CLASSIFICATION AND IDENTIFICATION OF CADASTRAL STRUCTURE CHANGE

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ABSTRACT:

Cadastral topological structure change is the foundation for conducting change analysis, and updating data in Cadastral Information Systems (CIS), and it almost happens every day in many cities. In this paper, we subdivide cadastral structure changes into small structure change and large structure change according the parcels involved in the transition. The classification methodology of small cadastral structure change is discussed; the sub-classifications of the small structure change are concluded and proved at a given level. The semantic of sub-classifications of small cadastral structure change is described. The identification algorithms for the sub-classifications of small cadastral structure change used in change reasoning and updating are described. The typical cases of large cadastral structure change are concluded. Then we use the incremental updating of small rectification as an example to illustrate how the sub-classification of cadastral structure change can be used to improve the procedure for updating cadastral databases.

1. INTRODUCTION

Cadastral changes include changes caused by legal actions and spatial changes [Stoter & Oosterom, 2006]. Cadastral spatial change includes two levels, i.e., the low level is the basic changes (e.g., appearance, disappearance, expansion, contraction, deformation…) of single entities (e.g., points, boundary lines, and parcels); the high level is topological structure change involving several parcels (e.g., union, split, re-allocation…) [Claramunt &Thériault, 1995; Claramunt & Libourel, 1999]. In this paper, we focus our study on the high level change: topological structure change; and we name it as cadastral structure change. Cadastral structure change happens almost every day in many cities, and it is the foundation for conducting change analysis, and updating data in Cadastral Information Systems (CIS). On the topic of updating, different cadastral structure change produces different changes to the involved objects, and causes to different rebuilding and updating operations.

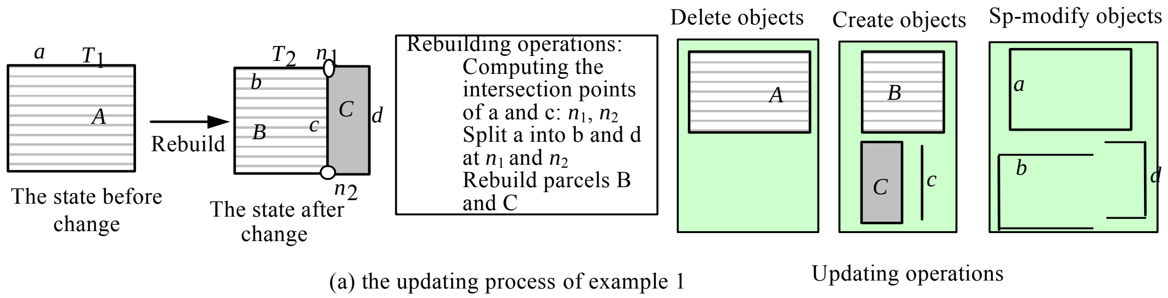
For example the rebuilding and updating operations of the two cases (as Figure 1 shows) are different. It is assumed that A is a big parcel surrounded by streets and the ownership of A, B, and C are different in Figure 1. In Figure 1 (a), it is denoted that a simple parcel divides into two simple parcels; the rebuilding operations include the operations for rebuilding boundary-line and reconstructing parcels. The rebuilding boundary-line operations include: computing the intersection points of the boundary lines a and c: get n_1 and n_2; splitting a into b and d at n_1 and n_2; reconstructing parcels C and D; the updating operations include: deleting the parcel A (implemented by defining their *end-time*), creating the parcels C and D. In Figure 1 (b), at T_1, A is a simple parcel; at T_2, A splits to B and C, C is a parcel with one hole (we call it as one-hole-parcel in this paper), B is the hole of C; the rebuilding operation just include splitting A into B and C; the updating operations include deleting parcel A, creating parcels B, C, and boundary line b.

From these examples, we can conclude that different cadastral structure change causes to different rebuilding and updating operations. In order to automate (or semi-automate) the updating process of cadastral database, it is needed to analyze (or conclude) the types of cadastral structure changes, develop corresponding automatic (or semi-automatic) identification and updating algorithms for each sub-classification of the structure changes. In this paper, we focus our study on the classification and identification of the cadastral structure changes.

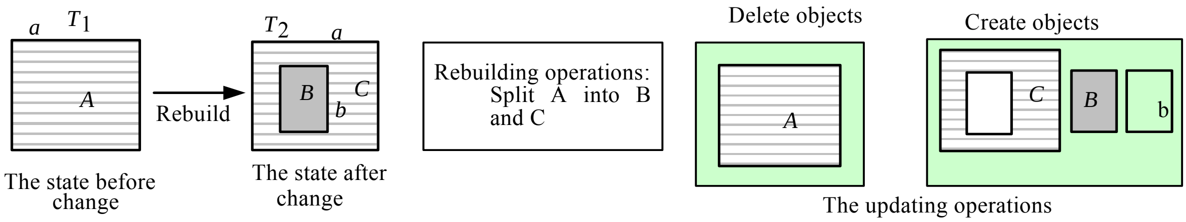
Changes (or transitions) are usually seemed as the transitions between states [Galton, 2000; Zhou, et. al, 2004; Zhou, 2007]. The classification of cadastral structure change should be in terms of the states of the entities involved in the transition. As the purpose of all cadastral structure change is to change the property of the interested parcels, e.g., number, shape, location, area… [Stoter & Oosterom, 2006]. The spatial changes of the other entities (i.e. boundary lines and points) are caused by the spatial change of parcels. So we classified the cadastral structure change based on the states of parcels. According to our analysis, the states of parcels involved in cadastral structure change include the shape of an individual parcel and the topological relationship (structure) between the involved parcels.

