Procedural Urban Forestry

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Overview

Goal: realistic vegetation generation for urban layouts

Contributions:

- Procedural modeling framework that factorize complexity
- A set of procedural placement model and their parameterization
- Novel pipeline for learning plant distributions in cities
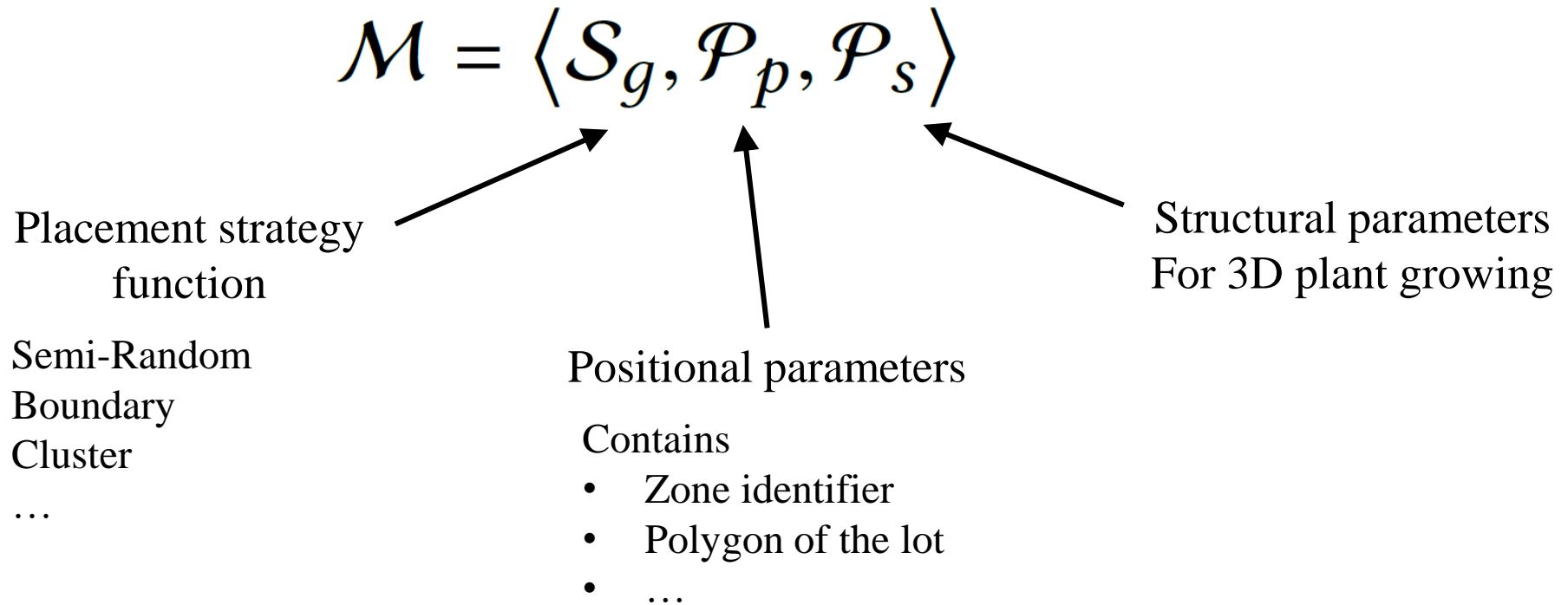
Overview

Satellite image

Individual lots

Procedural Placement Models - PPMs

A PPM defines a placement strategy and structural and positional parameters for populating single lots.

