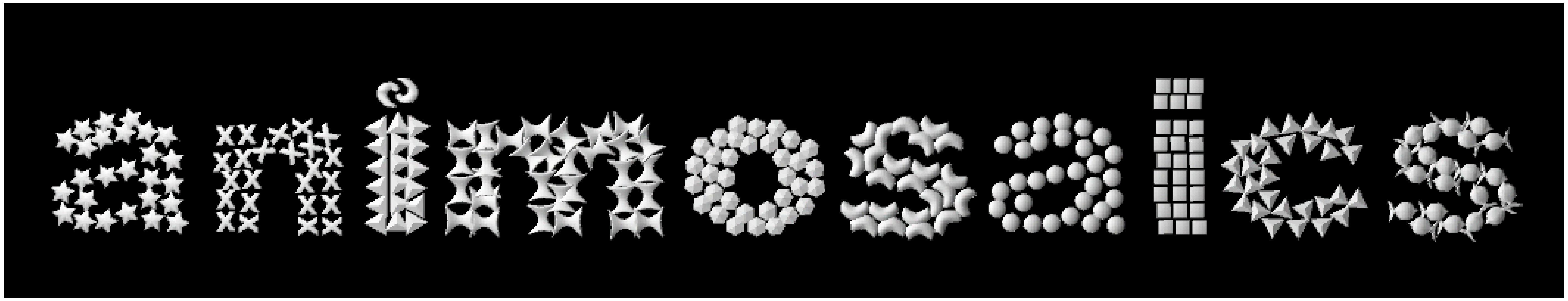
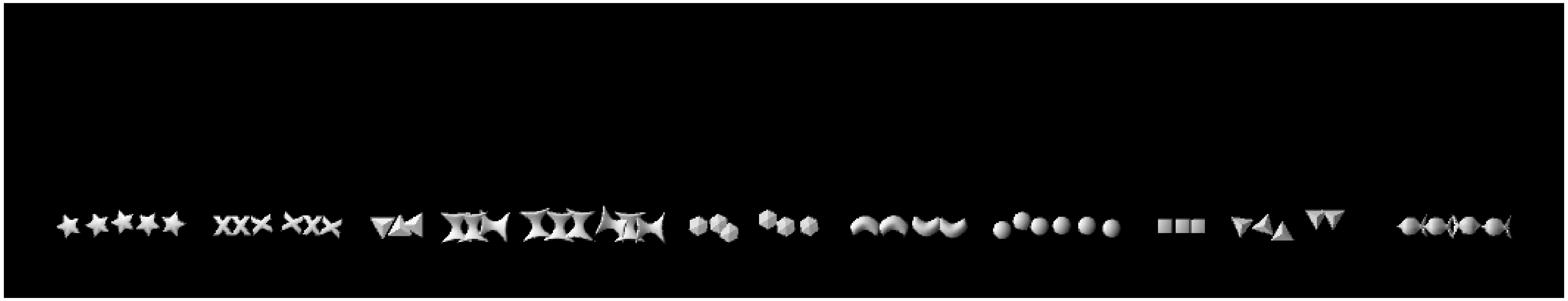


Kaleigh Smith†‡ **Yunjun Liu†** **Allison Klein†**

†McGill University
‡ MPI Informatik



Kaleigh Smith†‡ **Yunjun Liu†** **Allison Klein†**

†McGill University
‡ MPI Informatik

Static Mosaics

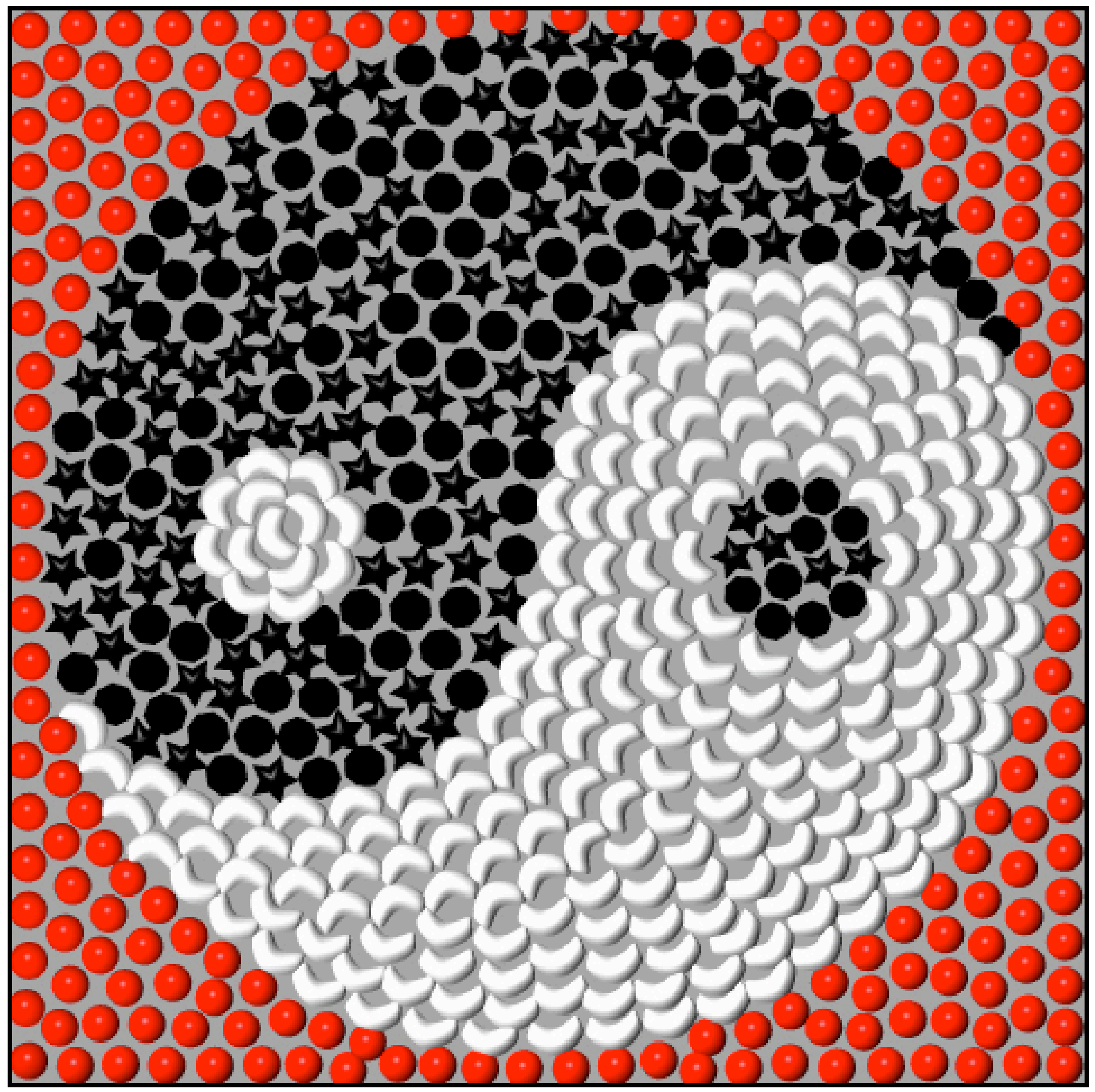
Mosaic imagery - traditional and modern

Detail of Roman mosaic, Herculaneum

Magritte photomosaic, Silvers

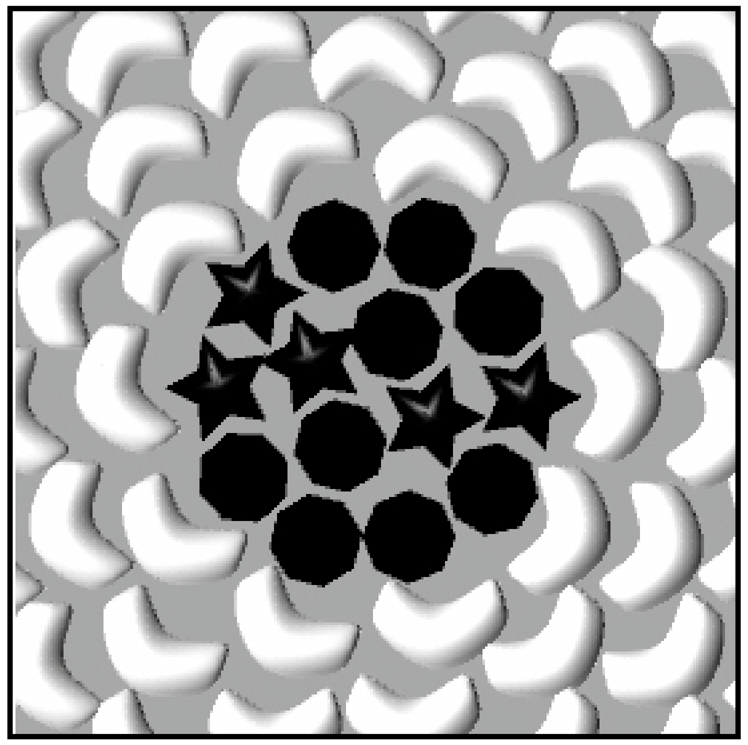
Static Mosaics

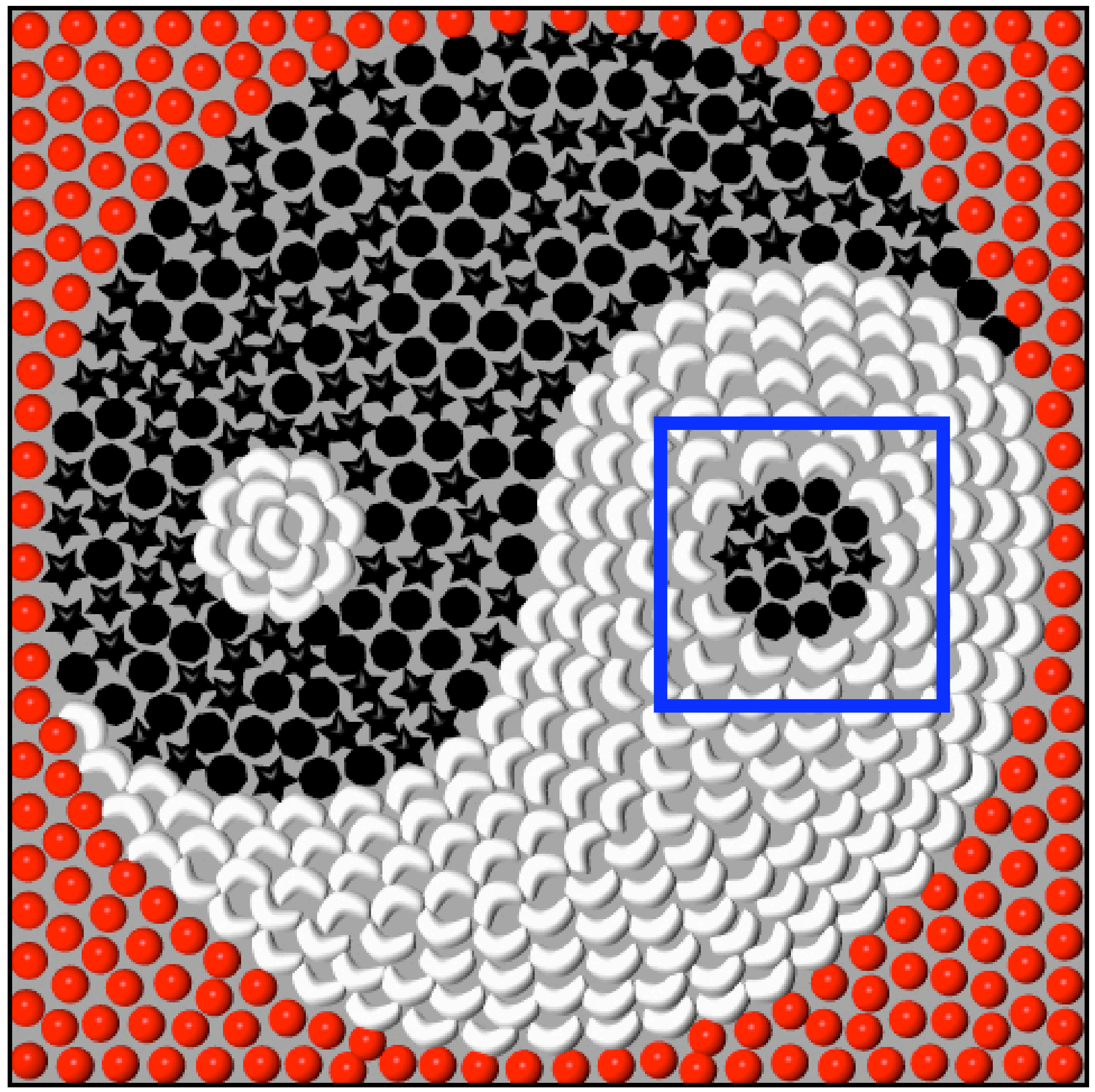
- Arrangement (packing) of objects (tiles)



Static Mosaics

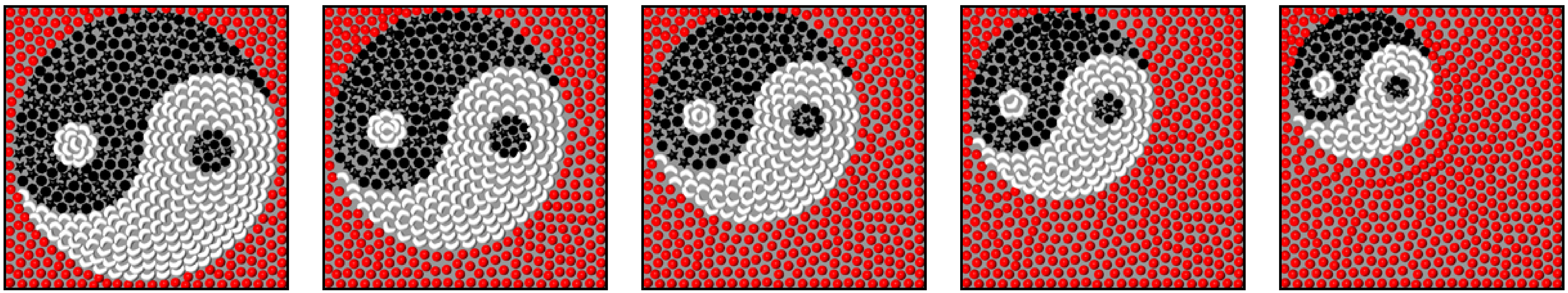
- Arrangement (packing) of objects (tiles)
- Perceptual duality of mosaics:
  - Individual tiles
  - Whole depiction





Animated Mosaics

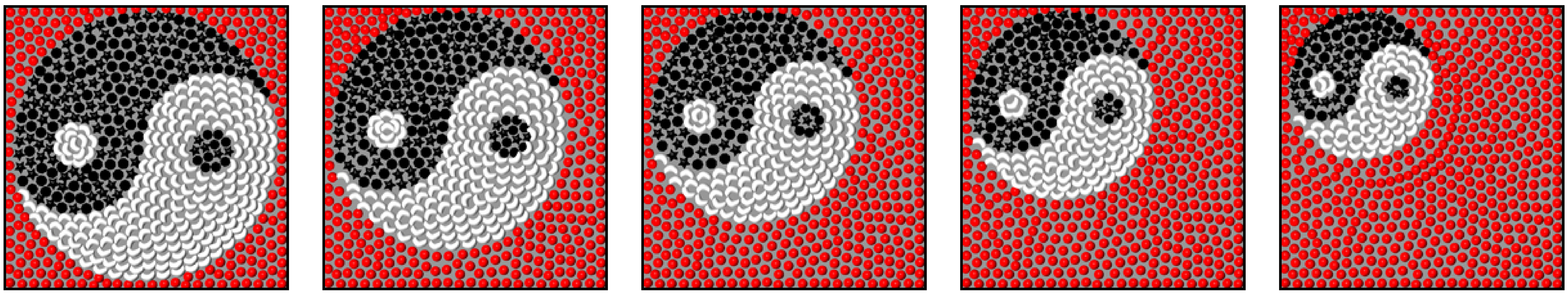
- Mosaic that changes over time
- Form of stop-motion animation
- Perceptual duality of mosaic animation:
  - Movement of tiles
  - Movement of overall scene



Animated Mosaics

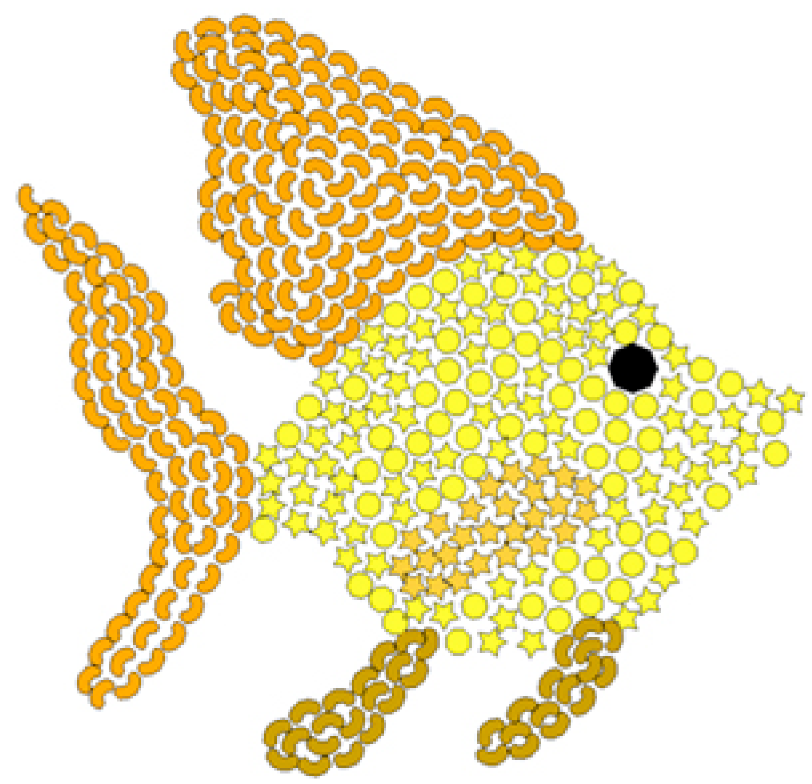
- Our goal: system for creating animated mosaics
- Challenges:

1. Per-frame Quality
2. Temporal Coherence
3. Performance



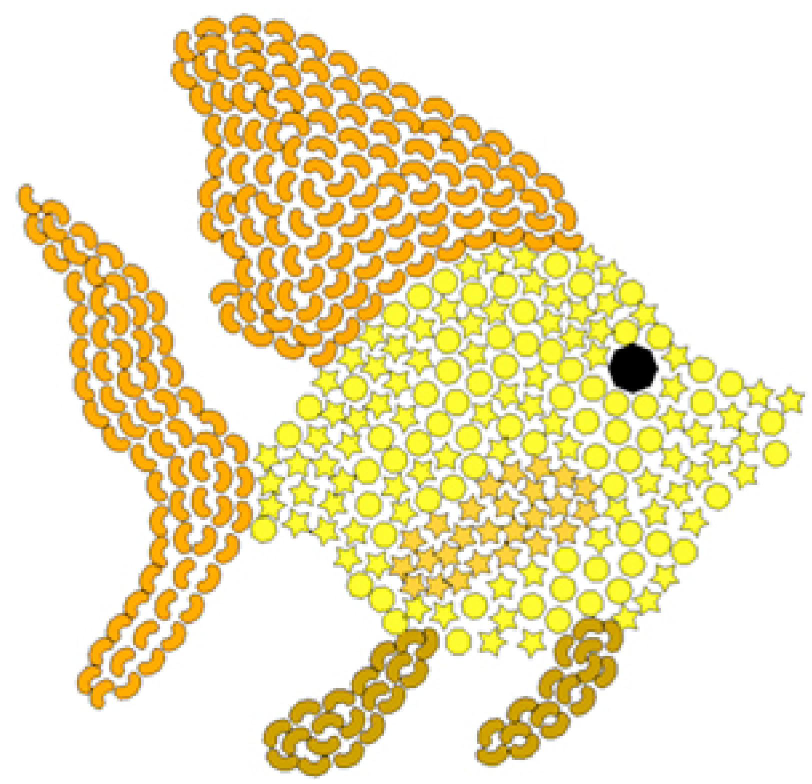
Outline

- Introduction
- Related Work
- Process Overview
- Challenges and Approach
- Packing
- Results and Conclusions



