6.1 INTRODUCTION

For decades it has been obvious that one of the last remaining frontiers of IT is still separating our rapidly evolving technological world of mobile devices, computers and the internet from the most precious and powerful asset of mankind, the human mind, the only system capable of thought, knowledge and emotion. Although we use computers to write, telephones to chat and the web to search for knowledge, IT has no direct access to the meaning, purpose and sentiment behind our trillions of written and spoken words. This is why technology is unable to summarise a text, answer a question, respond to a letter and to translate reliably. In many cases it cannot even correctly pronounce a simple English sentence. Visionaries such as Ray Kurzweil, Marvin Minsky and Bill Gates have long predicted that this border would eventually be overcome by artificial intelligence including language understanding whereas science fiction such as the Star Trek TV series suggested attractive ways in which technology would change our lives, by establishing the fantastic concept of an invisible computer that you have a conversation with and that is able to react to the most difficult commands and also of technology that can reliably translate any human and non-human language.

Many companies had started much too early to invest in language technology research and development and then lost faith after a long period without any tangible progress. During the years of apparent technological standstill, however, research continued to conquer new ground. The results were a deeper theoretical understanding of language, better machine-readable dictionaries, thesauri and grammars, specialised efficient language processing algorithms, hardware with increased computing power and storage capacities, large volumes of digitised text and speech data and new methods of statistical language processing that could exploit language data for learning hidden regularities governing our language use. We do not yet possess the complete know-how for unleashing the full potential of language technology as essential research results are still missing. Nevertheless, the speed of research keeps increasing and even small improvements can already be exploited for innovative products and services that are commercially viable. We are witnessing a chain of new products for a variety of applications entering the market in rapid succession.

These applications tend to be built on dedicated computational models of language processing that are specialised for a certain task. People, on the other hand, apply the basic knowledge of the language they have acquired during the first few years of their socialisation, throughout their lives to many different tasks of varying complexity such as reading, writing, skimming, summarising, studying, editing, arguing, teaching. They even use this knowledge for the learning of additional languages. After people have obtained proficiency in a second language, they can already translate simple sentences more fluently than many machine translation systems, whereas truly adequate and stylistically acceptable translation is a highly skillful art gained by special training.
Today, no text technology software can translate and check for grammatical correctness and no speech technology software could recognise all the sentences it can read aloud if they were spoken by people in their normal voices. But increasingly we observe a reuse of core components and language models for a wide variety of purposes. It started with dictionaries, spell checkers and text-to-speech tools. Google Translate, Apple’s Siri and IBM Watson still do not use the same technologies for analysing and producing language, because the generic processing components are simply not powerful enough to meet their respective needs. But many advanced research systems already utilise the same tools for syntactic analysis. This process is going to continue.

In ten years or less, basic language proficiency is going to be an integral component of any advanced IT. It will be available to any user interface, service and application development. Additional language skills for semantic search, knowledge discovery, human-technology communication, text analytics, language checking, e-learning, translation and other applications will employ and extend the basic proficiency. The shared basic language competence will ensure consistency and interoperability among services. Many adaptations and extensions will be derived and improved through sample data and interaction with people by powerful machine learning techniques.

In the envisaged big push toward realising this vision by massive research and innovation, the technology community is faced with three enormous challenges:

1. **Richness and diversity.** A serious challenge is the sheer number of languages, some closely related, others distantly apart. Within a language, technology has to deal with numerous dialects, sociolects, registers, professional jargons, genres and slangs.

2. **Depth and meaning.** Understanding language is a complex process. Human language is not only the key to knowledge and thought, it also cannot be interpreted without certain shared knowledge and active inference. Computational language proficiency needs semantic technologies.

3. **Multimodality and grounding.** Human language is embedded in our daily activities. It is combined with other modes and media of communication. It is affected by beliefs, desires, intentions and emotions and it affects all of these. Successful interactive language technology requires models of embodied and adaptive human interaction with people, technology and other parts of the world.

It is fortunate for research and economy that the only way to effectively tackle the three challenges involves submitting the evolving technology continuously to the growing demands and practical stress tests of real world applications. Google’s Translate, Apple’s Siri, Autonomy’s text analytics and scores of other products demonstrate that there are plenty of commercially viable applications for imperfect technologies. Only a continuous stream of technological innovation can provide the economic pull forces and the evolutionary environments for the realisation of the grand vision.

In the remainder of the Chapter, we propose five major action lines of research and innovation:

- Three priority themes connected with powerful application scenarios that can drive research and innovation. These will demonstrate novel technologies in attractive show-case solutions of high economic and societal impact. They will open up numerous new business opportunities for European language-technology and -service providers.

- A steadily evolving system of shared, collectively maintained interoperable core technologies and resources for the languages of Europe and selected economically relevant languages of its partners. These will ensure that our languages will be sufficiently supported and represented in the next generations of IT.