



# **Study on classifications of topological changes**

---

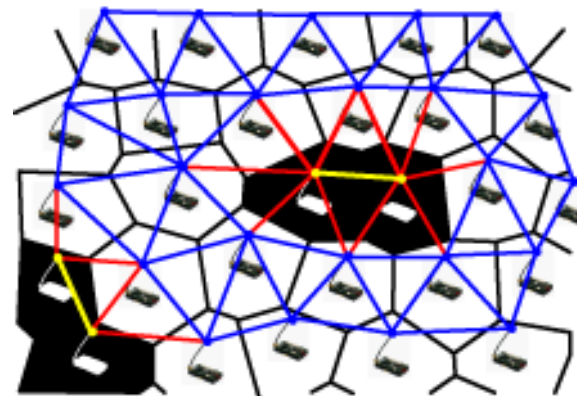
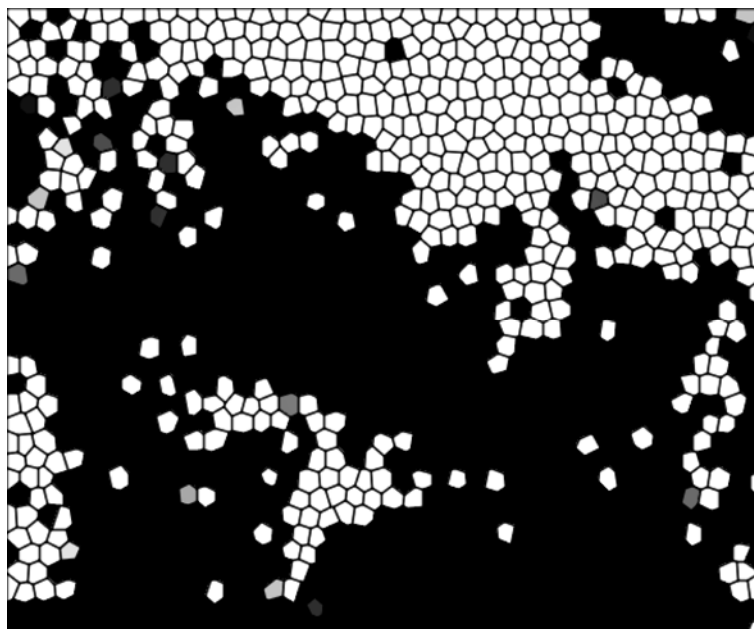
**Jixiang Jiang**

