

The Formalization of English Structures with “on” and Their Chinese Translations*

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Abstract—One of the main problems that affect the quality of machine translation is how to express the knowledge of language in precision. Based on the theory of Semantic Element (SE) and Semantic Element Representations (SER) in Unified Linguistics, the classification of English structures with preposition “on” is proposed from the perspective of C-E and E-C translation. These English structures and their Chinese translations are further formalized into English and Chinese SER respectively.

Index Terms—English preposition “on”, Chinese translation, formalization, SE, SER

I. INTRODUCTION

The history of machine translation is more than a half century long, but its quality is still poor and the machine translation systems still haven't reached the practical phase. The key lies in linguistics, that is, the knowledge of language cannot be expressed in precision, although many famous linguists have made many important achievements from different angles of study.

Prepositions are a class of active and commonly-used words in Chinese, which are seldom used alone, but with verbs, nouns and adjectives. Therefore we should set the study of prepositions into a dynamic context and analyze the relationships between prepositions and their collocated elements. Scholars at home or broad have studied on prepositions from various angles. In linguistics, prepositions have been studied in the aspects of syntax, pragmatics, cognition and second language teaching (Zhang, 2002; Yong, 2007; Cai, 1999). In MT field, prepositions have been studied in the aspects of PPA (prepositional phrase attachment) and WSD (word sense disambiguation) (Zhao, 2001; Feng, 2004; Guan, 2009).

In order to improve the quality of machine translation, we need to represent natural languages precisely. This paper offers an account of one problem of the precision of natural language: the formalization of English structures with preposition “on” and their Chinese translations. In section 2, we discuss the classification of English structures with preposition “on”. Section 3 presents the formalization of English structures with preposition “on” and their Chinese translations based on the theory of SE and SER.

II. THE CLASSIFICATION OF ENGLISH STRUCTURES WITH PREPOSITION “ON”

“COBUILD English-Chinese Dictionary” (Sinclair J., 2002), “Collins COBUILD Grammar Patterns 1: Verbs” (Sinclair J., 2002) and “Collins COBUILD Grammar Patterns 2: Nouns and Adjectives” (Sinclair J., 2002) give a comprehensive account of the verb, noun and adjective patterns of English, using COBUILD (The Bank of English) which now stands at 350 million words of current written and spoken English. Through the reliability and objectivity of the computer evidence, words can be subdivided according to patterns, and patterns can be seen to correlate with meaning.

In this paper, “N” denotes noun, “A” denotes adjective, “V” denotes verb, “P_{poss}” denotes possessive pronoun, “V_{ing}” denotes verb with progressive tense, “W_{h-clause}” denotes clause with relative adverb, “[]” represents the relation “or”, “[]” represents the words in it can appear in this structure.

A. The Structure “on N”

There are 30 types of the structure “on N” by the semantic meaning of collocated “N” in (Sinclair J., 2002). We can further divide them into the following types:

- set phrase (e.g.: Troops stationed in the region have been put *on alert*. She was obviously worried and *on edge*. The deal has been put *on ice* because there appears to be a problem over the fee.)
- “on [P_{poss} |the] N [V_{ing}” (e.g.: He was the best player *on the field*. She lives with her family *on the outskirts of Birmingham*.)
- “on [the] N+ other preposition +N [V_{ing}” (e.g.: The lifebelts were *on top of the wardrobe*. I was *on the point of returning* to bed when a motor bus chugged into view.).

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B. The Structure “N on N”

There are 21 types of the structure “N on N” by the semantic meaning of collocated “N” before “on” in (Sinclair J., 2002). We can represent the structures by only one expression “[P_{poss} |the |a |an] N on N |V_{ing} |W_{h-clause}” (e.g.: I would welcome *any comments on the book*. *His views on maintaining the family as the bedrock of stability* were widely applauded. *The decision on what to do with the economy* has now been put off until Monday.).

