

THE LUNA PROJECT: RESULTS FROM THE FIRST YEAR

*Silvia Mosso, Cosmin Popovici
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Loquendo is proud to announce that the FP6-IST LUNA project, coordinated by Loquendo, has successfully completed its first year. The first review of the project was carried out by two scientific experts nominated by the European Commission, and their conclusions were extremely positive thanks to the promising results achieved so far.

The aim of the LUNA project (spoken Language UNderstanding in multilinguAl communication systems) is to realize Spoken Language Understanding components for the fast deployment of **robust automated telephone services**. The ambitious goal of the project is to position itself at the forefront of the **third generation of spoken language interfaces**. Instead of the rigid system initiative, the deployment of Spoken Language Understanding technology can **improve automation rates** and **shorten call times** while maintaining high levels of **customer satisfaction**.

To reach its goals, the project will collect data from users engaged in complex tasks, and investigate algorithms for Spoken Language Understanding (SLU), in order to solve these complex tasks and adapt to the context of a dialog system. The research results will be validated in different domains and in **three languages** (French, Italian and Polish).

Besides Loquendo, the **consortium** is made up of the following organisations: RWTH Aachen, the University of Trento, the University of Avignon, France Telecom, CSI-Piemonte, the Polish-Japanese Institute of Information Technology and the Institute of Computer Science of the Polish Academy of Sciences.

Main results

During the first year of the project the scientific and technical infrastructure was defined. The partners provided a description of the different application scenarios in Italian, French and Polish that would be used for testing the system, as well as a description of the system architecture of the LUNA SLU systems.

Both **human-human and human-machine spoken dialogues** are currently being collected from the different application domains, in the three languages.

A major result for this initial phase was the design of a **flexible, multi-level, annotation protocol** which will be shared with the research community. This protocol is being used by the partners of the LUNA project for the transcription and semantic annotation of the collected corpora. The annotated data are to be used to train statistical models for the LUNA spoken understanding systems.

The **application domains** to be used for the collection of data are the following: in Italian, an information technology help desk is being used, provided by CSI Piemonte, while in Polish, data are being collected from public transport services under the Warsaw Transportation Authority. For the French language, France Telecom 1014 (customer care) and 3000 (customer self-care), as well as a stock exchange service, are being used.

Over the next two years the project will also make use of these services to validate the results, as well as to test out the LUNA SLU system architecture.

The project's major achievements in reaching its **scientific objectives** during the first year were as follows:

As far as **language modelling for Speech Understanding** is concerned, models used in machine translation and models for predicate/argument extraction from partial parses were designed and tested.

Regarding **semantic modelling for Speech Understanding**, the above mentioned annotation protocol was designed and implemented, and semantic composition from basic semantic constituents and words was investigated, as well as progressive understanding in telephone dialog systems.

For **automatic learning**, active learning was applied to French MEDIA data and probability distributions for a Partially Observable Markov Decision Process (POMDP) based dialog strategy were estimated from real data.

The **robustness issues for SLU** were dealt with through new confidence measures and evaluation procedures for SLU in telephone applications.

Finally, the **multilingual portability of SLU components** was addressed through the language independent semantic annotation protocol.

As an industrial partner, Loquendo has been closely involved in changing and adapting the design of the **VoxNauta Platform** and its components (in particular its ASR components) in order to meet the project requirements. Since one of the main goals of the LUNA Project is to process a large number of recognition hypotheses within the SLU module, Loquendo has developed a research version of the VoxNauta Platform (currently available only to the consortium partners) that enables the Word Lattice to be exported to the HTK Standard Lattice Format.

Moreover, Loquendo's experience has proved extremely valuable for the acquisition of corpora, in particular for acquisition by means of the 'Wizard of Oz' approach. Wizard of Oz is a framework for the collection of human-to-computer spoken dialogue in a simulated environment: the user interacts with what appears to be an automated system, but the system's responses are in fact generated by a human operator (the 'wizard').

The Voxnauta Platform has therefore been enriched with new features, and through CCXML a generic Wizard of Oz scenario has been implemented. The consortium partners have then made use of this for the corpora acquisition.

During the first year, to support the multilingual aspect of the project, Loquendo also developed the language pack for the Polish language.

From the research point of view, Loquendo is focusing its activity on the integration of understanding-information within the linguistic knowledge used by the ASR, and on the modelling of out-of-vocabulary speech.

LUNA SLU system architecture

The **architecture** of the LUNA SLU system, as defined and agreed by the partners of the consortium, can be seen in Fig. 1. On the one side, the **Automatic Speech Recognizer** (ASR) exports a large number of recognition hypotheses through the **Word Lattice** that becomes part of the input for the SLU module. On the other side the contextual information provided by the **Dialogue Manager** (DM), like information about the current dialogue act, or information retrieved from the dialogue history, complements the input. The resulting enriched lattice is known as the LUNA Lattice.

For Lattice representation the consortium agreed on the HTK Standard Lattice Format, which is flexible enough to support additions to the contextual information. The format used for the contextual information is XML.

The SLU output is the interpretation lattice. This lattice is also compliant with the HTK Standard Lattice Format. The semantically structured interpretations, represented through an XML string, are linked to the Lattice's transitions.