**Department of Spatial Information Science and Engineering  
University of Maine**

**Dec. 3<sup>rd</sup>, 2007**

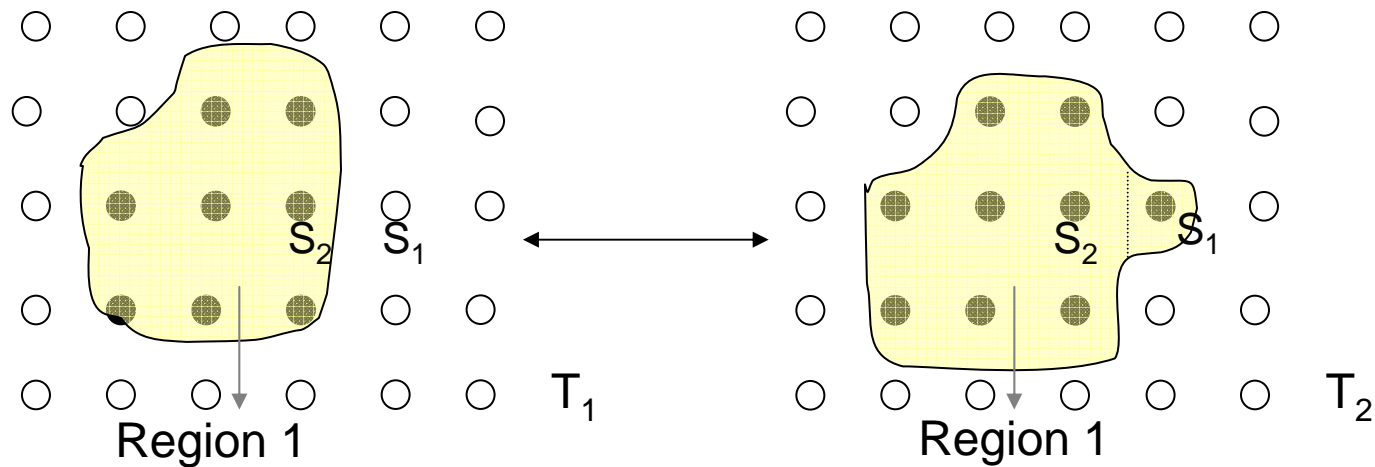
# Introduction

---



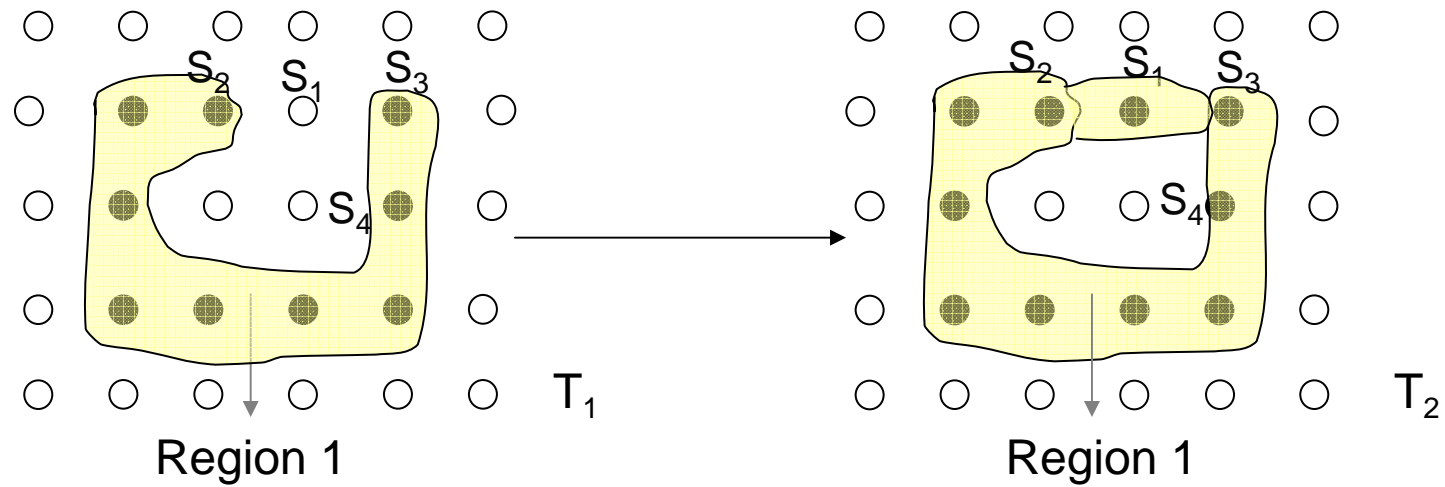
Cited from Chris' presentation

# Introduction



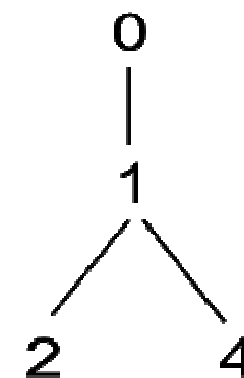
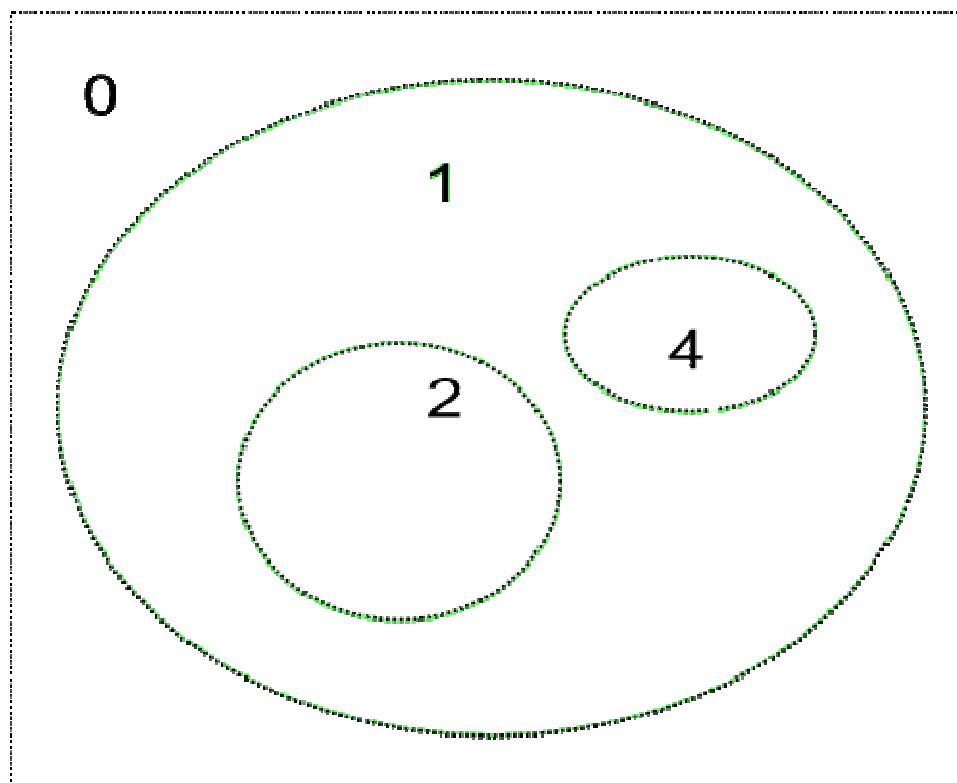
Cited from Cheng's presentation

# Introduction



# Introduction

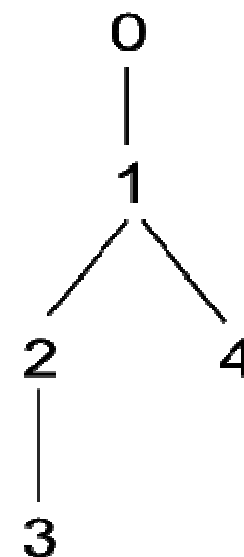
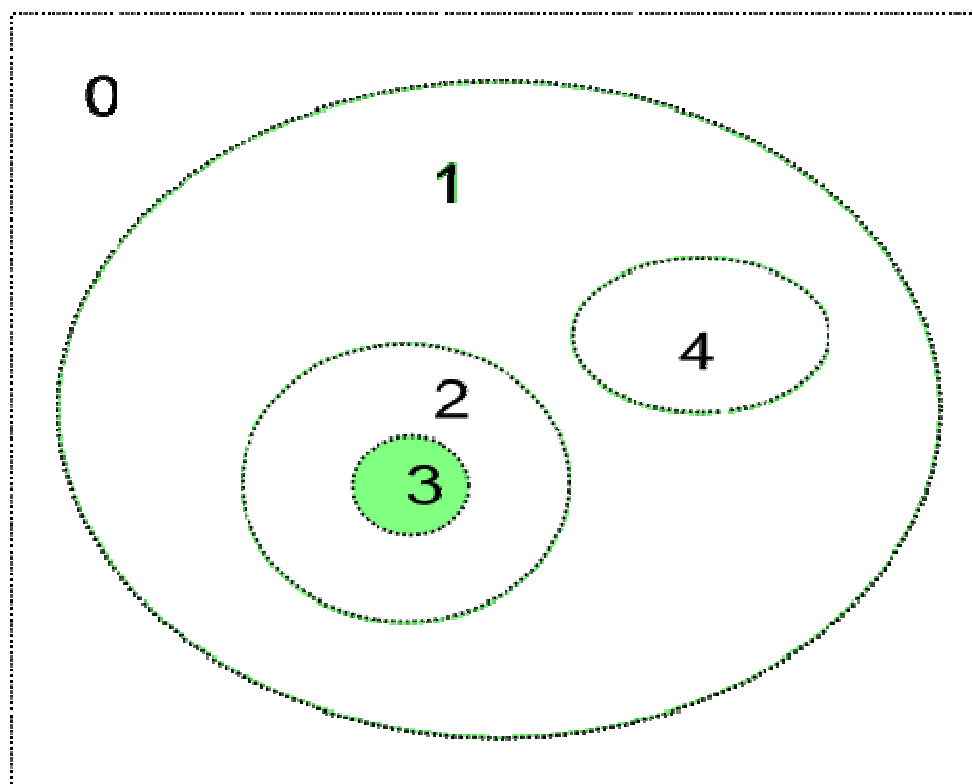
---