C. The Structure “N be A on N”

There are 13 types of the structure “N be A on N” by the semantic meaning of collocated “A” before “on” in (Sinclair J., 2002). We can represent the structures by only one expression “N be A on N |V_{ing}” (e.g.: Tea-tree oil is gentle *on the skin*. He’s always very intent *on doing what he wants*.)

D. The Structure “N V on N”

There are 3 types of the structure “N V on N” according to (Sinclair J., 2002). We can further divide them into the following types:

- a) set phrase (e.g.: The dog insisted *on coming with me into the room*.)
- b) “N V on N |V_{ing} |W_{h-clause}” (e.g.: I knocked *on the door*. Mr Waldegrave said British diplomats were working *on solving these problems*. Much will hinge *on how well the Free Democrats do tonight*.)

E. The Structure “N V N on N”

There are 2 types of the structure “N V N on N” according to (Sinclair J., 2002). We can represent the structures by only one expression “N V N on N |V_{ing} |W_{h-clause}” (e.g.: We will put pressure *on the authorities*. The prime minister complimented him *on leading what she described as the only Conservative government in Eastern Europe*. The debate is centered *on whether the country’s president should be elected directly by the people or by parliament*.)

III. THE FORMALIZATION OF ENGLISH STRUCTURES WITH “ON” AND THEIR CHINESE TRANSLATIONS

A. The Theory of SE and SER

In 1980’s, Institution of Computing Technology (ICT) of the Chinese Academy of Science (CAS) proposed a new concept (Gao, 1989), i.e., semantic element representation (SER) with variables and without variables. The concept of Semantic Element and Semantic Language was discussed in detail in the paper of Gao (2003; 2009). According to Unified Linguistics (Gao, 2009), different language can be translated into each other and people speaking different language can communicate with each other because there are words, phrases and sentences with the same meaning. Natural languages need to be described in a unified way from the perspective of semantics. Semantic of a sentence is called SS. An element to express a semantic meaning in an SS is called Semantic Element (SE). Semantic language (SL) consists of all SEs, including all SSs. The representation of an SE in a natural language-I, such as English, Chinese..., is called the Representation of Semantic Element in Language-I (SER_I). Semantic of SER is SE. Any natural language can be regarded as a representation of semantic language. The translation between two languages (I, J) is regarded as a transformation between two representations.

For example, the Chinese sentence is “李先生是教授 *Li xiansheng shi jiaoshou* (Mr. Li is a professor.)”. The four SEs in this sentence are 李(Li), 先生(X_{surname}) (Mr. (X)), 教授 (professor), 是_{title}(X_{people}, Y_{title}) (Is_{title}(X_{people}, Y_{title})). “X” and “Y” are two parameters. SE is an abstract concept and form. Actually, the above mentioned examples of SEs are only some remembrance forms to represent SE by using Chinese characters or English words. We can use “I” to substitute the SE “Li”, or use “4(X_{people}, Y_{title})” or “4(N_{people}, N_{title})” to substitute “是_{title}(X_{people}, Y_{title})”. The subscript denotes the semantic category of the word. An SER can reflect the semantics and syntax relations of the word in a phrase or a sentence.

The parameter is formed by two parts, in which one part is a symbol like “N, A, V, S” to represent noun, adjective, verb and sentence respectively, the other part is the subscript denoting the semantic category of the word. For example, “N_{person}” denotes nouns with the semantic category of person. Words with the same semantic category can be substituted by each other in an SER. Not only words but also phrases, clauses and sentences can be formalized into parameters.

The SE and SER theory has been applied into the formalization of Chinese classifier-noun phrases, English prepositional phrases and sentences (Guan, 2009). This theory has also been widely applied into other fields, such as machine translation, handwritten character recognition, Internet information monitoring and post-processing technique for speech and character recognition (Li, 2006; Gao, 2004; Gao, 2005).

