"THERE'S NOTHING TO EAT!"

Sanitary risk detection for a safer food chain management

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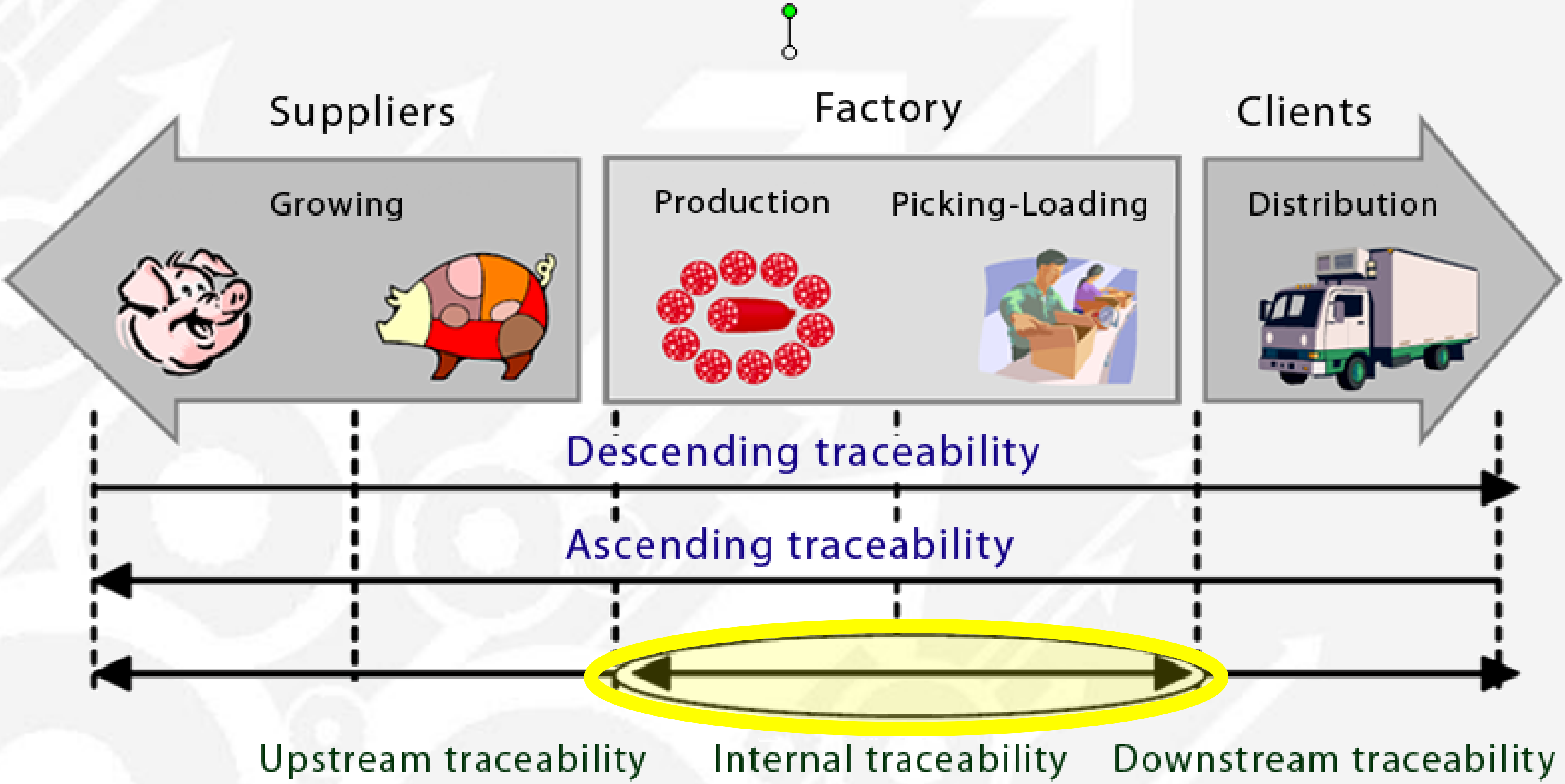
Introduction



Introduction

Management principles based on risk are currently exploited in many areas of business and government including :

- Food industry
- Finance
- Insurance
- Occupational safety
- Public health
- Pharmaceutical industry

Constraints imposed by agencies regulating these industries (Ionica et Al., 2007).