Cited from Jafar's presentation

# Introduction

---



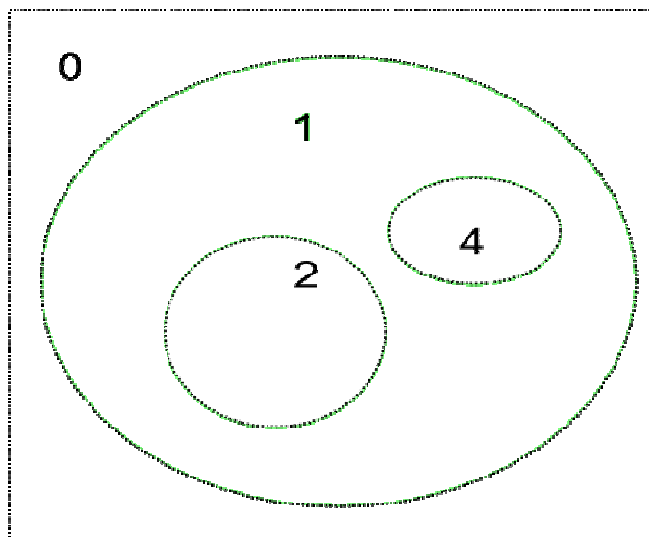
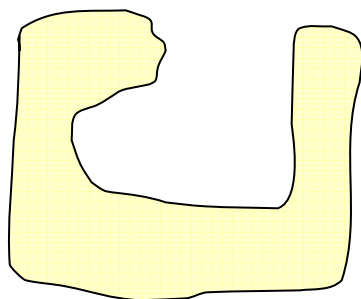
# Introduction

---

- ❖ This work analyzes the types of topological changes that reported by sensor readings.
- ❖ Find out the necessary information in order to differentiate types of topological changes.
- ❖ Provide a model to represent the information for classifying the topological changes.

# Areal objects

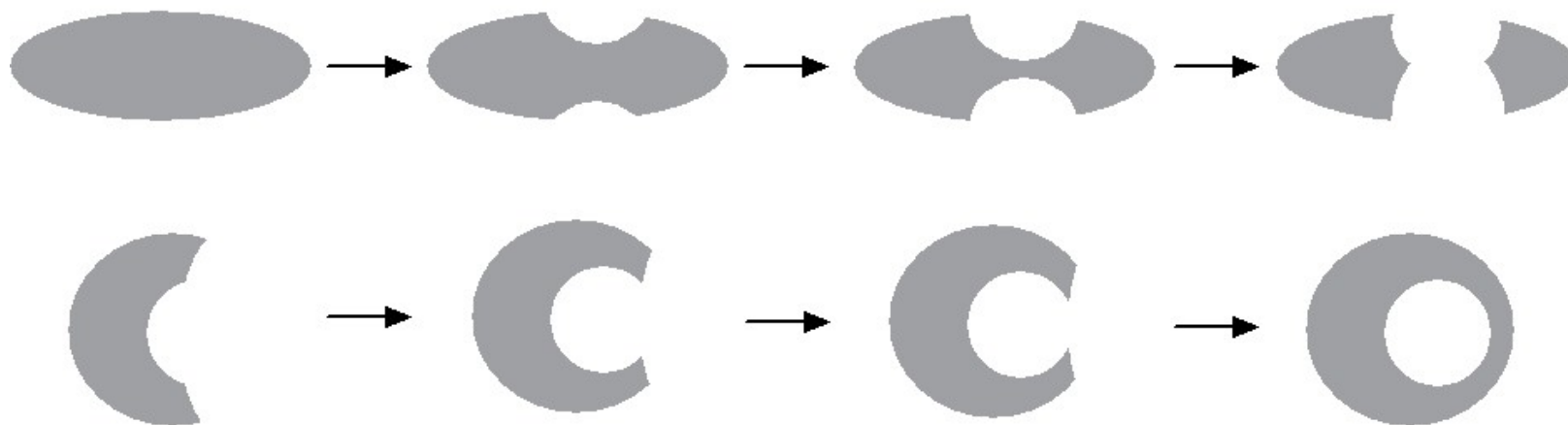
- ❖ A subset of the spatial domain
- ❖ Regular closed
- ❖ Finite number of connected components



## Topological changes

---

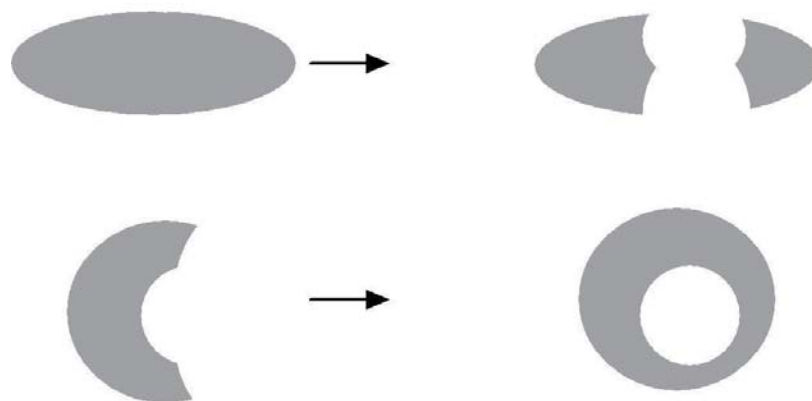
The topological properties change as the areal objects evolve through time.



