# QUALM:
# Quick, Unconstrained Approximate L-Shape Method

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CITYSCAPE DIGITAL

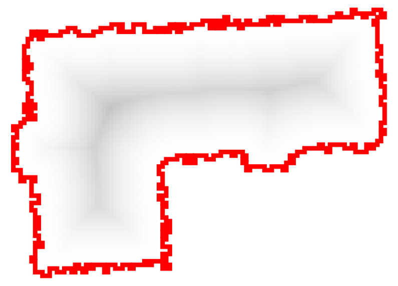
CDE Centre for Digital Entertainment

EPSRC Engineering and Physical Sciences Research Council

## 1 → Introduction

**What** → a simple, fast 2D shape approximation method for rectilinear building footprints.

**Why** → approaches based on a skeletal representation are sensitive to sensing noise at shape boundaries [1].



**Advantages, Applications & Benefits** →
→ compact footprints for 2D map-updating.
→ automatically vectorises airborne laser-scans.
→ data-driven, efficient and easy to implement.
→ works on structured or unstructured input.

## 2 → Approach

**Step 1** → compute minimal area bounding box (MABB) of input. (Hough-Transform)

**Step 2** → for each vertex in MABB: ***eat-away*** a corner by reducing the distance to the input.

### Measuring Geometric Error

**The Hausdorff-Distance Error Measure**

$$f(A,B) = \max(\|A_i - (B_j,B_{j+1})\|)\ \forall i \in A : \forall j \in B$$

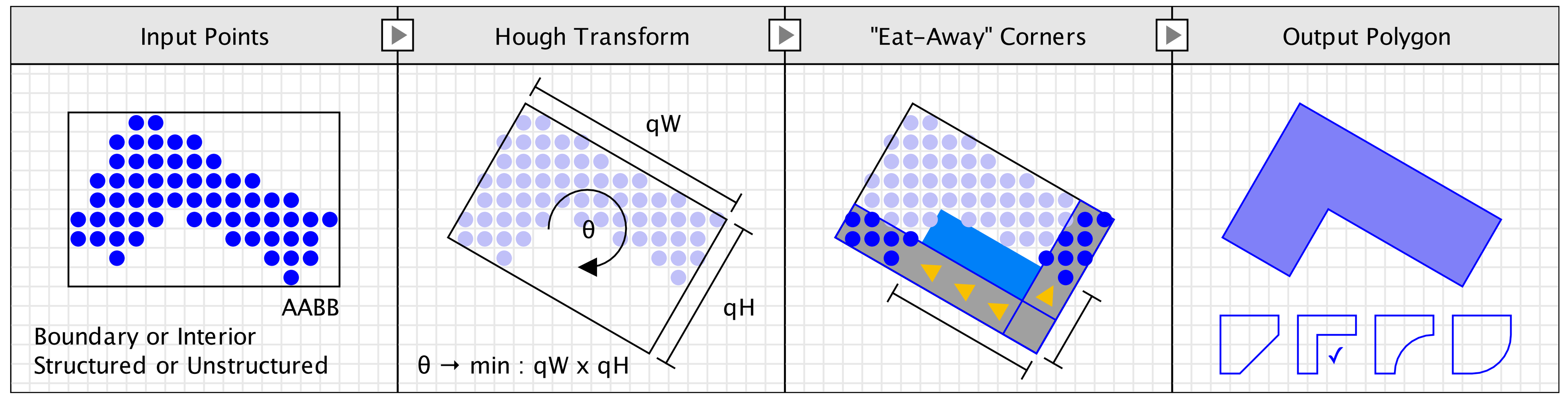
**The Intersect-over-Union Error Measure**