Active managerial control

HACCP, Hazard Analysis and Critical Control Points

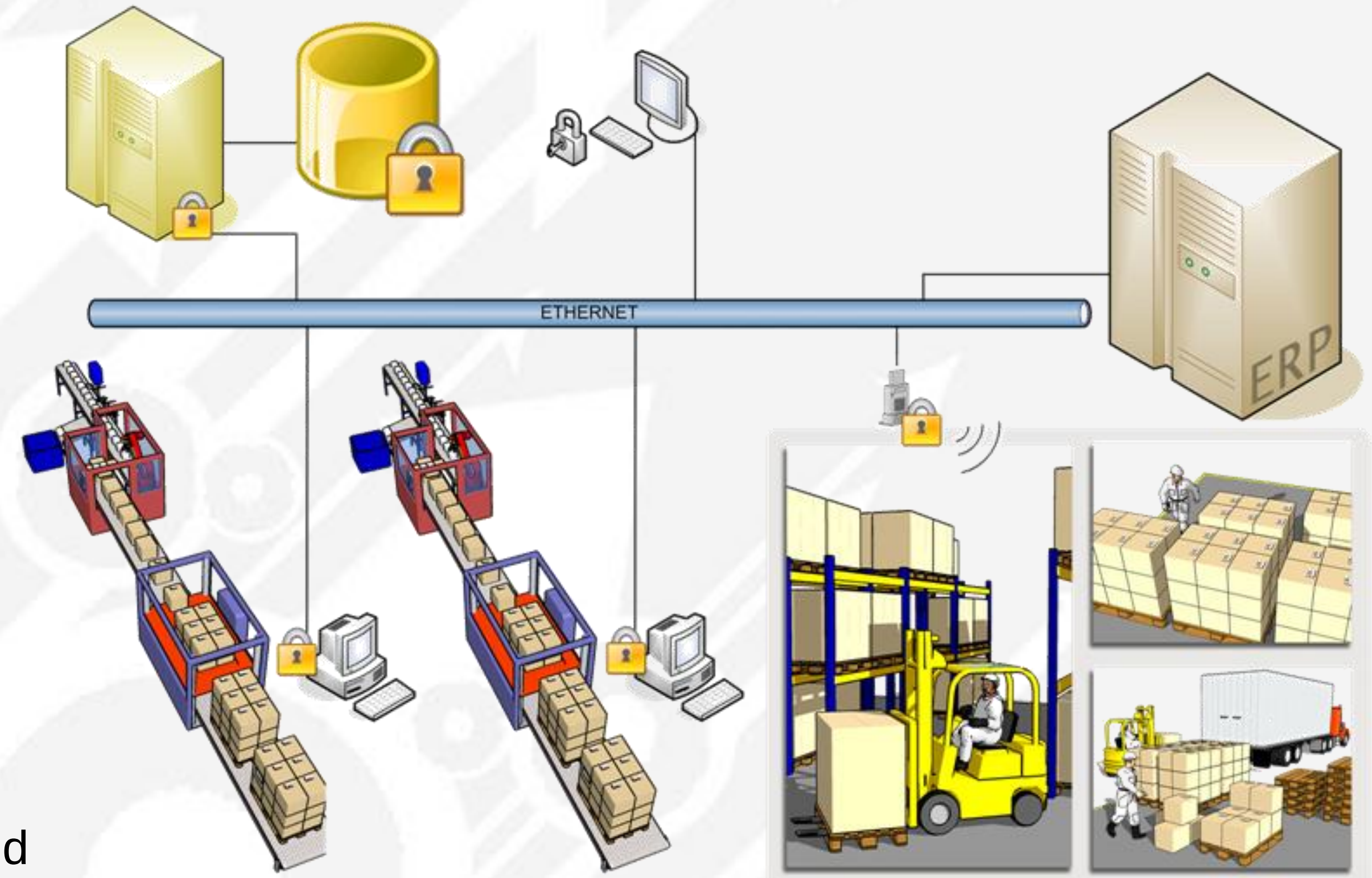
Actual systems lack the technical solutions to link both the monitoring and the operations stages.

Problem statement

Production indicators are computed to generate a measure of global risk that we name "Criticality"

- OBJECTIVE -

Achieve real-time monitoring process that continuously **computes** the production markers, related to the outgoing batches



Criticality values affect the packing and distribution operations

Literature review

Active managerial control (Kurtzweil, 1999)

HACCP, Hazard Analysis and Critical Control Points (Brandriff, 2008)

Management of agricultural operations (Drollette, 2009)

Risk impact and its ontological requirements (Borst et al., 1997)

Relevance of product tracking through the supply chain (Ramesh et al., 1997).

Raw material dispersion problem (Dupuy et al., 2005)