## Topological changes

---

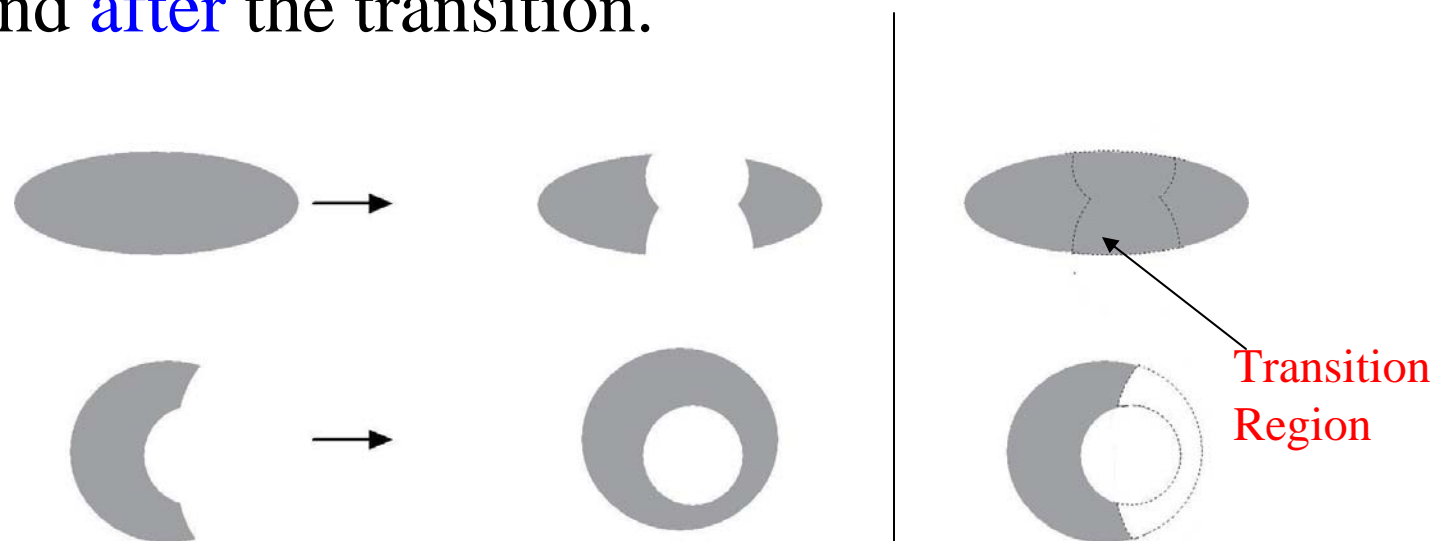
- ❖ A topological change is represented by the areal objects **before** and **after** the transition



- ❖ **Transition region** is defined to be the locations that have different states.

# Topological changes

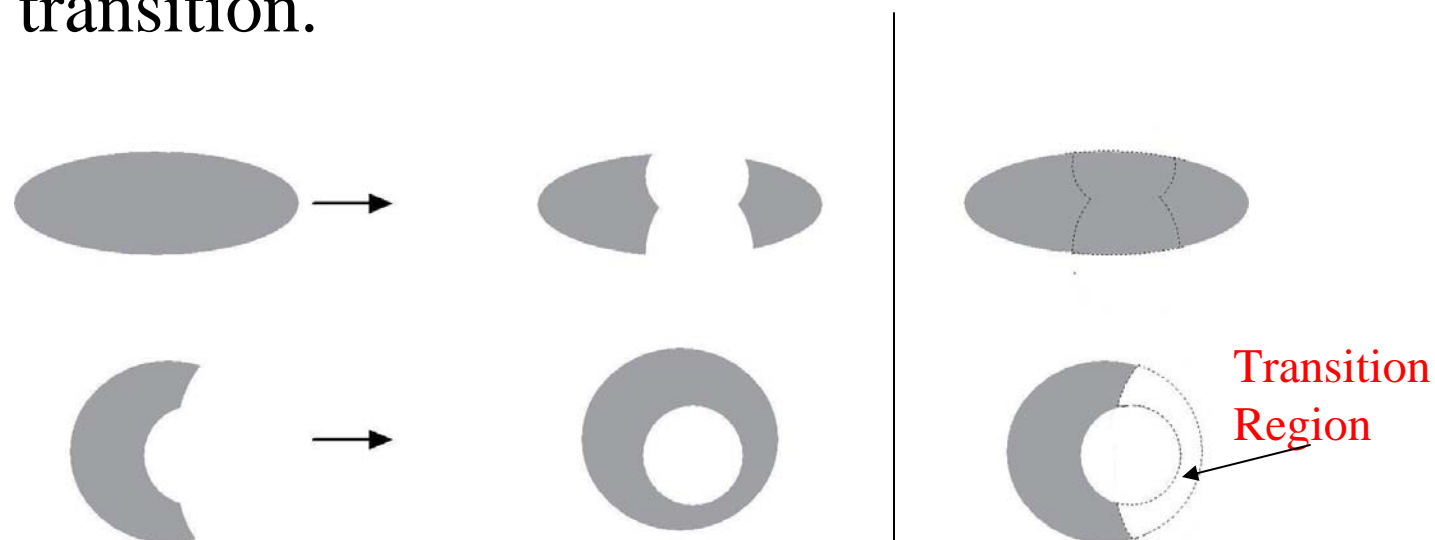
- ❖ A topological change is represented by the areal objects **before** and **after** the transition.



- ❖ **Transition region** is defined to be the locations that have different states.

# Topological changes

- ❖ A change is represented by the areal objects **before** and **after** the transition.



- ❖ **Transition region** is defined to be the locations that have different states.

