Linking Past to Present: Discovering Style in Two Centuries of Architecture

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The Big Picture

- Over 2.8 zettabytes of information created or duplicated in 2012 alone
- Much of the data we produce is visual
  - 285+ billion photos uploaded to Facebook, Instagram, & Flickr
  - 5+ million miles of panoramas on Google Street View
  - 300 hours of video uploaded to YouTube a minute




Social sciences and the humanities will need to build on computational foundations to condense and interpret this data.

Recent high-profile work focuses on text analysis

- Studying social media information to predict and track disease

  (Ginsberg et al., *Nature* 2009) (Ruths and Pfeffer, *Science* 2014)

- Examining historical law record

  (Klingenstein et al., *Proceedings of the National Academy of Sciences 2014)*

- Mapping the rise and fall of word use in large digital book collections

  (Michel et al., *Science 2011)*

Some visual analysis has been applied in these domains

- Finding similarities in large collections of art

  (Kim et al., *Scientific Reports,* 2014)

- Aligning 3D architectural models to paintings

  (Aubry et al., *ACM Transactions on Graphic,* 2014)

More closely related to this work:

- Discovering city-scale architectural differences

  (Doersch et al., *ACM Transactions on Graphics,* 2012)

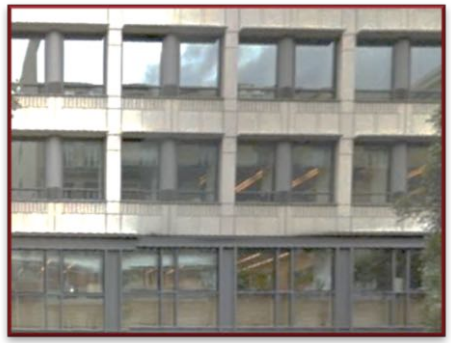
- Finding stylistic shifts in discriminative elements

  (Lee et al., *ICCV,* 2013)

Our Problem| Evolution of Architecture

1800

1915-1939



1990-1999

- **Automatically generate a large temporally labeled building facade dataset**
- **Identify visual elements specific to certain time periods**
- **Track stylistic changes in functionally identical elements**

120,000 Parisian Buildings

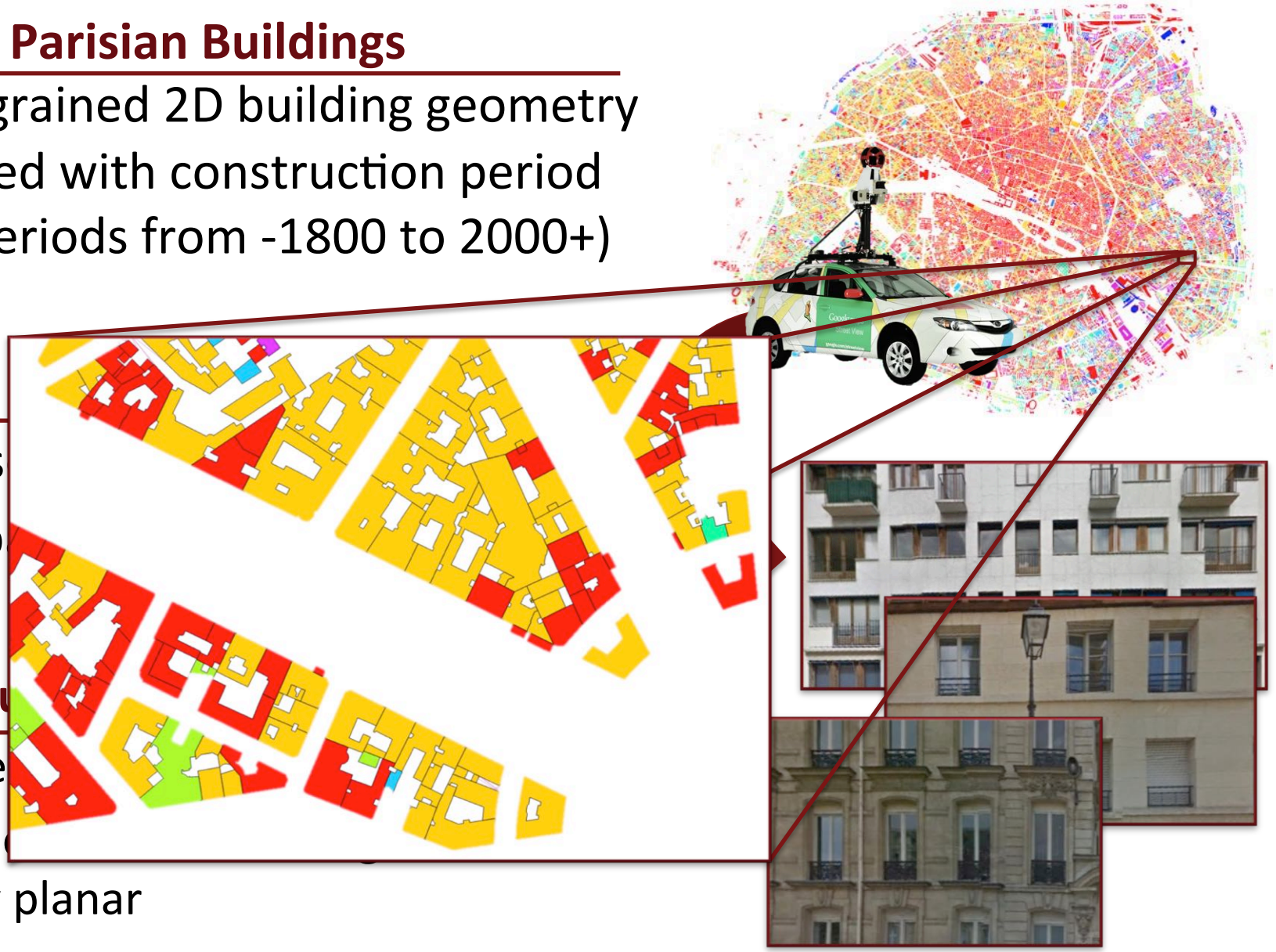
- Fine-grained 2D building geometry
- Labeled with construction period (10 periods from -1800 to 2000+)

