High Quality Building
Generalization by Extending the
Morphological Operators

Jonathan Damen    Marc van Kreveld    Bert Spaan

Department of Information and Computing Sciences
Utrecht University
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Morphological operators

- Erosion, dilation, opening, closure

\[ P \oplus Q = \{ p+q \mid p \in P \text{ and } q \in Q \} \]
Morphological operators

- **Dilation**: Minkowski sum of a polygon P with a fixed element like a circle or a square centered at the origin
Morphological operators

- **Erosion**: complement of Minkowski sum of complement of a polygon P with a fixed element like a circle or a square centered at the origin

![Diagram showing erosion operation](image)
Morphological operators

- **Closure**: dilation followed by erosion

![Diagram showing morphological operations](image-url)
Morphological operators

- **Closure**: dilation followed by erosion
Morphological operators

- **Opening**: erosion followed by dilation

\[ P = (P \ominus Q) \oplus Q \]
Morphological operators

• Always:

\[
\text{erosion}(P) \subseteq \text{opening}(P) \subseteq P \subseteq \text{closure}(P) \subseteq \text{dilation}(P)
\]
Building generalization

- Building generalization by morphological operators:
  
  Su, Li, Lodwick, and J.-C. Müller (1997), Li, Yan, Ai, and Chen (2004), Cámara and López (2005), Mayer (2005)

- Other research on building generalization:
  
  Bader, Barrault, Weibel, Burghardt, Cecconi, Duchêne, Bard, Barillot, Ruas, Trévistan, Holzapfel, Jones, Bundi, Ware, Lamy, Demazeau, Jackson, Mackaness, Lonergan, Purves, Rainsford, Revell, Regnauld, Edwardes, Sester, Brenner, Klein, Yan, Yang
Closure
Opening
After opening or closure

- Opening does not aggregate and does not close holes
- Closure does not remove small buildings or narrow connections
- Both may leave details (short edges)
Obvious idea

• Try opening and then closure
Obvious idea

- Try opening and then closure, or vice versa
Opening and then closure
Closure and then opening
Opening
Opening and then closure
Size, shape, orientation of the element

- Larger element $\rightarrow$ more elimination, more aggregation, more simplification
- Square element is better than circle to keep orthogonal character of buildings
- Orientation of square should correspond to orientation of most edges
Conclusions & further research

- Elegant, global solution
- Opening-Closure and Closure-Opening are both better than opening or closure individually

- Short edges remain; post-simplification desirable
- Best orientation of square may not be the same throughout whole building