## Basic changes

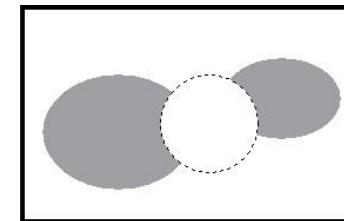
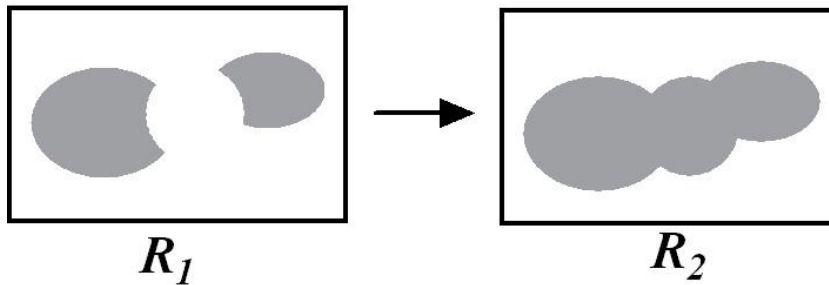
---

Basic changes are changes such that:

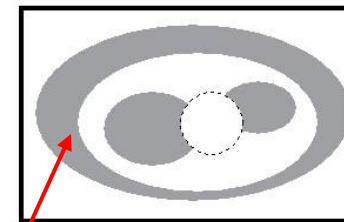
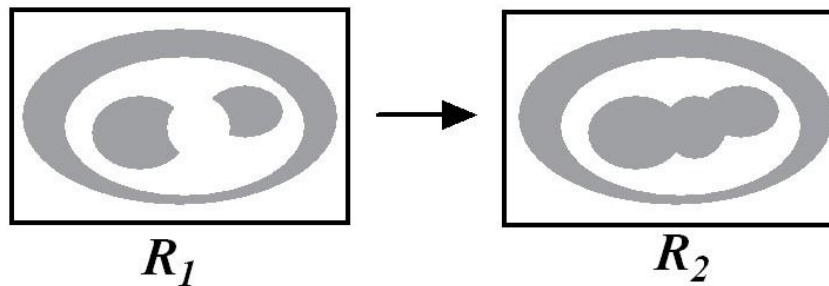
- ❖ The transition region is **topologically same** as a disk.
- ❖ The transition region is **either** completely contained in **the interior**, **or** is completely contained in **the exterior** of the areal object before the change.

# Classifying the basic changes

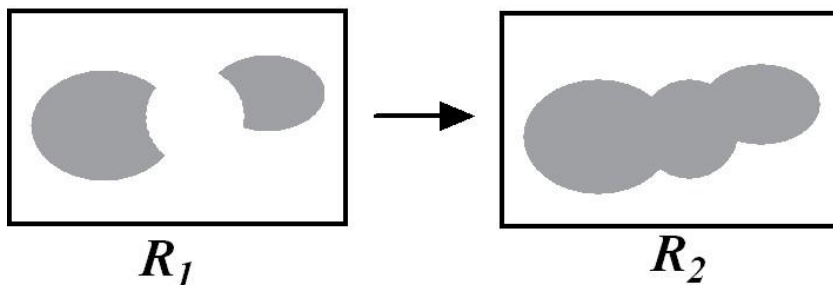
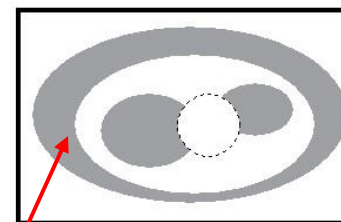
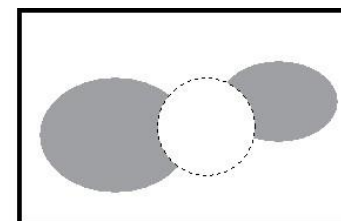
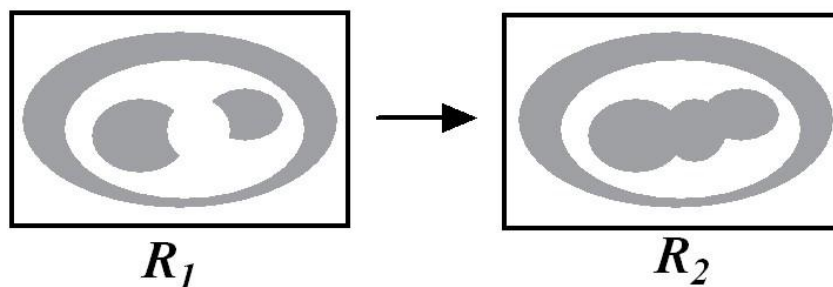
**BC<sub>1</sub>**



**BC<sub>2</sub>**



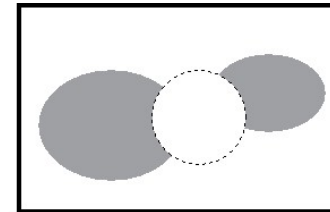
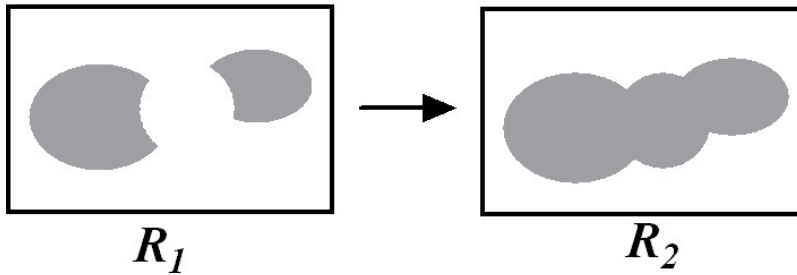
# Classifying the basic changes

