Chapter 13
Humans in the Loop of Localization Processes

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Abstract The Language Grid is a service-oriented infrastructure for language services. In the Language Grid, machine translation services play important roles in supporting multilingual activities for communities. Although the effectiveness of using machine translation services for multilingual communication has been shown in previous reports, the gap between human translators and machine translators remains huge especially in the domain of localization processes that require high translation quality. In this chapter, we aim at improving localization processes by introducing humans into the loop to utilize machine translation services. We try to compare several different types of localization processes (i.e., absolute machine translation processes, absolute human translation processes and processes by human and machine translation services) in the dimensions of translation quality and translation cost. The experiment results show that monolinguals can help improve the translation quality of machine translators with the aid of community dictionary services, and that collaboration of human and machine translation services make it possible to reduce the cost compared with absolute human translations.

13.1 Introduction

In recent years, more and more machine translation services have become available on the Internet that are provided by companies and research institutes. People use these machine translation services to browse information in different languages and communicate with other people who speak different languages. However, the gap between human and machine translation services remains huge. On the one hand, machine translators always have limitations in translation quality and therefore are seldom used for translating documents which require a high quality translation. On the other hand, human translators are not always available in the real world and the cost of translations of highly-trained bilingual individuals is always high. Although most of the previous studies show the possibility of combining human and machine translators for supporting multilingual communication, there is little consideration of how to apply such approaches for supporting

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professional translation that requires high business qualities in the real world, e.g., localization processes.

The Language Grid is developed to share many available language resources that are distributed on the Internet with different interfaces, including machine translation services, dictionary services and so on. Community users can combine existing language services, and create new language services for their own purposes as well. For example, machine translation services and community dictionary services can be composed to improve translation quality in the Language Grid. Moreover, the Language Grid is also designed to enable humans to be in the loop of processes. Therefore, the Language Grid offers the possibilities for improving traditional localization processes. Based on various language services provided on the Language Grid, we aim at improving localization processes by composing human and machine translation services. When introducing humans into the loop of localization processes, we consider both monolinguals and bilinguals. Monolinguals are considered in the localization processes because they are always more available and cost less than bilinguals. In more detail, monolinguals are introduced to modify the translation results produced by the machine translation services, while bilinguals are introduced to check the modification results and also translate the contents that cannot be modified by the monolinguals.

To evaluate the effectiveness of introducing humans into the machine translation processes, we conduct experiments to compare the translation qualities and costs using several different localization processes, including absolute machine translation processes, absolute human translation processes and translation processes by human and machine translators. By introducing humans in the loop of localization processes based on the Language Grid, we expect that (1) monolinguals could help improve the translation qualities of machine translation services with the aid of community dictionary services, and (2) collaboration of humans and machine translators could reduce translation cost compared with absolute human translations.

The remainder of the chapter is organized as follows: we first explain how the Language Grid can help to improve localization processes in Sect. 13.2. In Sect. 13.3, localization processes composing human and machine translation services are proposed. Section 13.4 shows a case study of translation processes with experiments. The analysis and discussion of the experiments is shown in Sect. 13.5. In Sect. 13.6, we introduce some related work. Section 13.7 is the conclusion of this research.

13.2 Language Grid for Localization Processes

The Language Grid collects language resources (e.g., machine translation services, dictionary services, parallel text services, morphological analysis services and so on), which are wrapped as atomic Web services by standard interfaces. Moreover, a series of composite services with advanced functions have also been developed based on the atomic services. Fig. 13.1 shows a composite machine translation service which was developed with a WS-BPEL specification (Alves et al. 2007) in the Language Grid, which combines several atomic services including morphological analysis service, a multilingual dictionary service, a machine translation service, and so on. By combining dictionary services and other services, the translation quality can be improved compared with the atomic machine translation service (Inaba et al. 2007) (Ishida 2010).