According to our analysis, the parcels involved in cadastral structure changes include three cases: one parcel, two parcels, and more than three (including three) parcels. The former two cases are about 50% (Effenberg & Williamson, 1996), we call them small cadastral structure changes; the thied changes are called large structure changes. As there are just a few parcels involved in a small structure change before and after the transition, the change types can be gotten by analysing theoretically, which will be discussed mainly in this paper. For large structure change, as the number of the parcels involved in such changes is variable, the change is difficult to analyse theoretically, we concluded 5 typical cases based on our experience and the current references.

This paper is organized with 7 sections. We then discuss the classification methodology of small cadastral structure change in Section 2. The semantic of sub-classifications of small cadastral structure change is described in section 3. The identification algorithms for the sub-classifications of small structure change used in change reasoning and updating are presented in section 4. We concluded the typical cases of large cadastral structure change in Section 5. An example using to illustrate the application of cadastral structure changes in the updating of cadastral databases is presented in Section 6. Section 7 provides a summary and concludes the discussion.



(a) the updating process of example 1



(b) the updating process of example 2

Figure1. The updating process of different cadastral topological structure change

2. THE CLASSIFICATION METHODOLOGY OF CADASTRAL STRUCTURE CHANGE

From the current references and our experience (we analyzed the parcels in two cities), we conclude that there are two kinds of basic parcels: simple parcel (Figure 2 (a)) and one-hole-parcel (Figure 2 (b)). It is an axiom that meeting at their boundary (or boundaries) is the topological relationship between the involved parcels transferred by small structure change. The relationship of meeting at sides, in theory, may include meeting at one side, two sides, three sides, etc. In our study cities, there is no meeting at more than one side, so we limit our study at the basic meeting relationship (contiguity at one side). There are four kinds of basic meeting relations (as Figure 3 shows) at this level: a) A, B are simple parcels, A meets B; b) A is a one-hole-parcel, B is the hole of A, A meets B; c) A is a one-hole-parcel, B is one part of the hole of A, A meets B; d) A is a one-hole-parcel, B is a simple parcel, A meets B at the exterior border [Zhou, et al, 2003; 2005].

(a) simple parcel (b) one-hole parcel

Figure.2 Shapes of parcel: two kinds of basic parcels, $\mathbf{H^A}$ denotes the hole of A

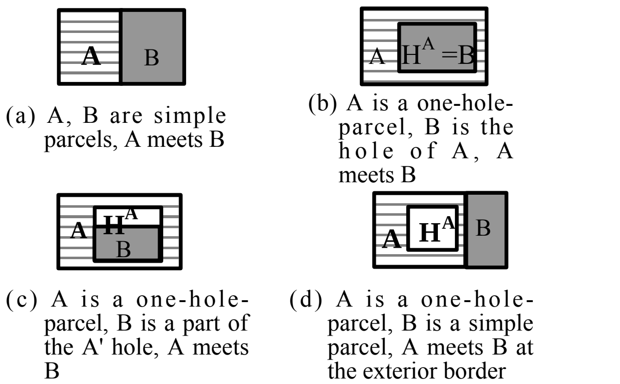


Figure. 3 States of two parcels: 4 kinds of meet relations between two parcels, $\mathbf{H^A}$ denotes the hole of A

It can be concluded that there are six states transferred by small cadastral structure changes, namely that there are six states before and after the transition. So there are 36 possibilities from these combinations, as Table.1 shows. In fact, not all of these possibilities exist, eliminating the impossible cases; we can get the existing cases.

It is an axiom that if X is the total area of the parcels involved in the structure change before transition, Y is the total area of the parcels involved in the structure change after transition, and then X is equal to Y.