**BC<sub>1</sub>****BC<sub>2</sub>**

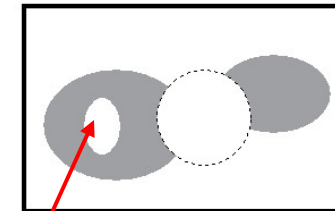
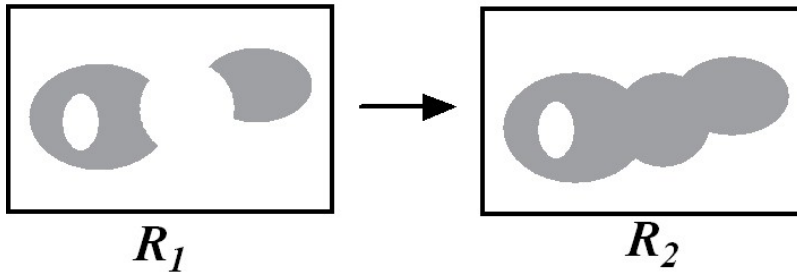
Assumption 1: Components that are not adjacent to the transition region are not considered when classifying the basic changes

# Classifying the basic changes

**BC<sub>1</sub>**

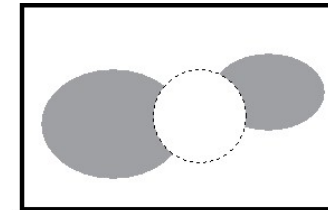
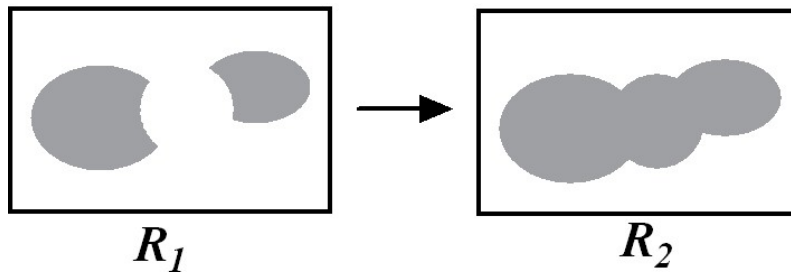


**BC<sub>3</sub>**

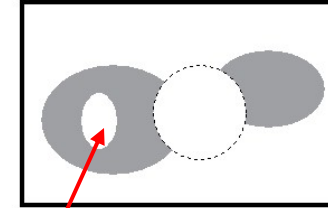
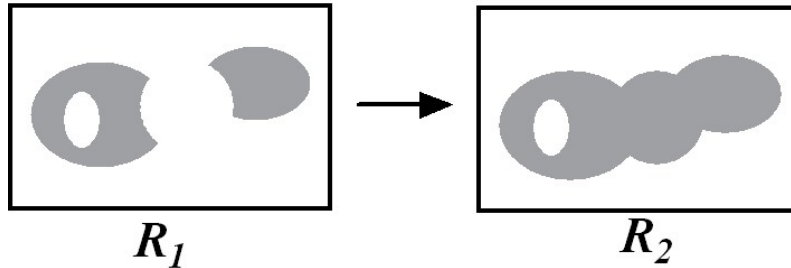


# Classifying the basic changes

**BC<sub>1</sub>**



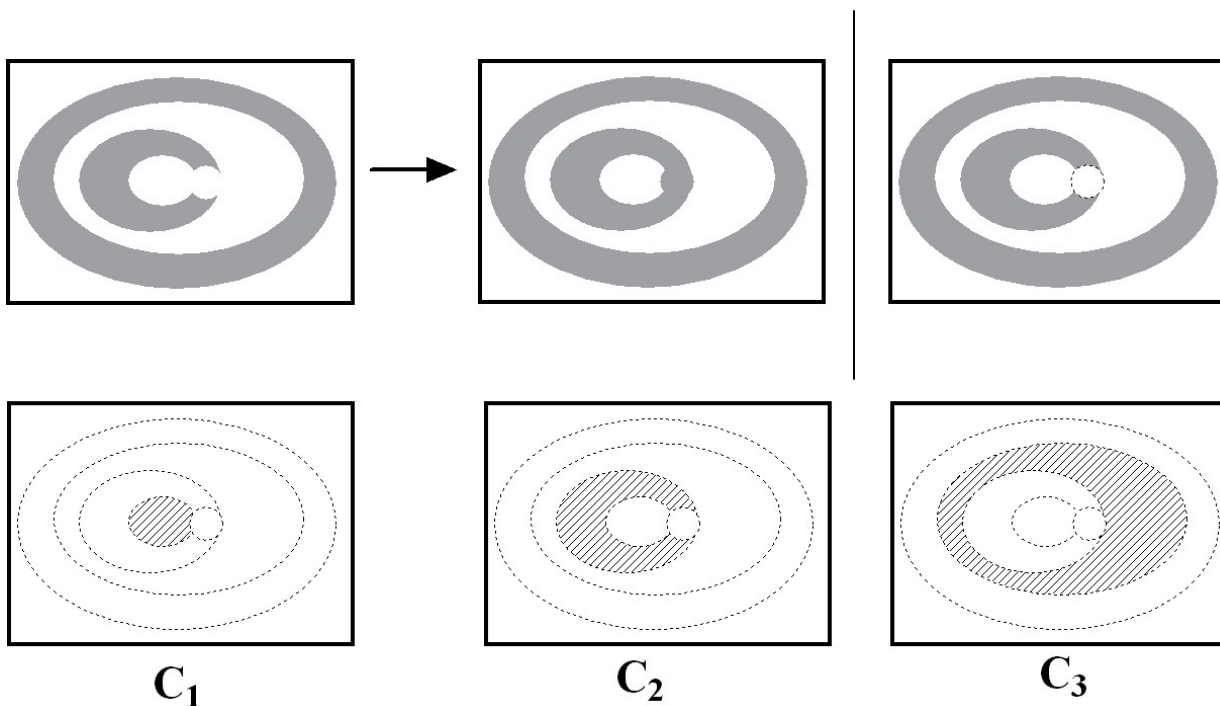
**BC<sub>3</sub>**



Assumption 2: The internal topological properties of each individual component are not considered when classifying basic changes

