A diagnosis support system for veterinary necropsy based on Bayesian networks

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1. Introduction

Veterinary necropsy requires a high level of expertise and skills that not all veterinarians necessarily master, especially in the context of the desertification of rural areas. The diagnosis support system we introduce here, **IVAN** ("**I**nnovative **V**eterinary **A**ssisted **N**ecropsy"), aims to engage the user in an explicit, understandable, validable and reviewable process, able to cope with the specific issues of cattle necropsy. IVAN relies on a Bayesian network to infer relevant proposals at each step of the diagnostic process.

2. Challenge

The challenge was to adress the following issues simultaneously :

No black box the diagnosis process must be explicit, understandable, validable and reviewable by the user

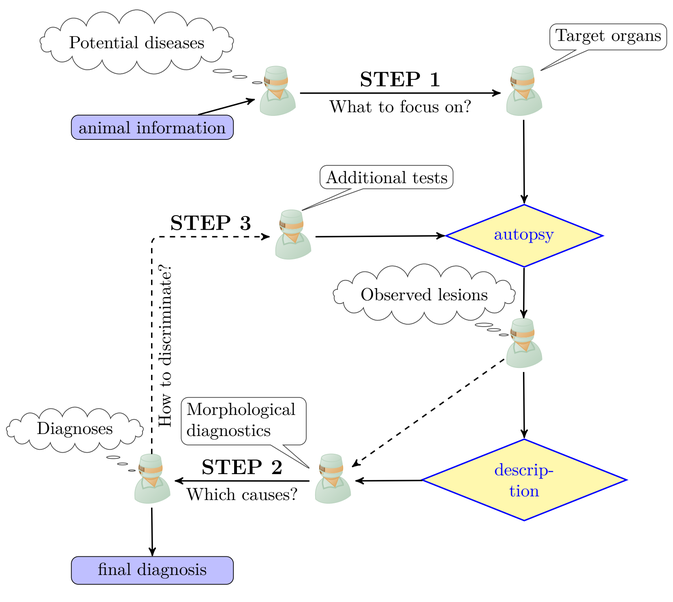
Uncertainty management assist and guide non-experts by providing them the most relevant proposals for accurate input information

Reactivity short response time even with highly combinatorial process

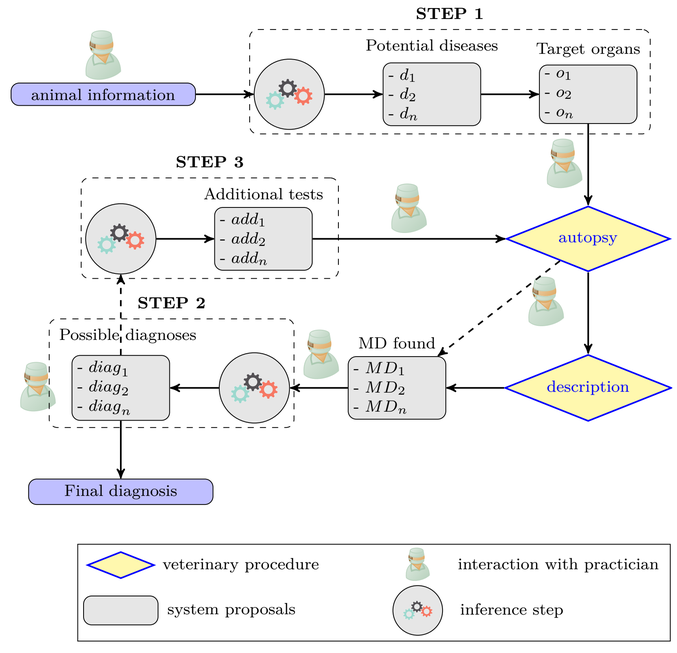
Versatility the application must run on both mobile device and web

3. Processes

Main steps of the classical diagnosis process. Information deduced by the practitioner can either stay implicit or be mentioned explicitly in the final necropsy report.