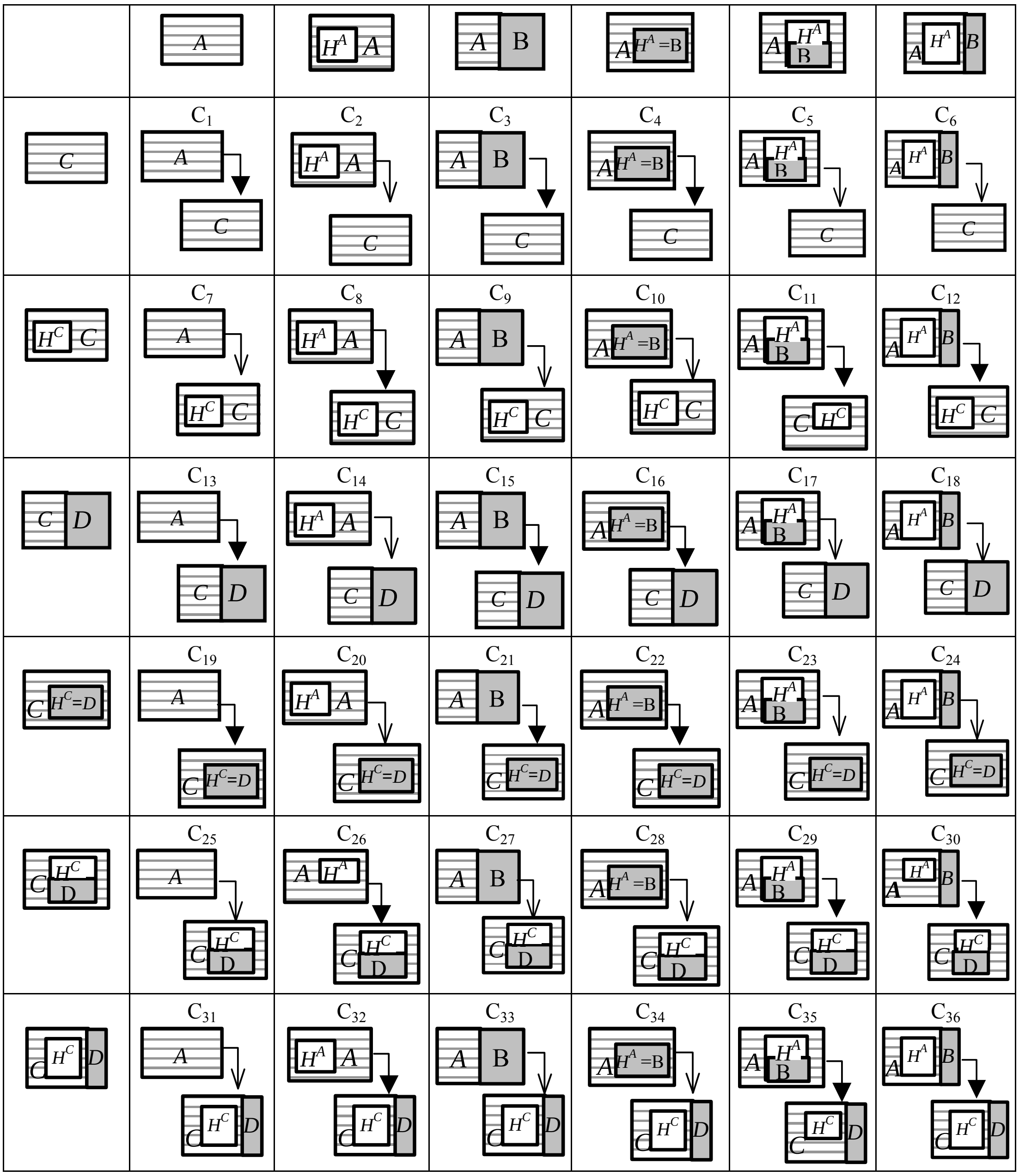


Table 1 Change description language visualization of the 36 possible combinations of small cadastral structure changes

In Table.1, it is proved that C_1, C_3, C_4, C_8, C_{11}, C_{12}, C_{13}, C_{15}, C_{16}, C_{19}, C_{21}, C_{22}, C_{26}, C_{29}, C_{30}, C_{32}, C_{35}, and C_{36} exist at this level.

Proposition 1. It is assumed that A, B, C, D, H^C and H^A aren't NULL in Table.1, then C_2, C_5, C_6, C_7, C_9, C_{10}, C_{14}, C_{17}, C_{18}, C_{20}, C_{23}, C_{24}, C_{25}, C_{27}, C_{28}, C_{31}, C_{33}, and C_{34} in Table.1cannot occur.

Proof. As H^C and H^A aren't NULL, in Table.1, for C_2, X= area (A), Y= area (C) = area (A) + area (H^A), X$\neq$Y; in C_5 and C_6, X= area (A) + area (B), Y= area (C) = area (A) + area (B) + area (H^A), X$\neq$Y; in C_7, X= area (A), Y= area (C) = area (A) - area (H^c), X$\neq$Y; in C_9, C_{10}, X= area (A) + area (B), Y= area (C) = area (A) + area (B) - area (H^c), X$\neq$Y; in C_{14}, X= area (A), Y= area (C) + area (D) = area (A) + area (H^A), X$\neq$Y; in C_{17}, C_{18}, C_{23}, and C_{24}, X= area (A) + area (B), Y= area (C) + area (D) = area (A) + area (B) + area (H^A), X$\neq$Y; in C_{20}, X= area (A), Y= area (C) + area (D) = area (A) + area (H^A), X$\neq$Y; in C_{25}, X= area (A), Y= area (C) + area (D) = area (A) - area (H^C), X$\neq$Y; in C_{27}, C_{28}, C_{33}, and C_{34}, X= area (A) + area (B), Y= area (C) + area (D) = area (A) + area (B) - area (H^C), X$\neq$Y; in C_{31}, X= area (A), Y= area (C) + area (D) = area (A) - area (H^C), X$\neq$Y. All of these possibilities cannot occur. This will complete the proof of the proposition.

Thus, it is concluded that in table.1, C_1, C_3, C_4, C_8, C_{11}, C_{12}, C_{13}, C_{15}, C_{16}, C_{19}, C_{21}, C_{22}, C_{26}, C_{29}, C_{30}, C_{32}, C_{35}, and C_{36} exist, in total, there is 18 small structure changes.

3. THE SEMANTIC OF SUB-CLASSIFICATIONS OF CADASTRAL STRUCTURE CHANGE

In table.1, C_1 and C_8 are ***semantic change*** transitions. As parcels form a complete coverage of a given area in geographic space, it is impossible that any parcel change its spatial property (shape, location, and area) without changing of the spatial property of the other parcels. So the transition just involved the change of an individual parcel (C_1 and C_8 in Table.1) is semantic change.

In table.1, C_3, C_4, C_{11}, and C_{12} denote that two parcels A and B (A is adjacent to B at one side) unite to a parcel C, and usually these structure changes are called as ***union***. C_3 denotes that simple parcels A and B unite to a simple parcel C. In C_4, A is one-hole-parcel, B is the hole of A, A and B unite to a simple parcel C. In C_{11}, A is one-hole-parcel, B is one part of the hole, A and B unite to C, C is also one-hole-parcel. In C_{12}, A is one-hole-parcel, B is a simple parcel which meets A at the exterior boundary of A, A and B unite to C, C is also one-hole-parcel.