## Classifying the basic changes

The components that are adjacent to the transition region are considered

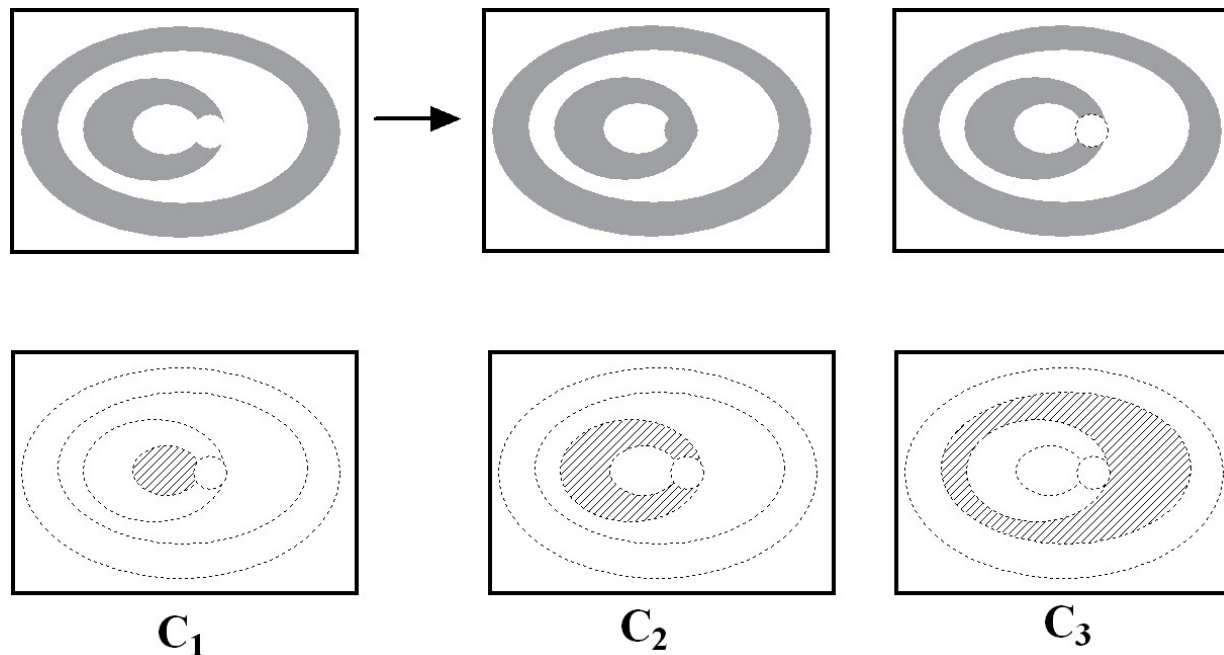


## Classifying the basic changes

---

- ❖ The relations between the components that are adjacent to the transition region are considered
- ❖ Adjacent relation  
 $C_1$  is **adjacent to**  $C_2$  if **the union** of  $C_1$  and  $C_2$  is a **single** component
- ❖ Surrounded-by relation  
 $C_1$  is **surrounded-by**  $C_2$  if  $C_1$  is contained in a **hole** of  $C_2$

## Classifying the basic changes



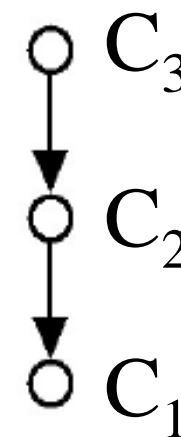
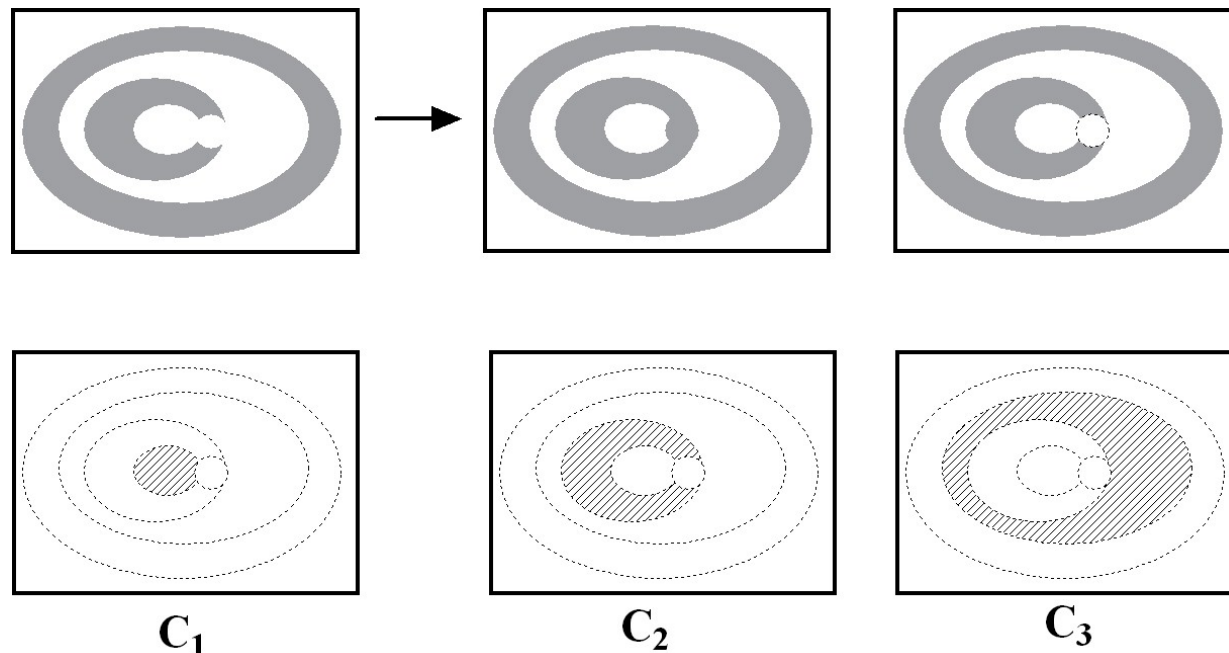
- ❖ Adjacency:  $C_1$  and  $C_2$ ,  $C_2$  and  $C_3$ .
- ❖ Surrounded-by: both  $C_1$  and  $C_2$  are surrounded by  $C_3$ .  $C_1$  is also surrounded by  $C_2$

## Models of basic changes

---

- ❖ Let  $C$  be a **basic change** with  $X$  being the set of components that are adjacent to the **transition region**. It can be proved that:
  - ❖ The **adjacency graph**  $\langle X, Rx \rangle$  is a tree.
  - ❖ There is **one and only one** component  $b$  in  $X$  which surrounds all the other components.
- ❖ Rooted tree  $\langle X, Rx, b \rangle$  representation.