145,000

- Precis
- 360˚ p

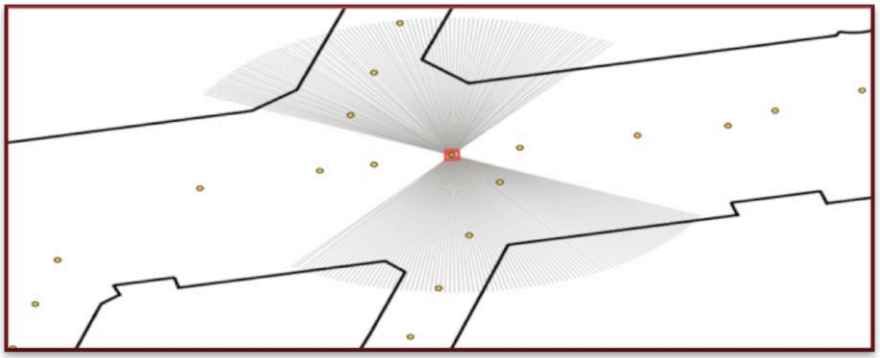
70,000 Bu

- Labele
- Rectifi nearly planar

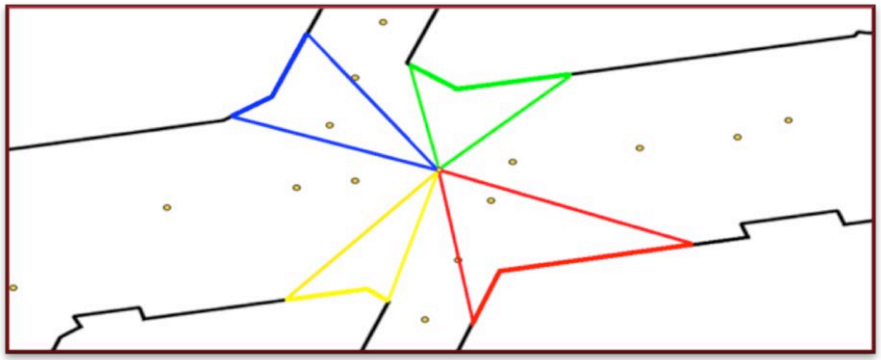


Dataset| Automatically generating facade images

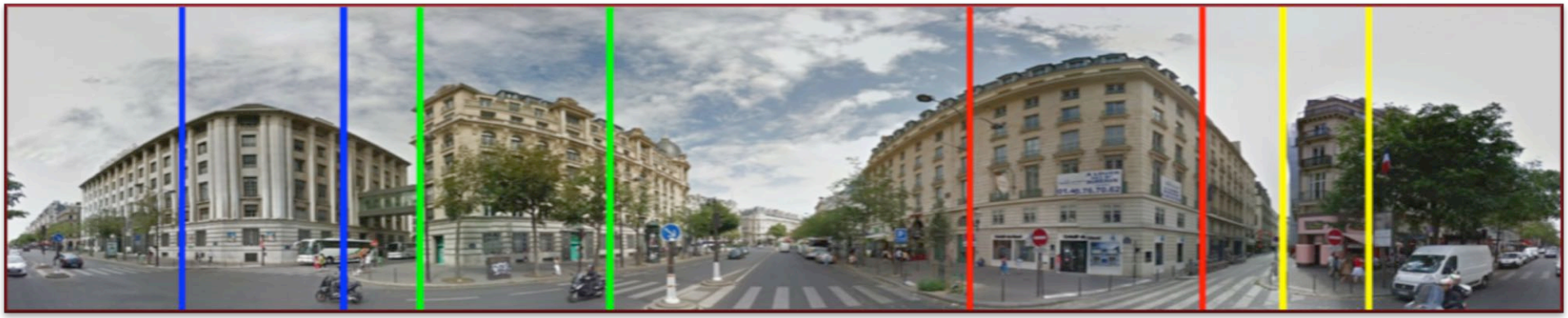
① **Cast 30m rays to the sides of each Street View capture location at 1° intervals**