Outline

- Introduction
- ➡ Related Work
- Process Overview
- Challenges and Approach
- Packing
- Results and Conclusions



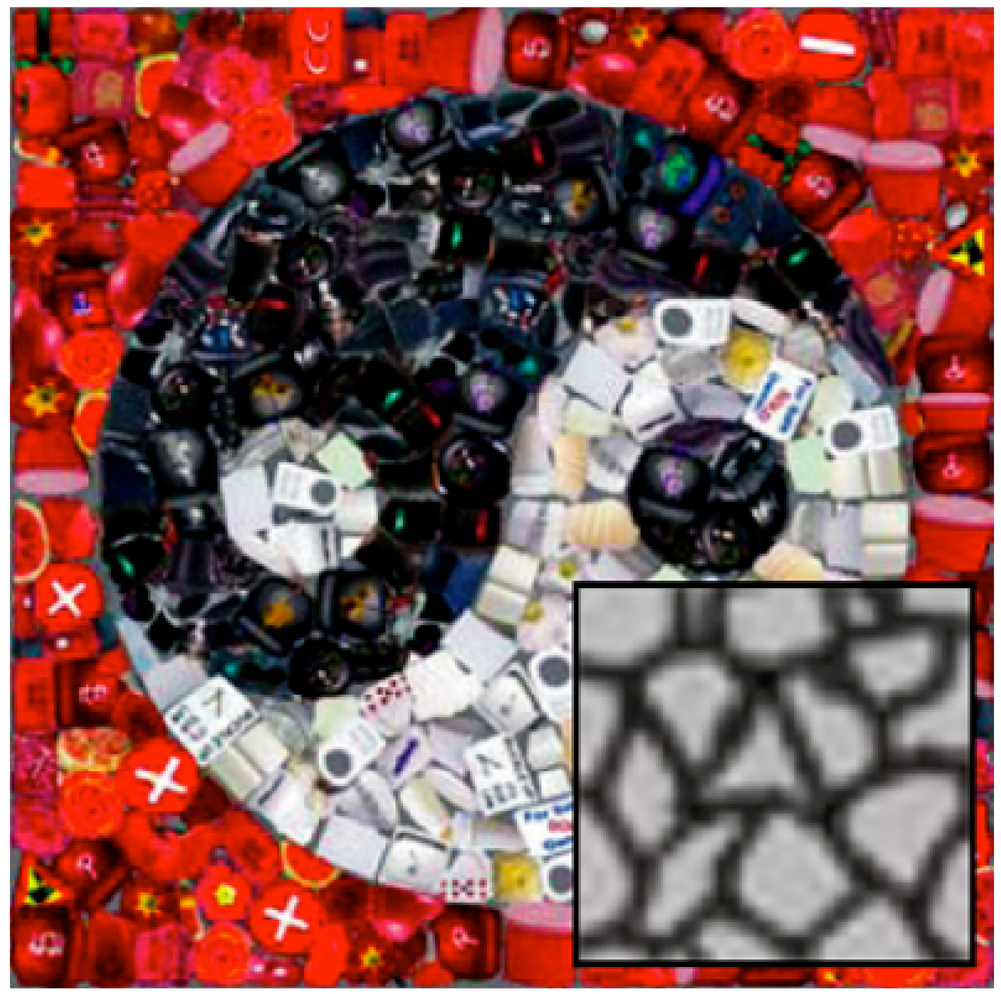
Related Work : Static Mosaics

Simulating Decorative Mosaics
[Hausner, 2001]

- Restricted tile shapes
- Point-based centroidal Voronoi diagram for tile placement.

Jigsaw Image Mosaics
[Kim, Pellacini, 2002]

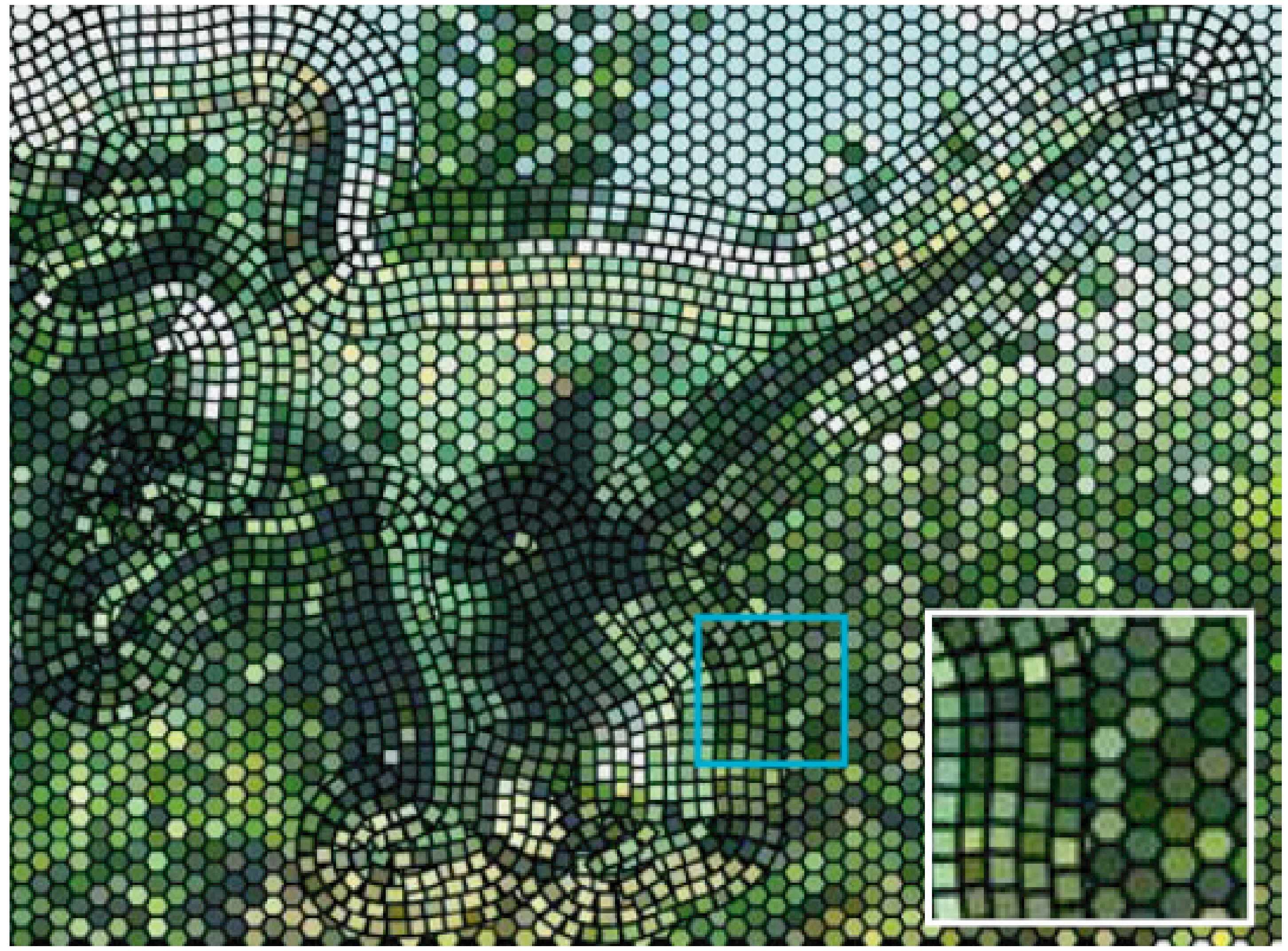
- Library of tiles
- Specified mosaic quality metric



Related Work : Static Mosaics

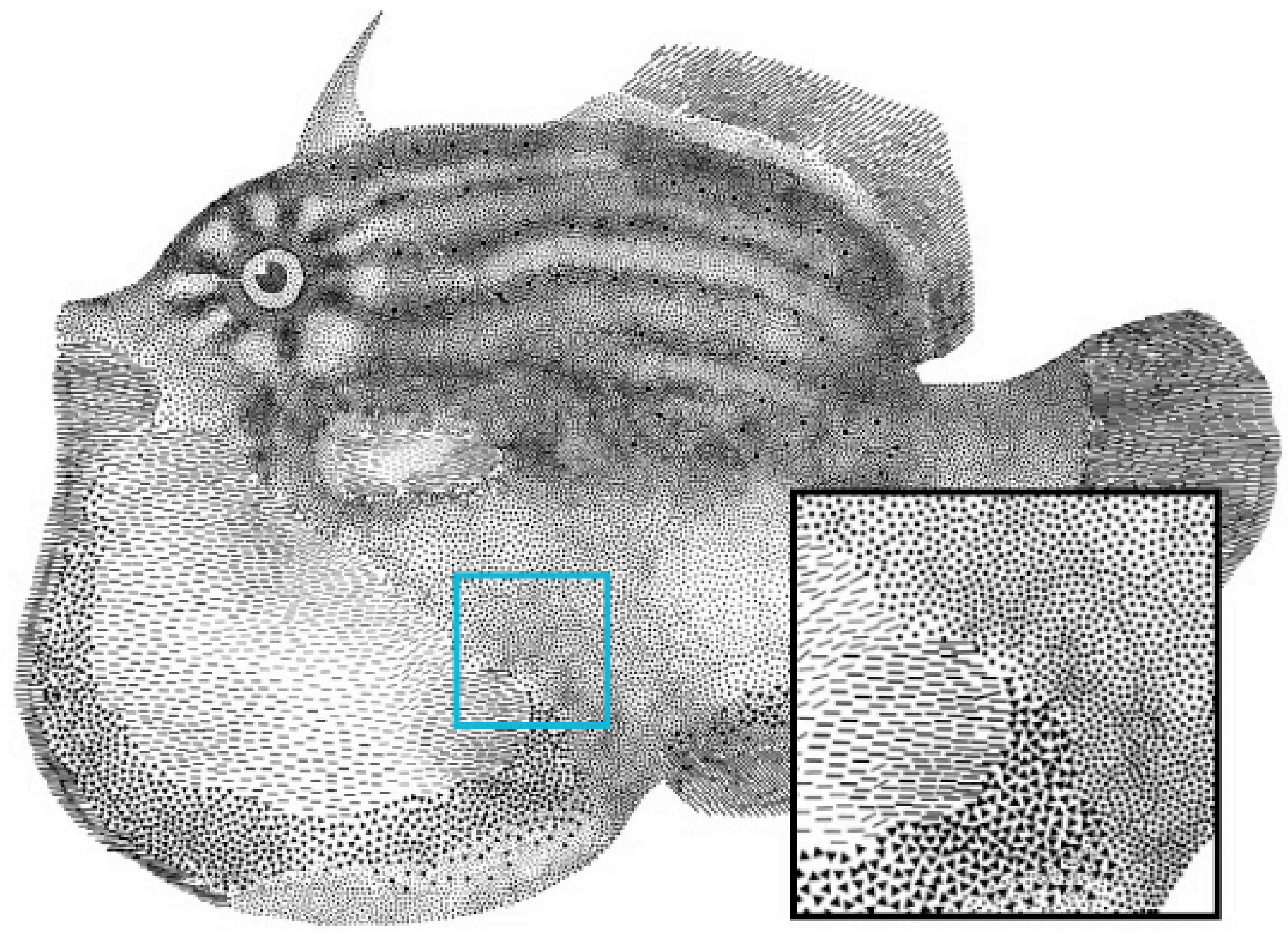
Rendering traditional mosaics
[Elber, Wolberg, 2003]

- Stack tiles along contour lines
- Restricted tile shapes



Beyond stippling - methods for distributing objects on the plane
[Hiller et al., 2003]

- Centroidal area Voronoi diagrams
- Stipple primitives



Related Work : Animated Mosaics

Painterly rendering for animation [Meier, 1996], ***Processing images and video for an Impressionist effect*** [Litwinowicz, 2000].

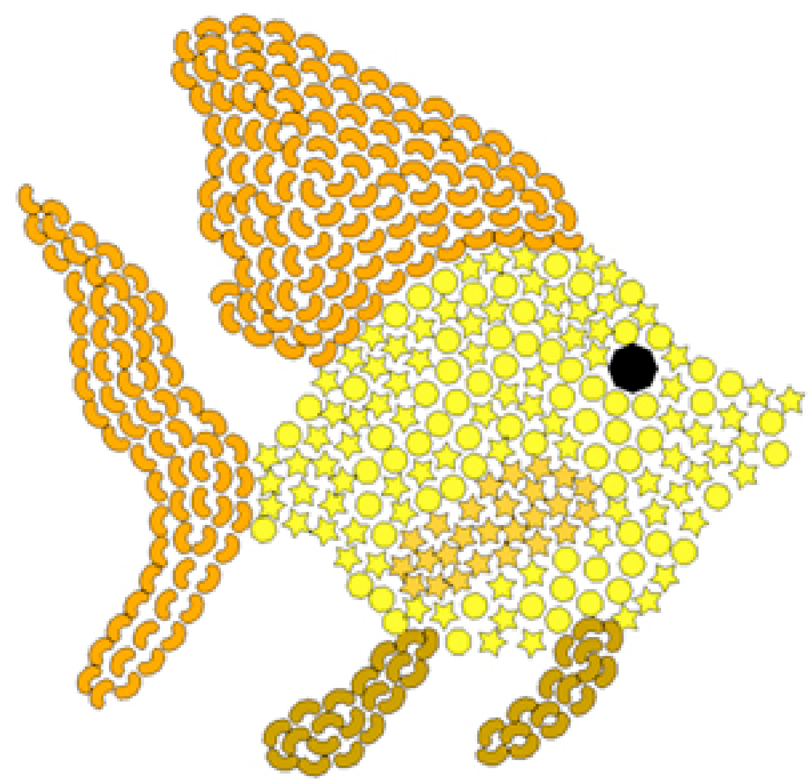
- NPR primitives (strokes) tied to underlying geometry (explicit or derived)
- Primitives can blend, grow and warp

Coherent stylized silhouettes [R. Kalnins et al., 2004].

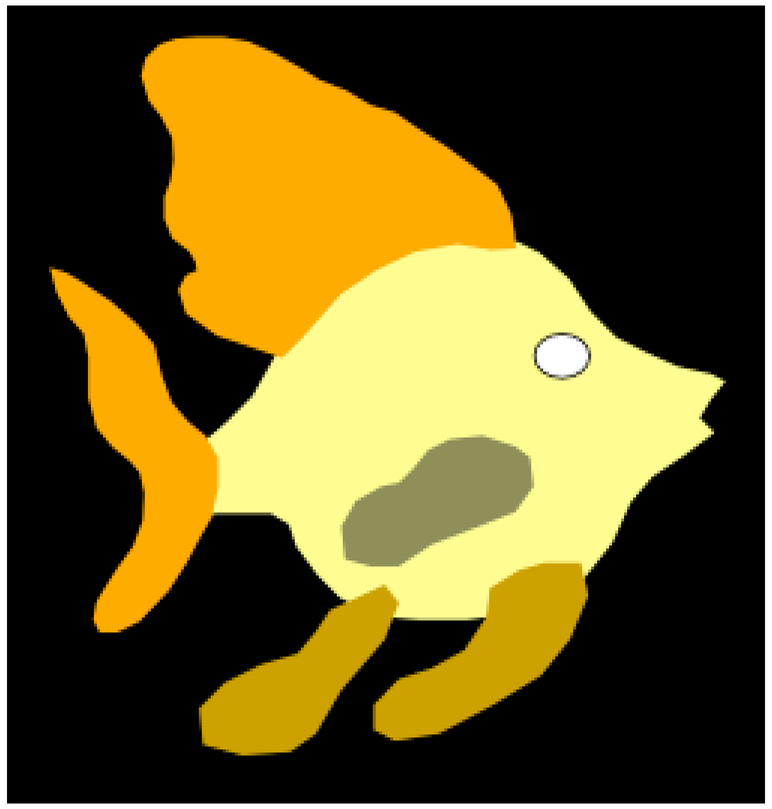
- Propogate NPR stylized contours

Outline

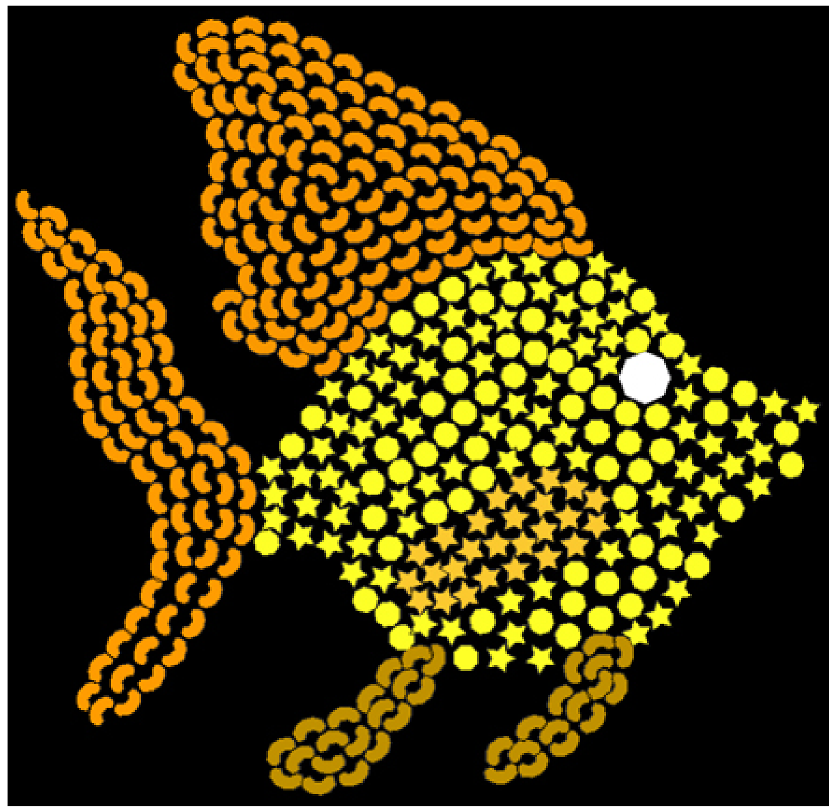
- Introduction
- Related Work
- ➡ Process Overview
- Challenges and Approach
- Packing
- Results and Conclusions



