### Adaptive Modular Housing Design

### for Crisis Situations

#### ANASTASIYA PECHKO

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Home

**E3DGSAR** 

### Effective rendering of 3D objects using Gaussian Splatting in an Augmented Reality environment

Exploring real-time performance and visual fidelity of Gaussian Splatting techniques within immersive AR experiences.









## Wave Function Collapse algorithm



### Constraint programming



constraints

### How you ever played sudoku?



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#### **Rules:**

•The numbers 1 to 4 must appear exactly once in each row

•The numbers 1 to 4 must appear exactly once in each column

•The numbers 1 to 4 must appear exactly once in each of the corner 2×2 boxes

### How you ever played sudoku?



#### **Rules:**

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**Domain:** 

{1, 2, 3, 4}



















3	4	2	1
1	2	3	4
2	1	4	3
4	3	1	2

### Back to WFC - inspiration

Array of domains{1, 2, 3, 4} => **Wave** 

Choosing a random tile => **Observation** 

The Copenhagen Interpretation:



### Least Entropy

We want to select the cell that minimizes:

entropy = 
$$-\sum_{i} p_i \log(p_i)$$

# But what if we apply the WFC to some real problems?

## MELONS

of ukrainians were forced to leave their homes due to the war

#### **UKRAINIAN EXPERIENCE**

Since 2015, 5 projects of the "temporary housing" type have been implemented in Ukraine. For most families, this is still their home.



### REFUKRAINE CUCTEMA refugee houses project

6A

6Б

8A

85

Modularity



### Flexibility & Scaling possibility





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#### **SECTION 01**

Floor plan of a family-type section





Living rooms Kitchens Utility rooms



#### **SECTION 03**

#### Floor plan

179.71 Residential block 55% Communal use space 42.21 13% Kitchens 19.69 6.50 6% Baby care room 2% 59.70 16.03 323.83 18% 5% Utility rooms Bathrooms Total area  $\rightarrow$ esidential blocks Communal use space Baby care roor

### WFC + RE:UKRAINE HOUSING

Adaptive Modular Housing Design for Crisis Situations





Floor plan of a family-type section

Living rooms	277.26	65%
Kitchens	85.81	20%
Utility rooms	27.31	6%
Bathrooms	37.18	9%
Total area	427.57	



	Living rooms
	Kitchens
	Utility rooms
0	Bathrooms

25<sup>th</sup> International Conference on Computational Science



7-9 July 2025 • Singapore

## Defining rules and domain



• Residential Standard Heuristic

• Residential Standard Heuristic



- Residential Standard Heuristic
- Bath Placement Heuristic

STANDARD MINIMUM







- Residential Standard Heuristic
- Bath Placement Heuristic
- Symmetry Patterns Heuristic

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- Accessibility Heuristic

#### EXAMPLE RESULTS



Symetria H



Symetria V



#### EXAMPLE RESULTS



32

#### EXAMPLE RESULTS



### CURRENT PROJECT

### How to modify Gaussian Splatting in VR



Well-fitted pre-existing mesh (Baseline)







GS is Not VR- or game-engine-ready (yet) 😌

- Limited Real-Time Lighting & Shadows
- Poor Interactivity & Animation Support
- Inconsistent Stereoscopic Rendering

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### Physics relates on mesh





#### FUTURE PLANS

### Real-time interactive visualisation of modular settlements design process



#### THANK YOU!