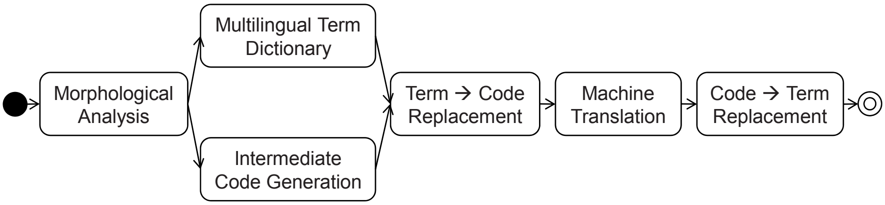

Fig. 13.1 Composite machine translation service on the Language Grid

The Language Grid promises to improve traditional localization processes based on the following features.

Variety of language services. Since users have different requirements for translation quality, it is necessary to provide different services/composite processes with different quality for the same function. In the Language Grid, language services are categorized into several classes. For each service class, multiple services/composite processes are provided for different requirements. For example, the translation service class includes atomic machine translation service (e.g., Google Translator, J-Server, Parsit, Toshiba, Translution, Web-Transer, YakushiteNet and so on), two-hop machine translation service, composite machine translation service combined with bilingual dictionary, and so on.

Customization of language services. The Language Grid enables community users to deploy their own language services following the standard interfaces. Therefore, users can flexibly choose atomic translation services or composite translation services (e.g., any combination of atomic translation services and global dictionaries or user dictionaries for composite machine translation service combined with dictionaries) on the Language Grid for their own requirements. Moreover, it is also possible to combine humans with the composite translation services on the Language Grid.

13.3 Composing Humans and Machine Translation Services

In the area of machine translation, translation results were evaluated based on two dimensions in previous reports, i.e., adequacy and fluency (White et al. 1994).

Adequacy refers to the degree to which the translation communicates information present in the original, while fluency refers to the degree to which the translation is well-formed according to the grammar of the target language. In this research, we also use these dimensions to evaluate the translation results.

Although many types of translation services/processes are provided in the Language Grid, automatic machine translation services can never have perfect fluency and adequacy on average even when they are combined with dictionaries or other services for quality improvement. For example, the composite service in Fig. 13.1 might be able to deal with the requirement for online chatting among people in different countries, while it is difficult to use such a service to write business documents or translate product manuals. Therefore, we consider combining machine translation services and human activities in cases of localization processes. As for humans in the loop of localization processes, monolinguals and bilinguals can be considered. When there is an existing machine translation service (either atomic service or composite service as described in Sect. 13.2), the human activities may be combined with the machine translation service in different ways to improve the whole process:

(1) Introduce a monolingual revision activity for preprocessing the source sentences for machine translation, e.g., changing long sentences into short ones or changing the sequence of words to one which may be handled by machine translation services more easily;
(2) Introduce a monolingual revision activity for post-processing the output translation results by improving the fluency of the machine translation results;
(3) Introduce a bilingual revision activity for post-processing the revision results products by the monolinguals.

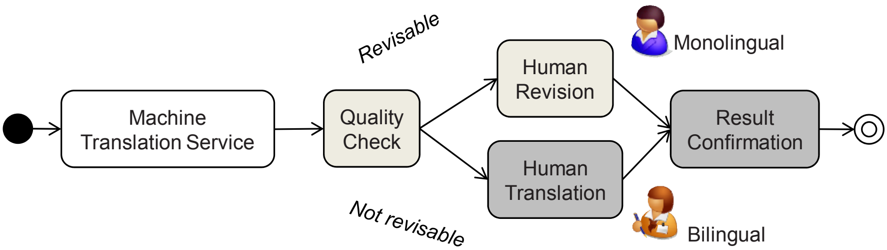

Fig. 13.2 Introducing humans into the loop of localization processes

In this research, we mainly consider localization processes where human roles are induced to process the translation results. In more detail, we focus on the process as shown in Fig. 13.2. The proposed process combines machine translator, monolinguals and bilinguals, where *Machine Translation Service* indicates the atomic machine translation service or composite machine translation service provided by the Language Grid. Monolinguals are introduced to revise the translation results of the machine translators, while bilinguals are introduced to check the revision results and also to translate the contents that cannot be revised by the monolingual revisers. The process can be realized by describing the human activities using BPEL4People (Kloppmann et al. 2005) to extend the existing machine translation services on the Language Grid.