Process Overview



Input Containers



Packed Containers

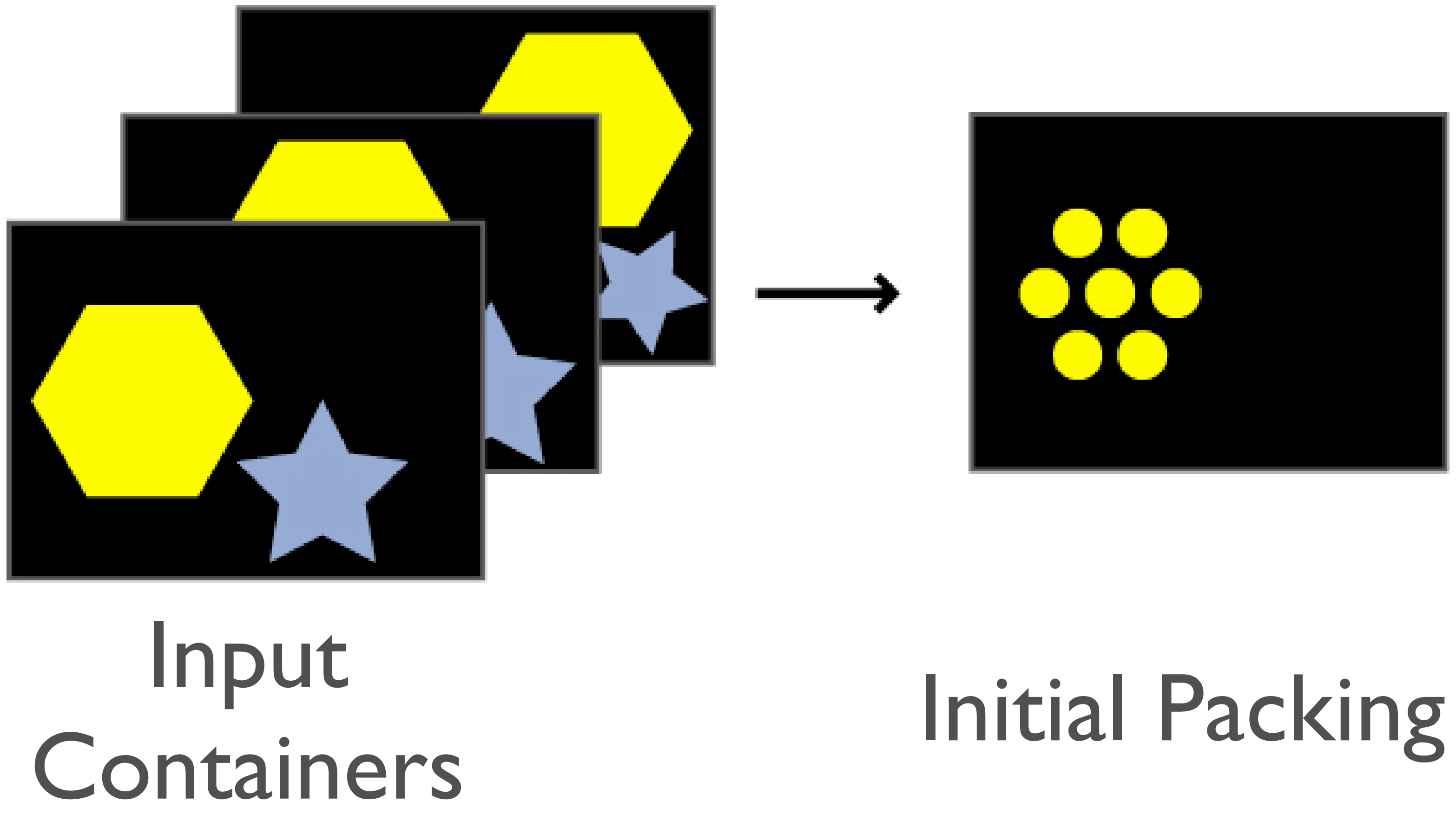
- **Containers** are input bounding shapes
- **Tiles** are **packed** into containers
- SVG defines container contours and deformations

Process Overview

Input Containers

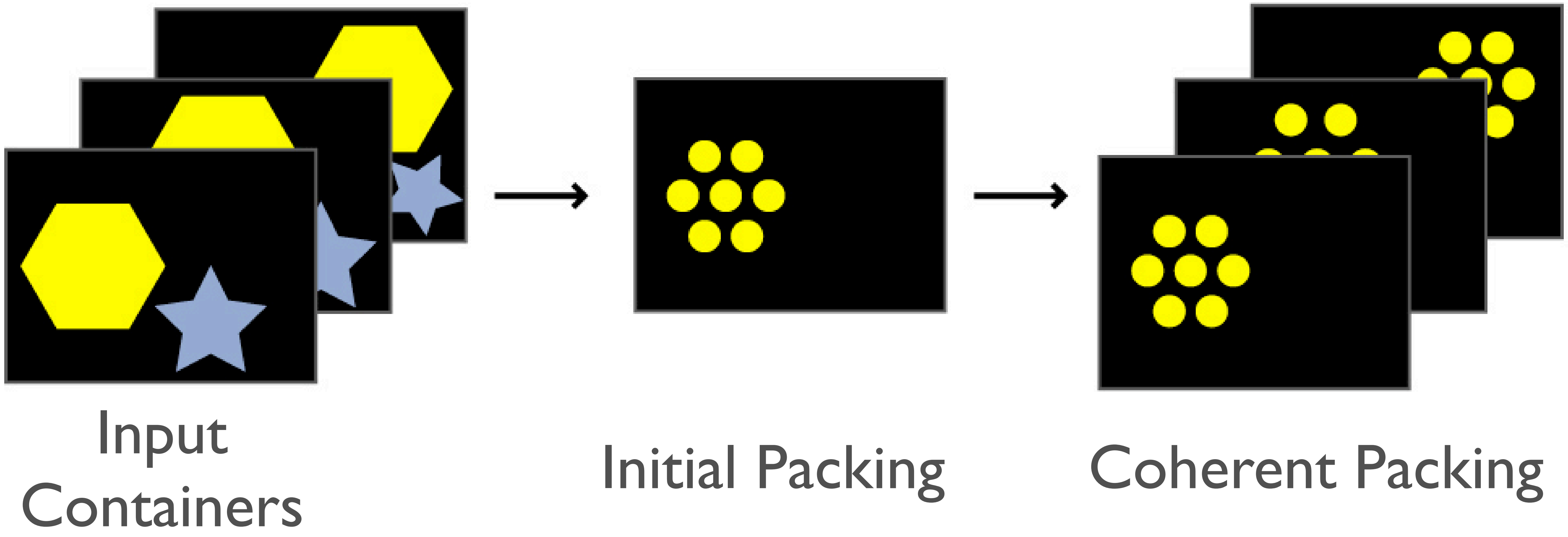
- **Containers** are input bounding shapes
- **Tiles** are **packed** into containers
- SVG defines container contours and deformations

Process Overview



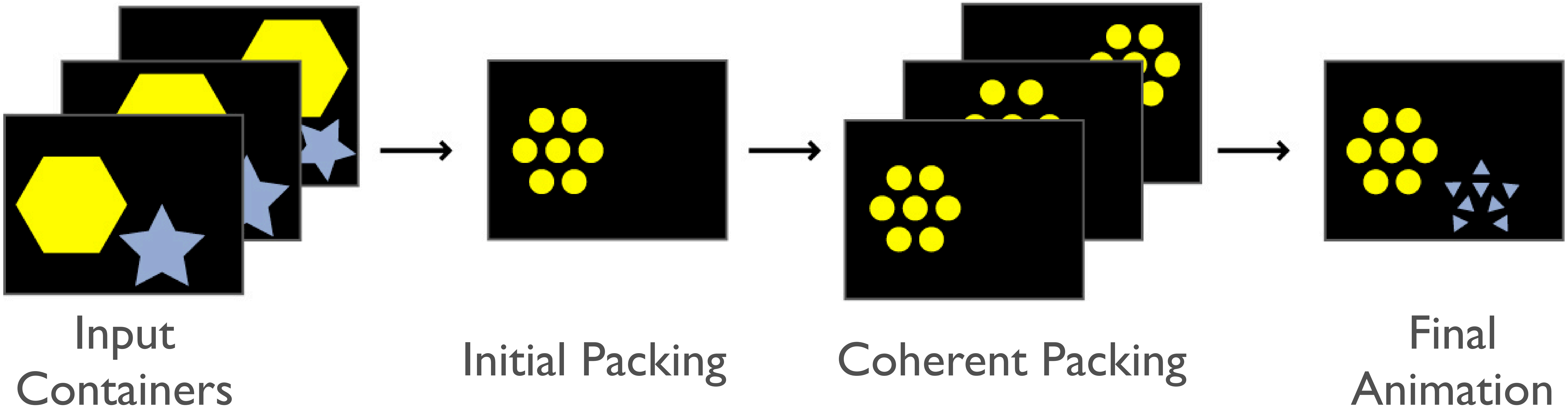
- For each container, make an **initial packing of tiles**
- User specifies the tile shapes and number of tiles

Process Overview



- Propogate initial packing to pack subsequent frames
- Tiles are **advected** to following frame
- Add/remove tiles and adjust tile positions

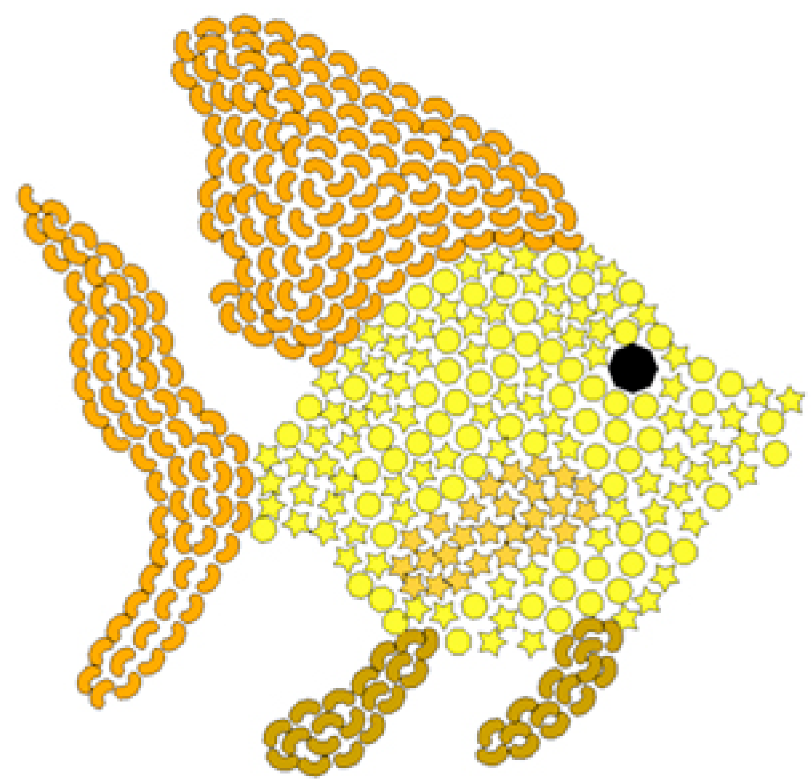
Process Overview



- Result: coherent packing of container over time
- Render frames or use tile positions as key frames

Outline

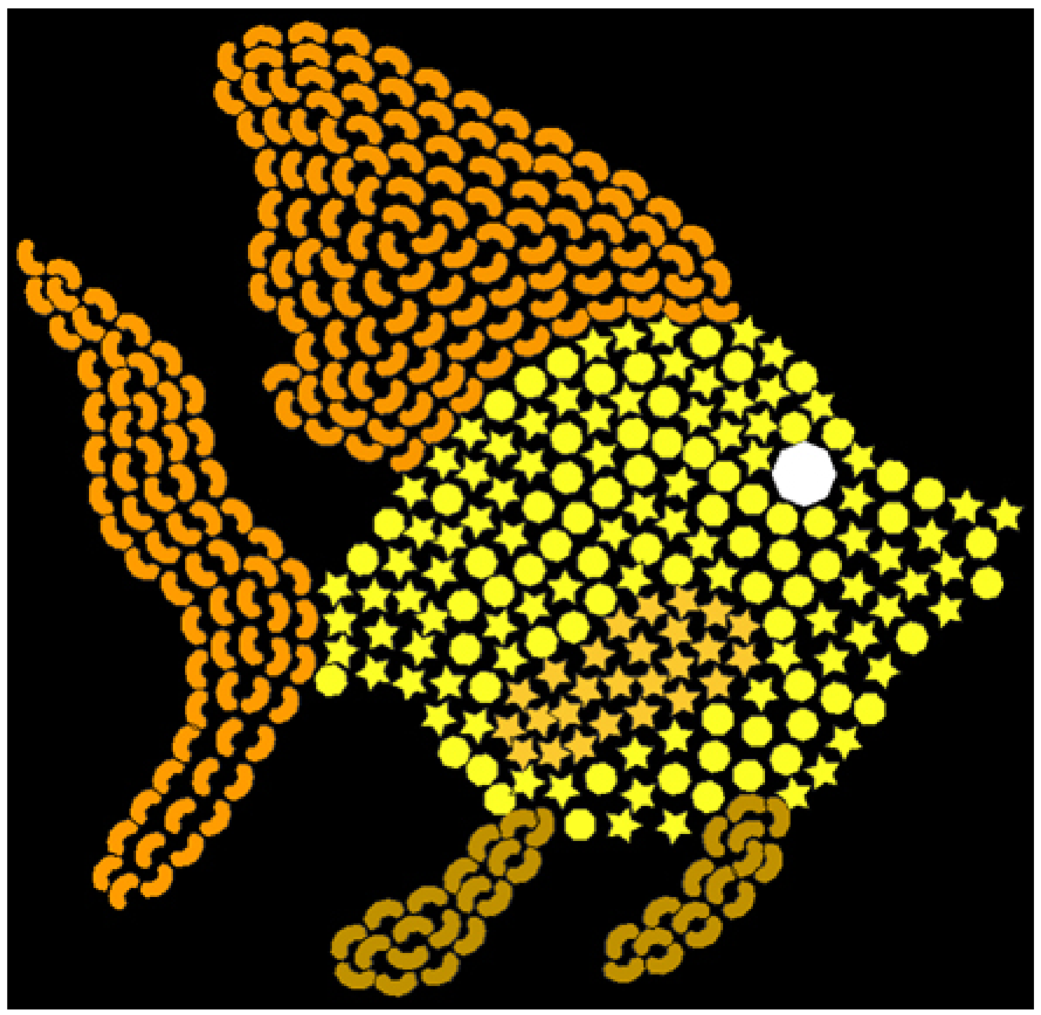
- Introduction
- Related Work
- Process Overview
- Challenges and Approach
- Packing
- Results and Conclusions



Challenges

1. Static Mosaic: Per-frame Quality

- Dense, evenly spaced packing
- Appropriate tile alignment
- Arbitrary tile shapes
- Multiple tile shapes within a single container

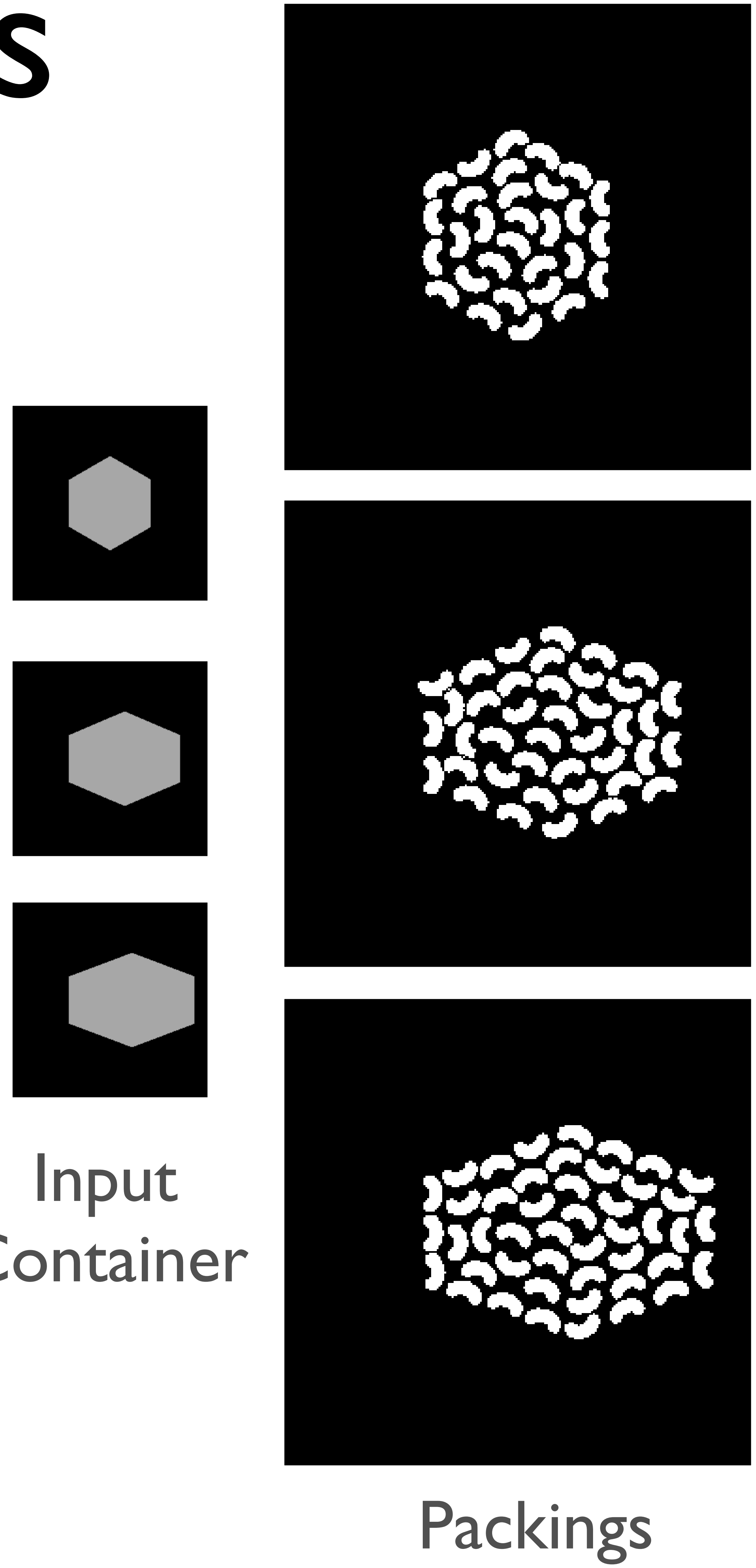


Challenges

1. Static Mosaic: Per-frame Quality

2. **Temporal Coherence**

- Packings should change smoothly over time.
- Tiles should appear attached to depicted object.
- Minimize tile appearances and disappearances (“pops”).

