High Performance in Text Processing : the CPP-TRS Environment

Graziella Tonfoni
Author of CPP-TRS
and CPP-TRS Applications Designer
at The CPP-TRS Lab.
Via Palestro 13
40123 Bologna, Italy
ph/fax +39-51-581246

and at the
University of Bologna, Italy
E-mail: tonfoni@alma.unibo.it

Abstract

A dynamic system for integrating natural language and vision is presented, specifically aimed toward supporting an interpretative model and a set of conceptual tools, which may consistently represent those qualitatively different aspects of natural language, which are opaque and therefore difficult to identify.
Qualitative reasoning about communication via natural language is being proposed as to allow identification and consistent definition of different values of each communicative action performed and reflecting upon texts, text segments and text units.
A visual representation system and a highly articulated and precise terminology are being used in order to explicitate results of observation of close relationships existing between language and visual perception phenomena as well as relevant concretions.
Terminology coming from vision is also being redefined as to adapt to precise definition of very specific natural language problems at various levels of complexity such as ambiguity, context dependency and non systematicity.
CPP-TRS (Tonfoni,1989-94) means precisely Communicative Positioning Program-Text Representation Systems; the main concept the new framework is based upon is that text processing can be effectively enhanced by first recognizing various and qualitatively different kinds of knowledge representation processes, which are involved and then visualizing them consistently.
Based on a very simple syntax, CPP-TRS is aimed toward representing and conveying communicative function, intention and turn-taking visually.

Keywords

Text Visualization - Transparency - Text Perception - Communicative Pattern Recognition - Text Segmentation - Text Compression

Introduction

Just like a scientist can isolate a molecule or discover the nature of a certain component in physics or in chemistry, it is possible to identify a basic cognitive component in human communicative behaviour, surfacing in actual language performance and analyze it carefully as to finally define it "the communicative positioning". (CPP-TRS Theory of Text Comprehension, Tonfoni , 1989-94).
It is based on such discovery that it is possible to proceed toward consistent organization of a "high speed communicative code" for highering information transparency and communication effectiveness, which reflects directly what has been observed to be happening naturally and make it visible (CPP-TRS Theory of Text Compression, Tonfoni , 1995).
More precisely the CPP-TRS Theory of Text Comprehension is for improving textual resolution, promoting active sensing and perception, enhancing visualization of information distribution, highering speed in knowledge processing, increasing reliability in positioning detection by communicative pattern recognition and increasing reliability in information structuring by promoting active text sensing and perception.
The CPP-TRS Theory of Text Compression (Tonfoni, 1995) is specifically for active processing and utilization of information redundancy, active processing and utilization of contradictory information, active extraction of abstractive

knowledge, high speed and high accuracy sensing and perception, active knowledge acquisition and noise reduction, effective processing of uncertain information and solving of illposed problems, consistent determination of sensing and perception strategies.
CPP-TRS is both a methodology and a language; through the methodology (CPP) very specific and precisely defined aspects of communicative interaction are first identified and then visually represented by the metalanguage (TRS).
CPP-TRS is a visual language based on a consistent combinatorial syntax of 12 canvas, 10 signs, 14 symbols and a wider set of visual dynamic schemes, therefore representing alltogether an unambiguous, both natural and conventional system for effectively supporting any kind of communicative interaction occurring in natural language, by conveying global communicative function of a text as well as local communicative intention and turn-taking of single paragraphs and sentences.
It is also a programming language in itself, which works on top of natural language.
Textual instructions are given both in a statement by statement manner and through meaningful graphic representations.
If vision reflects the information processing task of understanding a scene from its projected image, the same way both CPP-TRS Theory of Text-Comprehension (Tonfoni , 1989-94) and CPP-TRS Theory of Text-Compression (Tonfoni , 1995), upon which the system is based, show the task of understanding and processing a text from its projected communicative positioning .
If a very important task of a natural language processing system is to do text processing, text function identification and consequently text classification by communicative pattern recognition, the task of a CPP-TRS based text processing system is specifically to proceed toward signs and symbols identification as to achieve communicative pattern recognition.
It is absolutely important to recognize that text understanding is in fact a very hard task; given a certain text, a CPP-TRS based text understanding program will be able to build a solid description not just of those topic related knowledge domains, which are involved - here defined text images - but also of the complex and threelayered positioning they depict - here defined text scenes-.
In Artificial Intelligence research a lot of efforts have been addressed toward identifying and analyzing -text images-, means both in syntactic parsing and in knowledge representation, which may both and together be defined as twodimensional processing; the CPP-TRS approach is meant to specifically address threedimensional analysis of text scenes.
Text image research requires knowledge about the task as well as sophisticated text image processing techniques and, just like in vision, natural language processing may entail a set of text enhancement procedures.
Just like there are different levels of information processing in computer vision, the same way there are different levels of natural language information processing in a CPP-TRS based text processing system .
Early processing has been of syntactic nature, knowledge representation structures and primitives identification have followed (Minsky, 1975; Schank, 1981).
Early syntactic processing and knowledge representation have basically handled sentences and paragraphs, which maybe defined in terms of lines and regions, whereas implicit versus explicit knowledge maybe defined in terms of information intensity and change of information intensity and goal orientation maybe defined in terms of informative edge elements orientation, means concepts, from the original information intensity array.
CPP-TRS based text processing is specifically aimed toward building up descriptions of textual scenes, which means three dimensional text analysis .
What may look easy in communication via natural language is actually extremely difficult to represent, therefore any theory of natural language and any model, which may be derived as to be practically used, will show a high level of inherent complexity, therefore indicating the need for finding different solutions to qualitatively different problems.
Text understanding based on a text image oriented approach, means based exclusively upon syntactical representation and knowledge representation is incomplete, just like in vision an image may actually underconstrain a scene.
Many factors play different roles in a very fuzzy way and may be confounded in an image; all of these factors contribute to the intensity of a pixel, but at an image stage it is quite difficult to determine the contribution of each factor to a pixel value.
The very same way different factors play different roles in text understanding and it is very important to recognize them active.
Understanding an image requires a priori knowledge, the same way is for a text image referring to a certain knowledge domain.
Image understanding and text image understanding, meaning precisely visual perception and text perception, are strictly dependent on expectations and knowledge representation structures are a very important support for expectations.
There is some inherent "blindness" in any natural language system, which is not based on expectations in terms of knowledge slots, which may be filled in.
There exist, in any case, different kinds of expectations, like syntactical expectations, which are driven by a certain grammar and knowledge representation expectations triggered by frames