13.4 Experiment Settings

The localization processes are effective if translation quality keeps high while translation cost keeps low. Therefore, both translation quality and translation cost must be considered when evaluating localization processes. First, the translation quality is expected to be kept high compared with the absolute human processes since we still have human roles in the proposed processes. Second, the translation cost is expected to be kept low since we include machine translation services and monolingual human roles in the proposed processes that might be less expensive than bilingual human roles.

We have the following hypotheses for the experiments: (1) composing monolinguals and community dictionary services improves the translation quality of machine translators, and (2) collaboration of human and machine translators reduces the cost compared with the absolute bilingual translation.

13.4.1 Translation Processes

In this research, we use the two dimensions (fluency and adequacy) that we have introduced in Sect. 13.3 to evaluate the quality of translations using the method in the DARPA TIDES Project at University of Pennsylvania, with a five-level score for each dimension. For example, when evaluating the Chinese translation result, the evaluation criteria of fluency is 5: Flawless Chinese, 4: Good Chinese, 3: Non-native Chinese, 4: Unfluent Chinese, 5: Incomprehensible, and the evaluation criteria of adequacy is 5: All, 4: Most, 3: Much, 4: Little, 5: None.

We use the following processes in this experiment. *MT* is an atomic machine translation service. *MT+Dic* is a composite translation service with dictionary as shown in Fig. 13.1. *MT+Mono* and *MT+Dic+Mono* are collaborative translation processes by monolinguals and machine translation services (omitting the bilingual activities in Fig. 13.2). *MT+Mono+Bi* and *MT+Dic+Mono+Bi* are collaborative translation processes shown in Fig. 13.2. Machine translation services are atomic translation services in *MT+Mono* and *MT+Mono+Bi*, and composite translation services combined with a dictionary in *MT+Dic+Mono* and *MT+Dic+Mono+Bi*. *Bi* is an absolute human process. *Bi+TM* is an absolute human process with the aid of tools like translation memory which can automatically complete 15% of the translation tasks. The descriptions of the above processes are given in Table 13.1 in detail.

Table 13.1 Translation processes in the experiments

Process	**Description**
MT	An atomic Japanese-Chinese machine translation service.
MT+Dic	A composite Japanese-Chinese machine translation service combined with user dictionaries.
MT+Mono	An atomic Japanese-Chinese machine translation service combined with human tasks. The human tasks are conducted by a Chinese monolingual person to revise the understandable machine translation results.
MT+Dic+ Mono	A composite Japanese-Chinese machine translation service combined with user dictionaries and human tasks. The human tasks are conducted by a Chinese monolingual person to revise the understandable machine translation results.
MT+Mono+ Bi	An atomic Japanese-Chinese machine translation service combined with human tasks. The human tasks are conducted by a Chinese monolingual person to revise the understandable machine translation results and a Chinese-Japanese bilingual person to confirm the correctness of the revised results in *MT+Mono* as well as translating the unrevised parts in *MT+Mono*.
MT+Dic+ Mono+Bi	A composite Japanese-Chinese machine translation service combined with user dictionaries and human tasks. The human tasks are conducted by a Chinese monolingual person to revise the understandable machine translation results and a Chinese-Japanese bilingual person to confirm the correctness of the revised results in *MT+Dic+Mono* as well as translating the unrevised parts in *MT+Dic+Mono*.
Bi+TM	A human translation process conducted by a Japanese-Chinese bilingual person with translation memory software.
Bi	A human translation process conducted by a Japanese-Chinese bilingual person without any Web services or translation memory software.

For each process described in Table 13.1, we run 17 process instances to translate a Japanese sentence to a Chinese sentence. The Japanese sentences are randomly picked from a description manual for a digital camera from a Japanese company for localization, with average sentence length of 42 Japanese characters.

13.4.2 Machine Translation Services and Humans

Machine translation services used in the experiments include an atomic machine translation service and a composite machine translation service as shown in Fig. 13.1. Main language services used in our experiments are provided in the Language Grid by wrapping language resources including J-Server Japanese-Chinese machine translation service provided by Kodensha Co., Ltd, Mecab Japanese morphological analysis service provided by NTT Communication Science Laboratories, and a user Japanese-Chinese dictionary service for digital cameras which covers 18.75% of words in the Japanese sentences for execution.

Human tasks in the experiments are conducted by a Japanese-Chinese bilingual translator and a Chinese monolingual reviser with the cost of 30 units and 15 units per hour respectively.