② **Compute intersections with facades and select the widest view**



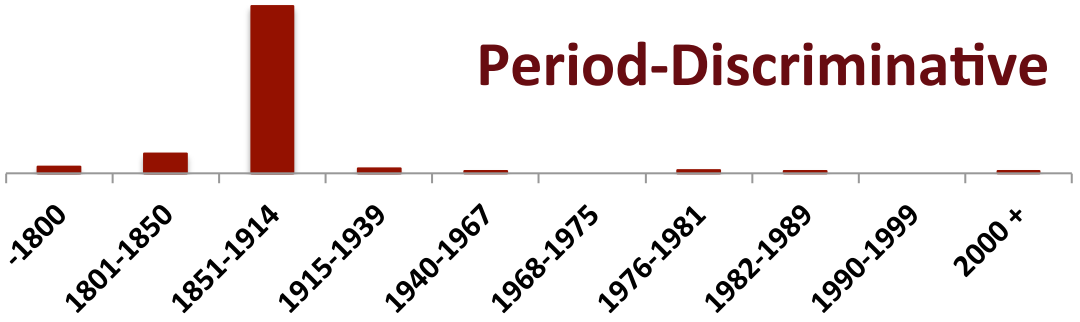
③ **Project onto the panoramas then crop and warp the facade images**

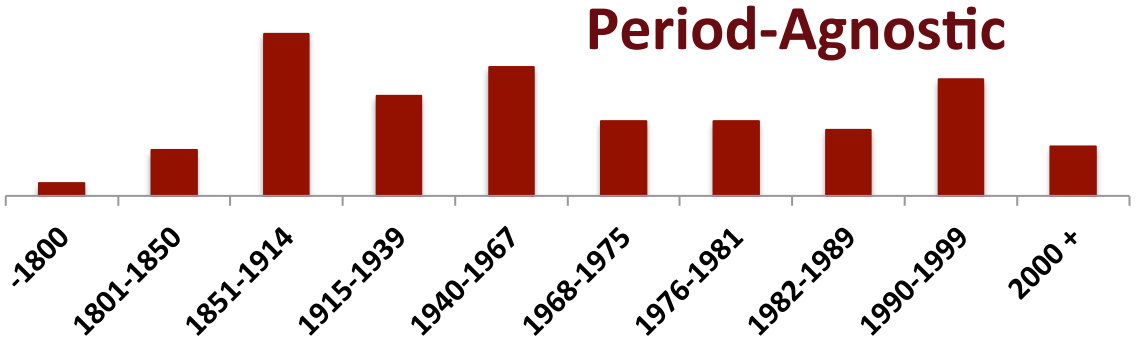


Filter buildings that are far skewed or too narrow in view, resulting in approximately 70,000 facades.