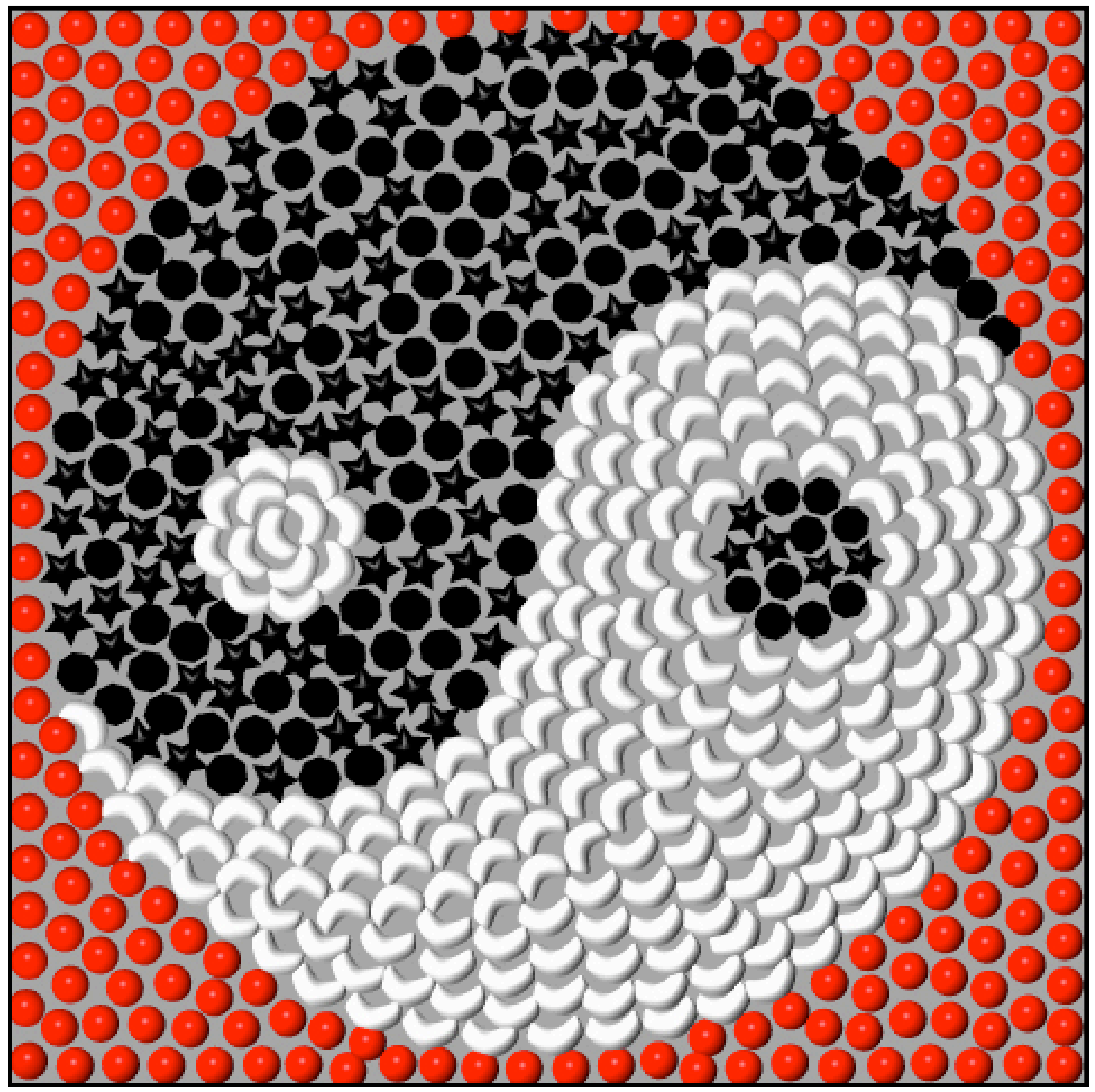


Challenges

1. Static Mosaic: Per-frame Quality
2. Temporal Coherence
3. **Performance**
   - Efficient packing method
     - Fast for single frames
     - Supports incremental changes
   - Interactive control for animator

Perceptual Approach

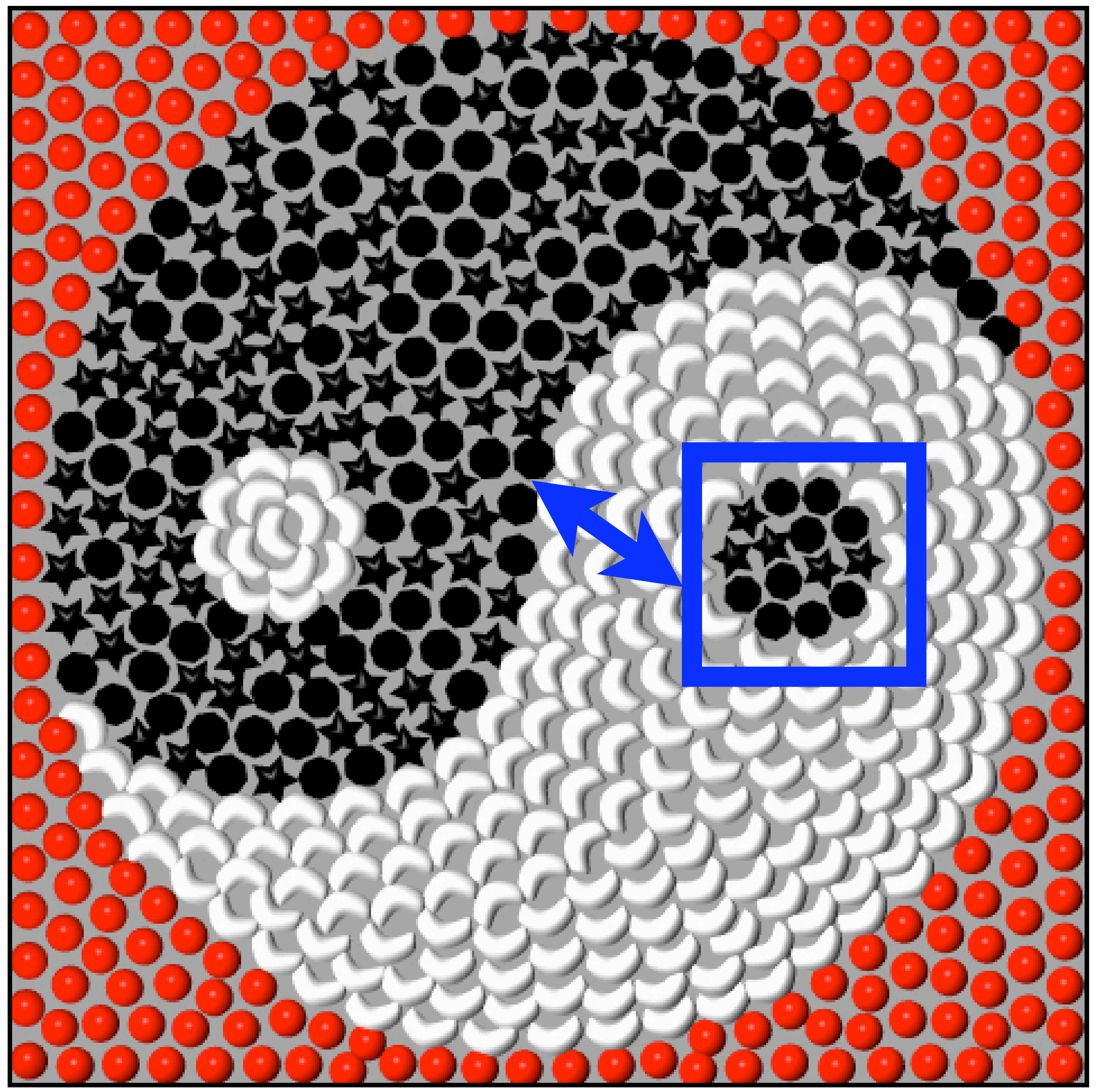
- Ultimate challenge: create a visually appealing animosaic
- Use grouping theory and perceptual aspects of HVS to:
  - Understand our perception of animated mosaics
  - Create animated mosaics that will simplify visual processing



Static Mosaic Perception

Group tiles to simplify and segment a scene according to:

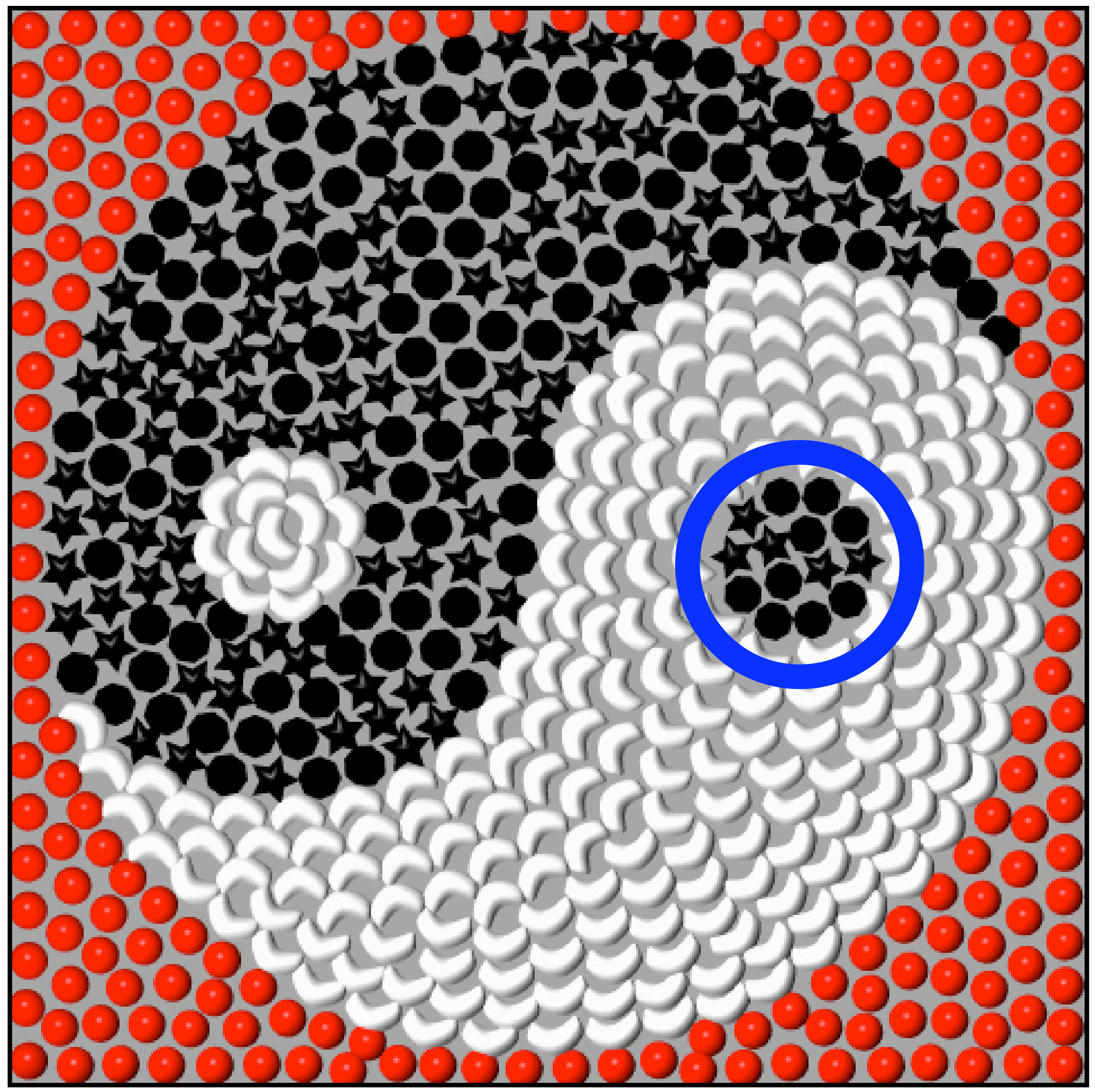
- Similarity (colour, shape, orientation)
- Tile proximity
- Likeness to common shape



Static Mosaic Perception

Group tiles to simplify and segment a scene according to:

- Similarity (colour, shape, orientation)
- Tile proximity
- Likeness to common shape



Animated Mosaic Perception

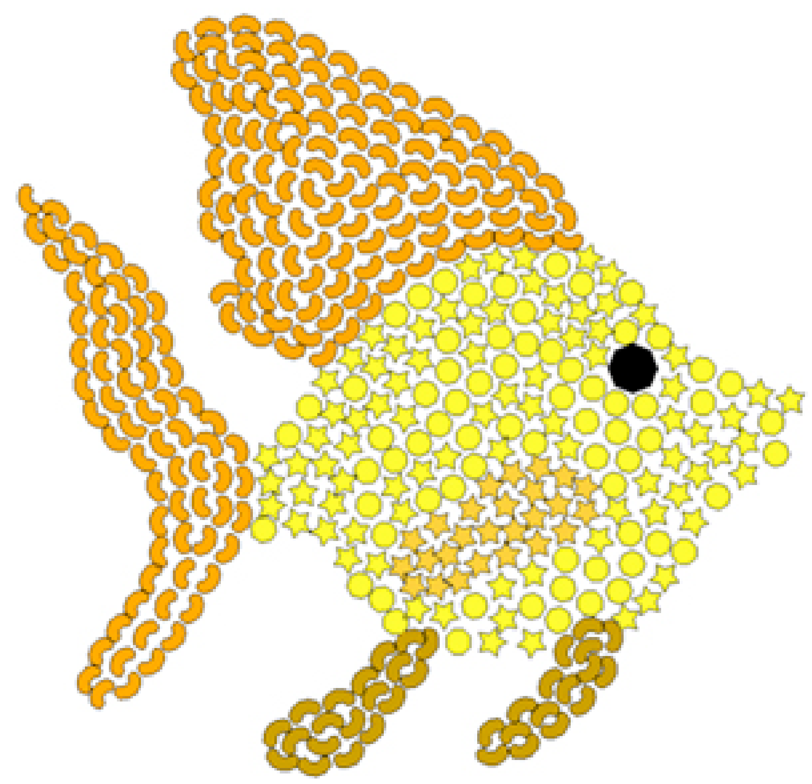
Maintain previous grouping and make changes coherent:

- Common movement of grouped tiles
- Insertion and deletion of groups, not individuals
- Maintain emphasis of contours

***Observation**: uncoordinated changes among groups of tiles will yield distracting, incoherent animations, even if individual tiles have temporal smoothness.*

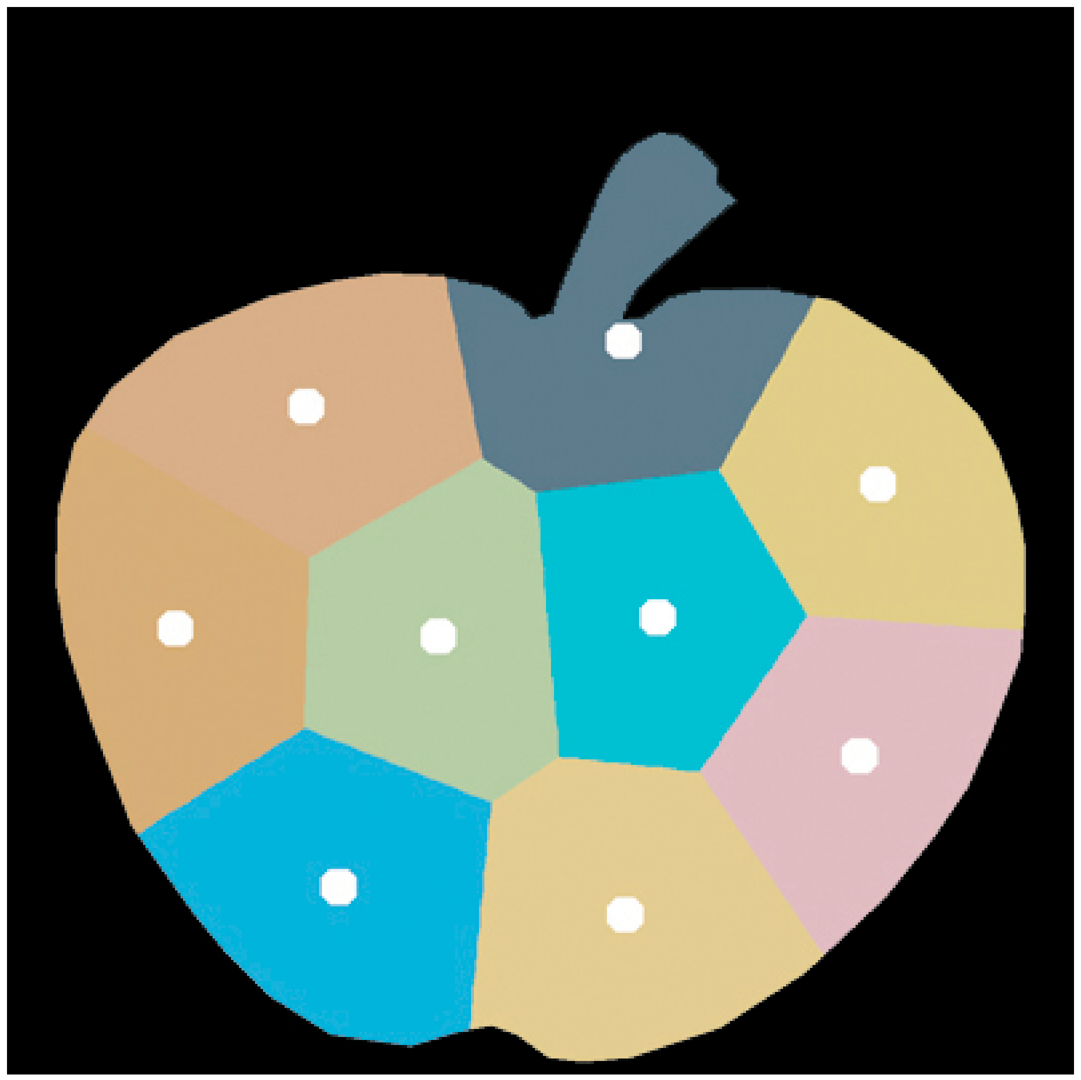
Outline

- Introduction
- Related Work
- Process Overview
- Challenges and Approach
- Packing
- Results and Conclusions

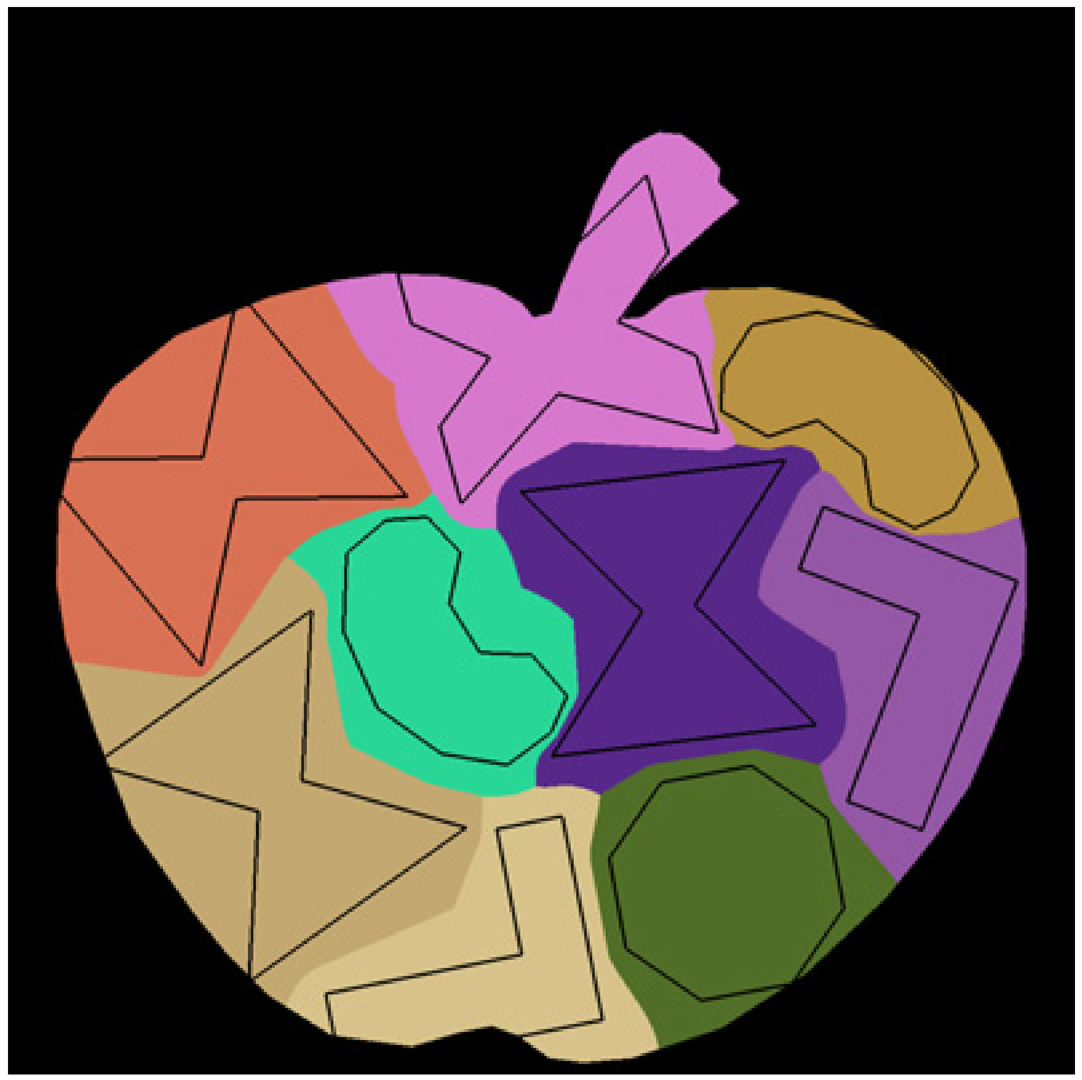


Packing: Tile Positioning

- No previous method packs multiple and arbitrary tile shapes in interactive time.
- Pack with centroidal **area** Voronoi diagram (**CAVD**).



