Holistic LLIS in BioMed

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Objectives

The integration of different concept drifts with active learning stages into a Intelligent System to self-improve (livelong learning, LL) with a minimal supervision.

- Detection of learning events in the different intelligent system modules.
- Holistic evaluation of the different plausible enhancements.
- Generation and explanation of the rationale of the proposals changes.
- Update the knowledge according to the oracle.

Introduction

The availability of new data seems endless. Intelligent systems developed today with scattered or incomplete knowledge require from strong learning and information processing capabilities to cope with concept drifts in order to be useful tomorrow. Intelligent systems' architectures, composed by different modules, each of them relying on its own decision models, and with a defined interaction (labelling) is subject to a constant revision due to the presence of new available data.
Each module can identify a concept drift regarding its model. Moreover, each module can use a different learning technique to update its decision model accordingly. However, an holistic approach is required for the LLIS as a whole. In so doing, labels among the different modules are included in the learning challenge.
Intelligent systems in healthcare not only deal with scatter and incomplete knowledge, but also with data heterogeneity in nature and delivering. In this context, the knowledge snippets that can be educed need a rationale and should be accepted by international advisory committees of experts.
The proposals should include not only the list of changes for approval, but also the new decision support scenario in which the intelligent system is being used and the rationale in human terms.

Hollistic approach

This approach proposes that LL should be applied not only to every module of the intelligent system, but also to the whole system. This means including LL solutions i) for the clustering of the input domain, ii) for the discovery of relationships among clusters and among clusters and labels, iii) for the decision models and iv) for the label set.
The detected changes need negotiation and evaluation: which are the more plausible and how relevant they are. A rationale should be generated in terms the Oracle can deal with. Then, accepted solutions can be deployed.

Challenges

The different module changes can be assumed as agents that negotiate their integration in the final proposal. Each of them needs to explain i) Why the modification is worthy, ii) the support on data, iii) the integration and post-processing requirements, iv) the relevance of the revision, v) the consequences.
To evaluate the different LL solutions, both locally and global evaluation are needed. Local evaluation refers to how far is the current solution to what is needed, while global evaluation refers to the performance together with different combination of modules -both currently in used and new modules. The Oracle is assumed as human experts that decide which is the best solution according to their rationale.

The main points

It is not one single intelligent module but the Whole Intelligent System **which needs the lifelong learning!**
And the experts need Thoughtful Understanding **of the results!**