In table.1, C_{13}, C_{19}, C_{26} and C_{32} denote that a parcel A divides into 2 parcels: B and C, and usually these structure changes are called as ***split***. C_{13} denotes that a simple parcel A ***split***s into 2 simple parcels: C and D. In C_{19}, A is a simple parcel, it is divided into two parcels: C and D, C is one-hole-parcel, D is the hole of C. In C_{26}, A is one-hole-parcel, it is divided into two parcels: C and D, C also is one-hole-parcel, D is a simple parcel, it is one part of C's hole. In C_{32}, A is one-hole-parcel, it is divided into two parcels: C and D, C also is one-hole-parcel, D is a simple parcel, C meets D at its exterior border.

In table.1, C_{15}, C_{16}, C_{21}, C_{22}, C_{29}, C_{30}, C_{35}, and C_{36} denote the spatial changes occurs between two parcels with adjacency relations, usually these structure changes are named as ***rectification***. In C_{15}, A, B, C and D are simple parcels. In C_{16}, the modification occurs between one-hole-parcel A and its hole B, after the transition, C and D are simple parcels. In C_{21}, the transition occurs between two simple parcels: A and B are simple parcels, while after modification, C is one-hole-parcel, D is the hole of C. In C_{22}, the modification occurs between one-hole-parcel A and its hole B, after modification, C is still one-hole-parcel, D is still the hole of C. In C_{29}, A is one-hole-parcel, B is one part of the hole of A, after modification, C is still one-hole-parcel, D still is one part of the hole of C. In C_{30}, A is one-hole-parcel, B is a simple parcel, A meets B at its exterior border, after the modification, C is still one-hole-parcel, B become one part of the hole of C. In C_{35}, A is one-hole-parcel, B is one part of the hole of A, after modification, C is still one-hole-parcel, D is a simple parcel, and C meets D at its exterior border. In C_{36}, the relation between A and B is similar to C_{35}, while after modification, C is still one-hole-parcel, D is a simple parcel, and C meets D at its exterior border.

4. THE IDENTIFICATION ALGORITHMS FOR THE SUB-CLASSIFICATIONS OF SMALL CADASTRAL STRUCTURE CHANGE

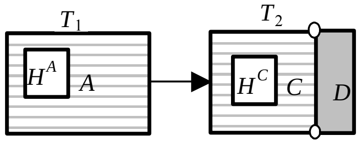
Cadastral structure change is the foundation for conducting change analysis and updating data in Cadastral Information Systems (CIS). The identification algorithms for change analysis and updating are different. In this section, we will discuss the identification algorithms.

Identify the sub-classifications for change analysis

People usually conduct change analysis with two states at different time (or two snapshots). The purpose of cadastral structure change analysis usually is to get the change type, i.e., to identify the sub-classifications of cadastral structure change, then to get the information about the change reason, change process, etc. As we classified the cadastral structure change based on the shape of an individual parcel and the topological relationship (structure) between the involved parcels, the change types can be gotten based on them too.

The shape of an individual parcel is measured by 'Euler number' (sometimes called Euler-Poincare, denoted by *Eul*) in this paper [ARMSTRONG, 1979; Zhou et al, 2006]. If A is a simple parcel, the Euler number of A is 1, denoted as *Eul(A)=1*; if A is one-hole-parcel, the Euler number of A is 0, denoted as *Eul (A) =0.* The topological relation between a simple parcel (A), and a one-hole-parcel (B) is described by the topological relations between: A and H^B, A and B* (B' generalized region) [Egenhofer et al, 1994; Zhou et al, 2003].

For example, in Figure. 4, at T_1, A is a one-hole-parcel, *Eul (A) =0.* At T_2, after the splitting, C is a one-hole-parcel, *Eul (C) =0, D* is a simple parcel, Eul (*D*) =1, C* meets D, H^C disjoint D, and the area of A is equal to the area of C adds the area of C, A covers C, and A covers D. If the change satisfies these conditions, we can determine that the change is C_{32}.



Eul (*A*)=0
Eul (*C*)=0
Eul (*D*)=1
C^* meets *D*
H^C disjoint *D*
A cover C
A cover D
Area (A) = Area (C) + Area (D)

Figure. 4 The identification algorithms for the sub-classifications of small cadastral structure change in change reasoning: an example (C32)

For Small Union (SU), including SU_1, SU_2, SU_3, and SU_4 in Figure 5, they all have the peculiarities: (1) *C covers A,* (2) *C covers B,* (3) Area *(A)* + Area *(B)* = Area (*C*). If the change still satisfies the following conditions, i.e. for SU_1, Eul(*A*)=1, Eul(*B*)=1, *A* meets *B,* Eul(*C*) =1 (Figure.5 (a)); for SU_2, Eul(*A*)=0, Eul(*B*)=1, $H^A = B$, Eul(*C*) =1 (Figure.5 (b)); for SU_3, Eul(*A*)=0, Eul(*B*)=1, H^A includes *B*, Eul(*C*) =0 (Figure.5 (c)); for SU_4, Eul (*A*) =0, Eul(*B*)=1, H^A disjoints *B*, Eul(*C*) =0 (Figure.5 (d)).

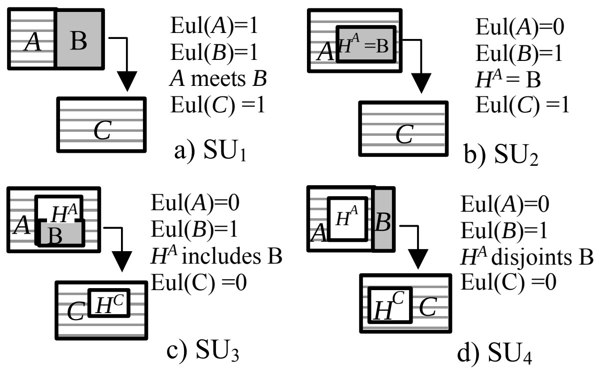


Figure. 5 The identification algorithms for the small Unions for change reasoning

For Small Split (SS), including SS_1, SS_2, SS_3, and SS_4 in Figure.6, they share the peculiarities: (1) A covers C, (2) A covers D, (3) Area (A) = Area (C) + Area (D). If the change still satisfies the conditions shown in Figure.6 (a), (b), (c), (d) respectively, the sub-classification can be determined.