$$\mathcal{M} = \langle \mathcal{S}_g, \mathcal{P}_p, \mathcal{P}_s \rangle$$

Placement strategy
function

Semi-Random
Boundary
Cluster
…

Positional parameters

Contains
- Zone identifier
- Polygon of the lot
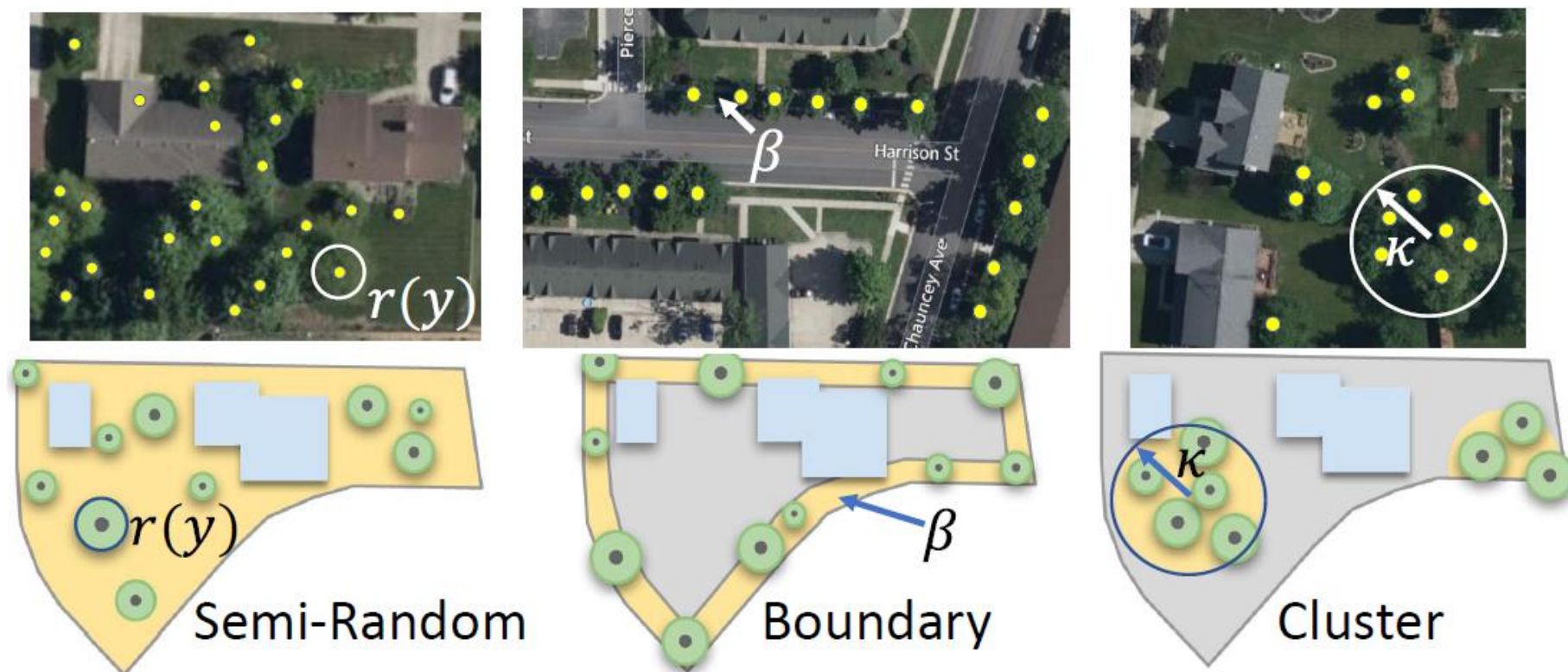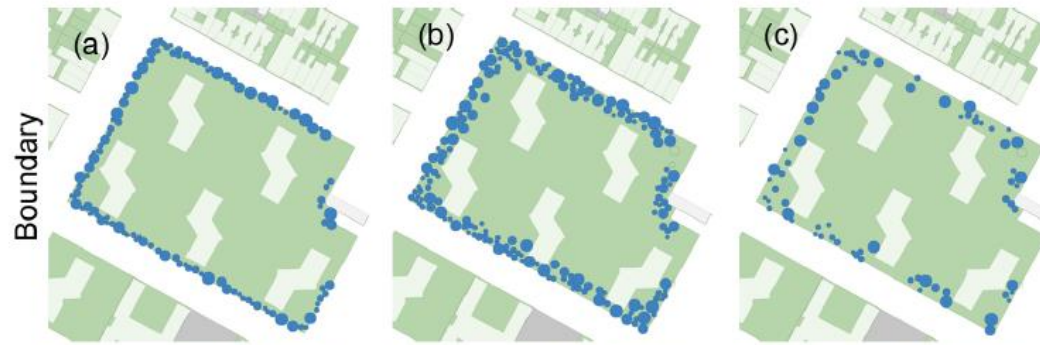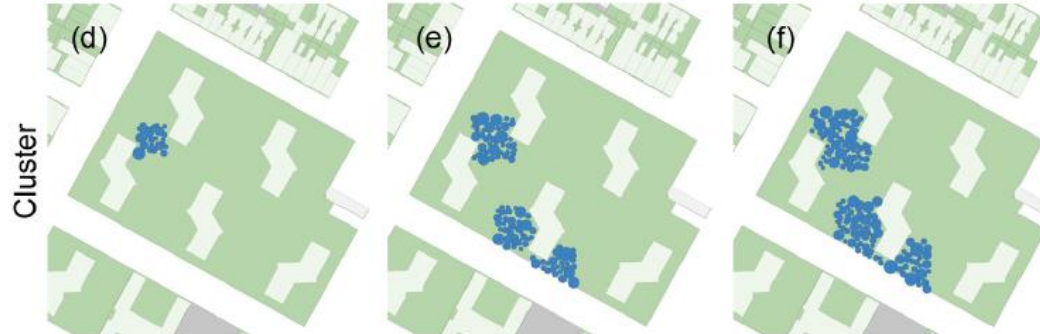- …