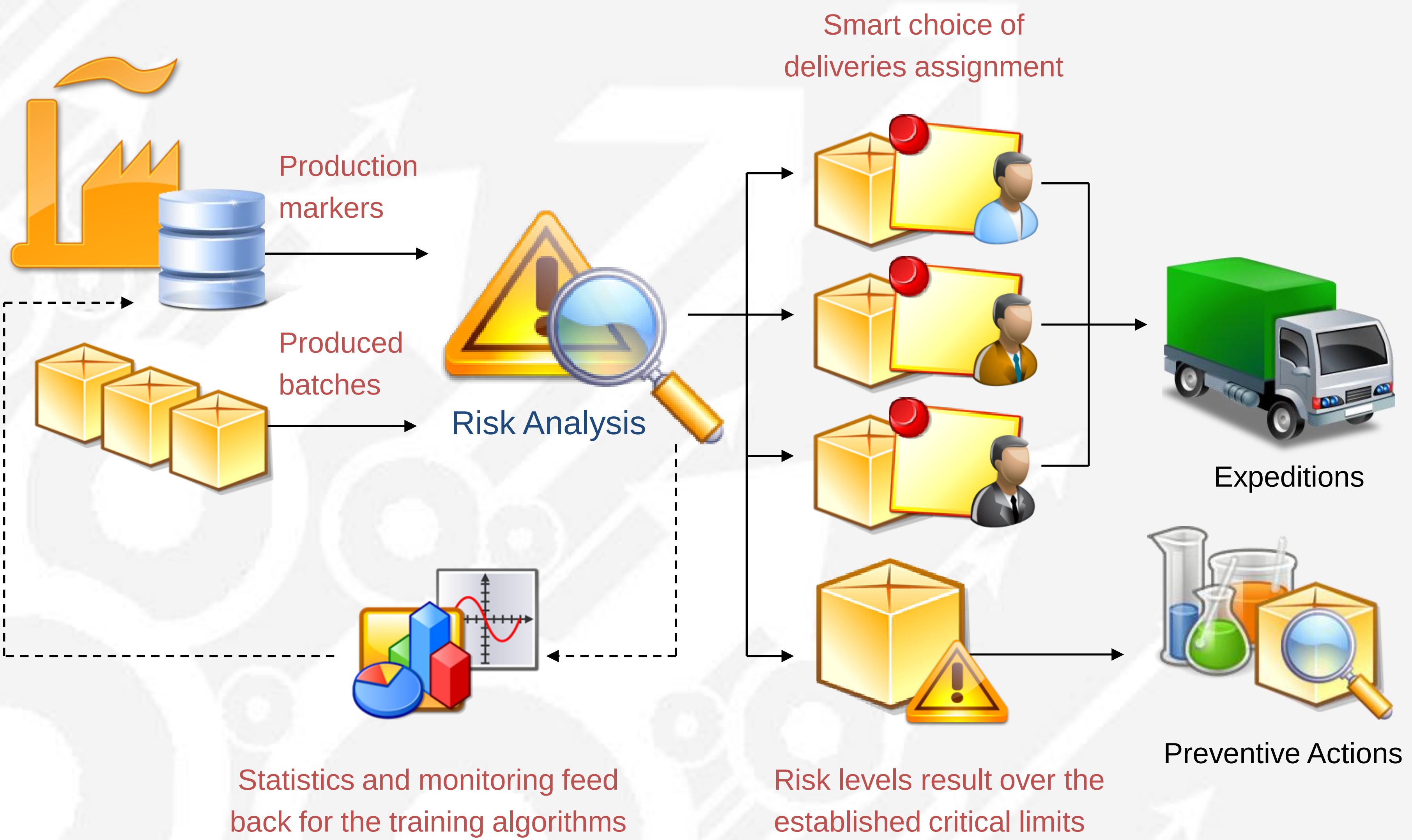
ANN’s in function inferring from observations (Najafi et al., 1998), (Yu et al., 2005).

Classifier ANNs in the diagnosis of industrial processes (Karpenko et al., 2002).

Decision making tools applied for diagnosis in mechanic systems (Angeli et al.,1999)

Filtering information with possibly noisy data input. (Shin et al., 1992) and (Martin el al., 1996)

Problem statement (2)



Measure of risk

Different types of information may be considered

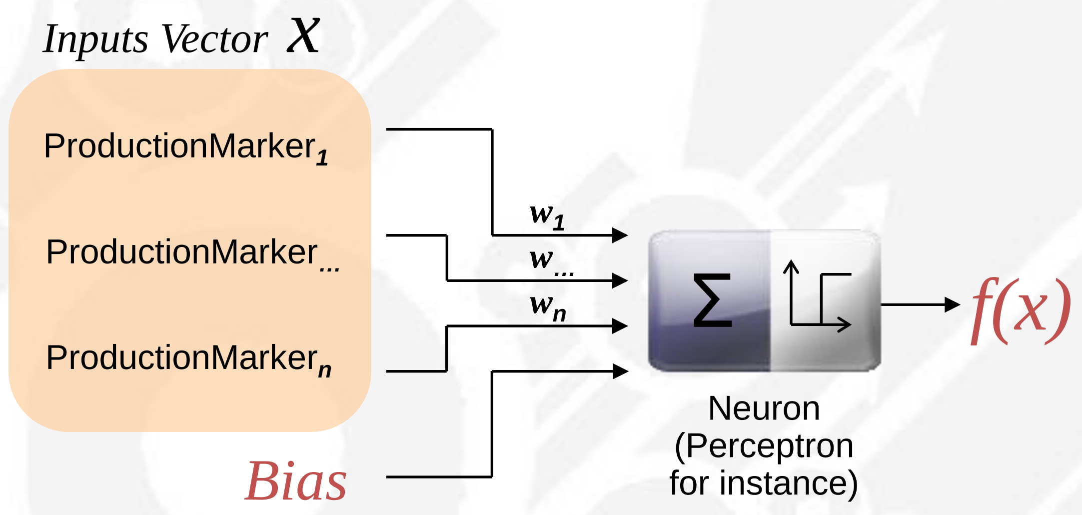
- Qualitative (example: quality of suppliers)
- Quantitative (example: duration of the production cycle).

