New Developments in Fuzzy Sets, Intuitionistic Fuzzy Sets, Generalized Nets and Related Topics. Volume II: Applications

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Dedicated to Professor Beloslav Riečan on his 75th anniversary

Limited syntactic analysis in music data processing

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Abstract

This paper describes an attempt to intelligent processing of the structured information space of the music. The large data requires partial processing, especially when such method does not lead to information lost. Processing always involves with performing operation, which is essential activity is space of data.
This paper shows our approach to intelligent processing as well as its consequences. Our attempt bases on extracting the smallest subtrees for specific operation and, by using Attribute Grammars, allowing to determine the real scope of this operation.

Keywords: syntactical structuring, data understanding, music data processing, intelligent processing.

1 Introduction

As time goes, people collect a lot of information. Pieces of this information, on its own, are often heavy. Nothing indicates that this situation is going to change. Our society will gather more and more information of different types: audio, video, image, text... Some of this data will not be touched or mentioned in the future, but the other part will probably turn out to be important and require processing.

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Very interesting activity is to act processing in an intelligent way. Processing in an ”intelligent way” means to process the smallest possible part of the entirety. The smallest part is not always known at the beginning of processing, because some parts (even non-consistent ones) are interdependent.

This work is approach to intelligent processing the structured information space of music, especially Braille and Printed Music Notations. Our interest is focused on this spaces because of our recent works on BrailleScore - application that allows blind peoples converting and editing Printed and Braille Music Notations.

Processing the data occurs after or before performing operations on structured information space. Processing the data has some purposes to be achieved. This purposes can be considered as operation to be performed on information space. Roughly speaking, processing always involves with performing operation.

Some examples of operations on structured information space of Braille Music and theirs layering in regard of hardness/easiness is given in [1]. That paper concerned only operations that does not change structure of document (searching and non-invasiveness, editing operations).

2 Goals to achieve

Amongst enticing aspects and consequences of intelligent processing the structured information space (in this case: the space of music) are not only the efficiency ones such as time and resources saving. By finding overall mechanism for intelligent processing will be obtained better knowledge of information space's structure and its parts' dependencies.

2.1 Limited processing

This observations will allow processing the smallest possible part of the entirety (Fig. 1). As was stated formerly, processing is involved with performing operations. In this case, after or before performing operation, there is a need to process some part of the entirety. The smallest part is indicated in the Fig. 1, by red color. Determining this area requires partial preprocessing, when this part was not affected by any operation before. The Fig. 1 shows the blindingly obvious aspect of limited syntactic analysis.

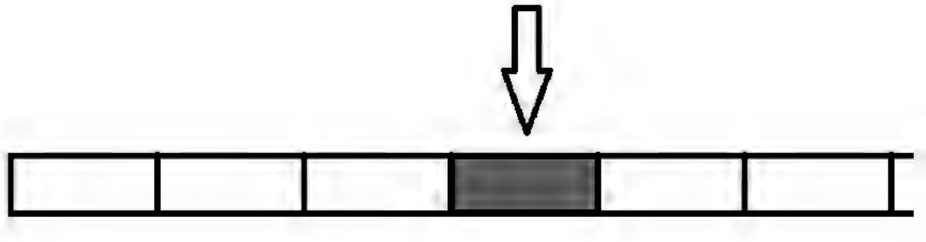

Figure 1: Processing the smallest part of the entirety.

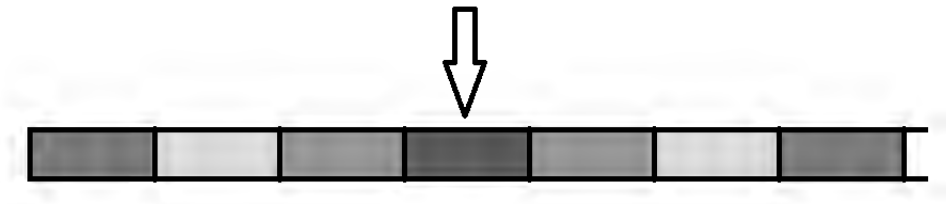

Figure 2: Determining operation boundaries.

2.2 Operation boundaries

Another result of intelligent processing the structured information space is the ability to determine operation boundaries. This is illustrated by Fig. 2. There is a part, where operation performed (red one selected by arrow). Some parts in neighborhood are also affected by this operation, but in lower degree (hues of pink). At least some part were not affected by this operation, are operation-free (green ones). The boundaries describe the scope of the specified operation.

2.3 Mutual dependency

The other result of limited syntactic analysis is the ability to determine mutual dependency between non-consistent parts of large data in regard to specified operation. Thanks to intelligent processing there can be measured a degree of dependence between two selected parts of data and as well as between each of this parts and part affected by operation. This is illustrated by Fig. 3. This dependency is always *in regard to* some operation.

3 Structured Space of Music Data

Both Printed and Braille Music Notation is given by Context-free Grammar (CFG). Probably Context-free Grammar is not enough for Printed and Braille Music No-

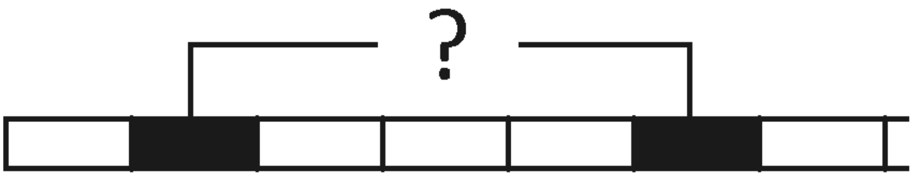

Figure 3: Mutual dependency between parts of large data.

tation languages. Probably this natural languages are given by Context-sensitive Grammar (CSG). We decided to use Context-free Grammar, because this types of grammars are better studied and are much more easy to process by computer. Our Context-free Grammars are an approximations of real grammars for Printed and Braille Music Notation grammars, i.e. they describe all possible language structures, but also incorrect ones. We assume that this grammars will not be use in malicious way.