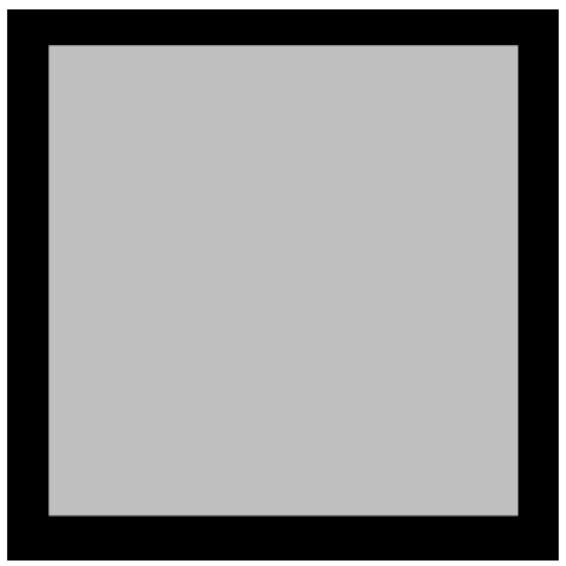
Standard Voronoi Diagram



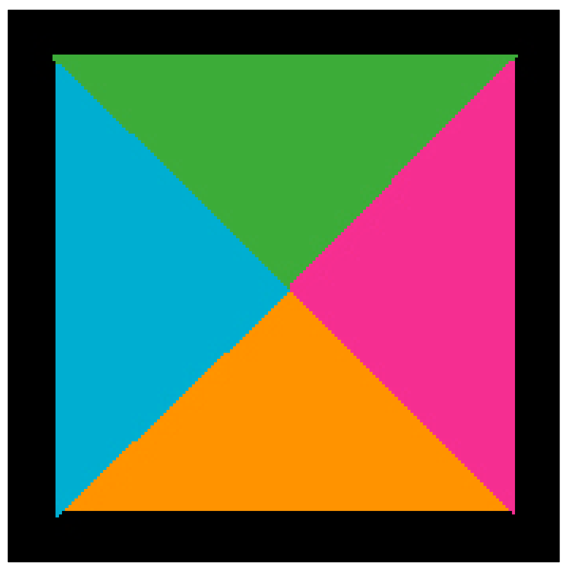
Area Voronoi Diagram

Packing: Tile Orientation

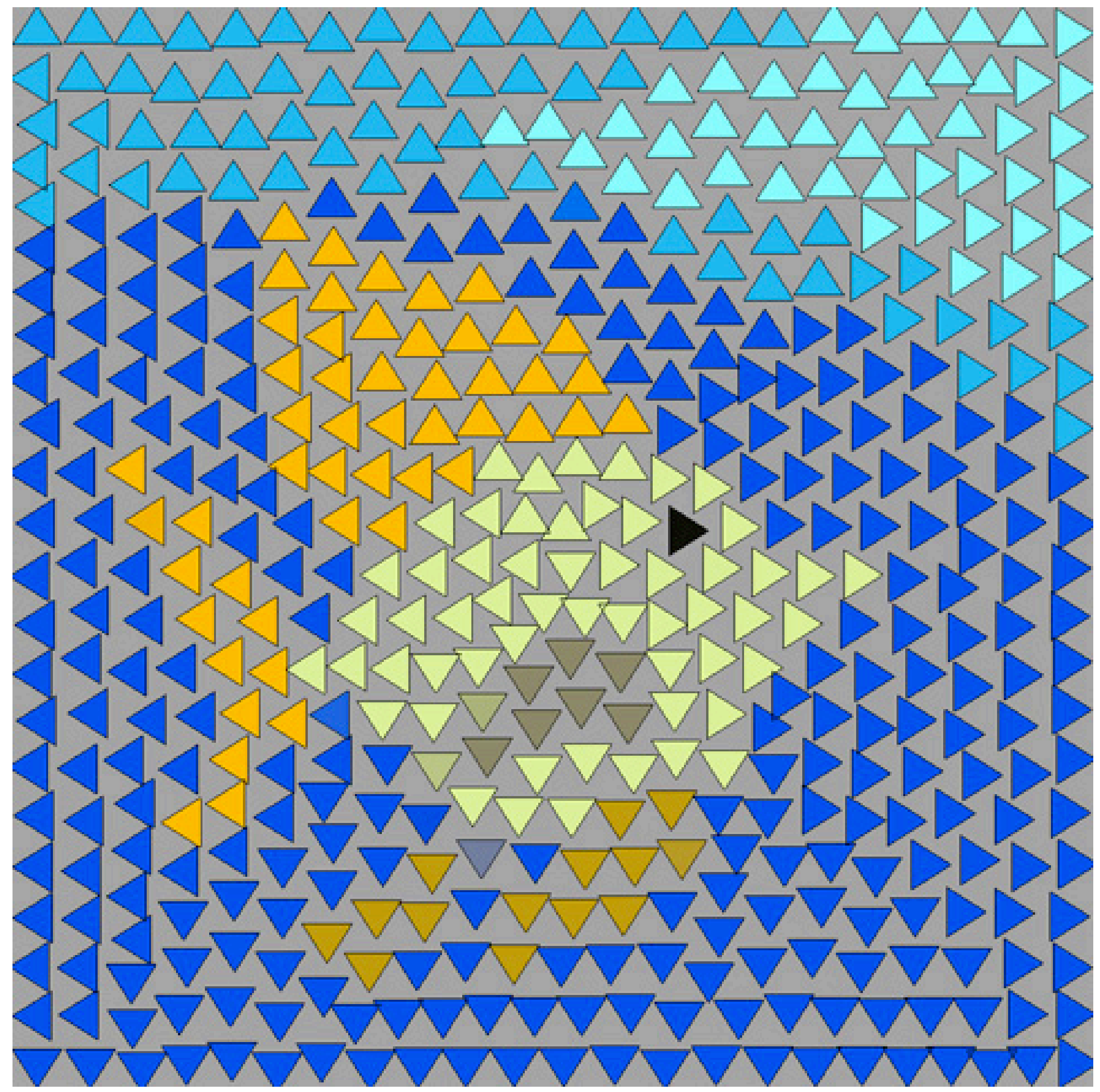
- Tiles oriented to nearest container edge.
- Fast to compute using AVD.
- Small container deformations yield coherent changes to tiles orientations.



Container



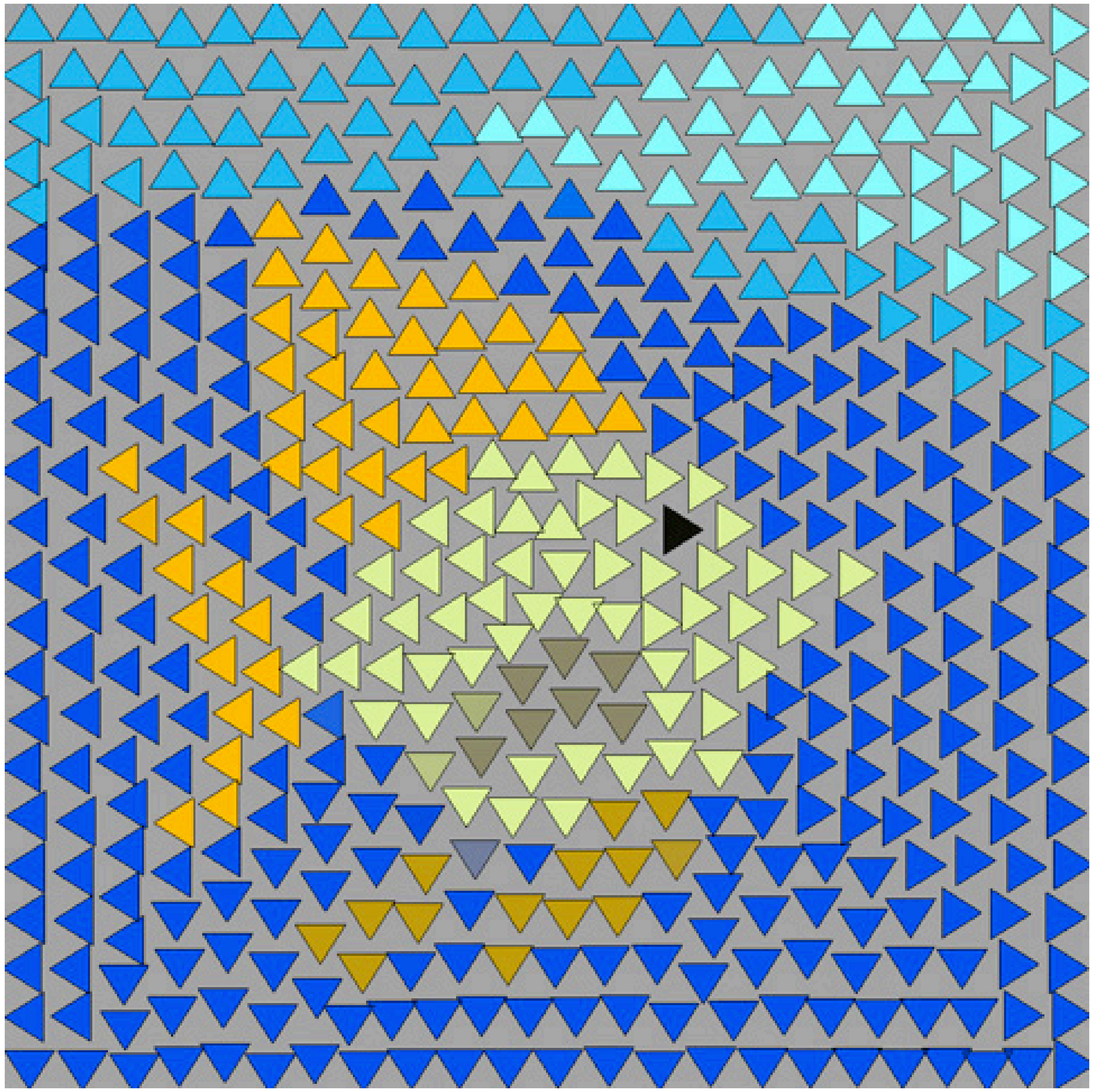
Container's Orientation Field



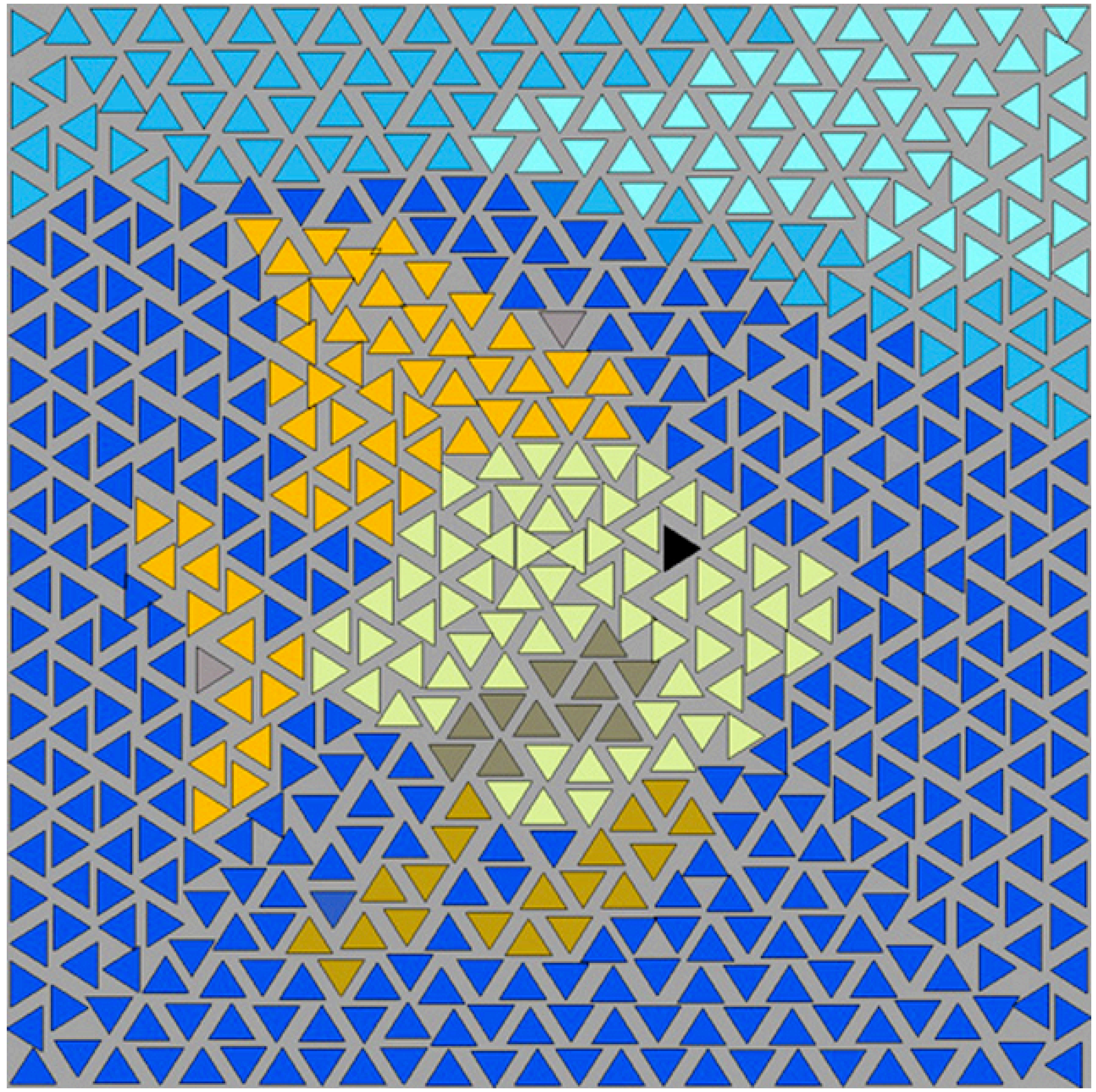
Resulting Packing

Packing: Tile Orientation

- Also supports equivalent tile orientations
- Better packing with no impact on packing speed



Without Equivalent Orientations

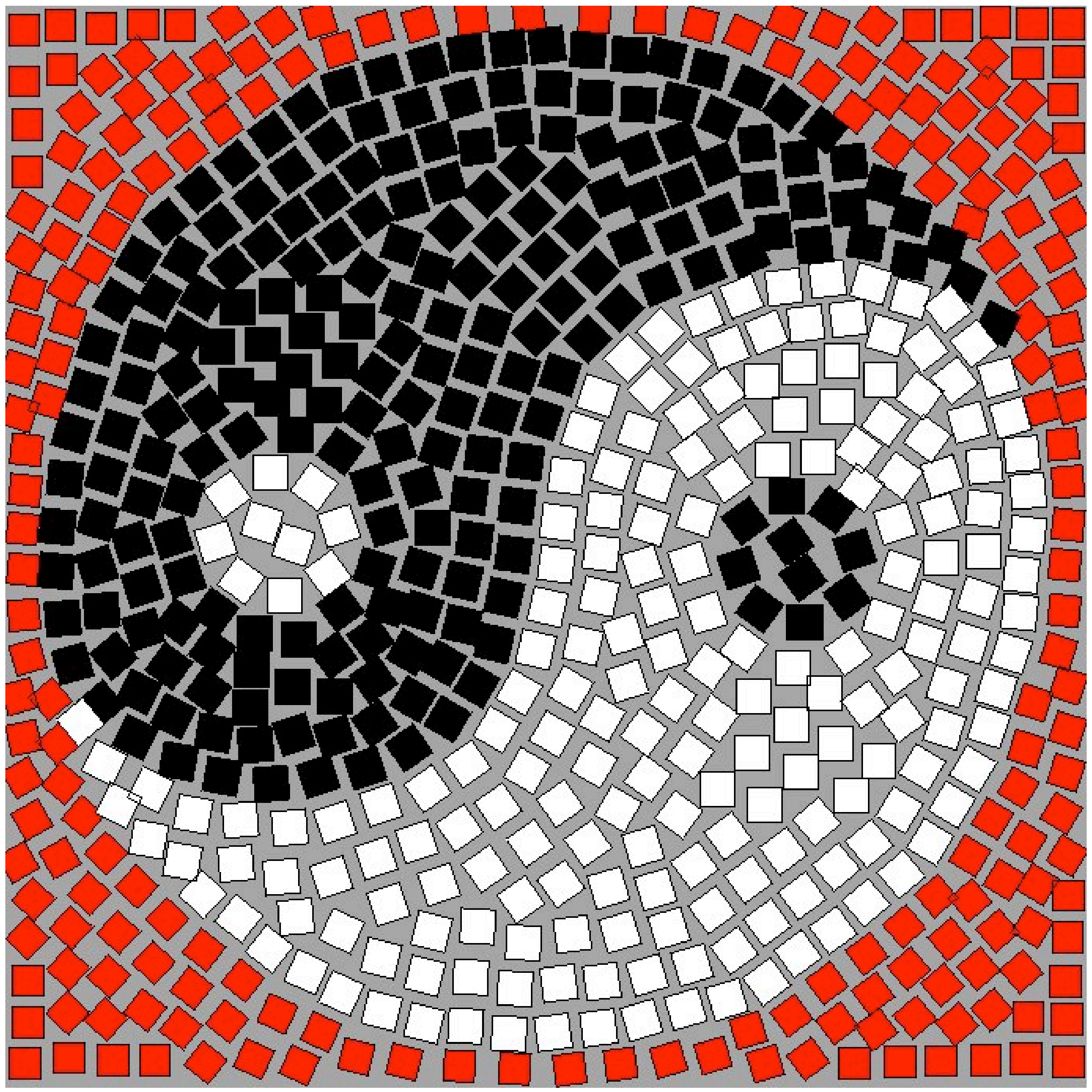


With Equivalent Orientations

SCA 05

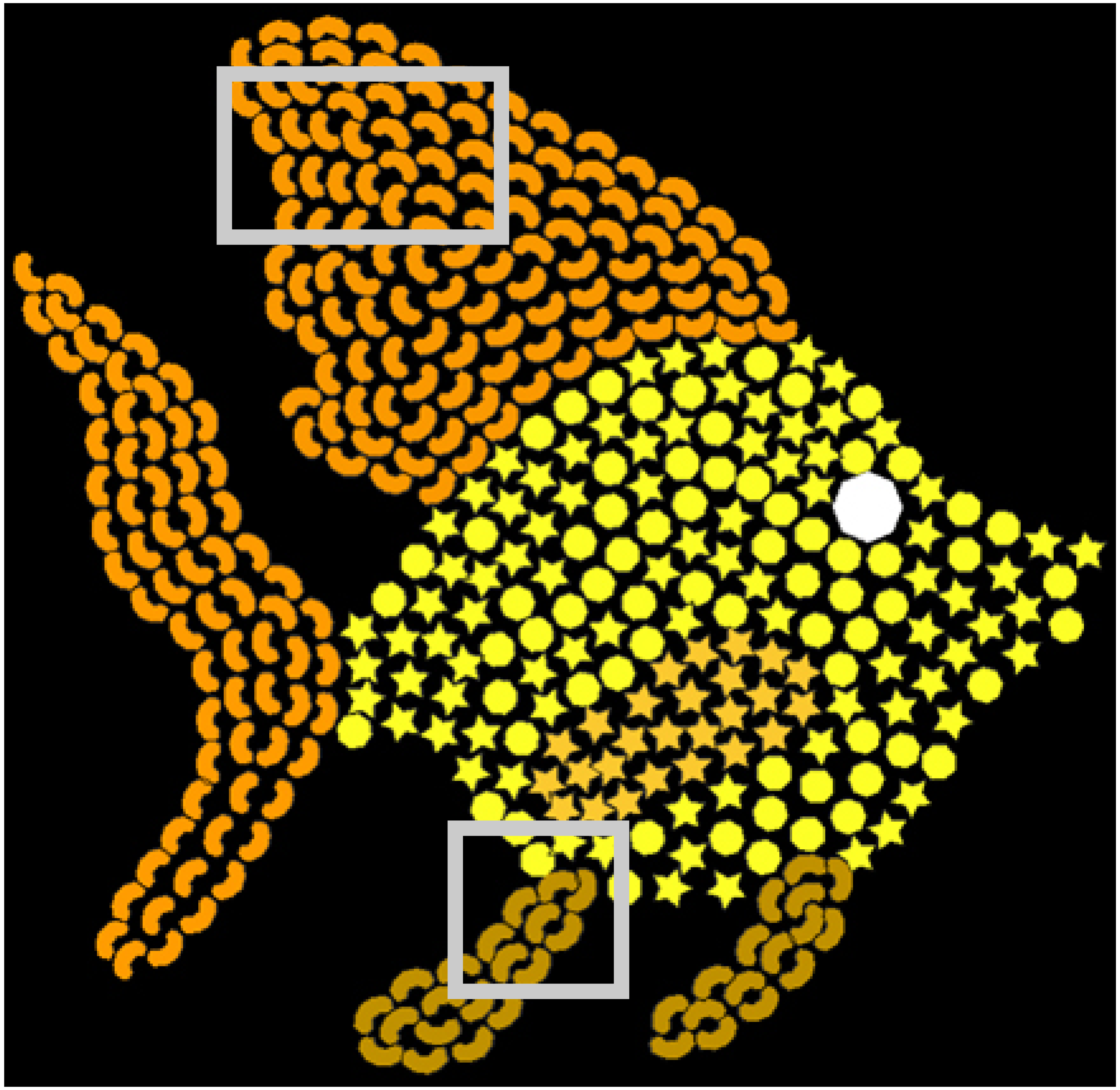
Packing: Tile Orientation

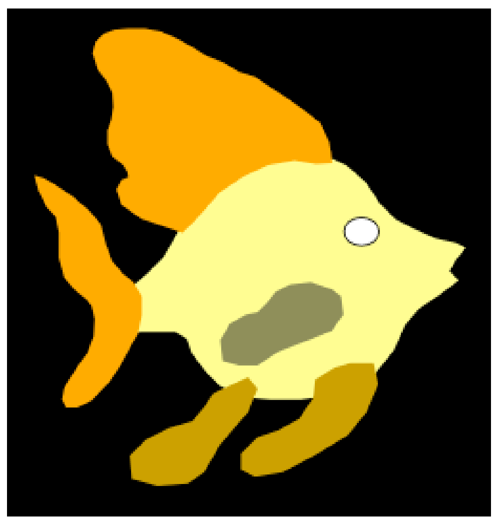
- Tile orientations respect and reflect container shape
- Continuous changes in continuous container regions
- Sharp changes in discontinuous container regions