13.5 Analysis

In our experiments, we analyze the translation quality and cost of different translation processes as described in Sect. 13.4.

13.5.1 Translation Quality

Table 13.2 presents the experimental results of fluency and adequacy of translation for *MT*, *MT+Dic*, *MT+Dic+Mono*. Besides, we also evaluate the translation quality for *MT+Mono* with the average fluency as 3.5 and adequacy as 3.3. Results of *MT+Mono+Bi*, *MT+Dic+Mono+Bi*, *Bi+TM* and *Bi* are not listed because fluency and adequacy are both 5 for each instance. The result shows that the machine translation quality in *MT* is limited and cannot meet the requirements for localization processes. However, it can be improved by using a composite translating service by combining dictionaries and other services. For *MT+Dic*}, adequacy of the translation result is not less than 3 in 88% of process instances (15 of 17). By combining machine translator and dictionaries, the translation quality can be further improved from *MT* to *MT+Dic* (fluency: 2.8 to 3.2, adequacy: 3.0 to 3.7). Composing monolingual human tasks with the composite translation service with dictionaries, the translation quality can be further improved from *MT+Dic* to *MT+Dic+Mono* (fluency: 3.2 to 4.5, adequacy: 3.7 to 4.4). There is also an interesting observation that the adequacy of translation result in *MT+Dic* (adequacy: 3.7) is even better than that of *MT+Mono* (adequacy: 3.3), which means that collaborative translation by human and machine translator also has limitations if the original translation quality is not good. The result reveals that community dictionary services are very important to improve machine translation quality. In one word, the results in Table 13.2 give evidence to support our first hypothesis that composing monolingual roles and dictionary services improves the translation quality of machine translators. We can also see that the improvement is very effective when the original translation quality (fluency and adequacy) of machine translation is around the level of 2 to 4.

Table 13.2 Experimental results of translation qualities in different processes.

Process	Fluency			Adequacy		
Instance	*MT*	*MT+Dic*	*MT+Dic+Mono*	*MT*	*MT+Dic*	*MT+Dic+Mono*
#1	5	5	5	5	5	5
#2	4	5	5	4	5	5
#3	2	3	5	2	4	4
#4	2	2	5	3	3	5
#5	1	1	1	1	2	2
#6	5	5	5	5	5	5
#7	1	2	5	2	3	5
#8	2	4	5	2	4	5
#9	1	1	1	2	2	2
#10	3	3	5	4	4	3
#11	3	3	5	4	4	5
#12	5	5	5	3	5	5
#13	3	3	5	3	4	5
#14	3	3	5	4	4	5
#15	4	4	5	3	3	5
#16	3	3	5	3	3	5
#17	1	3	5	1	3	4
Average	2.8	3.2	4.5	3.0	3.7	4.4

13.5.2 Translation Cost

Table 13.3 presents the experimental results on translation cost and time duration for *MT+Mono+Bi*, *MT+Dic+Mono+Bi*, *Bi+TM* and *Bi*, which have equal translation qualities with fluency and adequacy both 5 and can be used as localization processes. The results show that collaborative translation processes by human and machine translator (*MT+Mono+Bi* and *MT+Dic+Mono+Bi*) can reduce the translation cost compared with the human translation process (*Bi* and *Bi+TM*) by up to 35%. However, the time duration of the four processes do not significantly differ from each other since we simply add the execution duration of the machine translator and human tasks for all 17 process instances when computing the execution duration in collaborative translation processes (*MT+Mono+Bi* and

MT+Dic+Mono+Bi). However, if we consider the parallel execution of process instances and human tasks, the execution duration is expected to be reduced in collaborative translation processes (*MT+Mono+Bi* and *MT+Dic+Mono+Bi*). In summary, the results in Table 13.3 give evidence to support our second hypothesis that collaboration of human and machine translators may reduce the cost compared with the absolute bilingual human translation.