B. The Formalization of English Structures with Preposition “on” and Their Chinese Translations

English structures with preposition “on” and their Chinese translations are formalized based on the theory of SE and SER. SER_C denotes Chinese SER; SER_E denotes English SER. In the phrase and sentence structure with “on”, the meaning of the noun is defined as Thing Semantic, which is the Semantic meaning expressed by nouns representing things. The collocated nouns, especially in the phrase “on N” and “N on n”, are described as “N_x”, and “A” in the structure “N be A on N” are described as “A_x”, which mainly determine the meaning of “on”. Here, “x” denotes the semantic type of the noun or adjective or verb. Nouns or adjectives with the same semantic type can be substituted by

each other in a SER. In addition, we use “AD” to represent adverb, “N_{pron-refl}” to represent reflexive pronoun. The semantic types are summarized based on Sinclair J.(2002). The preposition “on” should be extracted as the fix structure in the SERe, and the corresponding Chinese translation part will also be extracted as the fix structure in the SERc. The other words in the phrase or sentence should be extracted as the parameters in both SERe and SERc.

C. The Formalization of the Structure “on N”

For the structure “on N”, we should extract the semantic meaning of “N” and its Chinese translation as the parameters in both SERe and SERc. The semantic types of the parameter are determined according to the patterns classified in the book of Sinclair J. (2002).

TABLE I.
SERE AND SERC OF “ON N”

SERe	SERc	Example
on [the] N _{place}	在 N _{place} [上]	Everything on offer at this attractive tea house is made <i>on the premises</i> .
on [the] N _{position} [of N]	在[N]的 N _{position}	Then he sat back and made some notes <i>on the back of an envelope</i> .
on P _{poss} N _{position}	在 P _{poss} N _{position} 上	Sam was sitting <i>on my lap</i> .
on N _{way} of store or record	在 N _{way} of store or record 上	Police believe Doyle carried out 104 raids over a four-year period - the longest string of robberies <i>on their records</i> .
on [the] N _{form} of transport	上 N _{form} of transport	But it's cheaper for me to go <i>on the bus</i> .
on [the] N _{way} of broadcast	在 N _{way} of broadcast -上 中	He also appeared <i>on TV programmes</i> such as Five Alive and the Ronn Lucas Show.
on [the] N _{list}	在 N _{list} 上	High <i>on the list of the most promising areas</i> for research are electronics, sensors, computers and software.
on N _{group}	在 N _{group} 中	There were three people <i>on the committee</i> at that stage.
on N _{journey} [legal system display]	V _{journey} [legal system display]	Glen Wilgrove was <i>on holiday</i> in Holland when he took this photo of a sea of tulips in the famous Keukenhof Gardens.
on [the] N _{activity} [increase]	V _{activity} [increase]	He's <i>on a course</i> this week at the Royal Military Academy at Sandhurst.
on the N _{telephone} to N _{person}	给 N _{person} V _{telephone}	Mark is <i>on the phone</i> to her now.
on N _{basis} [of N]	以 N 为 N _{basis}	People have criticised this film <i>on the grounds</i> that it is “just another period drama”.
on N _{action}	被 V _{action}	Nearly half of all death sentences are overturned <i>on appeal</i> .
on P _{poss} N _{action} on the N _{action} Of N _{person}	在 N _{person} V _{action} 时	<i>On his arrival</i> , he said Moscow wanted an honest dialogue with Lithuania.
on the N _{point} of time of	在 N _{event} V 的 N _{point} of time	I was <i>on the point of returning to bed</i> when a motor bus chugged into view.
on N _{payment}	以 N _{payment} 的方式	Parents think they can keep up with these demands by buying everything <i>on credit</i> .
on N _{income} source	依靠 N _{income} source	This would be a powerful encouragement to the unemployed to find a job instead of living <i>on benefit</i> .
on N _{medicine}	吃/服用 N _{medicine}	They probably think I'm <i>on drugs</i> or something.