Structural parameters
For 3D plant growing

Fig. 6. Semi-Random, Boundary, and Cluster placement strategies use Variable Radii Poisson-Disk Sampling to position trees.
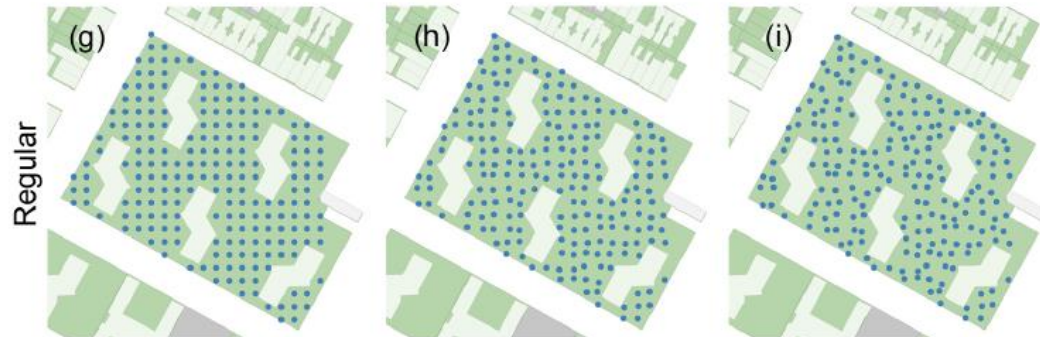
Boundary size
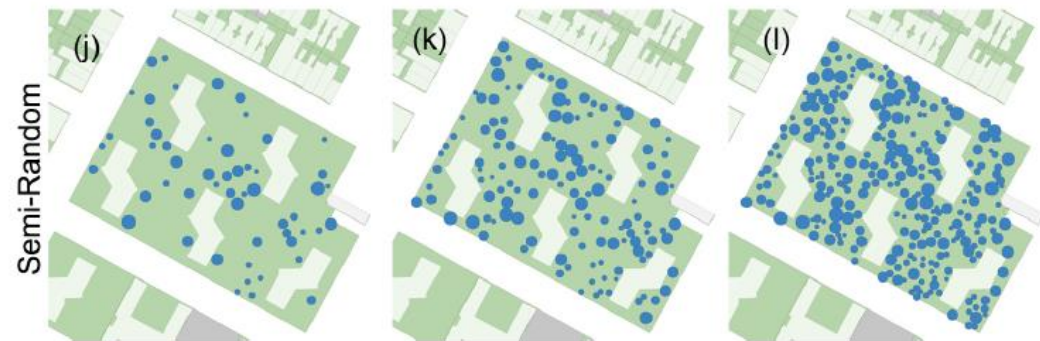
Number of cluster