(Minsky, 1975), scripts (Schank , 1981), plans (Wilensky, 1983) and plot units (Lehnert, 1981). There exist also communicative positioning expectations, which may be defined as more or less consensually shared expectations and alltogether allow a text scene to be understood in its full complexity.

Just like there has been computer image processing prior to computer vision, there has also been computer natural language processing prior to CPP-TRS based computer text processsing.

In early syntactic and knowledge representation research, in order to reach some positive results, sequences of language, means sentences and paragraphs were rather simplified through some process, which maybe defined in terms of "noise reduction": the approach, which was applied, was a rather sequential one.

In the early years of vision research, numerous techniques were developed for extracting lines and edges from images; Winston (1970) has very innovatively started thinking of extracting concepts out of narrative texts, drawing very significant analogies between vision and natural language.

After edge elements are detected, they are then grouped into meaningful lines; nevertheless gaps or noise occurrences may significantly complicate the process.

Another step in image analysis is region identification; segmenting an image into regions is the exact complementary process to edge detection; the process was nevertheless observed to be quite difficult.

Regions may be overdivided or underdivided: a region may correspond to more than one surface and surface variations may split a whole surface into several regions.

Based on the same assumptions, text segmentation is a difficult process: paragraphs and sentences may be overdivided or underdivided and a conceptual territory may correspond to more than just a sentence or a paragraph.

Some further analogies maybe drawn between research done in vision and in natural language processing by stating that a semantic based region analyzer (Yakimovsky and Feldman, 1973) and an interpretation guided segmentation (Tenenbaum and Barrow, 1976) may work just like a script or plan based analyzer (Schank, 1981; Wilensky, 1983) .

Marr's contribution and theory has been crucial for research in vision.

Marr (1978) underlines the need for choosing appropriate kinds of representation for different levels in vision processes. In natural language research it is extremely important to be able to differentiate among different levels of understanding in accordance with Minsky (1975), Schank (1981), Wilensky (1983); the role of a certain kind of representation is precisely to make certain information explicit at an appropriate level during the analysis of a certain text.

The choice of a certain kind of representation will therefore deeply affect the kind of analysis which a text may consistently undergo.

An advanced stage in text processing may be foreseen, getting from a twodimensional text image analysis into a threedimensional text scene analysis and such process will involve inferring text scene features from text image features.

Text scene features are precisely communicative function, communicative intention and communicative turn-taking, which are precisely identified, defined and represented in CPP-TRS (Tonfoni, 1989-94).

A threedimensional text scene analysis corresponds to a process of description and recognition of natural language inherent complexity, therefore integrating consistently already existing models for twodimensional text processing and finally obtaining three dimensional text processing.

Three dimensional text processing systems may be able to sense the communicative environment, sensing meaning precisely detecting and reconstructing the communicative positioning of a certain text both globally and locally.