D. The Formalization of the Structure “N on N”

In the structure “N on N”, the “N” before “on” can mainly determine the meaning of the preposition “on”. So we should extract the semantic meaning of this “N” and its Chinese translation as the parameters in both SERe and SERc, and the semantic types of the parameter are determined according to the patterns classified in the book of Sinclair J. (2002).

TABLE II.
SERE AND SERC OF “N ON N”

SERe	SERc	Example
N _{speech} [information on N _{person} thing V _{ing} W _h -clause]	针对 对 N _{person} thing V W _h -clause 的 N _{speech} [information]	<i>An announcement on a replacement for Mr O'Connell</i> is not expected before the end of the year.
N _{writing} [broadcast on N V _{ing} W _h -clause]	有关 关于 N V W _h -clause 的 N _{writing} [broadcast]	Currently, she is engaged in making <i>a documentary on the life and works of</i> one of the most prominent Indian artists, Jehangir Sabarwala.
N _{meeting} on N _{event}	有关 关于 N _{event} 的 N _{meeting}	In Seoul he will attend <i>a regional conference on trade issues</i> .
N _{thought} [opinion attitude on N _{thing} V _{ing} W _h -clause]	对 关于 N _{thing} V W _h -clause 的 N _{thought} [opinion attitude]	There will have to be <i>agreement on that issue</i> if there is to be a successful outcome of these latest talks.
N _{person} on N _{thing} V _{ing} W _h -clause	[在] N _{thing} V W _h -clause N _{person} 方面的 N _{person}	David Willis, <i>a specialist on US affairs</i> , looks at the implications for the President at home and abroad.
N _{focus} emphasis on N V _{ing}	N V 的 N _{focus} emphasis	But he says <i>the emphasis on advanced technology</i> is misplaced.
N _{attack} [action power influence effect dependence bet on N _{person} thing]	对 N _{person} thing 的 N _{attack} [action power influence effect dependence bet]	The letter is <i>an attack on the Prime Minister</i> from start to finish, and not a particularly well disguised attack.
N _{money} [burden on N _{person} thing]	N _{person} thing 的 N _{money} [burden]	In-toto Kitchens is offering Club members <i>a 50 per cent discount on its Wellmann and Contessa ranges</i> .
N _{hitting} on N _{thing}	V _{hitting} N _{thing}	She may have been killed by <i>a blow on the head</i> .
N _{work} [action on N V _{ing}]	在 N V 方面 的 N _{work} [action]	<i>Recent research on molecular genetics</i> supports this idea.
N _{mark} on N _{thing}	N _{thing} 上的 N _{mark}	<i>The only blemish on his record</i> was his dismissal for punching last year during France's 18-16 defeat by Canada in Ontario.

E. The Formalization of the Structure “N be A on N”

In the structure “N be A on N”, the “A” before “on” can mainly determine the meaning of the preposition “on”. We should extract “be” and “on” as the fix structure in the SERe, and the corresponding Chinese translation part will also be extracted as the fix structure in the SERc; the semantic types of “A” are determined according to the patterns classified in the book of Sinclair J. (2002).

TABLE III.
SERE AND SERC OF “N BE A ON N”

SERe	SERc	Example
N _{person} be A _{like} on N _{person} thing V _{ing}	N _{person} V _{like} N _{person} thing V	We would not <i>be fixated on</i> one person to the exclusion of the world. He's always very <i>intent on</i> doing what he wants.
N _{person} thing be A _{quantity} sum of money on N	N _{person} thing V _{quantity} sum of money N	Since 6 April 1990 a married woman has <i>been taxable on</i> any state retirement pension she receives.
N _{thing} be A _{depend} on N _{thing}	N _{thing} V _{depend} N _{thing}	The toy industry is heavily <i>reliant on</i> the whims of the pre-teen generation.
N _{person} be A _{attitude} view way of treat on N	N _{person} 对 N A _{attitude} view way of treat	The government <i>was inflexible on</i> the need for industrial reform.
N _{person} be A _{quality} on N	N _{person} 在 N 方面[很]A _{quality}	Malcolm may have <i>been weak on</i> theory, but with his dress, his behavior, and even his art, he laid claim to being the big revolutionary on campus.