Packing: Result

- Tightly packed tiles.

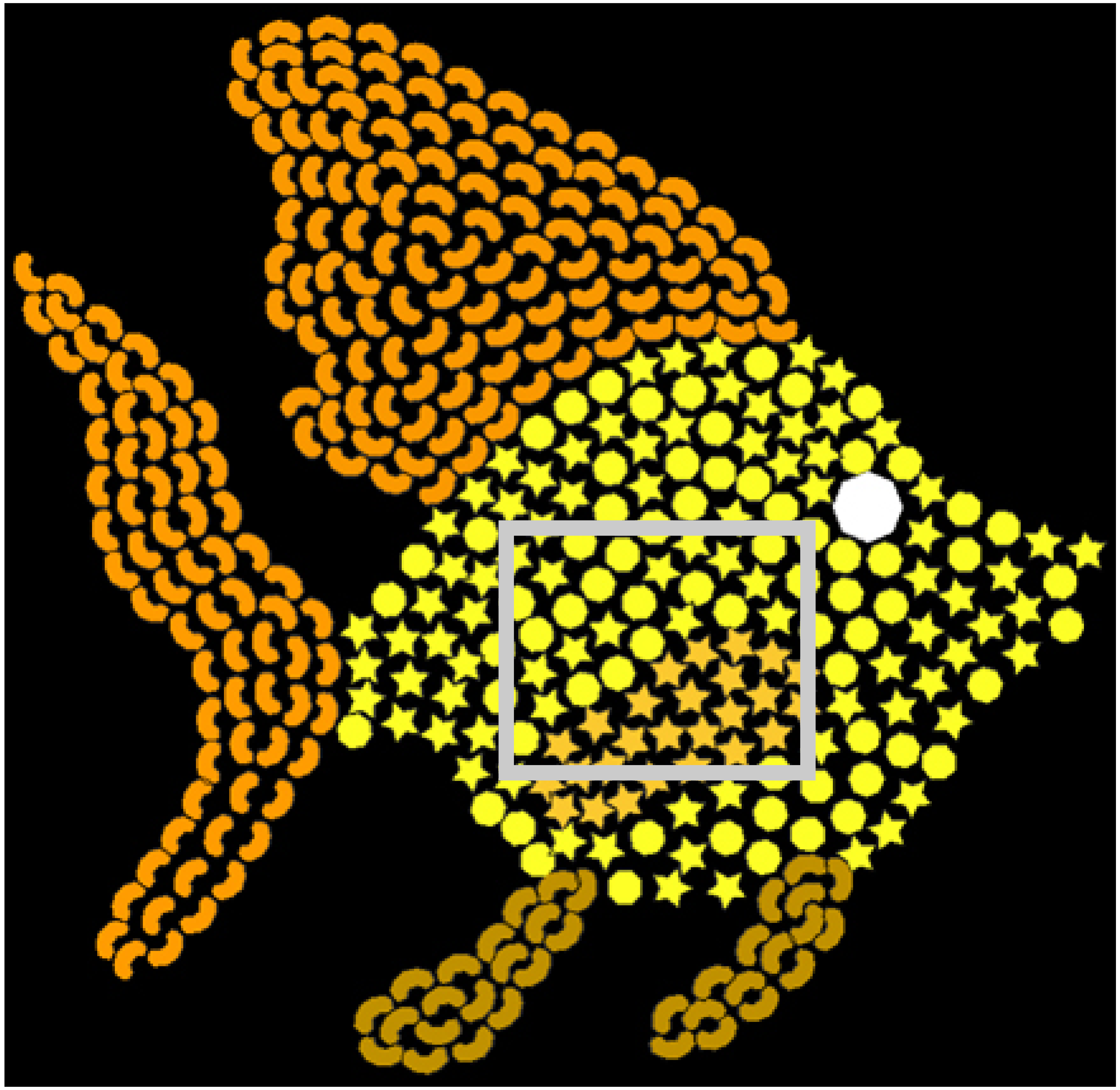


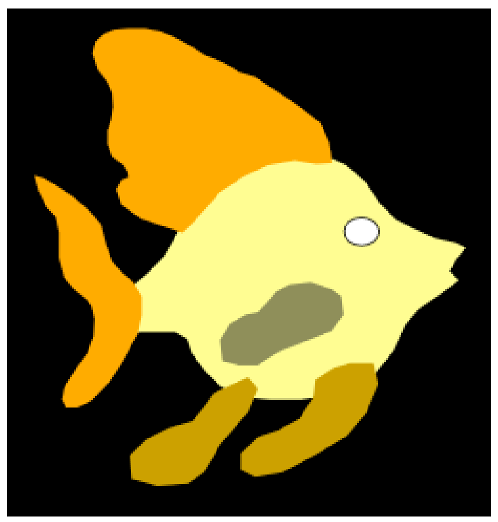


Input
(7 Containers)

Packing: Result

- Tightly packed tiles.
- Arbitrary and multiple tiles shapes.

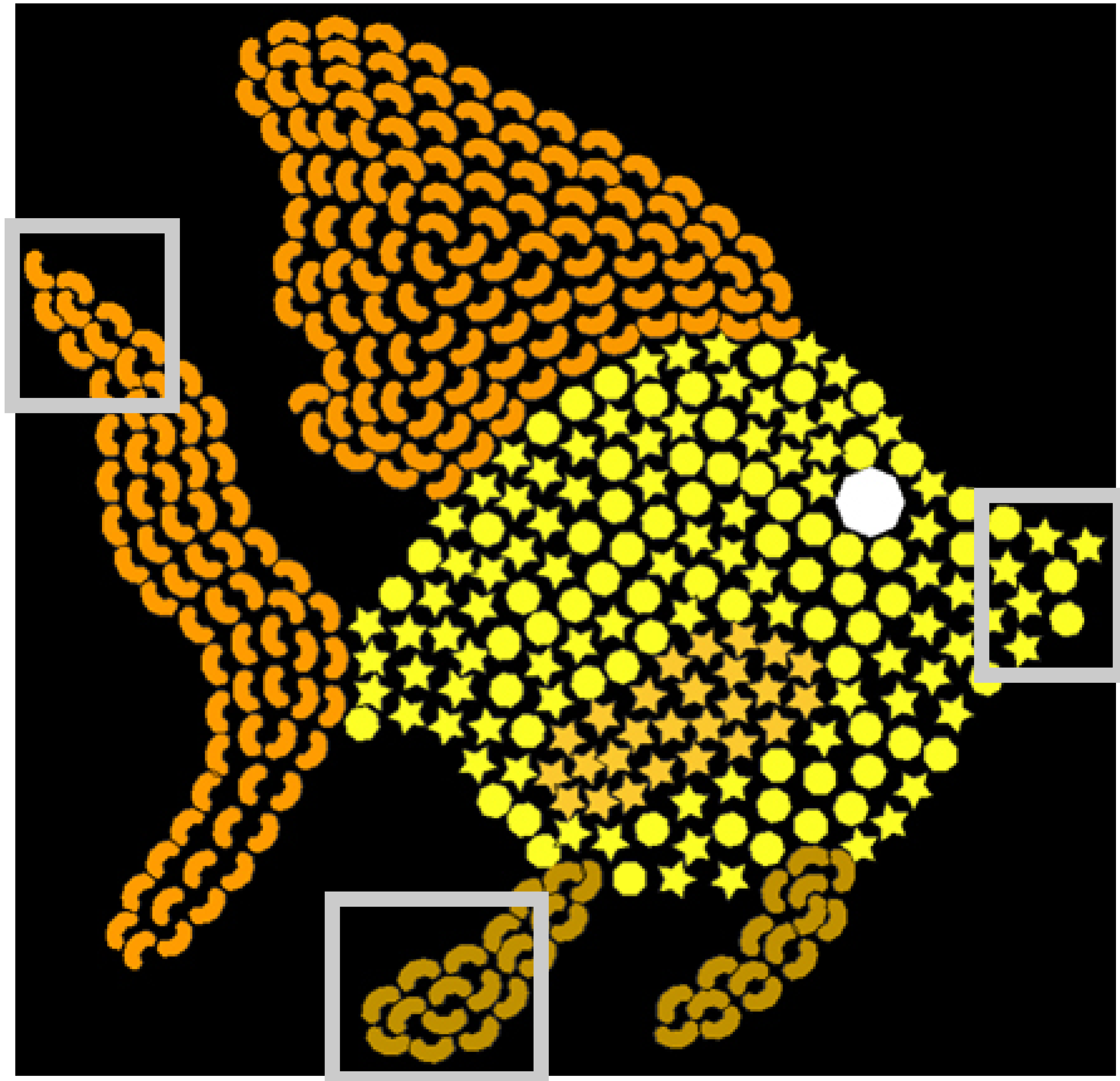


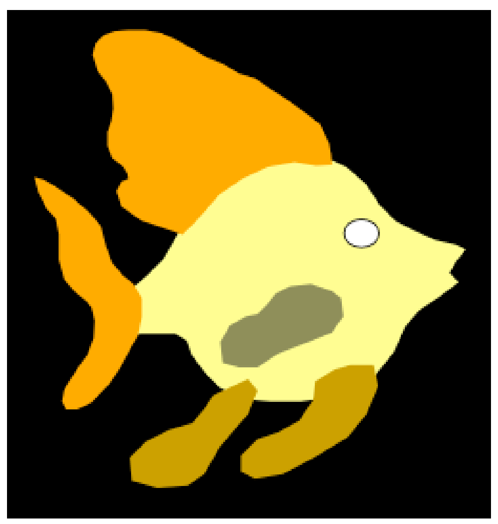


Input
(7 Containers)

Packing: Result

- Tightly packed tiles.
- Arbitrary and multiple tiles shapes.
- Placement and orientation respects and reflects the container shape.



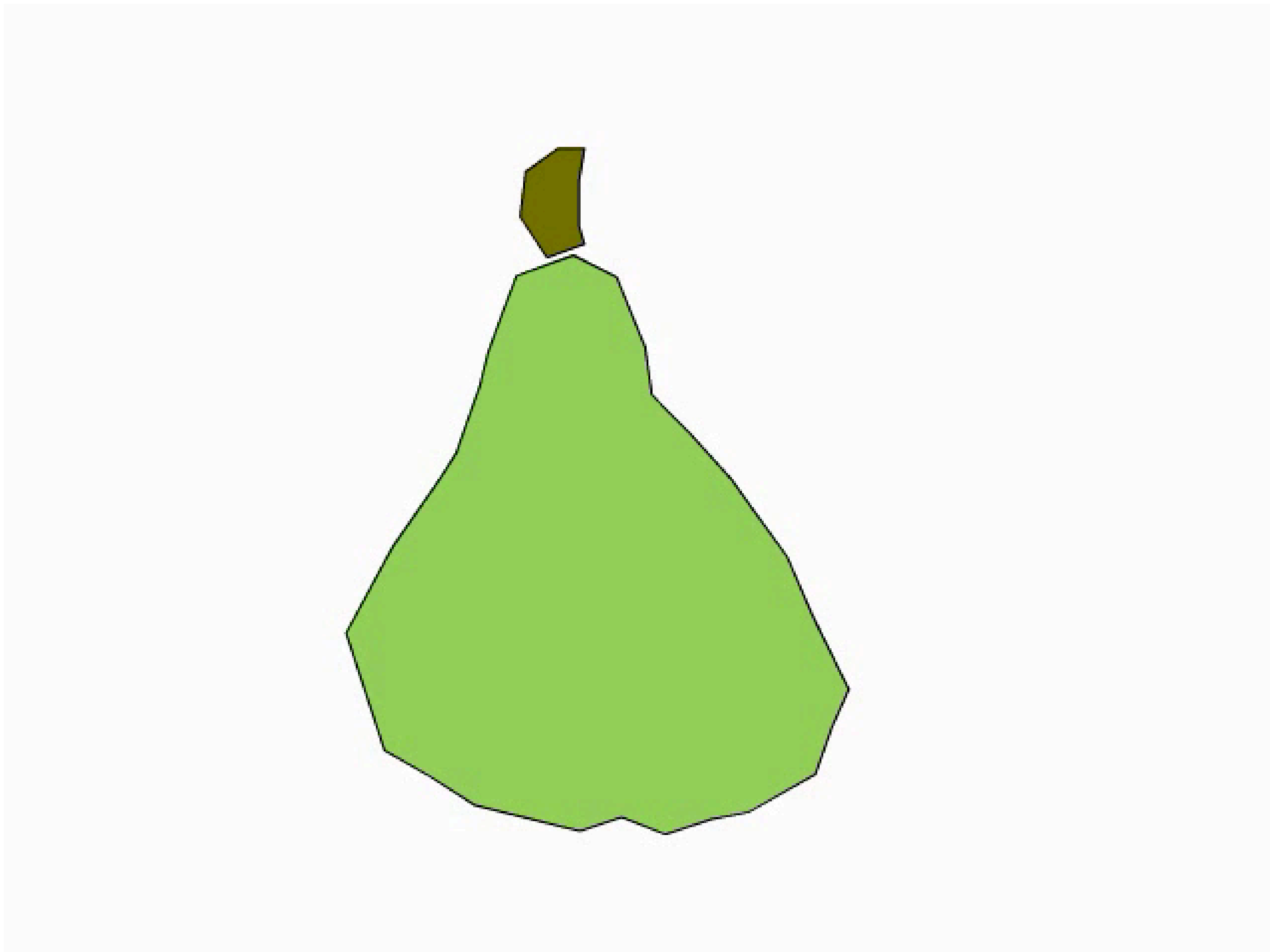


Input
(7 Containers)

Packing: Tile Advection

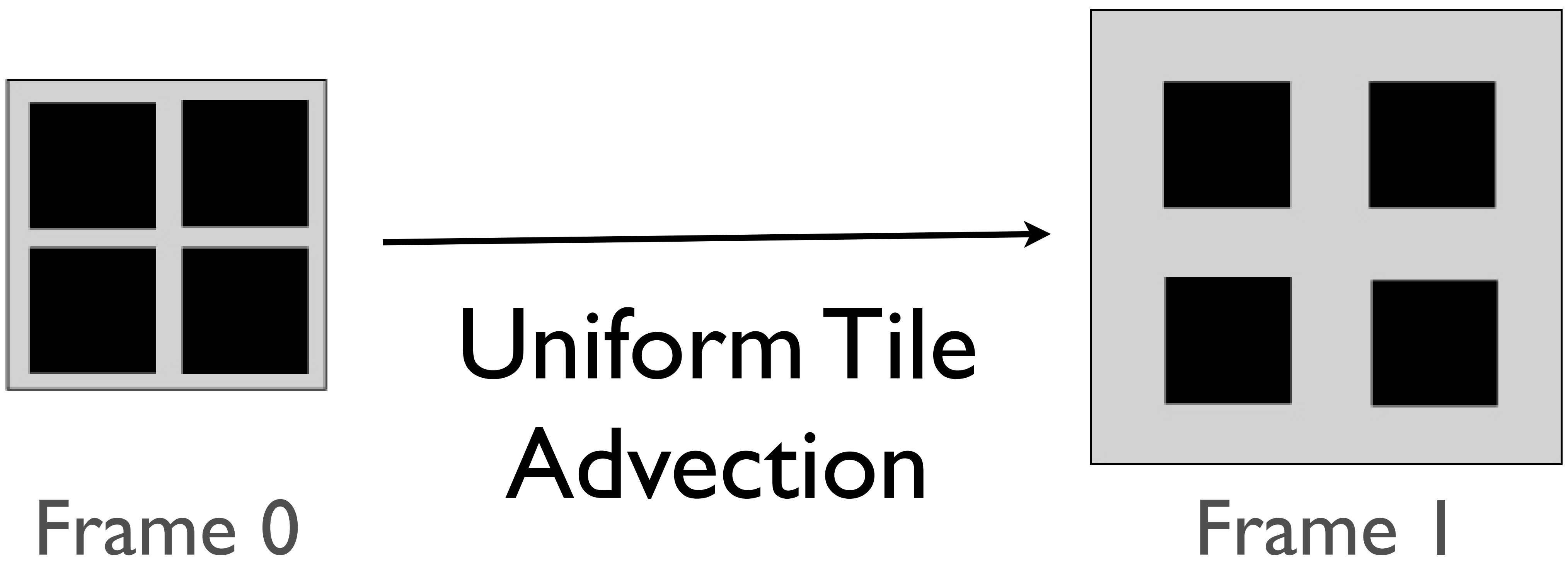
Temporal Coherence:

- Translations and rotations easy
- Deformations are hard because tiles must be displaced, added and deleted



