

Processi, prodotti e servizi
*Processes, products
and services*

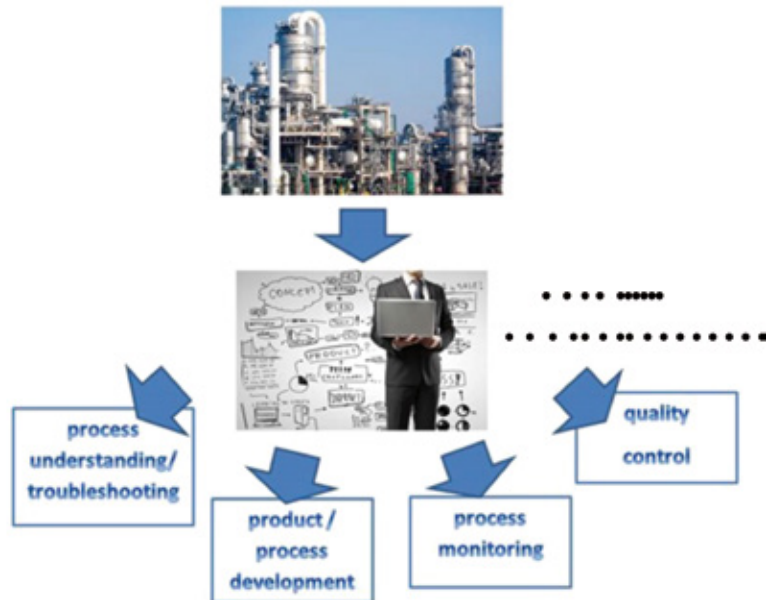
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Data analytics for process industry 4.0

Nowadays process industry is experiencing its 4th industrial revolution, in which an intelligent manufacturing can be obtained through integrated digitalization: connected factories, cloud technologies, internet of things. As a consequence of this juncture, the process engineers are overwhelmed by enormous amounts of process measurements that are available in real time. Dealing with “big data” is of invaluable importance to assist several engineering tasks, such as process understanding/troubleshooting, and process and product quality monitoring. One of the main goals of this research activity is to develop fast, cost-effective, and non-destructive techniques to accomplish these tasks. To this purpose, data-driven models are utilized for both the online data treatment and the information retrieval from historical data. The main data analytics modelling techniques derive from the integration of different disciplines: signal processing, statistical process control, machine and statistical learning, pattern recognition. These allow exploiting the knowledge hidden into the data to identify the critical parameters and the critical phases of a process, to promptly detect process faults, to diagnose the causes of malfunctions, to monitor the product quality in real time (for example by means of virtual-sensors or artificial vision systems) and to implement predictive maintenance.



However, not only the “big data”, but also the “small data” pose serious challenges to research. In fact, several situations are present in the process industry in which very small amount of data are available. This is typically the situation when a new product and process has to be developed and scaled-up. In this context, statistical design of experiments and data-based modelling can support the design of new products, the development of new processes and the transfer of products, processes and the respective technologies from the laboratory scale, to the commercial scale plants. Data based techniques provide effective methodologies to accelerate time-to-market of a new product by aiding to design cost-effective and maximally informative experiments.

Last, but not the least, once a product is launched into the market, it is of paramount importance to protect it from adulterations and counterfeiting, especially in the food and pharmaceutical industry where health and safety are a must. One of the research aims is to develop anti-fraud and anti-adulteration technologies from data fusion of different analytical technologies and atypical sensors (i.e., spectrometers, digital cameras, etc...).

Future research directions will be oriented to the development of data-driven methodologies for genomics and for biopharmaceutical process scale-up. All these research activities, whose effectiveness was successfully demonstrated in several applications within the fine chemicals, pharmaceutical, food, biomedical, electronic industries, are conducted in the CAPE-Lab (Computer-Aided Process Engineering Laboratory).

Main research topics:

- Data-based techniques and soft-sensing for process and quality monitoring
- Artificial vision systems for the characterization of materials
- Development of anti-fraud and anti-sophistication technologies for pharmaceutical and food industries
- Product, process and technology transfer among different production scales and sites
- Statistical design of experiments for quality improvement in the process industry