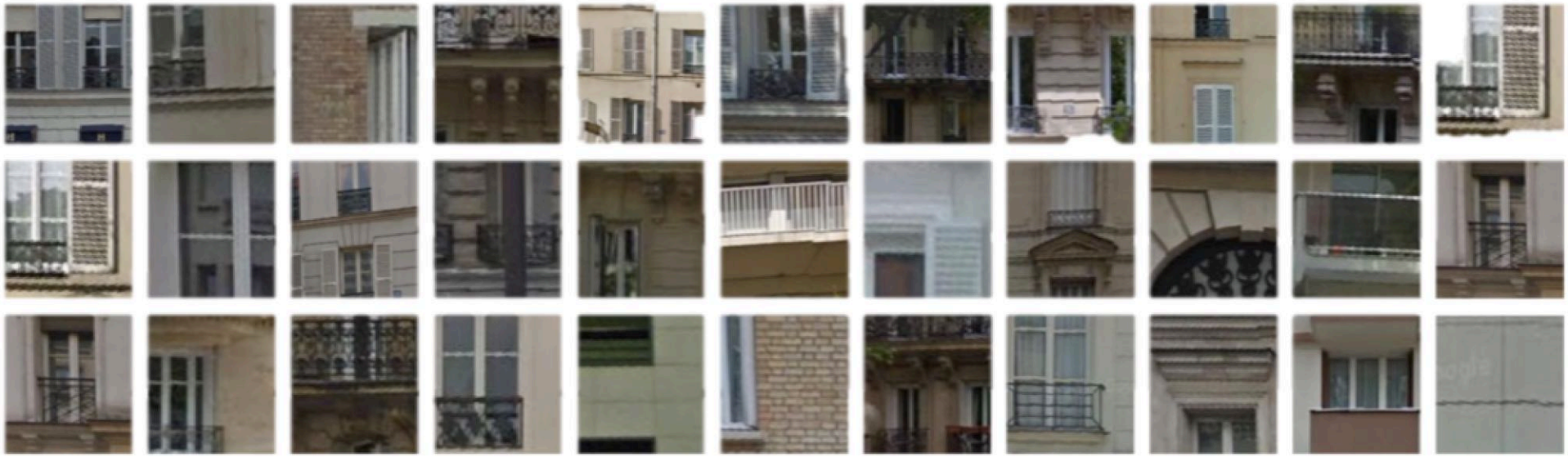
Period-Discriminative Elements:

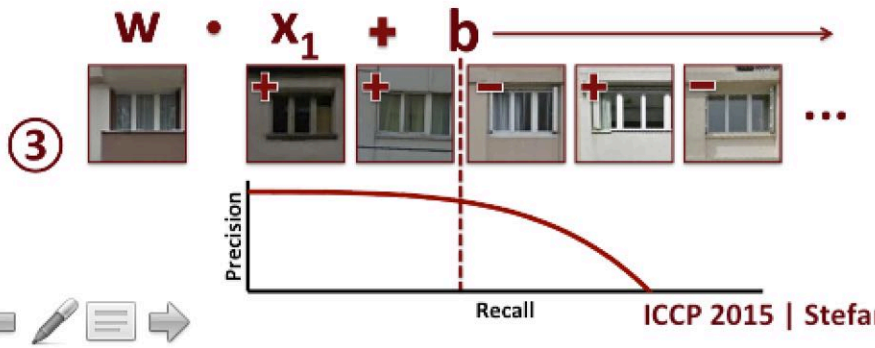
– Visual elements that occur frequently in one period but not in others