We cannot forget that text processing systems handle language material, which comes out of a noisy and variable communicative environment; high performance in text processing may consequently involve enhancement and readjustment at different stages and degrees.

The specific task of a CPP-TRS based system for high performance in text processing is therefore to facilitate communicative pattern recognition first as to then proceed toward text identification and classification, within a certain communicative environment, which means precisely by detecting and reconstructing communicative positioning of a given text, both globally through signs and locally through symbols.

A CPP-TRS based text preprocessor will be able to visually and consistently preorganize information texture according to a set of decision making processes which are active before a text is actualized.

A set of qualitative communication indicators will therefore be visually preprogrammed as to complement an actual text.

Starting from global control indicators, CPP-TRS will provide signs, which are global control icons for explicitating communicative function of the text and will then provide local control indicators; two kinds of symbols are actually available.

The first kind of symbols, called "cognitive symbols" or "style symbols", indicate paragraph by paragraph or sentence by sentence, communicative intention, reflecting upon different styles and therefore affecting the syntactic level at a final stage.

Each of these symbols represents consistently the kind of operation, which is designed to convey and has a very specific and highly technical meaning, that identifies a specific intention to be indicated for

consistent text perception and comprehension as to then proceed toward consistent text compression.
The second kind of symbols, called turn-taking symbols, indicate explicitly the kind of interaction requested.
Preprocessing as a first step for enhancement is a very common practice in visual data processing; the same maybe applied to natural language text preprocessing as to be able to enhance communication effectiveness and consequently achieve consistent text perception.
CPP-TRS text preprocessing will result into two different kinds of operations, which are precisely the following ones:

1) Reconstruction of a higher quality text from a lower quality text;

2) Enhancement and improvement of quality in the original text by eliminating ambiguity and vagueness, when needed, and by emphasizing selected concepts, in order to facilitate further and more sophisticated stages in text processing.

All text preprocessing techniques are aimed toward enhancing visibility of text function , intention and turn-taking, which are precisely the most difficult aspects to be represented in natural language, as to facilitate text comprehension and any kind of possible operation on text like summarization, active processing and utilization of information redundancy, active processing and utilization of contradictory information, active extraction of abstractive knowledge and textual noise reduction.
As a consequence, it will also be possible to improve textual resolution, as to enhance visualization of information distribution, to higher speed in knowledge processing and to increase accuracy and reliability in communicative positioning detection through communicative pattern recognition.
In CPP-TRS a consistent process of labeling, which will make transparent those aspects of language that are most difficult to represent, is made possible.
A very important aspect of text perception enhancement is the correction of functional or intentional or turn-taking distortion, which can be performed and actualized through a combination of specific CPP-TRS tools and corresponding techniques.
If the text is supported by a satisfactory set of control elements, both a distortion model and an idealized model may be generated according to a precise set of rules. A CPP-TRS based text preprocessing interactive system can be of tremendous assistance in assembly handling and inspection of natural language information packages, by allowing consistent recognition and identification of respective positioning and orientation.
What would otherwise be gathered and processed in a random or non fully consistent way, may through CPP-TRS gain speed, accuracy and consistency, by lowering costs and time of inspection based on visibility and reliability of a commonly shared therefore easily recognizable set of consensual text operations.
An intrinsic advantage of a commonly shared system of reference for interpretation is the possibility of constituting a solid basis for accurate requests about very specific operations to be then performed upon text according to a set of expectations to be fulfilled .
The qualitative value of information has been explicitly recognized, carefully analized and defined in CPP-TRS first as to constitute a shared standard to be then consensually interpreted.
By being able to identify the qualitative value of a given text as well as of differing parts in a highly articulated text, any user will not only be able to ask for a different quantity of information, but will also get support for identification of qualitative value of requested information.
According to the very same principles, the user will also be able to modify, add, delete and substitute parts of a text by explicitly declaring which kinds of operations have actually been performed .
Everything can be made transparent thanks to a visual consistent system of representation, which may also allow to trace back both choices, which have been made and consistent procedures, which have been applied accordingly.

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A precious support for my research on transferring different visual models into a comprehensive text processing model was The Handbook of Artificial Intelligence eds. P.R. Cohen and E.A. Feigenbaum, Heuristech Press and William Kaufmann Publishers, 1982.

Many observations made about vision, proved to be valid and transportable to natural language processing.

It is possible to notice that references tend to be quite old. This is precisely because the perspective here being presented can be related mostly to those original sources; certainly not to diminish the extremely valuable work done successively and more precisely in Natural Language and Vision Integration meetings, one of which was the 1995 AAAI Fall Symposium.

A wider bibliography by the author is available in italian and in english, which has been indicated here as Tonfoni (1989-94 and 1995).