Risk Function

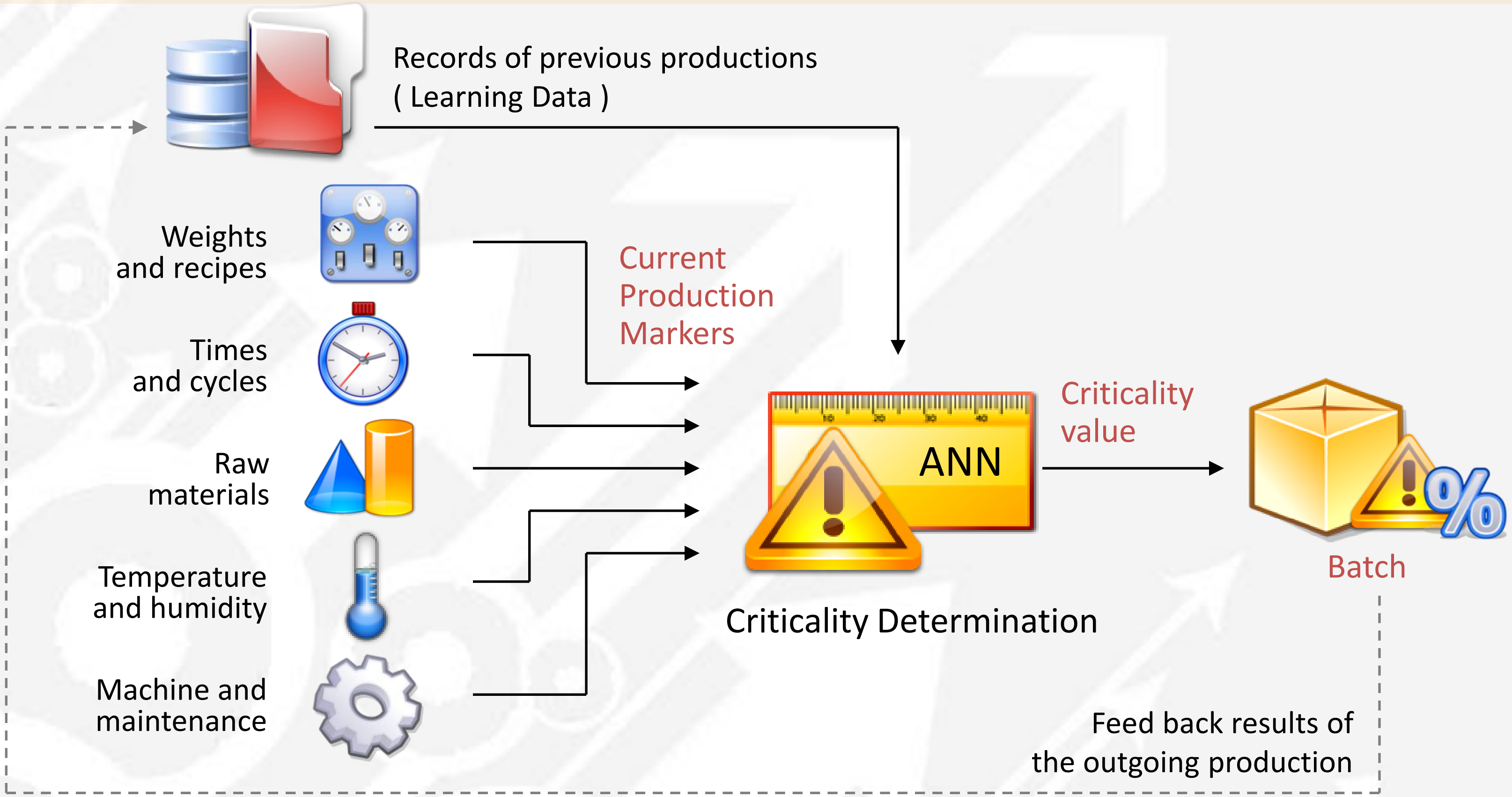
Hard to formalize.

Statistical problem of a filtering type with possibly complex data inputs.

It is a problem for which the **neural networks** have shown their effectiveness (Shin et al., 1992) and (Martin and Howard, 1996).



Measure of risk



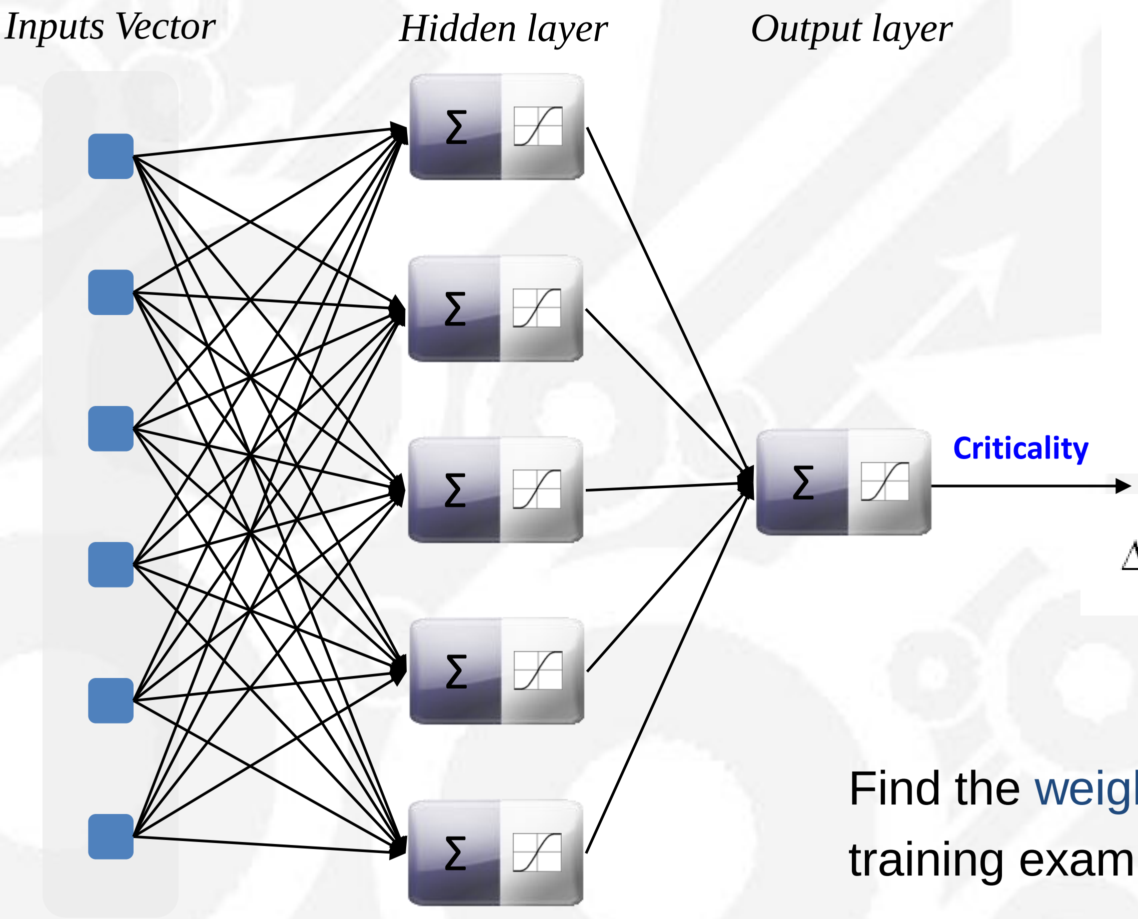
We propose the use of a multi-layer network trained with the backpropagation algorithm.