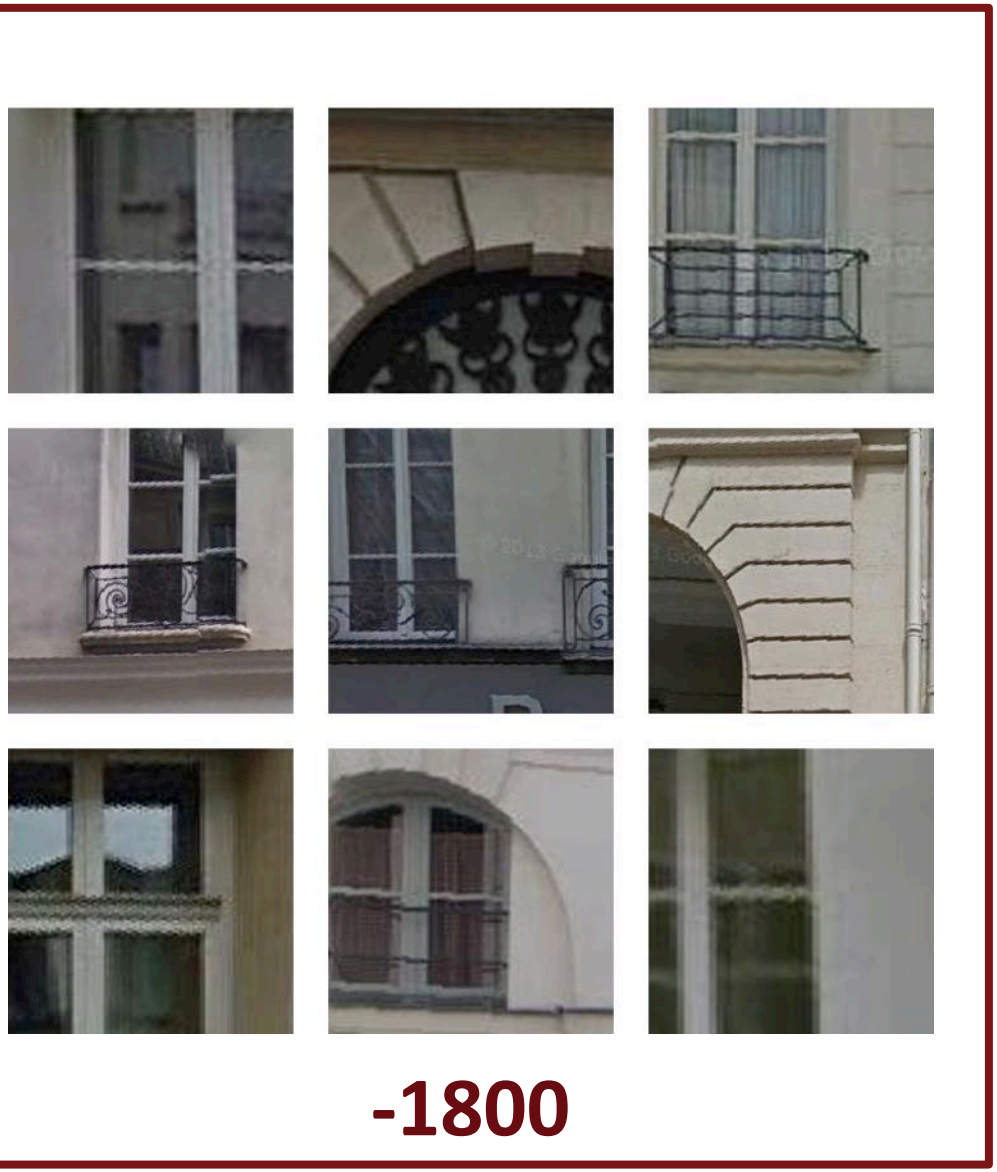


Method| Mining Period-Discriminative Elements





Results| Period-Discriminative Elements



-1800

Results| Period-Discriminative Elements

1801-1850

Results| Period-Discriminative Elements

1851-1914

Results| Period-Discriminative Elements

1915-1939

Results| Period-Discriminative Elements