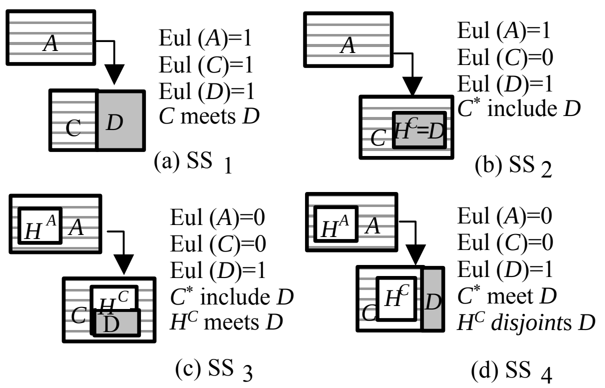


Figure. 6 The identification algorithms for the Small Splits

For rectification (RC), including RC1, RC2, …, RC8 in Figure.7, they share the characteristics: (1) it is assumed that fD ( ) denotes the dimension of the function, fD (A∩C) = 2 or fD (A∩D) = 2, and fD (B∩C) = 2 or fD (B∩D) = 2; (2) A≠C, A≠D, B≠C, and B≠D; (3) Area (A) + Area (B) = Area (C) + Area (D), (2) A covers C, (3) A covers D. If the change still satisfies the conditions shown in Figure.7 (a), (b), …, (h) respectively, the sub-classification can be determined.

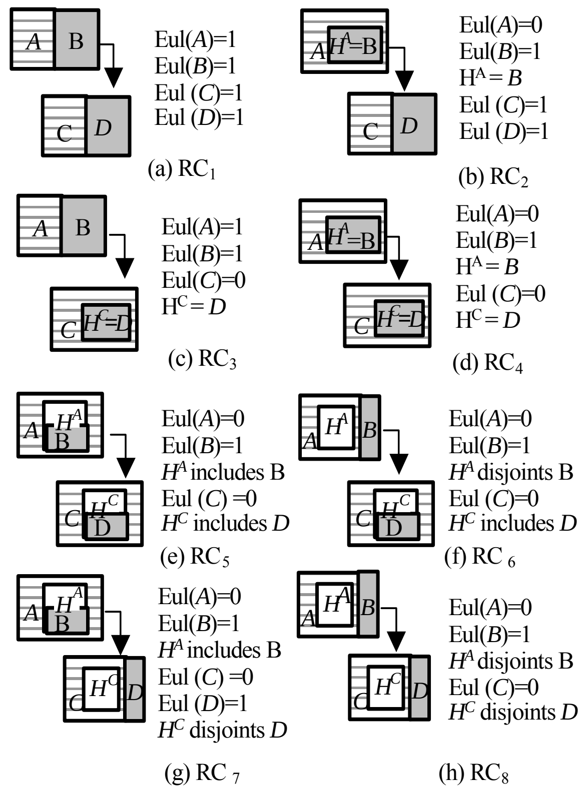


Figure. 7 The identification algorithms of the rectification for change

4.1 Identification the sub-classifications for updating

As mentioned above, the identification of the sub-classification of cadastral structure change can be benefit to reconstruct the objects after change and update a cadastral database. The state after the change is not available for the identification of cadastral structure change during the process of update; we cannot identify the cadastral structure change using the state after change. While in the process, for small cadastral structure change, the involved object (s) before change usually will be chosen interactively, the changed data will be collected and submitted according to the necessary. Therefore we can determine the sub-classification of cadastral structure change based on the involved object (s) before change and the submitted new data.

For small union, there are two parcels before the change involved in the transition. There is no necessary to input new data. The sub-classifications can be determined by the shape and the topological relations between the involved parcels. It is assumed that A and B are the two involved parcels, and C is the parcel after the transition. The identification rules are shown in the Figure.8, for the cases in the Figure.8, they share the rule: A meets B.

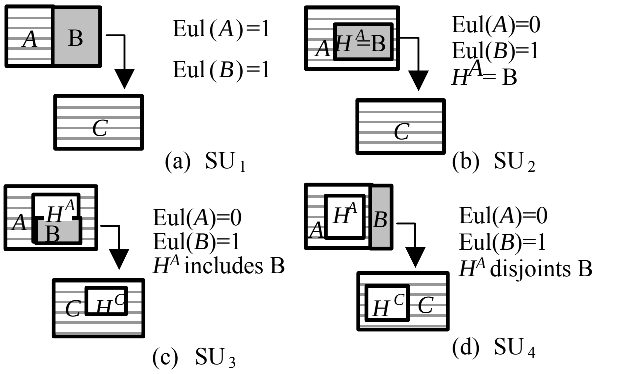


Figure. 8 The identification algorithms of small union for updating

For small split, it is necessary to input the data of a new boundary line, the sub-classifications can be determined by the shape of the parcel before the change, the shape of the new boundary line, and the topological relations with the involved parcels. The shape of the boundary line includes simple line and circle line, which can be discriminated by the endpoints. It is assumed that l is the input new boundary line, n_1 and n_2 are the endpoints of l. *If* $n_1 \neq n_2$, then l is a simple line; if $n_1 = n_2$, then l is a circle line. The topological relations between the new boundary line and the involved parcels are needed only when the parcel is a one-hole-parcel, and which can be determined by the relations between H^A (the hole of A) and l. The identification rules are shown in the Figure.9. For the four cases in the Figure.9, they share the rule: $f_D(A \cap l) = 1$.