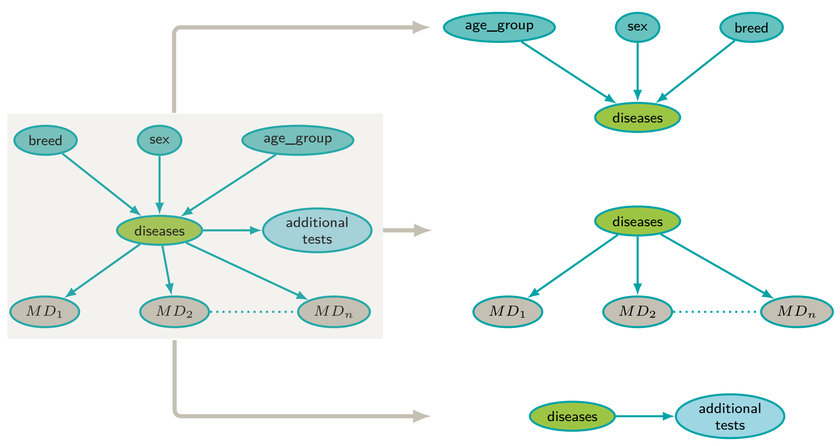
Main steps of the diagnosis process in IVAN. The veterinarian chooses whether to acknowledge or revise proposals at each key step identified previously.



4. Subgraph division

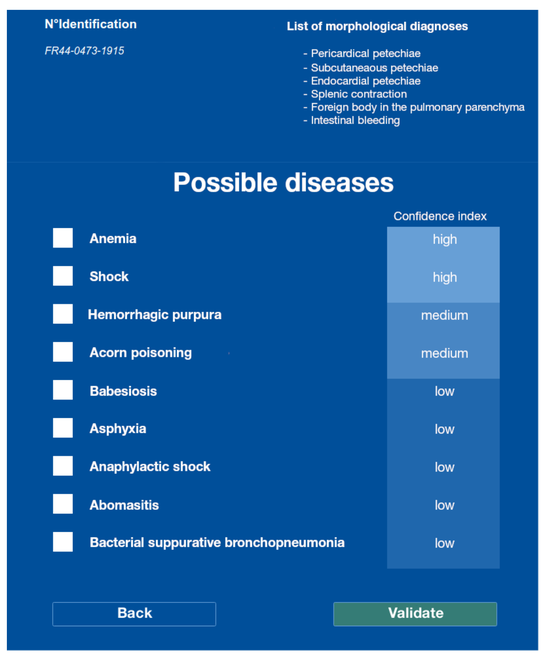
The diagnosis process is composed of three main steps, which corresponds to a partial use of the main graph :

step 1 determine a set of potential diseases based on animal information
step 2 diagnose diseases from a set of Morphological Diagnoses (MD)
step 3 propose additional tests



This significantly reduces the calculation times for BN processing, making a Javascript implementation possible, hence enabling the final application to be usable in the field.

5. Application



➤ To facilitate the interpretation of outputs inferred in each subgraph, the proposals are not displayed directly with their calculated probability value. Instead, IVAN provides a confidence level and a relative order of proposals.

➤ To do so, results are clustered into 1 to 3 categories: High, Medium and Low probabilities, based on the K-means algorithm and the Silhouette method.

Figure: Step 2, IVAN proposes 9 possible diseases, two of them with a high level of confidence. The veterinarian has to check the boxes corresponding to the diseases he estimates the most likely.

6. Available data and processes

➤ Two data sources are available :
1 four-year necropsy reports performed by veterinary necropsy specialists
(Necropsy service of the French veterinary school Oniris)
2 corpus of theoretical knowledge compiled by a veterinarian necropsy specialist

➤ Conditional probability tables are calculated with the R library *bnlearn*

➤ To optimize calculation :
- marginal probabilities are computed "just in time" and results are stored for later use
- propagation calculated only for the branch concerned (Depth-First Search algorithm)

➤ Belief propagation is based on the opposite of causal effect

$$\begin{cases} P(A|X_1, X_2, \ldots, X_n) = \alpha \left[\prod_{i=1}^{n} P(X_i|A) \right] \cdot P(A) \\ \text{with } \alpha = \dfrac{1}{\sum_{i=1}^{n} P(A|X_i)} \end{cases}$$

6. Perspectives

➤ broad assessment of the added value of IVAN in field context
➤ integration of IVAN within a professional software platform
➤ extend to other breeds
➤ include clinical signs to apply on living animals

7. How to cite

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