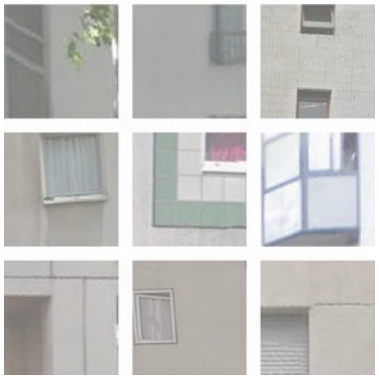
1940-1967

Results| Period-Discriminative Elements

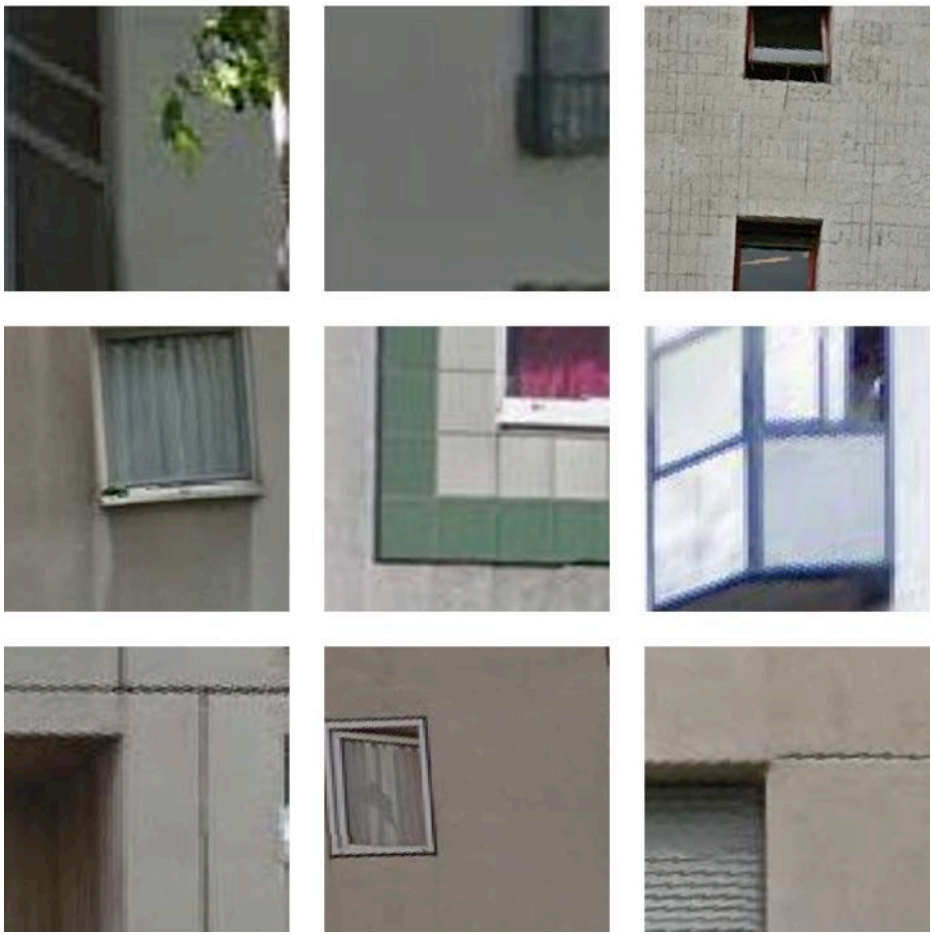
1968-1975

Results| Period-Discriminative Elements

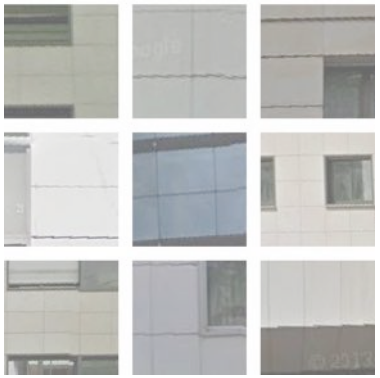
1976-1981



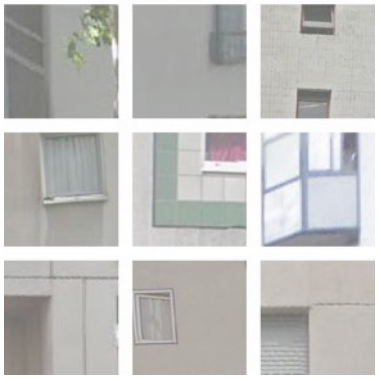
Results| Period-Discriminative Elements



1982-1989

