With stochastic subspace algorithms, sometimes also called output-only identification methods, we can identify a mathematical model starting from an output sequence $y(k)$, $k=0,1,2,\ldots,N$, of a system with $l$ outputs $y(k) \in \mathbb{R}^l$, generated by a discrete-time linear system of the form:

$$x(k+1) = A \cdot x(k) + w(k),$$

$$y(k) = C \cdot x(k) + v(k),$$

in which $x(k) \in \mathbb{R}^n$ is the (unknown) state vector with the $n$ states at time instant $k$, $A$ is the unknown system matrix, $C$ is the unknown output matrix. The vectors $w(k) \in \mathbb{R}^n$ and $v(k) \in \mathbb{R}^l$ are unknown noise sequences, that are assumed to be white, zero mean and normally distributed with unknown covariance matrices

$$E [w(k)^T v(k)^T v(t)^T w(t)] = \begin{bmatrix} Q & S \\ S^T & R \end{bmatrix} \delta_{kt}.$$
In this presentation, we will not devote too much attention to the mathematical, algebraic, geometric and statistical insights that have lead to subspace algorithms. For this we refer to recent books and journal articles. Instead, we will go over the main historical insights, some of them centuries old, all of which are essential ingredients in subspace methods (among others): the technique of least squares (Gauss, 1809) and its interpretation in terms of orthogonal projections, angles between subspaces (Jordan, 1875) and its statistical counterpart called canonical correlation analysis (Hotelling, 1936), the QR-decomposition (Gram, 1883; Schmidt, 1907), the singular value decomposition (Beltrami, 1873; Jordan, 1874; Sylvester, 1885; Autonne, 1913; Eckart & Young, 1936) and its algorithms (Golub & Kahan, 1965), the Kalman filter (Kalman, 1960), realization theory (Ho & Kalman, 1966; Zeiger & McEwen, 1974; Kung, 1978), stochastic realization theory (Akaike, 1974; Faure, 1976) and relatively recent work on system identification (Box-Jenkins, 1976; Willems, 1986; Ljung, 1987).

The main messages of my lecture are:
- Many concepts in science need a long incubation period before they are ever applied in engineering.
- Clever combinations of seemingly unrelated concepts and techniques lead to very powerful and useful engineering algorithms: Today there is a blossoming industry of subspace identification software and applications in mechatronics, civil engineering, econometrics and the process industry.

**Short CV Bart De Moor**

Bart De Moor obtained a PhD (1988) in Electrical Engineering at the Katholieke Universiteit Leuven, Belgium, where he is now a full professor. He was a Visiting Research Associate at Stanford University (1988-1990). His research interests, shared with more than 30 PhD students in the past and with more than 30 PhD students and postdocs at present, are in numerical linear algebra and optimization, system theory, control and identification, quantum information theory, data-mining, information retrieval and bio-informatics. He has (co-)authored more than 250 journal papers, 350 conference proceedings publications and 5 books and numerous science popularizing contributions. His work has won him several scientific awards. Since 2004 he is a fellow of the IEEE. From 1991-1999 he has been the chief advisor on Science and Technology of several ministers of the Belgian Federal and the Flanders Regional Governments. At present, he is the chief-of-staff of the minister-president of Flanders.

Full biographical details can be found at [www.esat.kuleuven.ac.be/~demoor](http://www.esat.kuleuven.ac.be/~demoor).