Subspace Identification

$\rightsquigarrow$ **Reduce the state dimension, split $w = (u, y)$ into inputs and outputs, and solve by least squares, using the reduced $\tilde{x}$,**

$$\begin{bmatrix} \tilde{x}(t_1+1) & \cdots & \tilde{x}(t_2) \\ \tilde{y}(t_1) & \cdots & \tilde{y}(t_2-1) \end{bmatrix} = \begin{bmatrix} A & B \\ C & D \end{bmatrix} \begin{bmatrix} \tilde{x}(t_1) & \cdots & \tilde{x}(t_2-1) \\ \tilde{u}(t_1) & \cdots & \tilde{u}(t_2-1) \end{bmatrix}$$

This leads to the identified model:

$$x(t+1) = Ax(t) + Bu(t)$$
$$y(t) = Cx(t) + Du(t)$$

These subspace algorithms have very nice properties...