Jittering
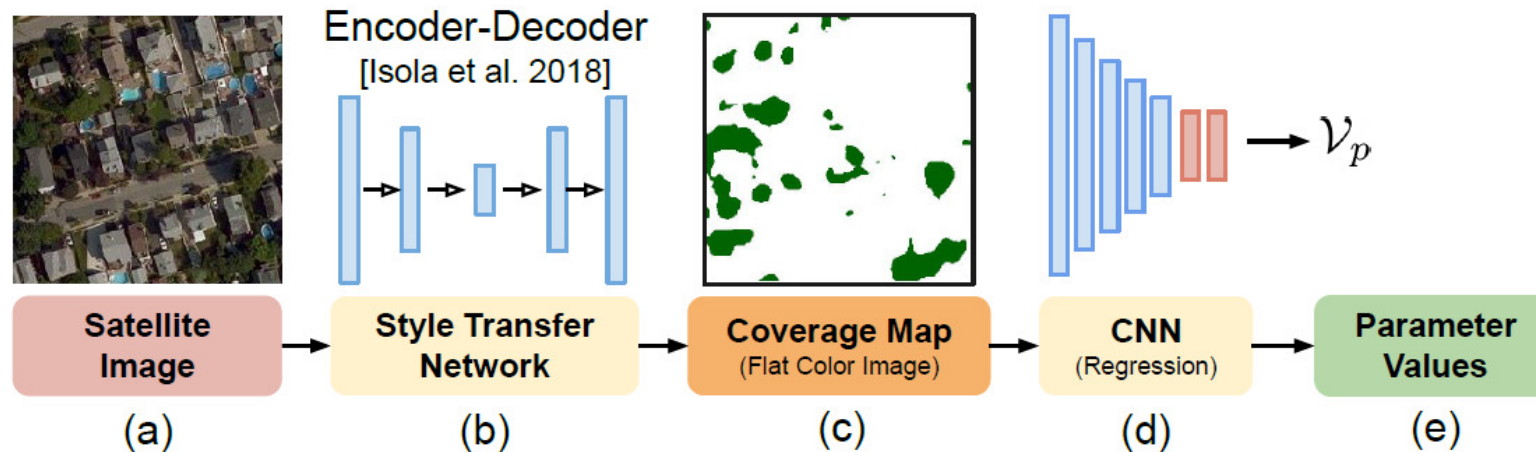
Density

Strategies from Miller 2015

Learning vegetation placement

Learning plant positions directly seems challenging

Learning vegetation placement

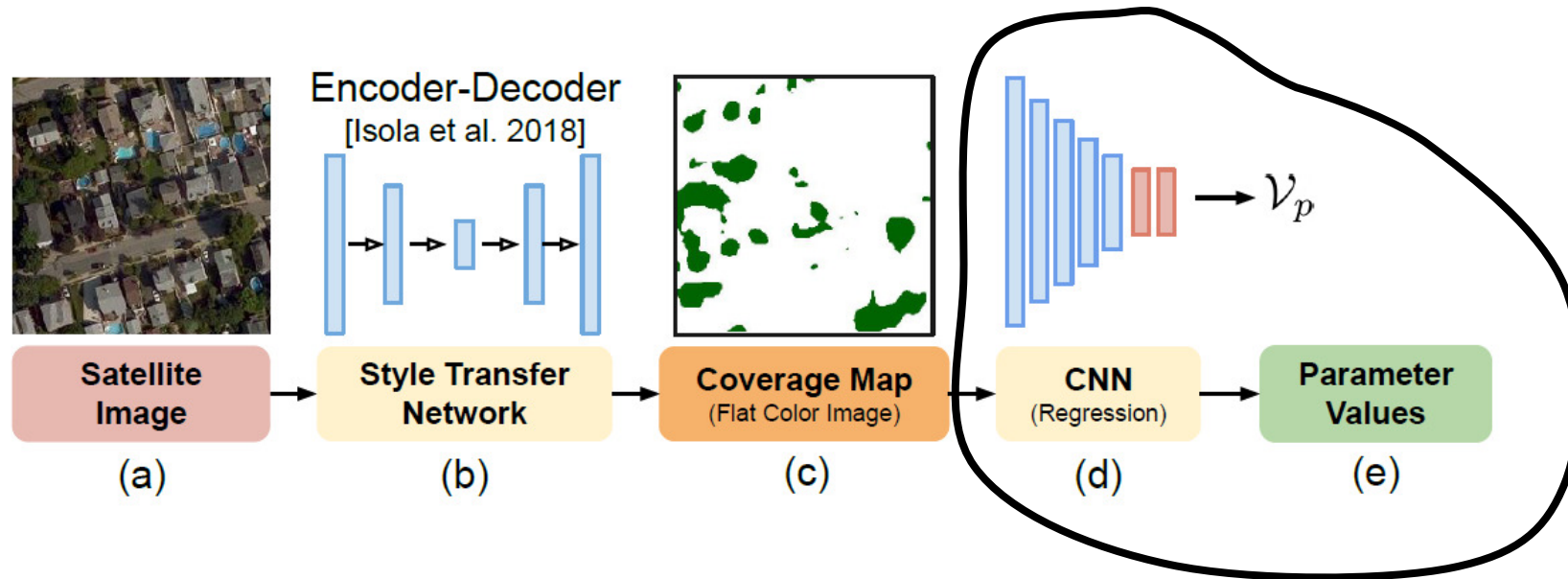Learning plant positions directly seems challenging

Therefore, they learn plant distributions in their parameter space of positional parameters (PPMs).