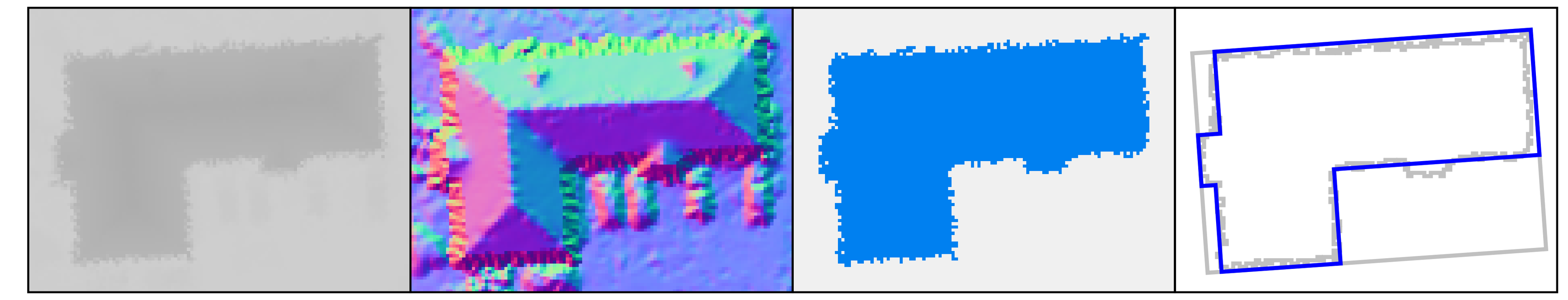
$$(A \cap B) / (A \cup B) > \omega : \omega \in [0 : 1]$$

As this is a heuristic shape approximation method, it is vital to be able to measure the geometric accuracy of each generated polygon relative to the original input-points. For this two measures are used. A discrete maximum ***point-to-edge distance*** and a continuous normalised ***shape-to-shape-overlap ratio***.

## 3 → The QUALM Algorithm Illustrated

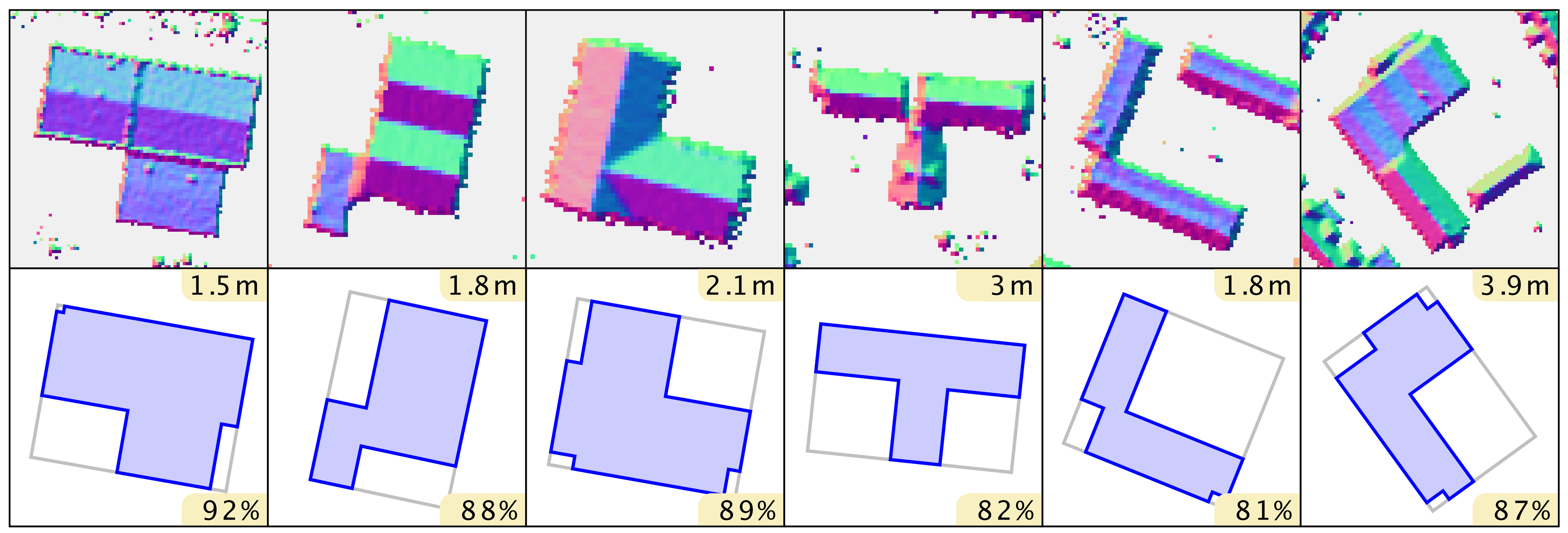
**The Key Idea** intuitive, data-driven, determinism.