F. The Formalization of the Structure “N V on N”

For the structure “N V on N”, both “V” (verb) and “on” should be extracted as the fix parts in SERe based on the theory of SE and SER, i.e. the verb should be represented by the real word in SERe. But in order to clarify the semantic types of the verbs in such a structure, we mark the verb by “V_x”. Other parts in this structure and the corresponding Chinese translation should be extracted as parameters in the SERe and SERc. The semantic types of “V” are determined according to the patterns classified in the book of Sinclair J. (2002).

TABLE IV.
SERE AND SERC OF “N V ON N”

SERe	SERc	Example
N _{person} V _{speak} write on N V _{ing} W _h -clause	N _{person} V _{speak} write N V W _h -clause N _{person} 针对 N V W _h -clause V _{speak} write	The government has not yet <i>commented on</i> his release. The Parliament is also due to <i>vote on</i> lowering the legal voting age from twenty-one to eighteen. Mr. Potter declined to <i>comment\$ on</i> why he left the company and said he doesn't yet know what he will be doing.
N _{person} V _{say} more touch interrupt attack harm watch find out tell change attitude wild eat consume on N _{person} thing	N _{person} V _{say} more touch interrupt attack harm watch find out tell change attitude wild eat consume N _{person} thing	Mr Dienstbier <i>was enlarging on</i> proposals he made last night to members of the Royal Institute of International Affairs.
N _{person} V _{depend} on N V _{ing} W _h -clause	N _{person} V _{depend} N V W _h -clause	I hope we can <i>count on</i> your support. People can no longer <i>rely on</i> doing their chosen job for life. Much will <i>hinge on</i> how well the Free Democrats do tonight.
N _{person} V _{gamble} on N V _{ing} W _h -clause	N _{person} 就 N V W _h -clause V _{gamble}	A greyhound trainer has won £200,000 from the bookies by <i>betting on</i> his own dog. Interest rates might go up again, so people \$(are)\$ sort of <i>gambling on</i> what's going to happen in the next five or ten years from now.
N _{person} V _{work} on N _{thing} V _{ing}	N _{person} V _{work} N _{thing} V	He <i>was operated on</i> immediately and the assailant's knife removed from his back. Mr Waldegrave said British diplomats <i>were working on</i> solving these problems.
N _{person} V _{live} on N _{thing} V _{ing}	N _{person} 靠 N _{thing} V V _{live}	They may not look for work once they are accustomed to <i>living on</i> benefit. Switzerland <i>has thrived on</i> being different from its neighbours.
N _{person} V _{use} on N _{thing}	N _{person} 在 N _{thing} 方面 V _{use}	I think I was too naive at the time. I didn't <i>capitalize on</i> opportunities.
N _{person} V _{think} on N W _h -clause	N _{person} V _{think} N W _h -clause	The student must carefully <i>meditate on</i> the symbols and concepts that relate to the element of Earth.
N ₁ V _{focus} on N ₂	N ₁ V _{focus} 在 N ₂ 上	Chomsky tends to <i>focus on</i> well-studied languages like English rather than languages from far afield.
N _{person} V _{attitude} on N _{person} thing	N _{person} 对 向 N _{person} thing V _{attitude}	Last week he appeared to <i>back-pedal on</i> that statement, but it was too late.
N _{person} V _{affect} on N _{person} thing	N _{person} V _{affect} 到 N _{person} thing	Sometimes the thought of my husband's wartime ordeals <i>weighed on</i> me dreadfully.

G. The Formalization of the Structure “N V N on N”

For the structure “N V N on N”, “V” (verb) is also marked by “V_x”. Other parts in this structure and the corresponding Chinese translation should be extracted as parameters in the SERe and SERc. The semantic types of “V” are determined according to the patterns classified in the book of Sinclair J. (2002).