A multi-layer network mechanizes the separation of data into categories, or classes, characterized by a distinct set of features, which will classify our given set of entries as a corresponding "class" of criticality.

Measure of risk

$$f(X) = \sigma\left(\sum_{j=1}^{n}(w_j * x_j) + b_j\right)$$

$$\sigma(x) = \left(\frac{a}{1+e^{(-k*x)}}\right)$$



$$\delta_k = \frac{d\sigma_k(\mathrm{x})}{dx} * (TARGET_k - OUTPUT_k)$$

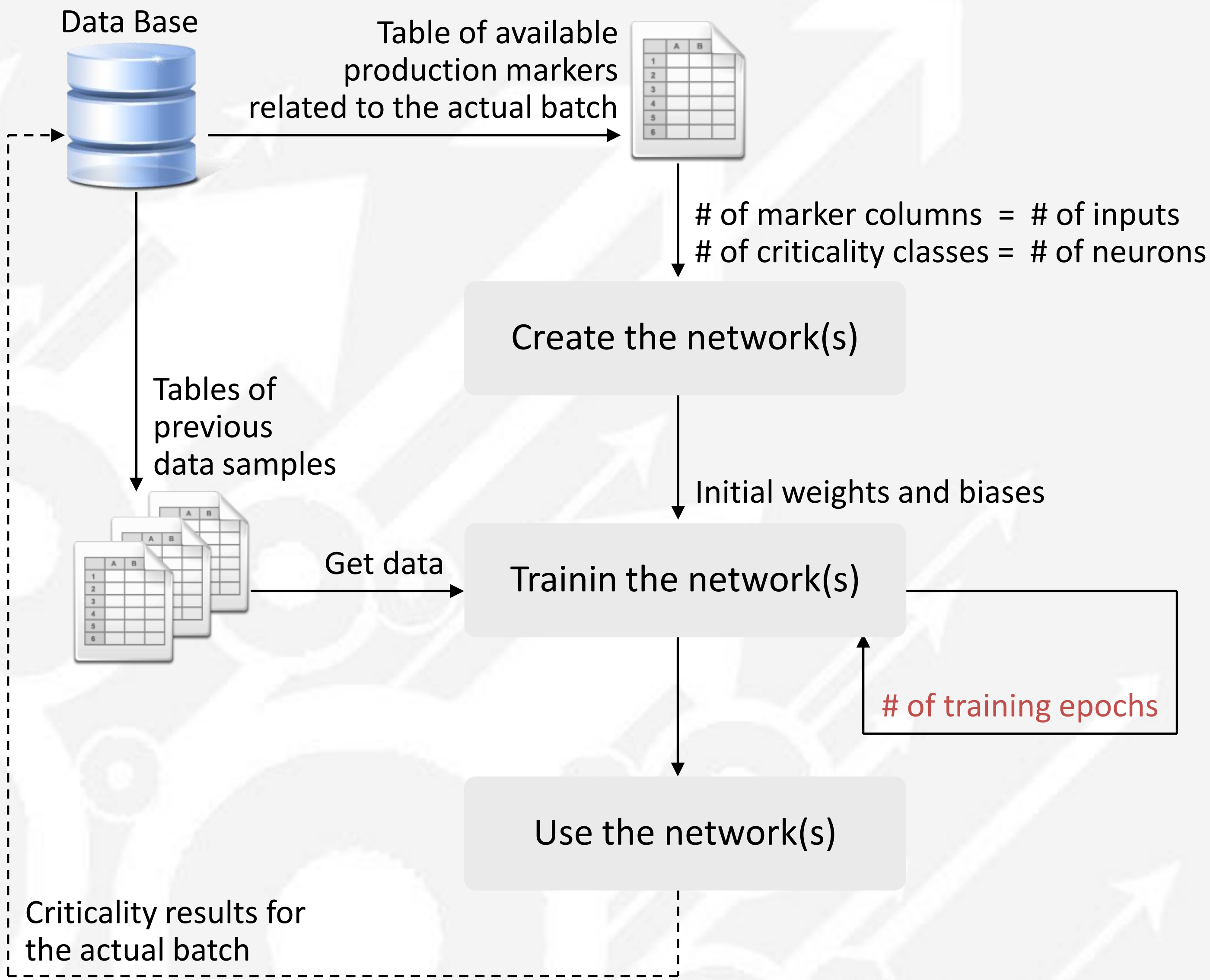
$$\delta_h = \frac{d\sigma_h(\mathrm{x})}{dx} * \sum_{k=1}^{neurons}(w_{h,k} * \delta_k)$$