# Models of basic changes



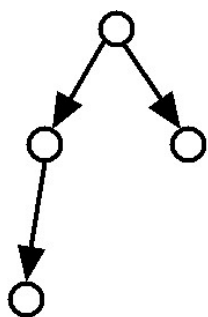
Representation  $\langle X, Rx, b \rangle$ , in which  $X = \{C_1, C_2, C_3\}$ ,  
 $Rx = \{\{C_1, C_2\}, \{C_2, C_3\}\}$ ,  $b = C_3$

# Models of basic changes

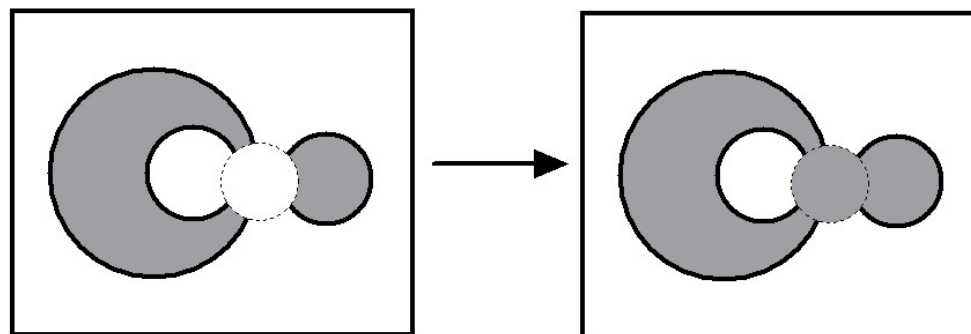
<b>T<sub>1</sub></b>	○	$\xrightarrow{A}$	<b>A: Region appear</b> <b>B: Region disappear</b>	$\xrightarrow{I}$	<b>I: Hole disappear</b> <b>J: Hole appear</b>
<b>T<sub>2</sub></b>	○ ↓ ○	$\xrightarrow{C}$	<b>C,D: Non-topological changes</b>	$\xrightarrow{K}$	<b>K,L: Non-topological changes</b>
<b>T<sub>3</sub></b>	○ / \ ○ ○	$\xrightarrow{E}$	<b>E: Regions merge</b> <b>F: Region split</b>	$\xrightarrow{M}$	<b>M: Hole split</b> <b>N: Hole merge</b>
<b>T<sub>4</sub></b>	○ ↓ ○ ↓ ○	$\xrightarrow{G}$	<b>G: Region self-merge</b> <b>H: Region self-split</b>	$\xrightarrow{O}$	<b>O: Hole self-split</b> <b>P: Hole self-merge</b>

# Models of basic changes

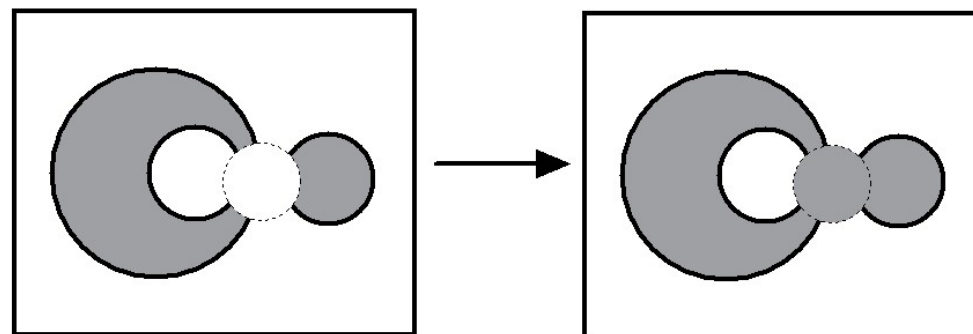
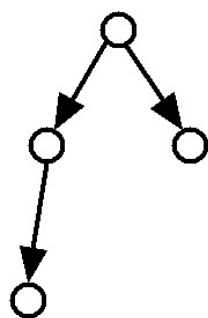
---



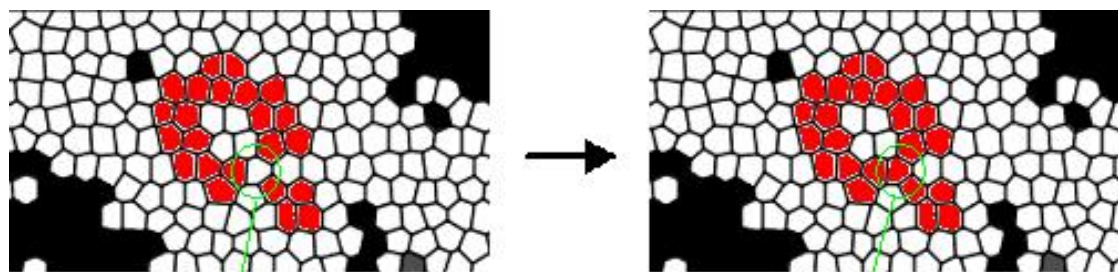
**T<sub>5</sub>**



# Models of basic changes



**T<sub>5</sub>**



Transition Region

Transition Region

## Conclusion and future work

---

- ❖ The rooted tree model is proposed to represent and specify different types of basic changes.
- ❖ Future work includes the specification of topological changes considering weak connectivity.



# Thanks

---

Questions?