Table 13.3 Comparison of translation cost and duration for different translation processes

Process	Human	Time	Cost
Bi	Bilingual (1)	40min	20.00
Bi+TM	Bilingual (1)	35min	17.50
MT+Mono+Bi	Bilingual (1) Monolingual (1)	39min	16.50
MT+Dic+Mono+Bi	Bilingual (1) Monolingual (1)	36min	13.00

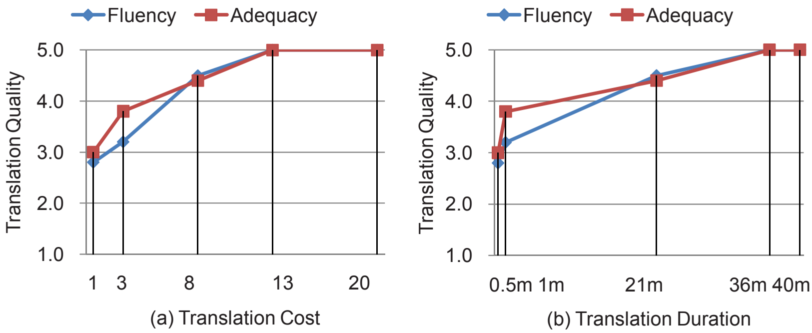

Fig. 13.3 Translation cost and duration (Processes from left to right in each chart: *MT, MT+Dic, MT+Dic+Mono, MT+Dic+Mono+Bi, Bi*)

Fig. 13.3 shows the relationship between translation quality and translation cost/duration for five different processes: *MT, MT+Dic, MT+Dic+Mono, MT+Dic+Mono+Bi* and *Bi*. The result shows that both execution cost and execution duration increase from *MT, MT+Dic, MT+Dic+Mono, MT+Dic+Mono+Bi* to *Bi*, which means that more cost and duration are required to get higher translation quality. For *MT* and *MT+Dic* that consist of automatic services only, the cost and duration are much less compared with processes composed of both human and services. However, the acquired translation quality is also very limited. For *MT+Dic+Mono+Bi* and *Bi* with the requirements of perfect translation quality, the cost and duration are many times more than those of *MT* and *MT+Dic*. *MT+Dic+Mono+Bi* which is composed of both human and Web services saves 20% execution cost compared to *Bi* which is a completely human process. The experiment result also shows that execution duration of *MT+Dic+Mono+Bi* and *Bi* do not significantly differ from each other since we simply add the execution duration of the services and human tasks for all 17 process instances when computing the execution duration of *MT+Dic+Mono+Bi*. However, if we consider the parallel execution of process instances and human tasks, the execution duration can be reduced significantly in *MT+Dic+Mono+Bi*. The translation quality of *MT+Dic+Mono* is not perfect compared to *MT+Dic+Mono+Bi* and *Bi*, but at a relatively high level compared to *MT* and *MT+Dic*. The execution cost and execution duration of *MT+Dic+Mono* are more than *MT* and *MT+Dic*, but much less than *MT+Dic+Mono+Bi* and *Bi* (save about 50%).

13.5.3 Discussion

Since the experimental results are based on an experiment of very small scale, we cannot simply conclude that the hypotheses in Sect. 13.4 are true for all cases. Actually, when inducing human activities to keep high translation quality, the translation cost is affected in different ways by the varying execution rate of human activities and machine translation services in the proposed localization processes. In cases where human activities are induced but not efficiently executed, the translation cost of a composite process comprising both machine translation services and human activities is even higher than an absolute human process. In the experiments we conduct, the monolingual human task *human revision* is executed in 88% of process instances in *MT+Dic+Mono* and *MT+Dic+Mono+Bi*. To analyze how the execution rate of *human revision* would affect the translation cost of the proposed process, we conduct further simulations. To keep the translation quality at fluency=5.0 and adequacy=5.0, we use *MT+Dic+Mono+Bi* as the simulation process. We conduct the simulation by varying the execution rate (rr) of the monolingual human task *human revision* with other settings the same as we have described in Sect. 13.4.2. For example, rr=25% means that the execution probability of *human revision* in *MT+Dic+Mono+Bi* is 25%. We simulate several cases (rr=100%, 75%, 50%, 25%, 0%) for all the 17 process instances. The simulation result is shown in Table 13.4. From the result, we can see that with the increase of rr, translation cost and translation duration both decrease. The case of rr=100% can save 38.5% of translation cost and 15.6% of translation duration compared to the case of rr=0%, where monolingual human activity is intended to be induced to revise the translation result but actually nothing can be revised and all the translations are done again by the bilingual human translator. The simulation also has the result that the execution cost and execution duration of the case rr<55% in *MT+Dic+Mono+Bi* are even more than those in *Bi* because of the wasted execution of composite machine translation services and monolingual human tasks. The simulation is conducted with IBM's Websphere Business Modeler Advanced V6.2.