$$w_{ij} = w_{ij} + (\alpha * \delta_j * x_{ij})$$

$$\Delta w_{ij} = \alpha * ((m * \Delta w_{ij}) + (1-m) * (\delta_j * x_{ij}))$$

Find the weights vector that fits the best to the training examples

Application architecture



Industrial application

FORMALIZE

Training database : List of Examples

Agro-alimentary industries will not share their internal information on sanitary risks

Parameters affecting production criticality:

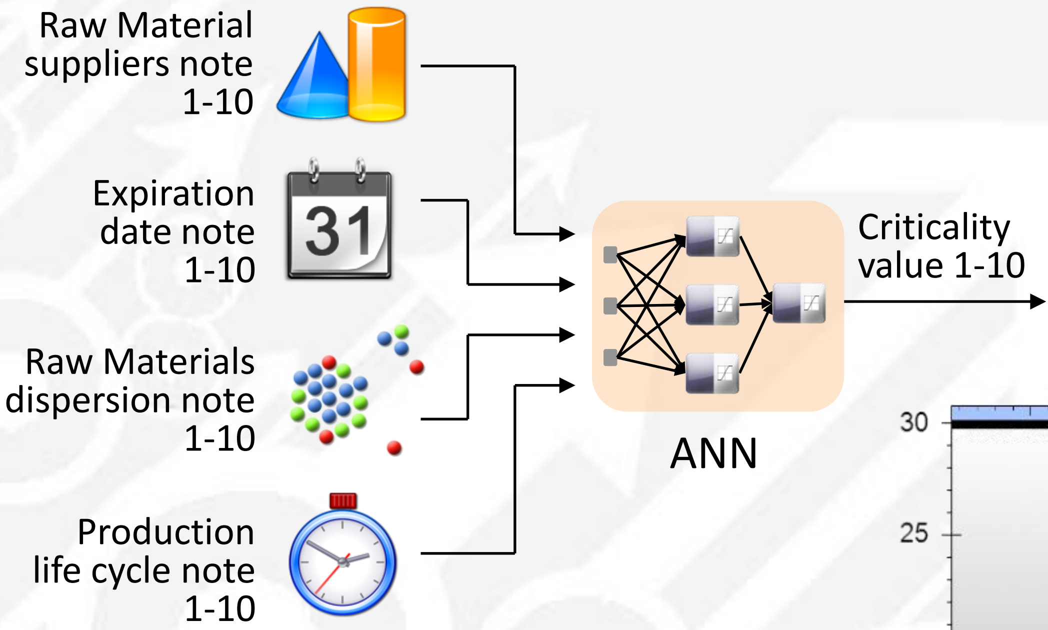
Raw materials supplier's note: Average note of the suppliers group associated to the current production.

Expiration date note: Nearest expiration date of the raw materials involved to the finished products.

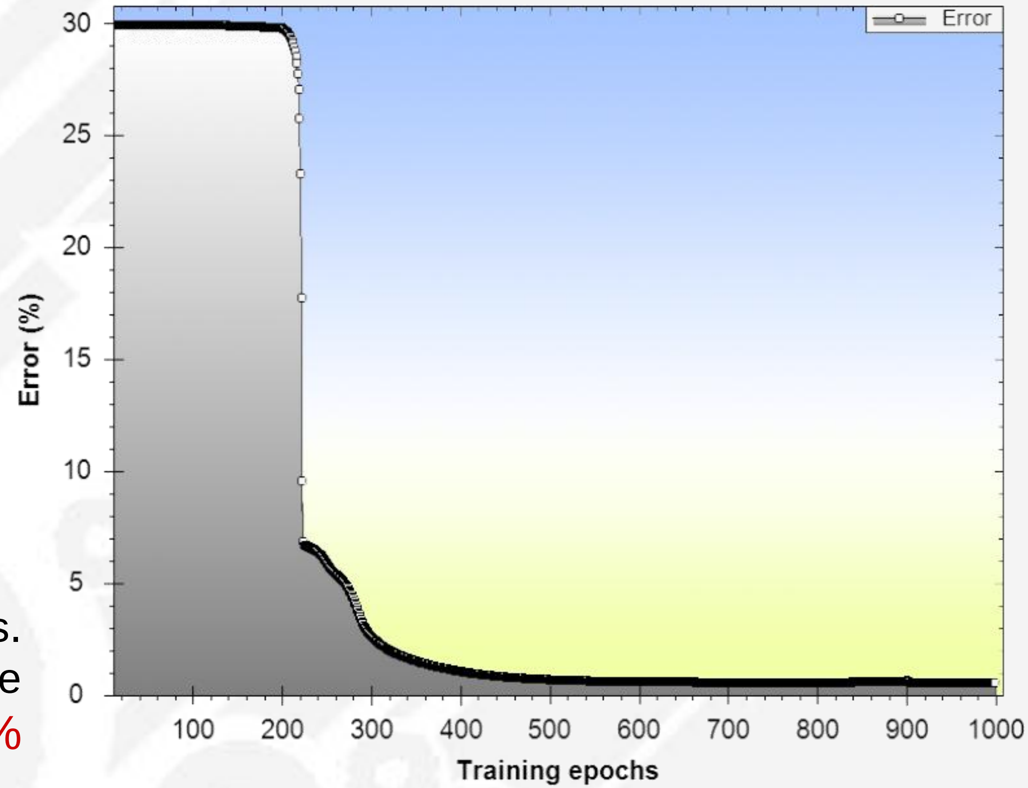
Raw materials dispersion note: Ratio between the production's real dispersion and the optimal dispersion that the production could have had.