TABLE V.
SERE AND SERC OF “N V N ON N”

SERe	SERc	Example
N _{person} V _{give} N _{thing} on N _{person}	N _{person} 对 给 N _{person} V _{give} N _{thing}	Japanese car bosses <i>have heaped praise on</i> British workers who accelerated their factory into profit a year early.
N _{person} _{thing} V _{write} _{speak} N _{person} on N V _{ing} _{W_h-clause}	N _{person} _{thing} 针对 就 对 N V _{ing} _{W_h-clause} V _{write} _{speak} N _{person}	His hosts will clearly want to <i>question him closely on</i> what he said in Dublin. The prime minister <i>complimented him on</i> leading what she described as the only BR made it clear that it would <i>consult its legal advisers on</i> whether court action could be taken to prevent the strikes.
N _{person} V _{focus} N _{thing} on N _{person}	N _{person} 把 N _{thing} V _{focus} 在 于 N _{person}	The public housing authorities were encouraged to <i>concentrate their efforts on</i> slum clearance and redevelopment rehousing.
N _{person} V _{direct} N _{weapon} on N _{person}	N _{person} V _{direct} N _{weapon} 对着 N _{person}	I reminded him that Feld had <i>pulled a gun on</i> me and, most probably, had later ransacked my apartment.
N _{person} V _{strike} N _{thing1} on N _{thing2}	N _{person} 把 N _{thing1} V _{strike} 到 N _{thing2} 上	He shouted out loud in his anger, and <i>banged his fists on</i> the steering wheel.
N _{person1} V _{touch} N _{person2} on N _{body}	N _{person1} V _{touch} N _{person2} 的 N _{body}	His fist lashed out, <i>caught her on</i> the side of her face and knocked her down.
N _{person} V _{carve} N _{thing1} on N _{thing2}	N _{person} 把 N _{thing1} V _{carve} 在 N _{thing2} 中	He will say your name as often as he can, thus <i>engraving it on</i> his memory.
N _{person} V _{base} N _{thing1} on N _{thing2}	N _{person} 把 N _{thing1} V _{base} 于 N _{thing2} [上]	They tried to <i>build an empire on</i> shaky foundations.
N _{person} V _{put} N _{thing} on N	N _{person} 对 N V _{put} N _{thing} N _{person} V _{put} 对 N 的 N _{thing}	The World Bank <i>has cast doubt on reports</i> in Argentina that it is to extend loans to the government of four thousand million dollars.
N _{person} V _{gamble} N on N V _{ing}	N _{person} V _{gamble} N V N _{person} on N 上 V _{gamble} N	I'll <i>bet a quid on</i> anything, but never more than a fiver.
N _{person} V _{spend} _{waste} N _{thing1} on N _{thing2} V _{ing}	N _{person} V _{spend} _{waste} N _{thing1} 在 N _{thing2} 上 N _{person} V _{spend} _{waste} N _{thing1} 来 V	My father thought a university education <i>was wasted on</i> a woman.
N _{person} V _{model} N ₁ on N ₂	N _{person} 以 N ₂ 来 V _{model} N ₁	Their organizational structure <i>was patterned on</i> the World War II underground resistance movement.
N _{person} V _{model} pron-refl on N	N _{person} 以 N V _{model}	As far as their preferences and dislikes are concerned, most children tend to <i>model themselves on</i> their parents.

IV. CONCLUSION

This paper focuses on solving one of key problems of describing language phenomenon precisely in MT—the formalization of English structures with preposition “on” and their Chinese translations. A classification The English structures with preposition “on” are classified and formalized together with their Chinese translations based on the theory of SE and SER. The study in the paper will be beneficial to the process of word disambiguation and selection in MT. More efforts should be made to put this method into practice and to improve the quality of lexical translation in machine translation.

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