To cover translation quality and translation cost, composition of human activities and machine translation services can be regarded as a promising approach. However, it is necessary to consider how to design mechanisms to reduce translation cost while keeping the translation quality. Although the experimental results in this chapter might not be significant from a statistical perspective, many lessons can be obtained from an empirical perspective as a fundamental trial of composing human and machine translation services for improving localization processes. We have also observed several important issues concerning controlling human tasks that should be considered in the future. First, although this chapter mainly focuses on the translation quality and translation cost of localization processes composed of both human and machine translation services, the design of interaction mechanisms among human and translation services, and between human activities in a localization process is actually an important issue to be considered. If the interactions are not effective, translation cost might be increased because of the additional interaction cost. Second, in composite processes it is necessary to unify human activities and Web services in order to control human assignment, quality control of human tasks, dynamic human service selection and so on. Third, dynamic management of human task execution is also important for reducing the cost of human tasks.

Table 13.4 Simulation results of translation cost and time for different translation revision rate

Items	Revision rate of translation result in MT+Dic+Mono+Bi				
	rr = 100%	rr = 75%	rr = 50%	rr = 25%	rr = 0%
Cost	14.75	17.50	19.25	22.25	24.00
Time	38min	39min	41min	43min	45min

13.6 Related Work

Web service composition has been an important issue for the past several years in the service-oriented computing area. Recently, QoS-aware service composition has become the focus in this area (Zeng et al. 2004) (Aggarwal et al. 2004) (Menascé 2002) (Cardoso et al. 2004). The work of Zeng et al. (Zeng et al. 2004) is among the earliest on QoS-aware service composition. The authors propose a multidimensional QoS model for Web service composition including dimensions of execution price, execution duration, reputation, successful execution rate and availability. In this research, we also use QoS dimensions like execution cost and execution duration for analysis. However, we also consider the application-specific QoS (fluency and adequacy of translation) and focus more on it.

Human activities have been considered in workflow management from the perspective of linking organization elements and business process (Zhao et al. 2008) and from the perspective of organization management (Zur Muehlen 2004).

BPEL4People has been used to specify human tasks in previous work (Russell and Aalst 2008) (Zhao et al. 2008) (Mendling et al. 2008). However, our research is the first to use human tasks for improving application-specific QoS and conduct experiments in the language domain in the real world to analyze the composition of human activities and machine translation services.

In the area of intercultural collaboration, machine translators have been applied in multilingual communication in previous research. From the point of view of communication analysis, effects and difficulties of using machine translation in collaborative work have been discussed (Yamashita and Ishida 2006) (Yamashita et al. 2009). Moreover, it has been reported that combining community dictionaries and machine translators can improve mutual understanding in multilingual communications (Inaba et al. 2007). Further, effectiveness of collaborative translation by machine translators and monolingual human has been shown in some work (Hu 2009) (Morita and Ishida 2009). However, the effects of applying machine translation services in localization processes with the aid of human activities are rarely observed in this area, which is the focus of this research.

13.7 Conclusion

The Language Grid provides the possibility of combining human and machine translators to improve localization processes in the real world. The main contribution of this chapter is to propose an approach to composing human activities and machine translation services for localization processes considering both translation quality and translation cost. First, we propose the approach of improving localization processes by composing human and machine translation services based on the Language Grid, a language service platform that we have developed. Then, we show how to conduct localization processes on the Language Grid. Further, we conduct experiments to compare translation qualities and costs using several translation processes, including absolute machine translation processes, absolute human translation processes and translation processes involving both human and machine translators. The experimental results show that (1) composing monolingual roles and dictionary services improves the translation quality of machine translators, and (2) collaboration of human and machine translators is possible to reduce the cost compared with absolute bilingual human translation. The proposed approach is expected to be applied in localizing community contents within local communities.

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