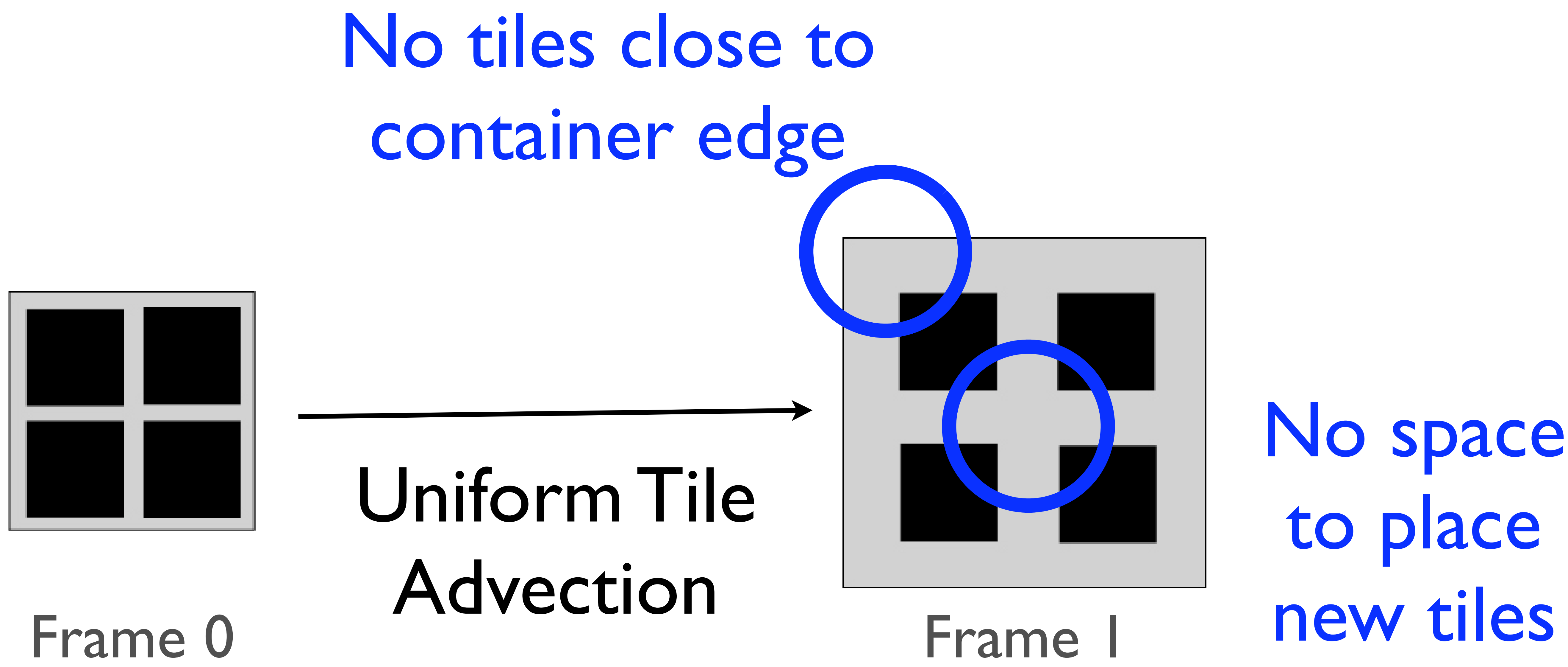
Packing: Tile Advection

- What would happen if tiles were advected uniformly over the container area?
- Example: map tiles to the next frame according to all container edges.



Packing: Tile Advection

- What would happen if tiles were advected uniformly over the container area?
- Example: map tiles to the next frame according to all container edges.



Packing: Tile Advection

Recall, in order to promote perceived coherence:

- Related tiles should move in groups
- Avoid individual tile insertions by concentrating insertion locations
- Concentrate deletions
- Emphasize container contour

Packing: Tile Advection

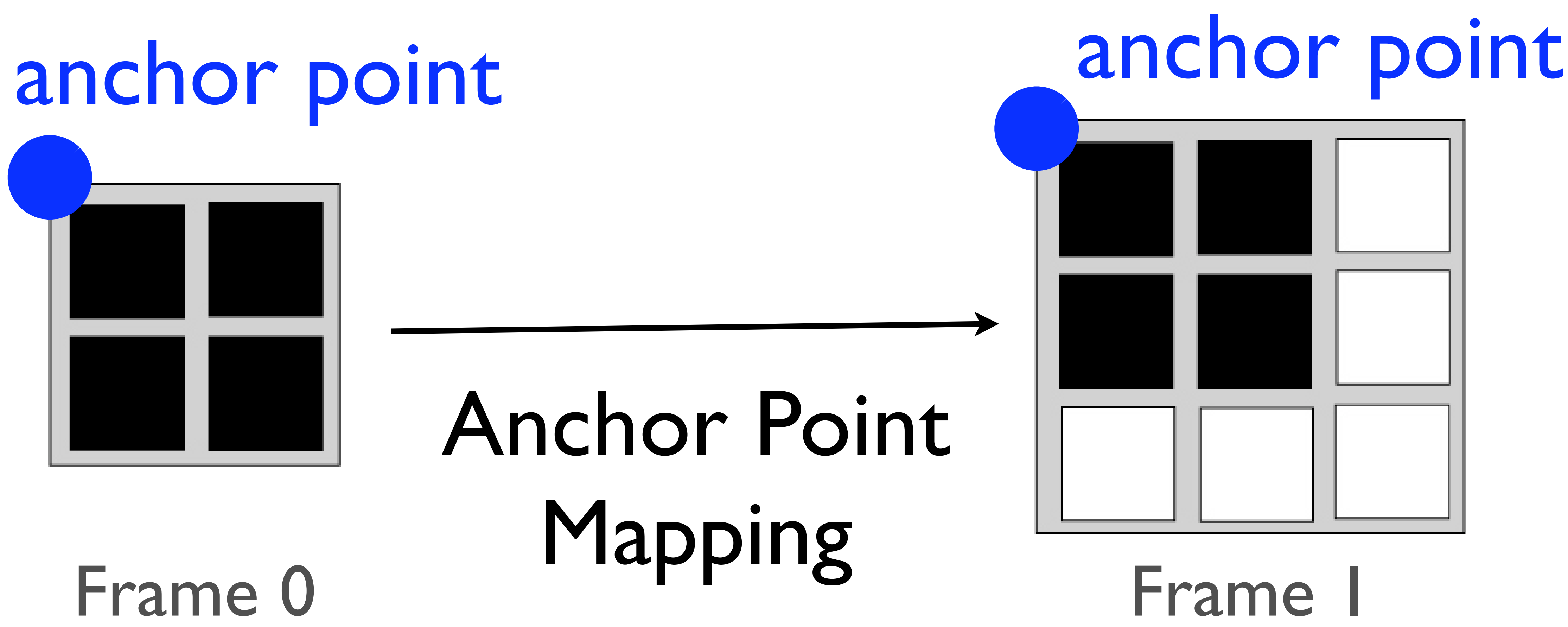
We propose two tile advection methods:

- Anchor Point Mapping
- Nearest-Edge Mapping

Previous techniques in NPR animation do not target group motion or perceptual grouping.

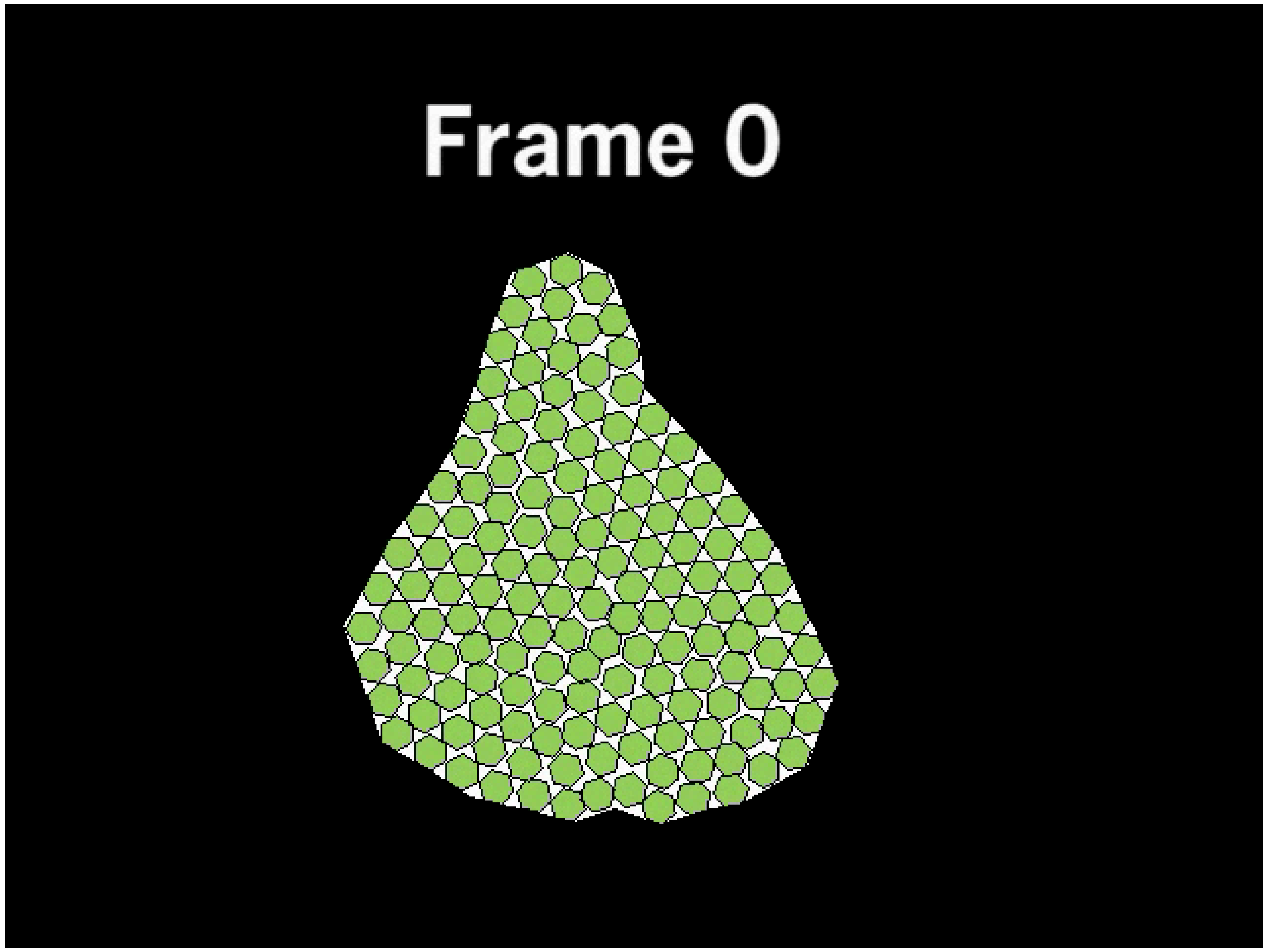
Anchor Point Mapping

- Appears that the tiles are being added to the border of the existing packing.
- During container contraction, outlying tiles are deleted.