Production life cycle note: Behavior of the production in terms of stops.

Industrial application



$$E(\vec{w}) = \frac{1}{N}\sum_{k=1}^{N}\left(TARGET_k - OUTPUT_k\right)^2$$



Evolution of ***E*** along 1000 training epochs. At the end of the learning iterations the error result was 0.057%

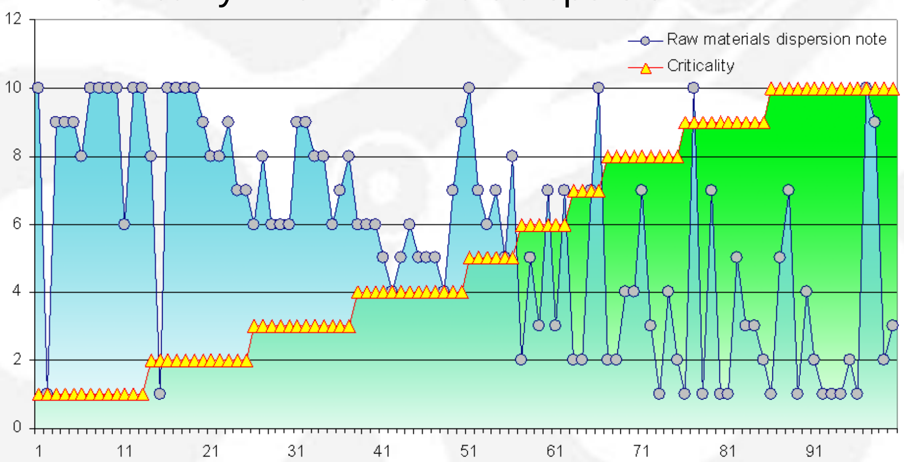
Industrial application

Dispersion	Suppliers	Cycle	Date	**Criticality**
10	10	10	10	**1**
1	1	1	1	**10**
1	1	5	5	**9**
10	10	1	1	**9**
6	9	10	8	**3**
2	3	10	9	**6**
8	8	8	8	**2**
2	2	10	10	**8**
10	8	6	3	**5**
5	1	5	1	**10**
5	5	5	5	**6**
10	7	6	5	**3**
2	2	5	5	**7**

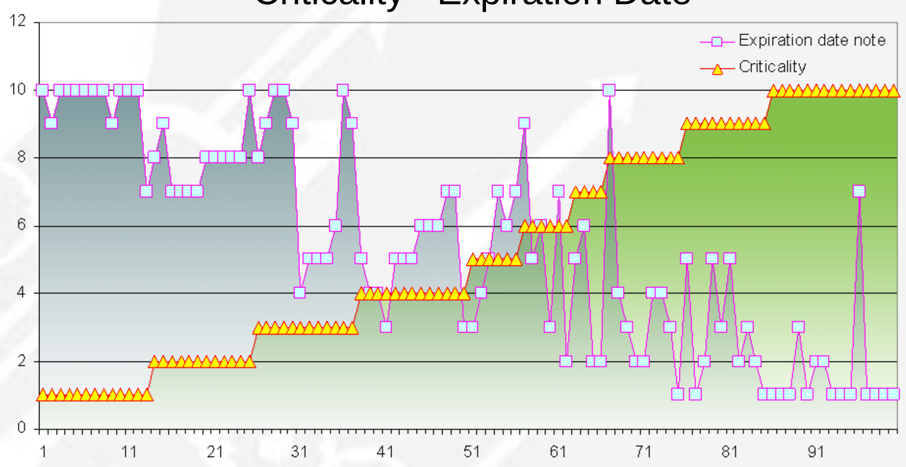
Data analyzing

- Influence of a given production marker in the risk level
- Combinations of risk-engendering parameters .
- Piloting and re-engineering tool
- Detect the most sensitive criteria within a large set of parameters