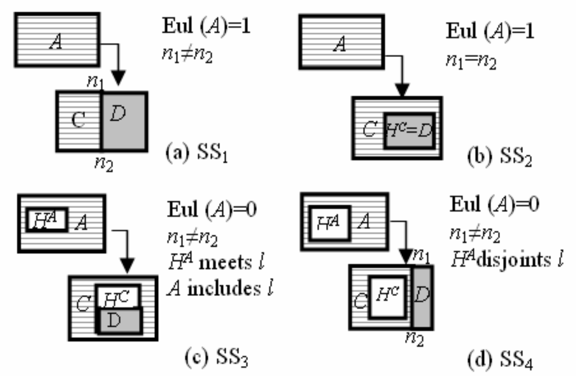


Figure. 9 The identification algorithms of the small split for updating. l is input the new boundary line, n_1 and n_2 are the endpoints of l.

For ***rectification (RC)***, there are two parcels before the change involved in the transition, and it is necessary to input the data of a new boundary line. Thus the sub-classifications can be determined by the shape of these two parcels and the new boundary line; the relations between these two parcels, and between the two parcels and the new boundary line. It is assumed that A and B are the two involved parcels before the transition, C and D is the parcels after the transition, and l is the input new boundary line, n_1 and n_2 are the endpoints of l. The shape of l is the similar with the ***small split***. The topological relations between l and the involved parcels are needed only when the parcels include a one-hole-parcel, and which can be determined by the relations between H^A (the hole of *A*, it is assumed that *A* is the one-hole-parcel) and l, and between A^* (*A*' generalized region) and l. The identification rules are shown in the Figure10. For the eight cases in the Figure10, they share the rules: (a) A meets B*; (b) Let* $P = A \cup B$, $f_D(P \cap l) = 1$.

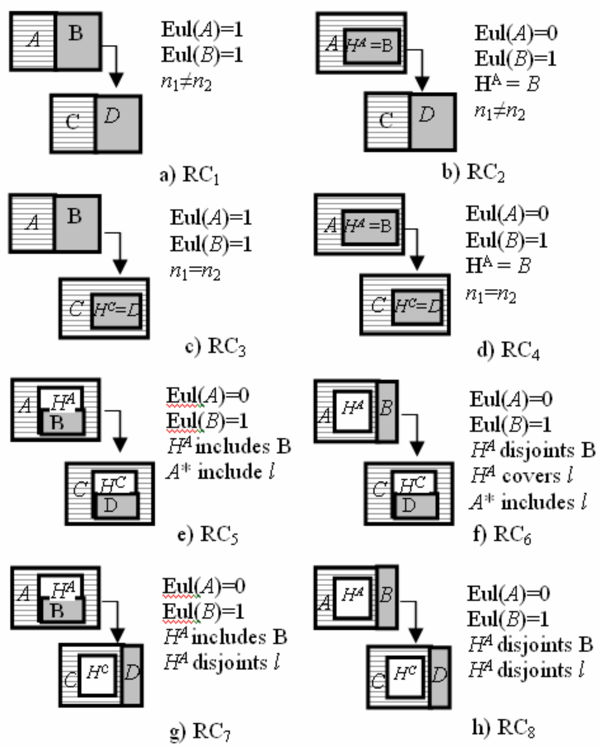


Figure. 10 The identification algorithms of the rectification for updating

5. THE TYPICAL CASES OF LARGE CADASTRAL STRUCTURE CHANGE

For large cadastral structure change, as the number of the parcels involved in such changes is variable, it is difficult to analyse the change types theoretically, we concluded 5 typical cases based on our experience and current references. According to our analysis, from the updating point of view, cadastral large structure changes still can be subdivided to five cases according to the inputting spatial data:

- **Node moving**, changes caused by one point shared several parcels, for updating, it is only needed to choose one point before change, and input the spatial data after change, Figure11.
- **Large union**, m parcels unite to one parcel, for updating, we only need to choose the m parcels meeting one by one, needn't input new data, Figure12.
- **Large split**, one parcel splits to n parcels, for updating, we need to choose one parcel before change, and input n-1 boundary lines, Figure13.
- **Reallocation by one line,** it usually means p parcels reallocate to p+1 parcels, as Figure14 shows. It also includes two cases, i.e. reallocation by one simple line (Figure14 (a)), and by one loop line (Figure14 (b)). For updating, one needs to choose p parcels meeting one by one, and input the new boundary line.
- **The other reallocations**, mean p parcels reallocate to q parcels, Figure15 is an example for such transitions. For updating, one needs to choose p parcels meeting one by one, and input several boundary lines.