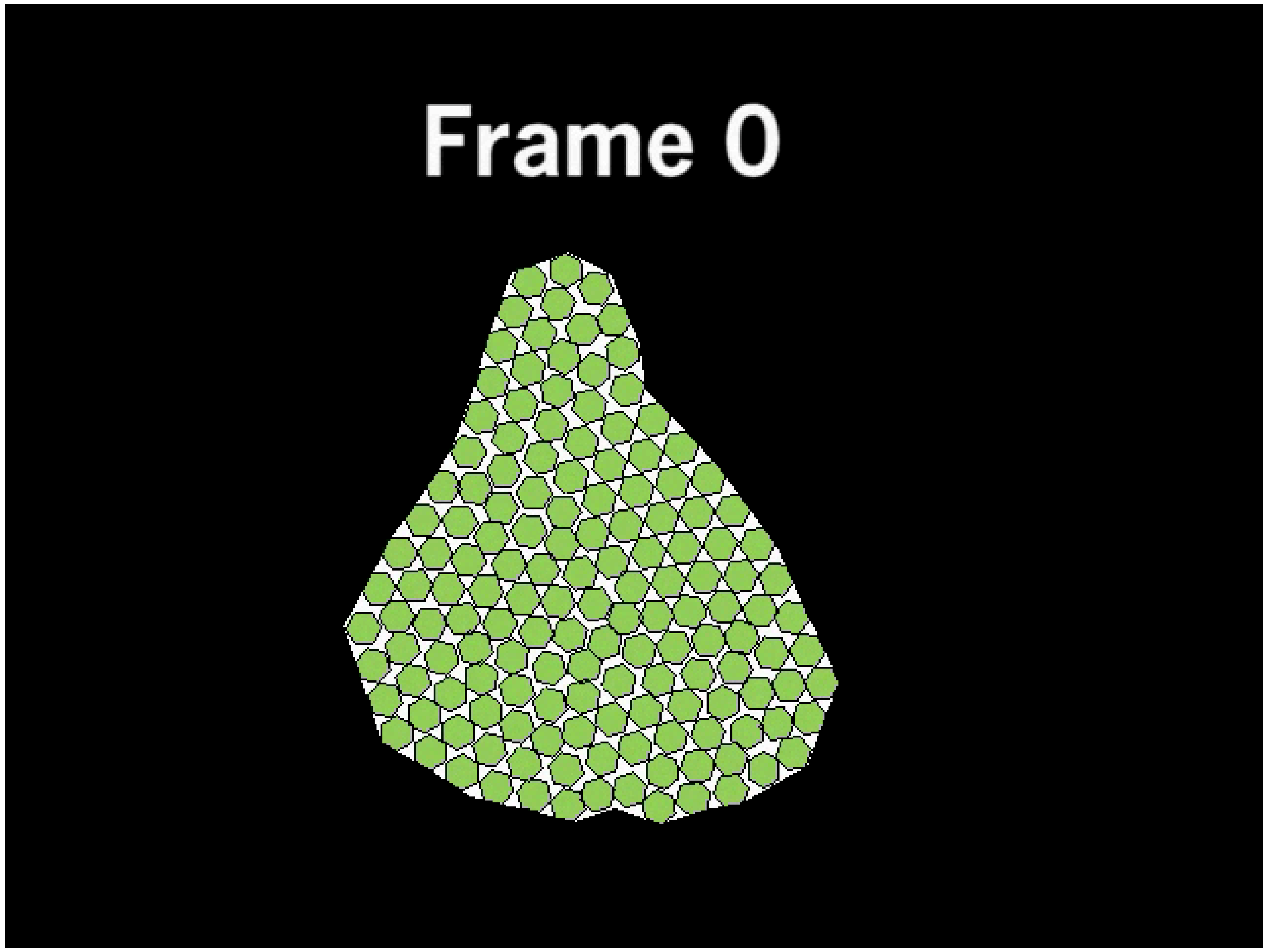
Anchor Point Mapping

Uses container center point as anchor point



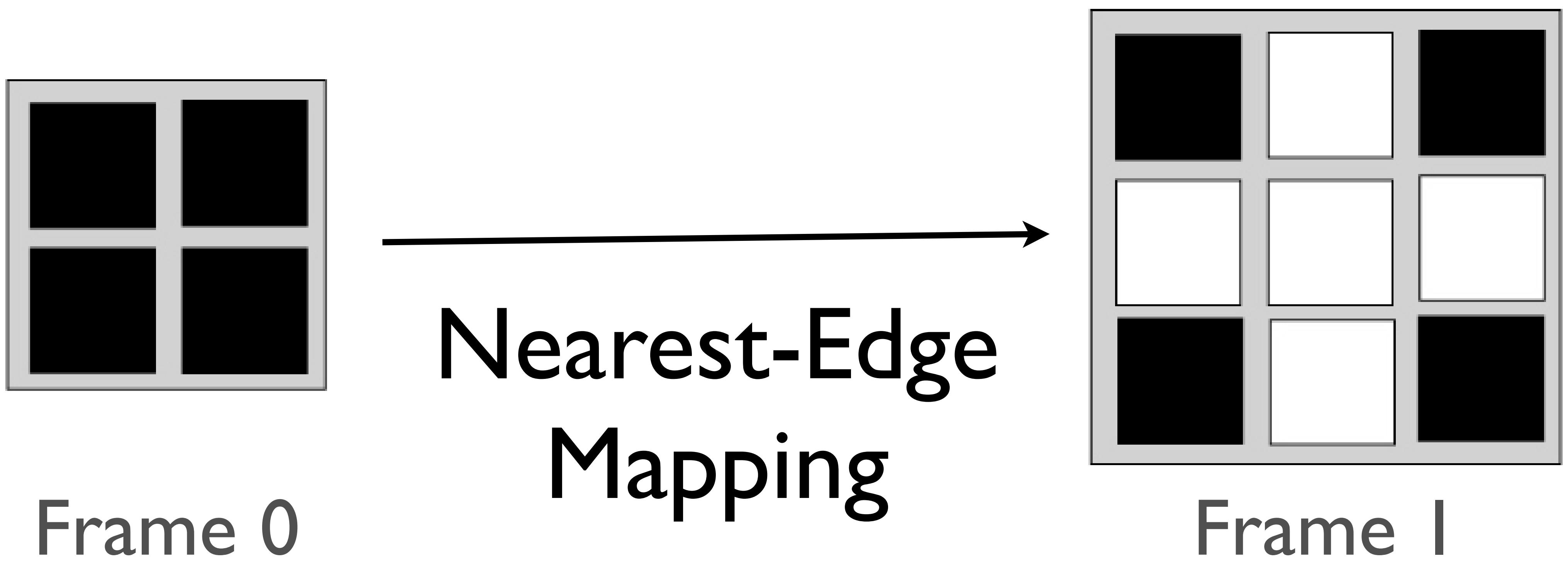
Anchor Point Mapping

Uses container center point as anchor point

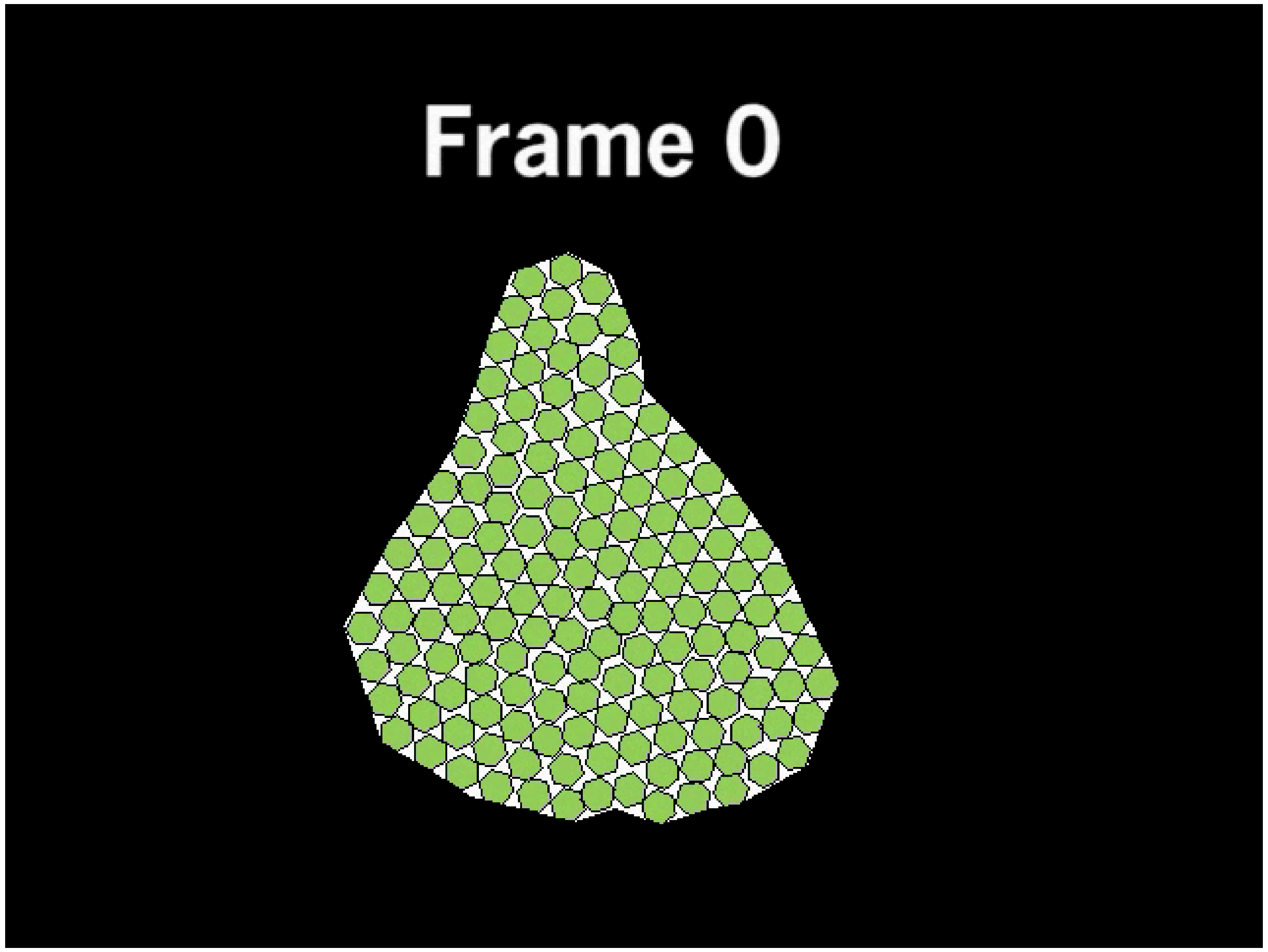


Nearest-Edge Mapping

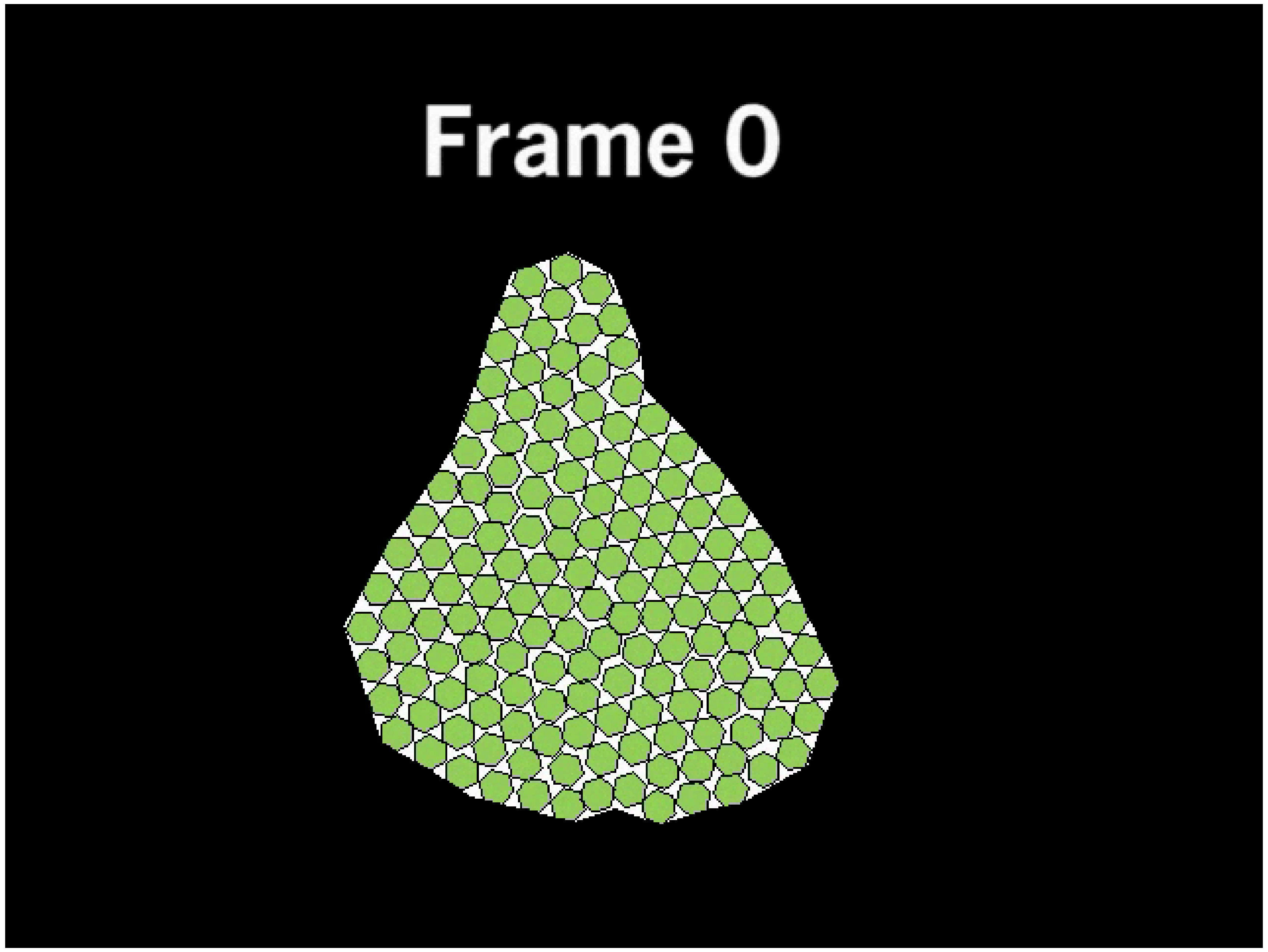
- Container boundaries coherent and strongly preserved
- Tiles added in a group at the center of the container
- Overlapping tiles are removed from center of container during container contractions



Nearest-Edge Mapping

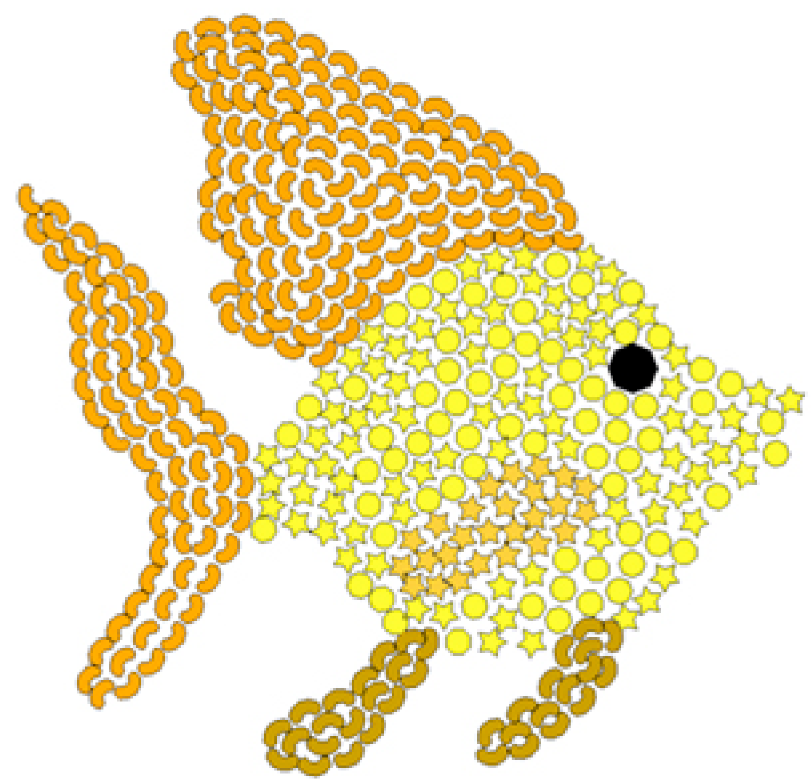


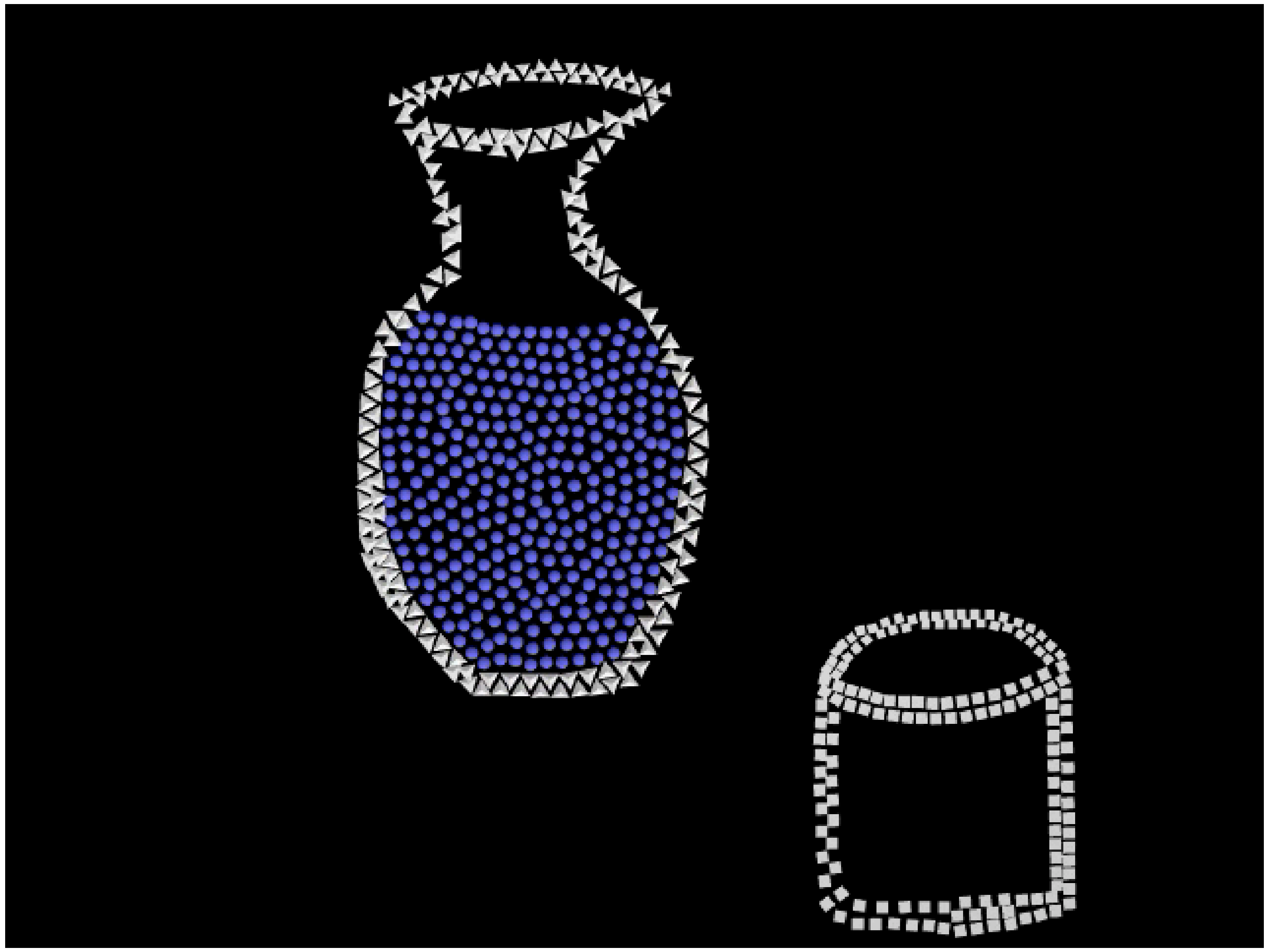
Nearest-Edge Mapping



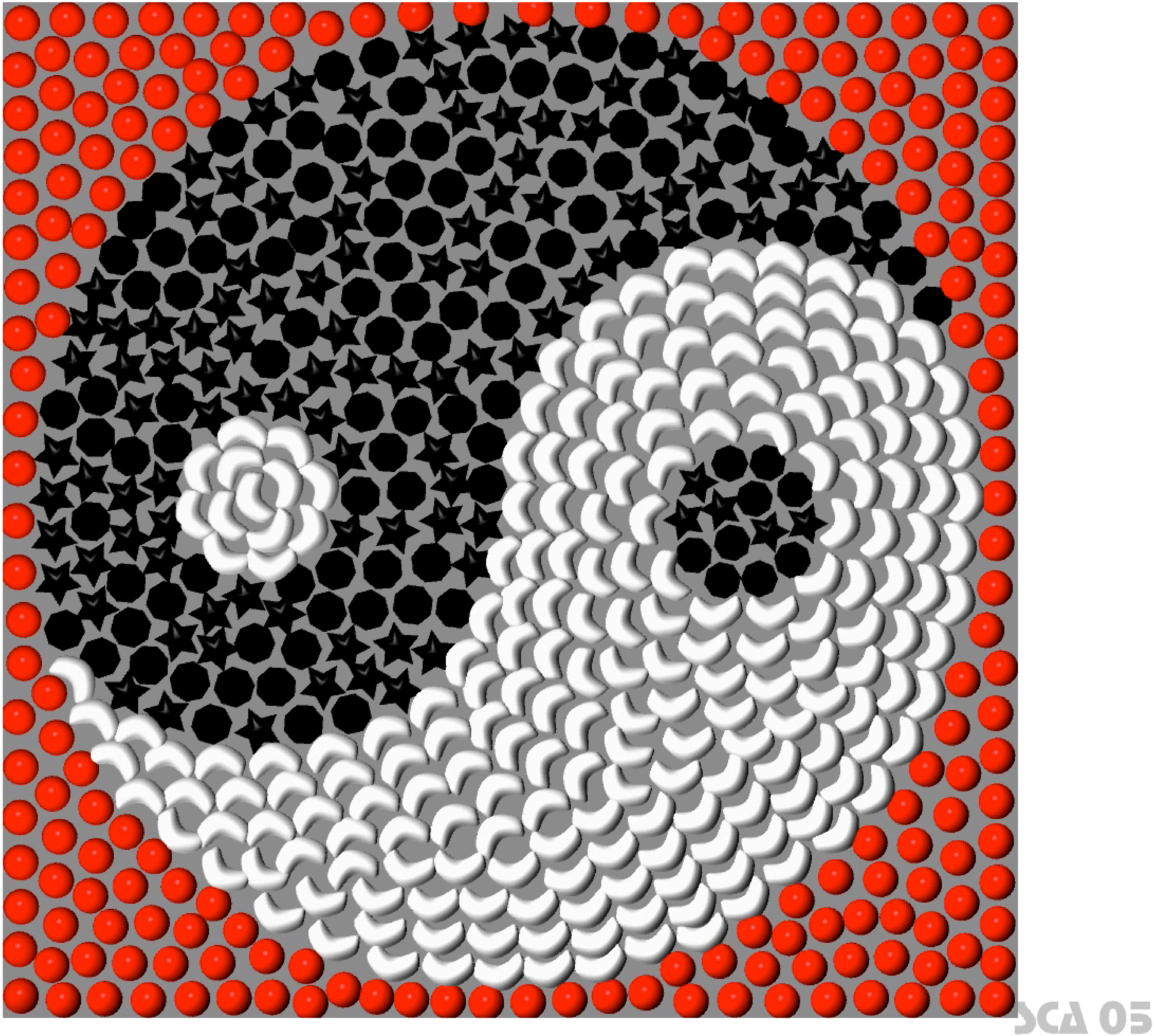
Outline

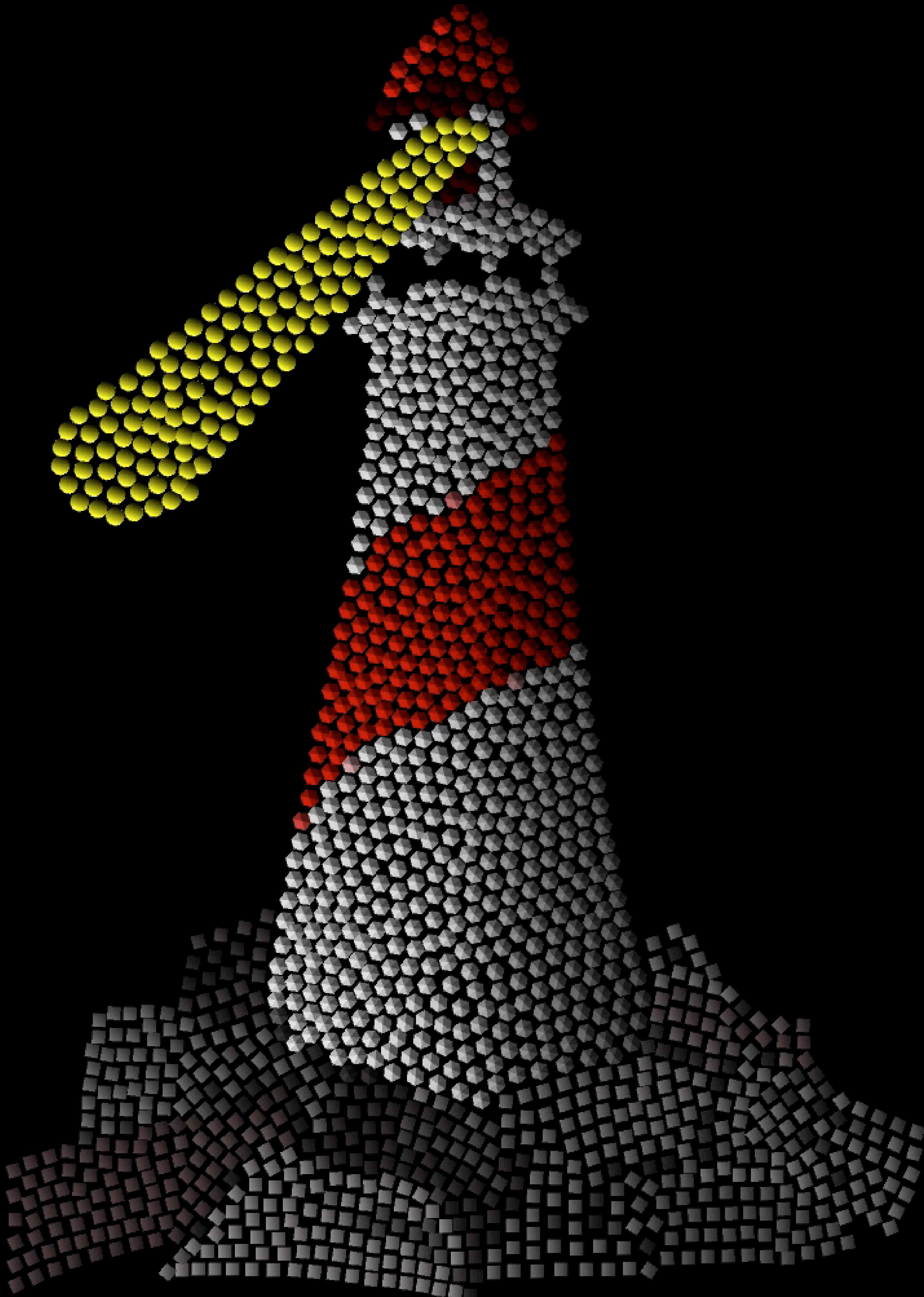
- Introduction
- Related Work
- Process Overview
- Challenges and Approach
- Packing
- ➡ Results and Conclusions





SCA 05


SCA 05



Conclusions

- **New techniques for static mosaic creation**
  - Multiple tile shapes
  - Improved tile orientation
- **New characterization of temporal coherence**
  - Group movement
  - Underlying geometry not necessary
- **New system for mosaic animations**
  - Easy animation specification
  - Original, stylized results

Future Work

- Further applications of perceptual grouping laws
- Make system choices more automatic
- Consider optimizing tile orientation according to the placement of neighbouring tiles

Acknowledgements

- Natural Sciences and Engineering Research Council of Canada
- Le Fonds québécois de la recherche sur la nature et les technologies
- ATI Technologies Inc. and Alias Systems Corp.
- Karol Myszkowski and Hans-Peter Seidel of MPI Informatik
- Louisa Sage
- Chansoo Kim and Yorico Murakami of UCLA Animation

Project: http://www.cs.mcgill.ca/~kaleigh/publications/animosaics