Criticality - Raw materials dispersion

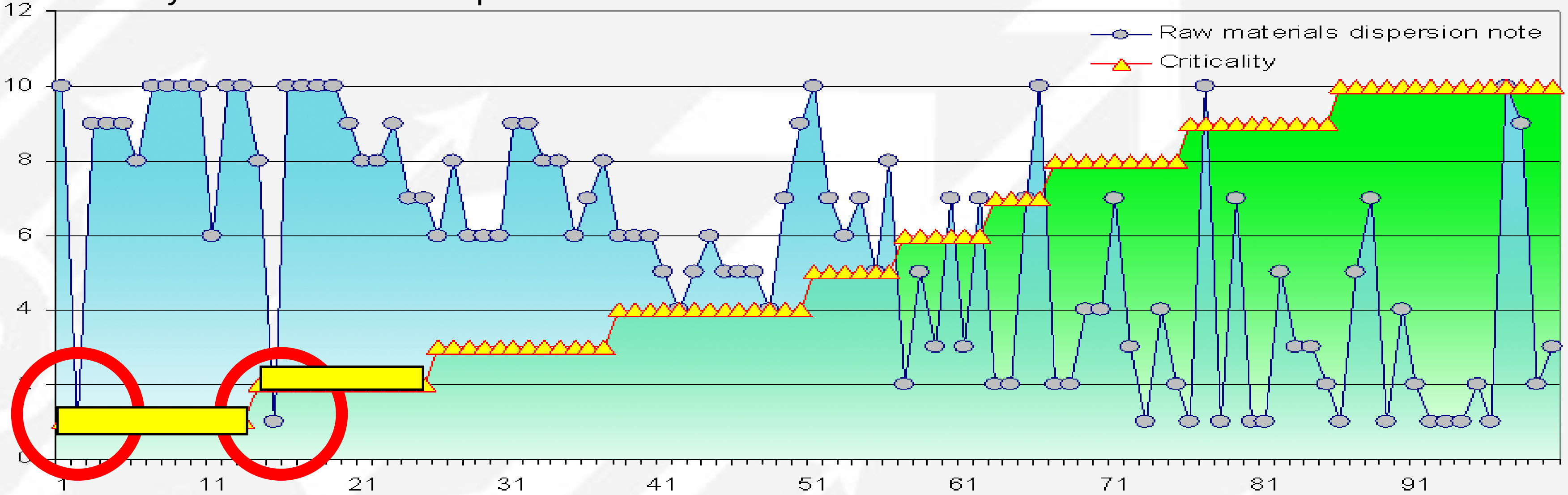


Criticality - Expiration Date

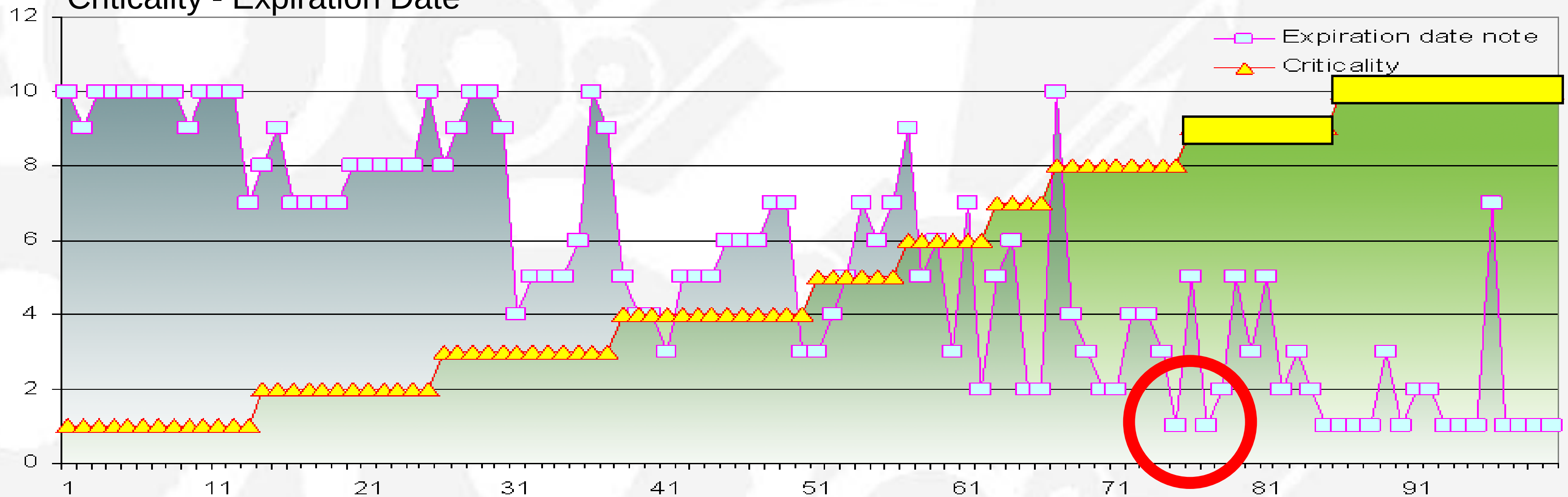


Industrial application

Criticality - Raw materials dispersion



Criticality - Expiration Date



Conclusions, Difficulties and Current works

A robust solution: The proposed tool of real-time risk detection by using artificial neural networks, tends to be more robust than any conventional data analyzing structure. It has the ability to cope with incomplete or fuzzy data.

Reactivity: The rapidity of the tool allows to avoid important threats that represent the reality of delivering (and spreading) products containing possible hazards. The ANN can operate at a considerable speed, rapidly adapting to the production's data flow.

Flexibility: Artificial neural networks are very flexible in adapting their behavior to new and changing environments. They are also easier to maintain, with some having the ability to learn from experience and auto-improve their performance.

Conclusions, Difficulties and Current works

As a difficulty, ANN do not produce an explicit model of risk detection, although different cases of production configuration can be fed into them and new results may be obtained as predictions.

The presented tool lacks an explanation capability. Justifications for the risk results may sometimes be difficult to obtain, because the weights connections usually do not have obvious interpretations.

Install and evaluate the ANN's module **> > >** Visteon project

Implementation of fuzzy-expert systems using the risk values to optimize downstream logistics and avoid recall difficulties.

Thank you for your attention