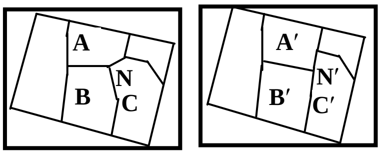


Figure.11 Node moving

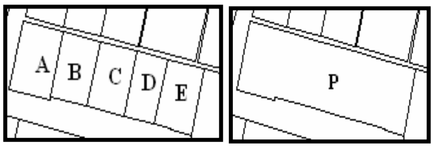


Figure.12 Large union

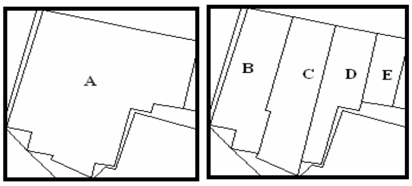
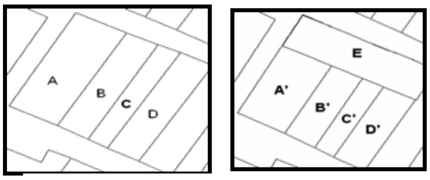
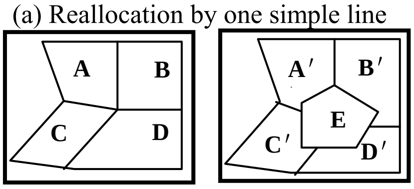


Figure.13 Large split



(a) Reallocation by one simple line



(b) Reallocation by one loop line

Figure.14 reallocation by one line

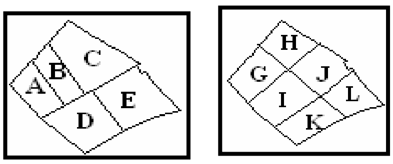


Figure.15 The other reallocations: example

6. APPLICATION IN UPDATING: AN EXAMPLE

As mentioned above, cadastral topological structure change plays very important roles in updating data in CIS. If we can identify the different types of cadastral structure change, reconstruct the objects after the transition for each structure change, and determine the basic change type for each single objects, then a cadastral database can be updated automatically (or semi-automatically) according to the mapping relationship between change type of single object and the updating operators (Zhou, et al, 2004). We use the incremental updating of small rectification as an example to illustrate how the sub-classification of cadastral structure change can be used to improve the procedure for updating cadastral databases.

In order to implement the updating process automatically, a set of functions have been designed, including the function used to determine the type of transitions; the functions used to get the properties of the involving objects; the functions used to rebuild the objects after transition; the function used to check the topological integrity; the function used to determine the change type of entities; and the function used to form the updating operation.

1) Function used to determine the type of change

Functions used to determine the type of change just includes **DetermineChange (P1, L, P2).** It is the function used to determine the small group change change type, P1 and P2 is the involved parcels, L is the new boundary, P2 and L can be default, when L is default, the change is a union change; when P2 is default, the change is a split change; else it is a rectification change. The result of this function is the code of change.

2) Functions used to get the properties of the involving objects

Functions used to get the properties of the involving objects mainly include GetBoundary (), GetBoundaryI (), GetBoundaryE (), GetOwner (), GetCoboundary (P1, P2):

GetBoundary (A) denotes the function used to get the boundary lines of parcel A from boundary line table;
GetBoundaryI (A) denotes the function used to get the inner boundary lines of parcel A (which is one-hole-parcel) from boundary line table;
GetBoundaryE (A) denotes the function used to get the exterior boundary lines of parcel A (which is one-hole-parcel) from boundary line table;
GetOwner (A) denotes the function used to get the owner of parcel A;
GetCoboundary (P1, P2): denotes the function used to get the coboundary of **P1and P2**

3) Functions used to rebuild the objects after change:
RebuildLI (SL, L) is a function used to rebuild the boundary lines after inserting new boundary L in L1;
RebuildLD (SL, L) is a function used to rebuild the boundary lines after deleting the boundary L in L1;
RebuildL (SL) is a function used to rebuild the set of boundary lines to make them satisfy the integrity between boundaries;
RebuildP (L) is a function used to rebuild the parcels using the set of boundary lines L;
Split (P, L) is a function used to split simple parcel P into two parcels using the loop boundary line L;
Union (P1, P2) is a function used to Union two meeting parcels: P1 and P2 to one parcel

4) Function used to check the topological integrity:
CheckIntegrity (P, L) is a function used to check the topological integrity between the objects in two sets: the set of parcels P and the set of boundary lines L;

5) Function used to determine the change type of entities:
DetermineChangeP (PA, PB) is the function used to determine the change type of the two sets of parcels: PA (the set of parcels before change) and PB (the set of parcels after change);
DetermineChangeL (LA, LB) is the function used to determine the change type of the two sets of boundary lines: LA (the set of boundary lines before change) and LB (the set of boundary lines after change);

6) Function used to form the updating operation

In this paper, the Change Pattern Language (EPL) developed in active database is adopted in the formal representation of the updating process. Where an updating operation (such as create or delete), defined as a primitive change, a whole cadastral change updating process as a composite change, the composite changes are represent by EPL (Chen Jun &Jiang Jie, 2000).
UpdateP (CP) is the function used to form the updating operation of parcels according to the change type of parcels;
UpdateL (CL) is the function used to form the updating operation of boundary lines according to the change type of boundary lines.

With the functions, the procedure of the implementation for incremental updating of small rectification is shown in Figure16. In Figure16, A, B denote the parcels before the transition; L denotes the new boundary line; L1 denotes the set of boundary lines before the transition; LA denotes the boundary lines of A; LB denotes the boundary lines of B; OA denotes the owner of A; OB denotes the owner of B; P1 denotes the set of parcels before change; LC denotes the co-boundary lines of A and B; PC denotes the parcel of A union B; LR denotes the set of boundary lines of PC; P2 denotes the set of parcels after change; L2 denotes the set of boundary lines after change; CP denotes the set of change types of each individual parcels involved in the changes; CL denotes the set of change types of each individual boundary lines involved in the changes; UP denotes the set of updating operations of each individual parcels involved in the changes; UL denotes the set of updating operations of each individual boundary lines involved in the changes. In this procedure, the portion in the yellow box will be finished automatically.

From this example, we can conclude that the reconstruction of the objects after change is a precondition in updating cadastral databases, and the identification of the sub-classification of the structure changes is benefit to the automation of the objects' reconstruction process. Therefore there is benefit in terms of the updating a cadastral database automatically or semi-automatically.

