

Automatic building interior designer for building performance simulation

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Motivation

- **The absence of the parametrical studies showing the direct influence of the space layout on occupant thermal comfort**
- **No available software solution for transient short-period (1h/1day) occupant simulations**
- **Lack of space layout generator in building energy performance software**

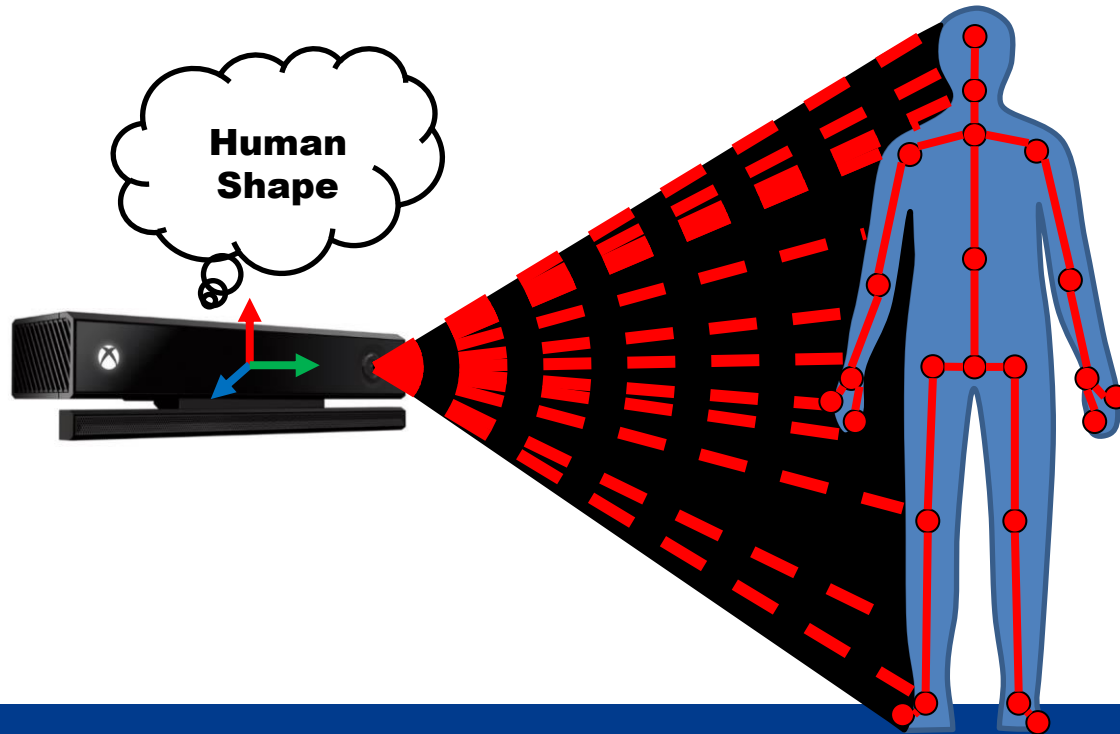