Encoder-Decoder
[Isola et al. 2018]

$\mathcal{V}_p$

Satellite Image	Style Transfer Network	Coverage Map (Flat Color Image)	CNN (Regression)	Parameter Values
(a)	(b)	(c)	(d)	(e)

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Training & Results

Dataset is made of pairs: **coverage map** + **PPM**

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Fig. 12. Vegetation placement based on real data: we use vegetation coverage maps (middle) to identify active regions for individual lots and populate them with our PPMs. This allows us to generate plant distributions (right) similar to what can be observed in satellite images (left).
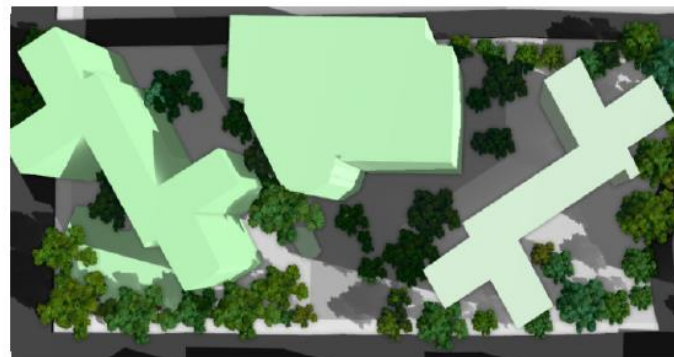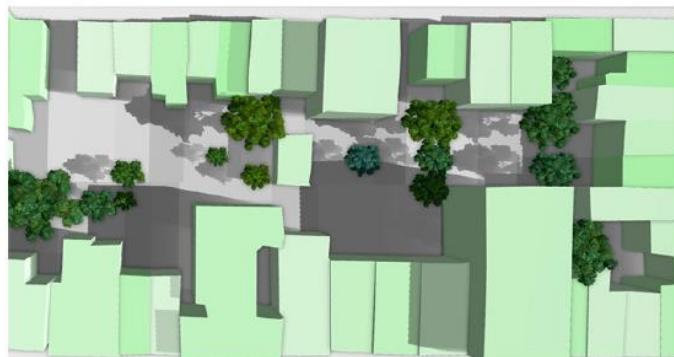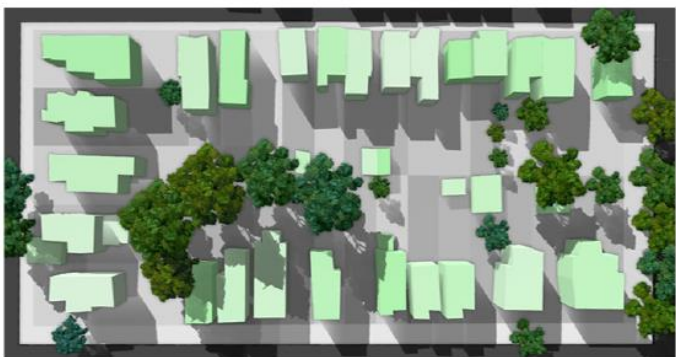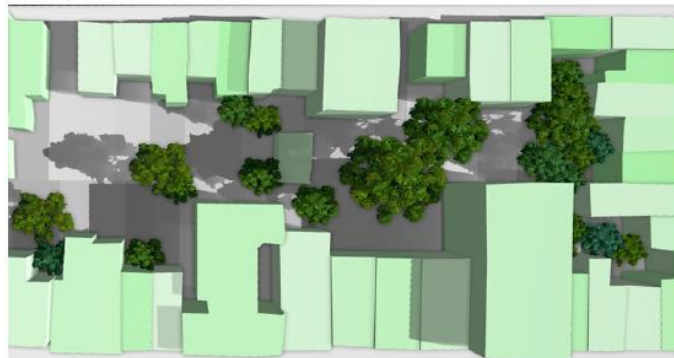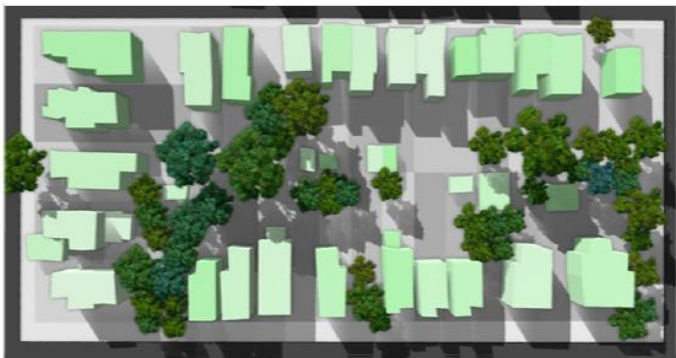
Satellite image (a)

Rendered in-app (b)

Reconstructed from learning (c)

Validation

User study to evaluate realism

  All their approaches get good results (slightly better than Benes, 2011)

Pipeline usefulness validation with 3D artists

  Rating of plant placement from « strongly agree » to « strongly disagree »

Discussion

- No comparison with *Data-driven Authoring of Large-scale Ecosystems, 2020*

- Heavily based on urban planning research (Miller 2015, referenced 8 times)

- User study : validation with artists… But no urban expert ?