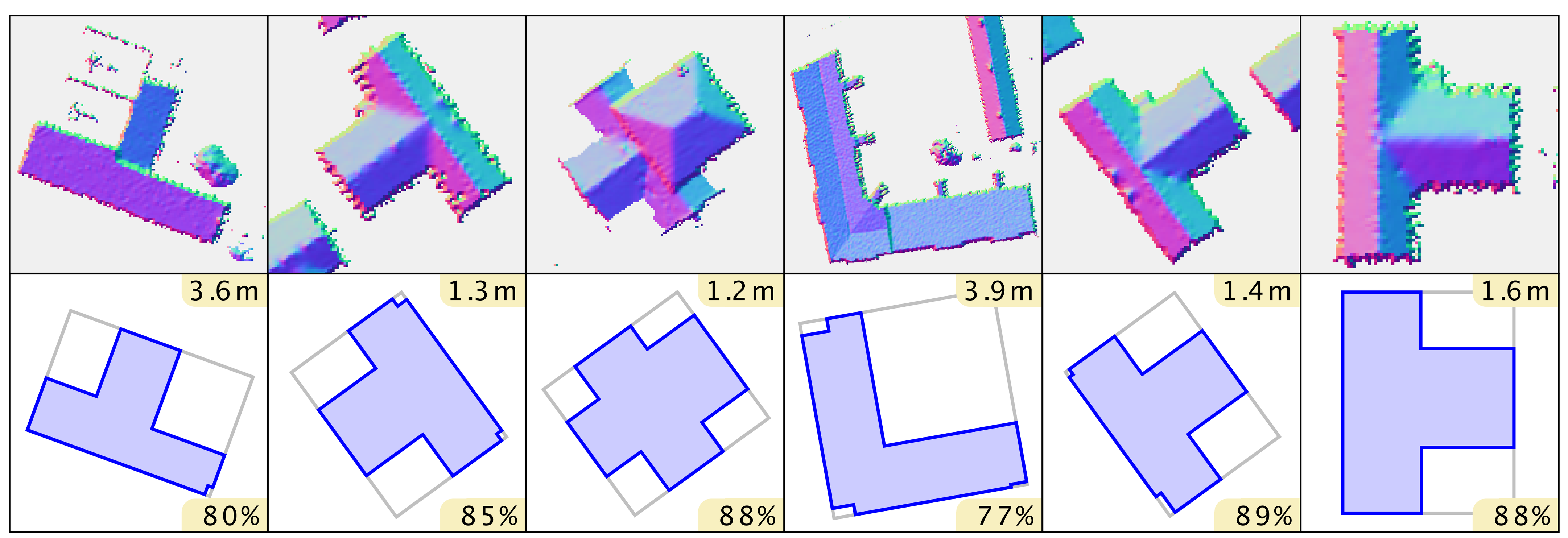



*a real-world example from the 50cm point-spacing city of London dataset (from left to right) input-range-points, normals, difference of elevation building segment, resulting automatic l-shape footprint (scan-converted boundary in gray, eat-away hull in blue)*

## 4 → Experimental Results




*building footprints automatically recovered from 1m point-spacing airborne range scans of the City of Bath, UK - input (top-row) and output (second-row) with error-measures*




*building footprints automatically recovered from 25cm point-spacing airborne range scans of the City of Manchester, UK (with error-measures shown for each polygon)*

## 5 → Further Research

**Optimise** → nearest-neighbour and point-inside-polygon tests using sweep-line for faster detection.

**Optimise** → efficiency of initial Hough-transform for MABB, using convex hull and or recursive evaluation.

**Extension** → to 2.5D parallax building masses.

**Extension** → to full 3D Mahanttan style buildings.

**Extension** → generalisation from the Hough transform quad to 'eating-away' at the convex hull.

**Extension** → via the inclusion of alternative corner types such as those illustrated in the output polygon cell of the overview - and further eating-away at edges.

**Evaluation** → relative to open-street map data.

## 6 → References

1 → SZELISKI, R. 2010.
Computer vision: algorithms and applications.
Springer.

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Airborne range scans of the cities of Bath, Manchester and London courtesy of the Environments Agency.