Context-free Grammar (CFG) is a tuple $G = (V, T, P, S)$, where:

- V is a finite set of *variables* (called also *nonterminals*),
- T is a finite set of terminal symbols (simply called *terminals*),
- a nonterminal S is the initial symbol of the grammar,
- P is a finite set of productions,
- $(\forall p)(p \in P \Rightarrow p \in V \times (V \cup T)^*)$

Any piece of notation is created by derivation tree, which is governed by grammar rules.

The Context-free Grammars for Printed and Braille Music Notation as well as derivation trees examples were given in [2] and [1] respectively.

4 Intelligent processing

At any time of processing a data there is an ability to analyze a whole notation, which means that a whole derivation tree is examined. The derivation tree is large data structure. Analysis consumes more time and resources than it should and is needless and redundant. As was stated formerly, the single performed operation impacts only a part of the entirety.

Processing the smallest possible part of the entirety means to process the smallest subtree rooted in one of a nodes of a derivation tree of whole notation. The nodes in a derivation tree determine quanta of information.

4.1 Determining quanta of information

The size of quanta of information is operation dependant. Each operation has its own scope. To determine the size of quantum of information in regard to specified operation there is a need to attach some semantic information to derivation tree structure. There is a need to use Attribute Grammars.
By marking some inter-(voice, measure, ...) attributes and following theirs flow through derivation tree, there is a chance to detect smallest subtrees that is being searched.

4.1.1 Boundaries

We got a fix on boundaries for the quanta of information, that are defined by the smallest subtrees.

The lower boundary is the smallest subtree, that derived a directly affected notation's unit (that can be a note, a voice, a measure, ...).

The upper boundary is the whole derivation tree.

The optimal subtree is rooted somewhere between the lower and the upper boundary.

4.1.2 Risks

There are several risks associated with fixing boundaries. To wide subtree causes redundant processing and increases time and resources consuming. To narrow subtree causes block of attributes flow through a derivation tree and leads to improper processing.

4.2 Initial results

Our initial study leads us to conclusion, that some elements of music notation are good candidate to be selected as attributes in Attribute Grammar. For grammars shown in [1] and [2] and for Braille and Printed Music Notation respectively the best candidates appears to be ”long” symbols such as slurs, wedges, ties. For Braille Music Notation octave sign is also good candidate to be attributed.

4.2.1 Example

Figure 4 presents an example of Printed Music Notation that contains ”long” symbols, in this case: slurs and ties. The example shows two measures and beginning of the third one. There are three slurs (one of them is inter-measure) and one chord tie (that is built from two ties).

Figure 4: Measures with ”long” symbols: slurs and ties

Until consideration covers inner-measure slurs, and also assumes operation on single measure, we do not need to process anything above the specified measure. Performed operation affected one measure and we process one measure.

In this example, in case of inter-measure slur, we need to process both measures even if performed operation affected the single measure’s part of the slur. But that is the all that should be processed. The third measure is not going to be analyzed.

5 Future work

This approach is at very initial stage. We are going to prepare Attribute Grammars for Printed and Braille Music Notations and examined the attribute’s flow through the derivation tree. This will allow us to define much more precisely each operation’s scope.

We will try to extend this approach to other music formats. The next step will be generalization of this approach to other spaces of information, not necessarily music information.

We will perform a deeper study on consequences of this intelligent processing such as: operation boundaries and a mutual dependency of non-consistent parts of the large data.

Acknowledgment

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[1] Homenda, W., Sitarek, T.: Performing Operations on Structured Information Space of Braille Music. In: Andreas Knig, Andreas Dengel, Knut Hinkelmann, Koichi Kise, Robert J. Howlett, Lakhmi C. Jain (Eds.) KES 2011. LNCS (LNAI), vol. 6884, pp. 232-241. Springer, Heidelberg (2011)

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The papers presented in this Volume 2 constitute a collection of contributions, both of a foundational and applied type, by both well-known experts and young researchers in various fields of broadly perceived intelligent systems.
It may be viewed as a result of fruitful discussions held during the Tenth International Workshop on Intuitionistic Fuzzy Sets and Generalized Nets (IWIFSGN-2011) organized in Warsaw on September 30, 2011 by the Systems Research Institute, Polish Academy of Sciences, in Warsaw, Poland, Institute of Biophysics and Biomedical Engineering, Bulgarian Academy of Sciences in Sofia, Bulgaria, and WIT - Warsaw School of Information Technology in Warsaw, Poland, and co-organized by: the Matej Bel University, Banska Bystrica, Slovakia, Universidad Publica de Navarra, Pamplona, Spain, Universidade de Tras-Os-Montes e Alto Douro, Vila Real, Portugal, and the University of Westminster, Harrow, UK:

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The consecutive International Workshops on Intuitionistic Fuzzy Sets and Generalized Nets (IWIFSGNs) have been meant to provide a forum for the presentation of new results and for scientific discussion on new developments in foundations and applications of intuitionistic fuzzy sets and generalized nets pioneered by Professor Krassimir T. Atanassov. Other topics related to broadly perceived representation and processing of uncertain and imprecise information and intelligent systems have also been included. The Tenth International Workshop on Intuitionistic Fuzzy Sets and Generalized Nets (IWIFSGN-2011) is a continuation of this undertaking, and provides many new ideas and results in the areas concerned.

We hope that a collection of main contributions presented at the Workshop, completed with many papers by leading experts who have not been able to participate, will provide a source of much needed information on recent trends in the topics considered.

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