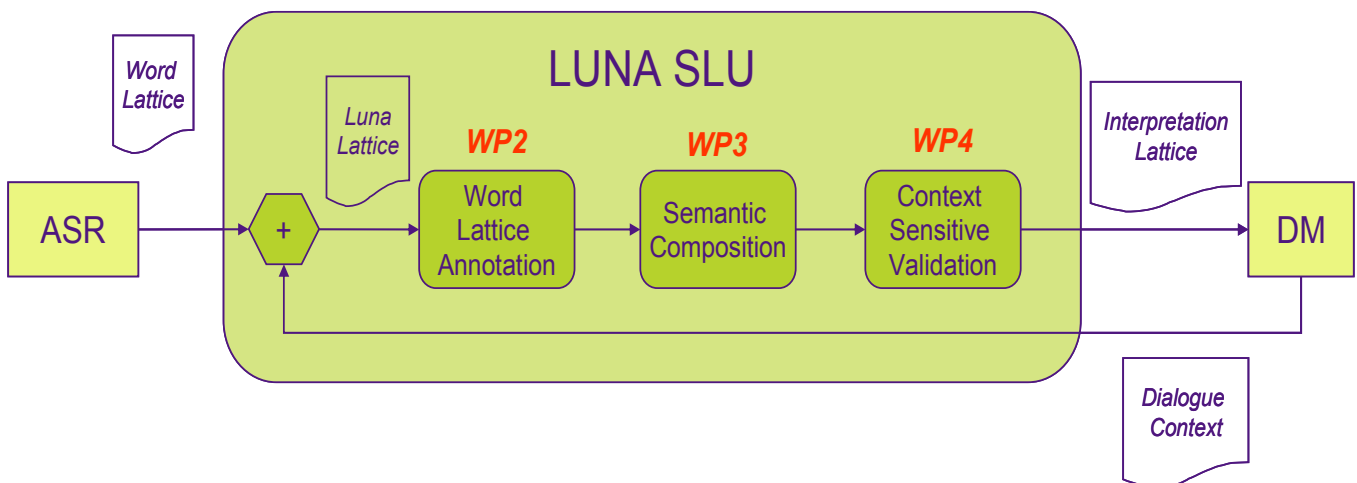


Figure 1 – architecture of the LUNA SLU system

From the architectural point of view, LUNA's SLU module can be broken down into three core sub-modules: the **Word Lattice Annotation** (WLA) module, the **Semantic Composition** (SC) module and the **Context Sensitive Validation** (CSV) module.

The target for the **WLA module** is the generation of semantic concept lattices starting mainly from speech recognition output (word lattices). The main objective is the study of open problems in spoken language understanding research, regarding flat concepts and the implementation of the most promising algorithms into a SLU module. Research work will focus on modelling and training, on robustness, on the exploitation of language models (LMs), and on the coupling of ASR and natural language understanding (NLU).

Before consortium data were available for the training of statistical models within the WLA module, data from the French MEDIA corpus and the ATIS corpus were used.

The **SC module** is responsible for building rich semantic representations of utterances based on the simple concepts produced by the WLA module and contextual information provided by the DM. These semantic interpretations will be scored according to a combination of several confidence scores, some of them related to the ASR models, and some specific to the semantic models. A decision strategy can then be applied, based on these confidence scores, in order to re-score and discard one or several interpretations.

An automatic selection process of problematic utterances, used as an Active Learning strategy, will enrich the SC component

The main objective of the **CSV module** is, firstly, to characterize which contextual information, from the dialogue system, is relevant for SLU and, secondly, to exploit this contextual knowledge through a re-scoring process over semantic structure hypotheses.

Since the **portability** issue, both to a new domain and to a new language, is an important aspect of the LUNA project, this issue is addressed for each sub-module.

Conclusion

As a result of the encouraging results already achieved, the members of the LUNA project were invited, during the first year, to attend some of the most prestigious **conferences** around the world such as INTERSPEECH 2007, ACL 2007 - LAW, ASRU 2007, TSD 2007, at which the project objectives and the preliminary results were presented.

In addition, LUNA co-organized the DECALOG workshop as well as many other events hosted by the various partners.

During the second and third years of the project, the partners will continue their scientific research and will seek to validate the research results by using prototypes of voice-enabled applications.

The industrial partners of the consortium intend to integrate the most promising results in their future commercial products and to deploy large-scale applications; in addition, since one member of the consortium is a provider of IT services to local government, this could be the ideal vehicle for proposing new and advanced services to the public.

Acronyms

CSV	Context Sensitive Validation
DM	Dialogue Manager
FP6	Framework Programme 6
HTK	Hidden Markov Model Toolkit
IST	Information Society Technology
LM	Language Model
NLU	Natural Language Understanding
POMDP	Partially Observable Markov Decision Process
SC	Semantic Composition
SLU	Spoken Language Understanding
XML	eXtensible Markup Language
WLA	Word Lattice Annotation

Useful links

LUNA website: <http://www.ist-luna.eu>

Community Research & Development Information Service: <http://cordis.europa.eu/en/home.html>

FP6 home page: <http://cordis.europa.eu/fp6/dc/index.cfm?fuseaction=UserSite.FP6HomePage>

ACL 2007 - LAW: <http://ufal.mff.cuni.cz/acl2007/workshops/program/index.php/ws10>

ASRU 2007: <http://www.asru2007.org>

DECALOG: <http://www.cimec.unitn.it/events/decalog/index.htm>

INTERSPEECH 2007: <http://www.interspeech2007.org>

TSD 2007: <http://liks.fav.zcu.cz/tsd2007/>

MEDIA corpus (ELRA's catalogue):

http://catalog.elra.info/product_info.php?products_id=998&language=en

ATIS corpus (Linguistic Data Consortium catalogue):

<http://www ldc.upenn.edu/Catalog/CatalogEntry.jsp?catalogId=LDC95S26>