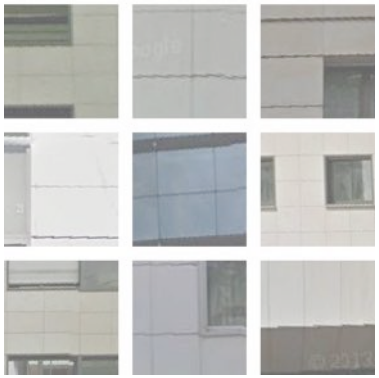


Results| Period-Discriminative Elements



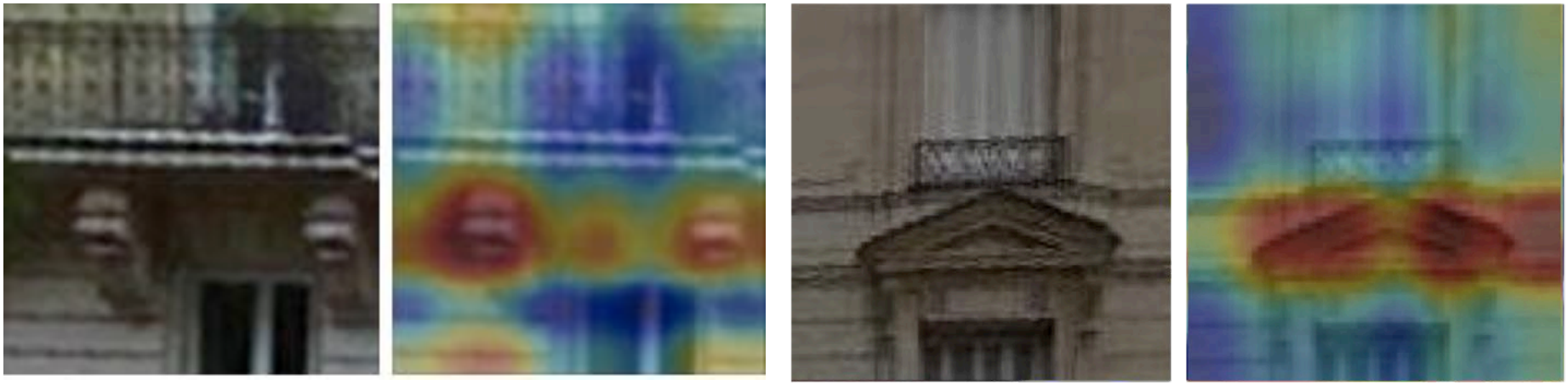
1990-1999

Results| Period-Discriminative Elements



2000+

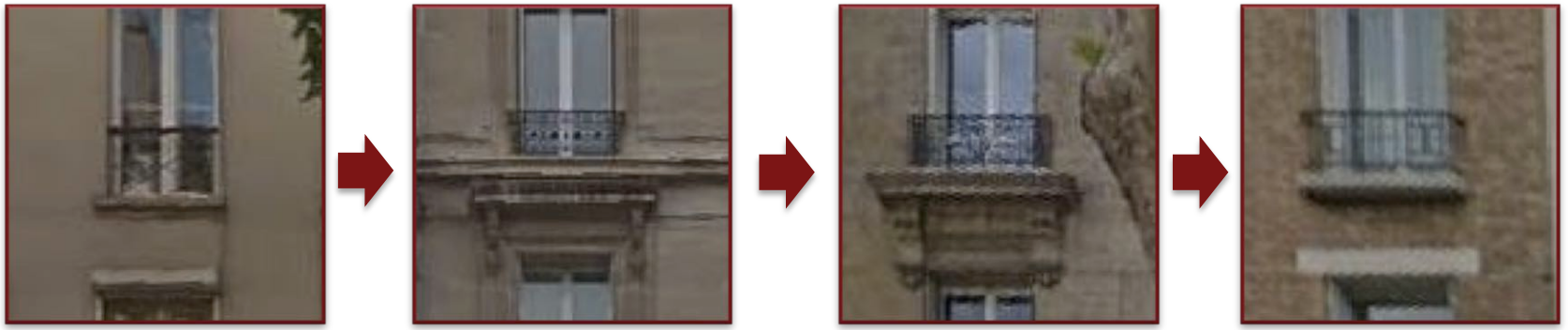
Mining fine-grained importance



Visualizing period influences at the facade level

How do we define style in architecture?