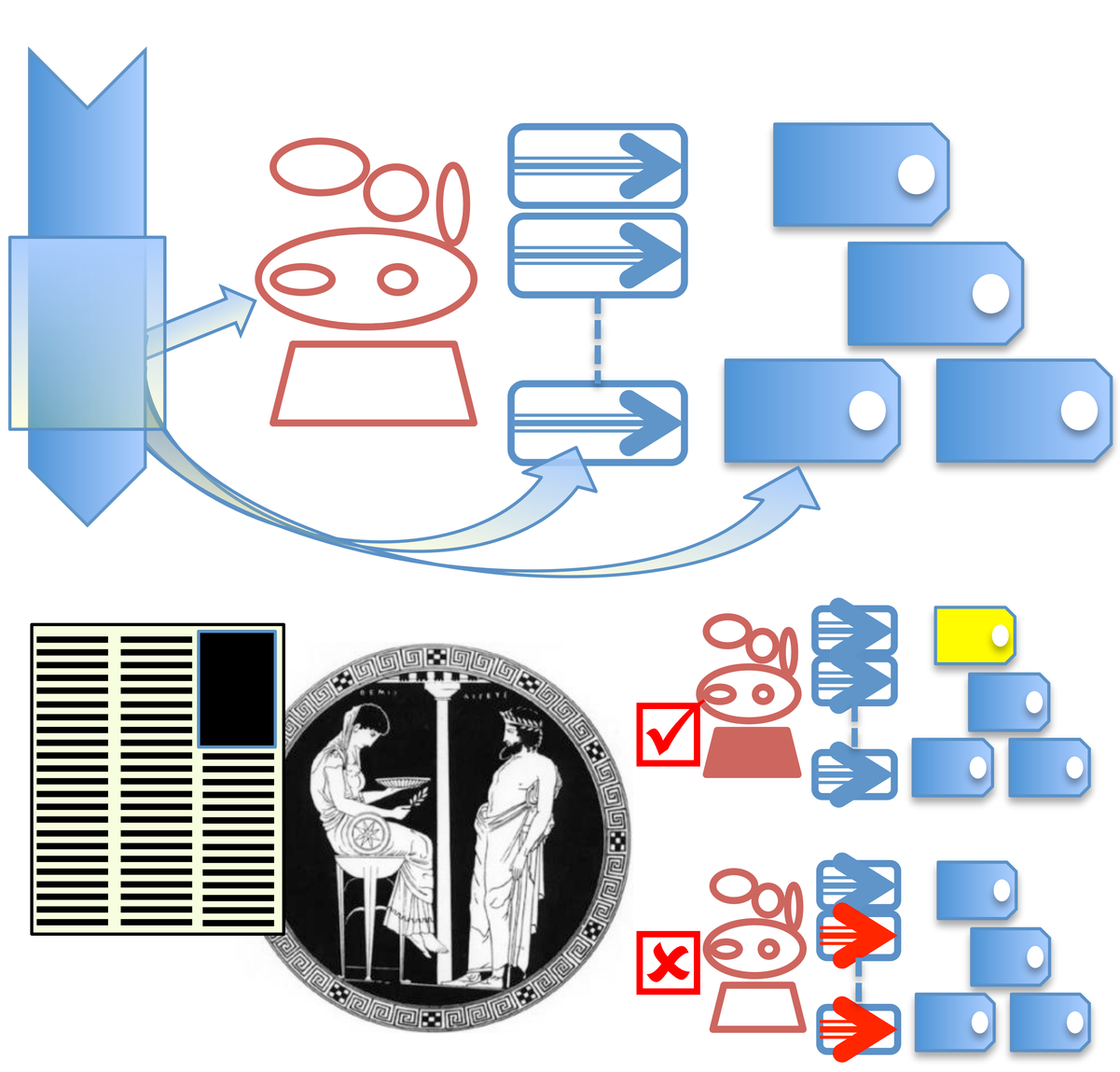

Figure 1: The Oracle is presented with a rationale, showing a performance of each possibility. Then, the conclusions can be drawn and the active learning performs.

Discussion

There are several topics that need further discussion and decision in terms of lifelong learning, for instance, the different parts of an intelligent system need their own lifelong learning solutions.
Besides, the evaluation of the different concurrent learning activities needs special care to avoid exponential computational costs.
Finally, the translation to the Oracle's language becomes mandatory, mainly in BioMed domains. Natural Language Generation comes to term for this purpose.

Application and testing

This project is to be tested with two real world scenarios, using real data.

- ADNI for a better comprehension of the Biomarkers.
- Diabetes patient support.

These real world scenarios, including data from patients obtained from several consecutive years, would help to evaluate if the hypothesis of lifelong learning of the intelligent systems is a solution in those domains where the knowledge is sparse and incomplete.

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Diagnostic accuracy in Alzheimer's disease based in active learning of clinical and biomarkers derived knowledge

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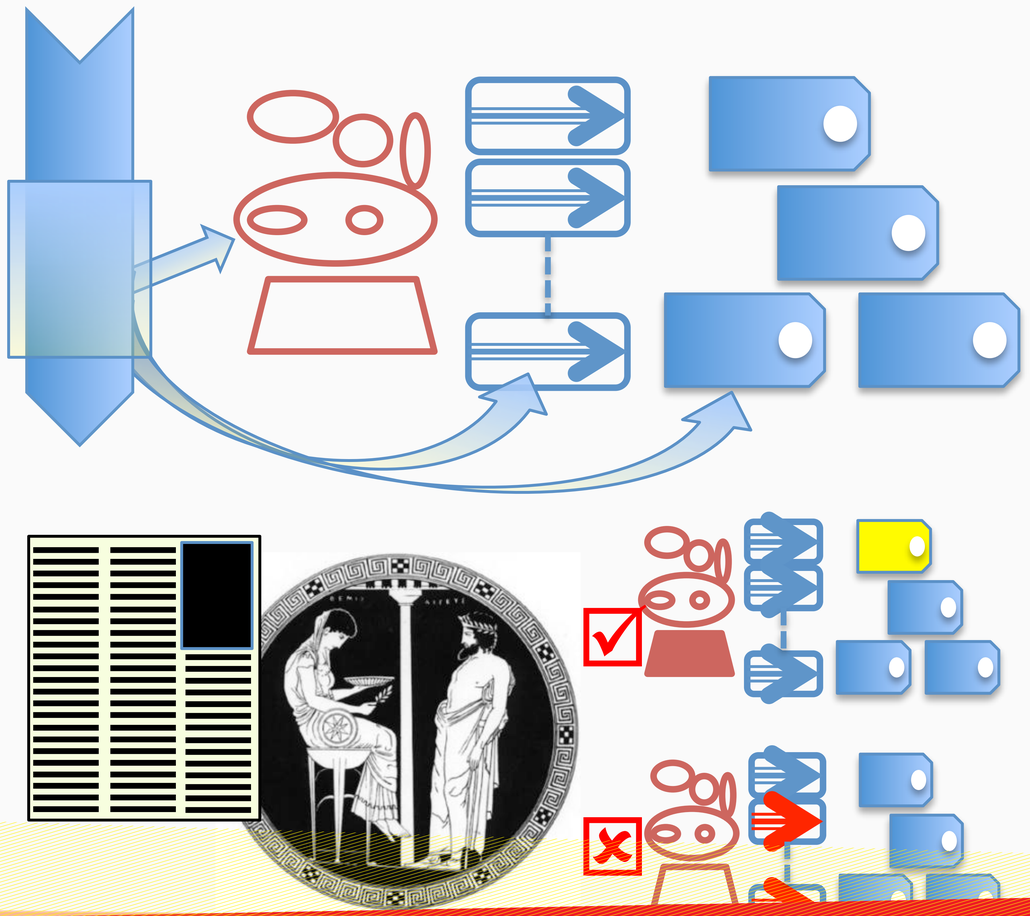

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