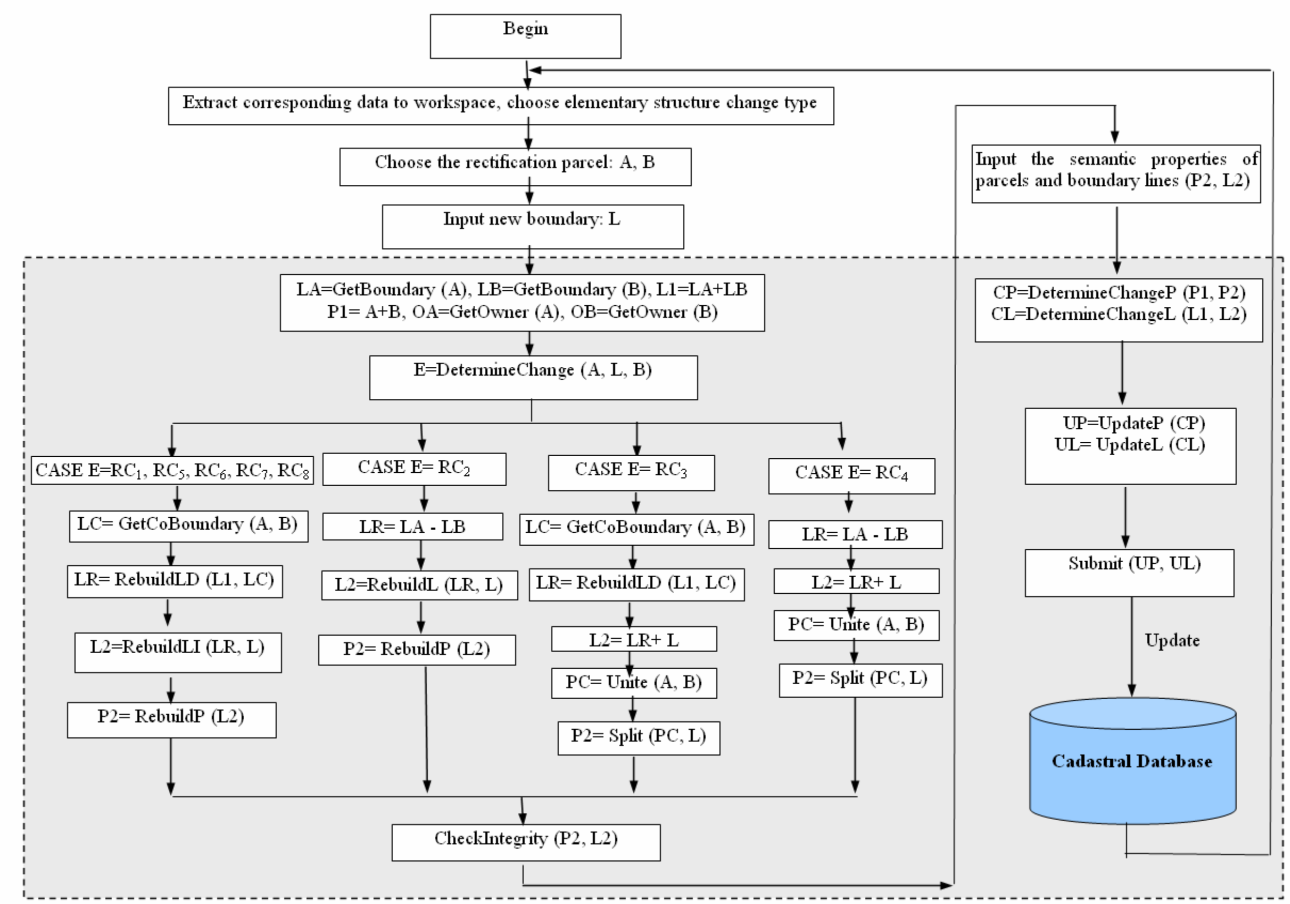


Figure.16 The application: an example of incremental updating of small rectification

7. SUMMARY AND CONCLUSION

Cadastral topological structure change is subdivided to small structure change and large structure change in this paper. The classification methodology of small cadastral structure change is discussed; the sub-classifications of the small structure change are concluded and proved at a given level. The semantic of the sub-classifications of small cadastral structure change is described. The identification algorithms for the sub-classifications of small cadastral structure change used in both change reasoning and updating are presented. The typical cases of large cadastral structure change are concluded. An example was used to illustrate how the sub-classification of cadastral

structure change can be used to improve the procedure for updating cadastral databases.
It is concluded that at the level of: the shape of parcel just includes simple parcel and one-hole-parcel; the meeting relationship between the involved parcels limited to the basic meeting at one side, there are 18 kinds of small cadastral structure changes, i.e. two kinds of semantic changes, four kinds of union, four kinds of split, and eight kinds of rectification. 5 typical cases of large cadastral structure change are concluded based on our experience and current references, i.e. node moving, large union, large split, reallocation by one line, and the other reallocations.

The identification algorithms for the sub-classifications of small cadastral structure change used in both change reasoning and updating are presented. The identification algorithms for change reasoning are based on the shape of an individual parcel and the topological relationship (structure) between the involved parcels before and after the transition. The identification algorithms for updating are based on the shape of the individual parcel and the topological relations (structure) between the involved parcels before the transition, and the submitted new data.

The cognition of the cadastral structure change will be benefit to the designing of CIS, cadastral spatial data change analysis, and update cadastral data bases. Using the proposed approach to automatically update the cadastral database, and maintain the topological integrity will be the work for future research.

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