– Changes in visual appearance through time for functionally identical elements

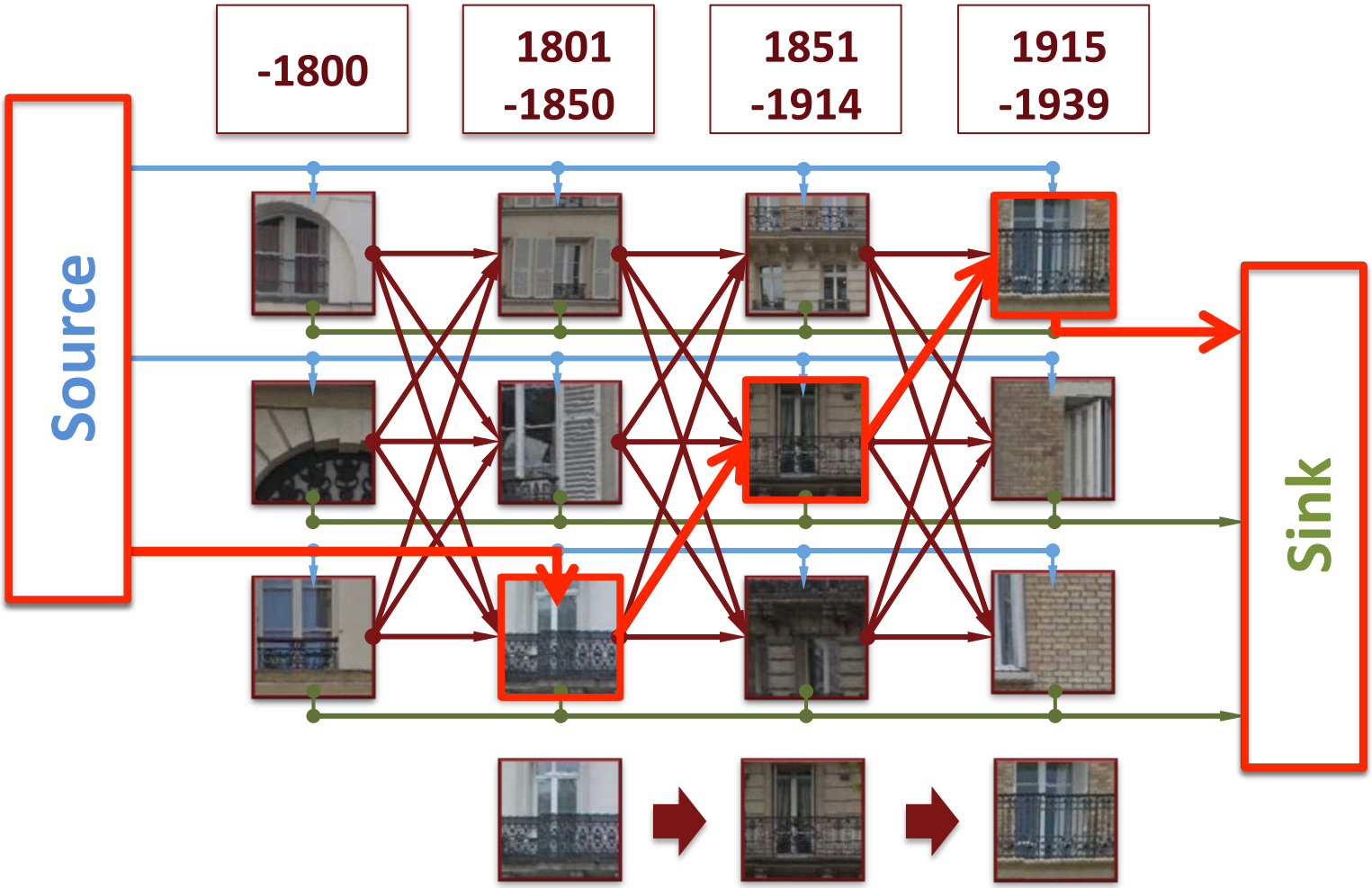


Each element of a style chain should

– be somewhat distinctive to its own period and

– coarsely visually similar to its neighbors in the chain

Method| Tracking style over time



Straightforward k-shortest path algorithms produce chains from the graph by finding from source to sink.

Results| Style

Take-homes

Social sciences and the humanities will need to build on computational foundations to condense and interpret this data.

Large automatically labeled datasets for social science research can be created by combining open data sources and fine-grained metadata.

Architecturally interesting elements and evolutions can be automatically discovered using straight-forward data mining techniques.

Visit the project page at vision.soic.indiana.edu for more info and full browsable results

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