Using Xbox Kinect in OB Research

- **A depth registration camera able to capture human activity**

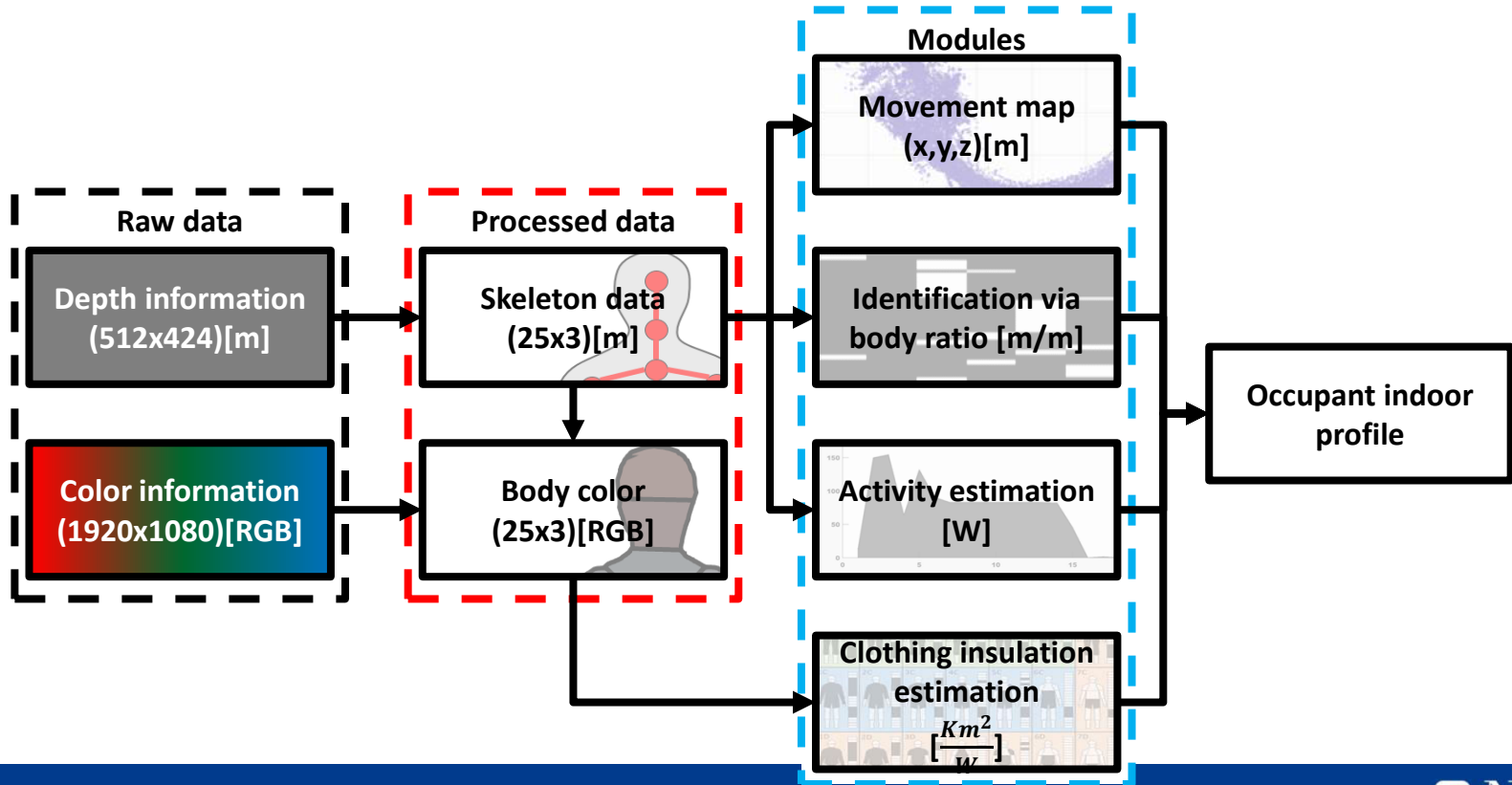


- **Microsoft device used for entertainment**
- **We started with monitoring and registration of occupant movement in the Zero Emission Building Living LAB at NTNU (a small residential building)**

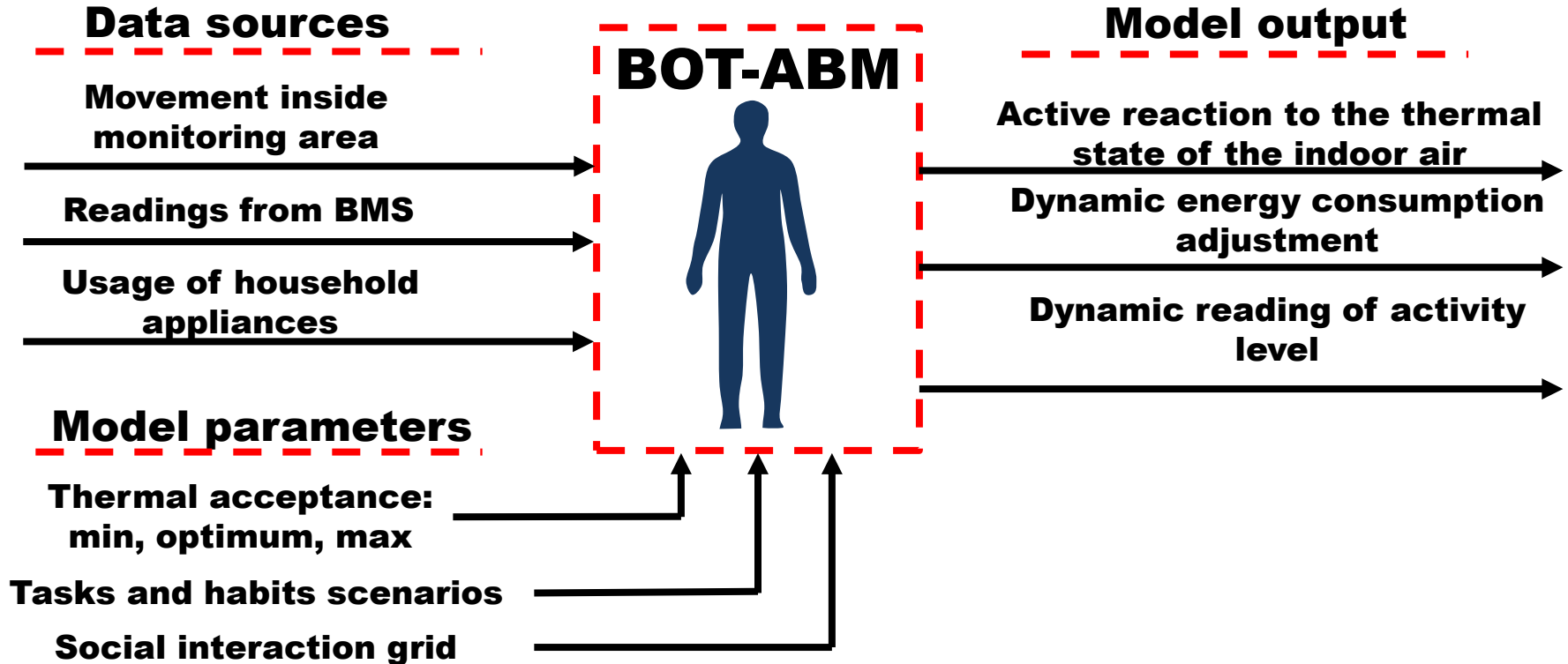
How does it work?



Occupant profile generator via depth registration



Building Occupant Transient-Agent Based Model

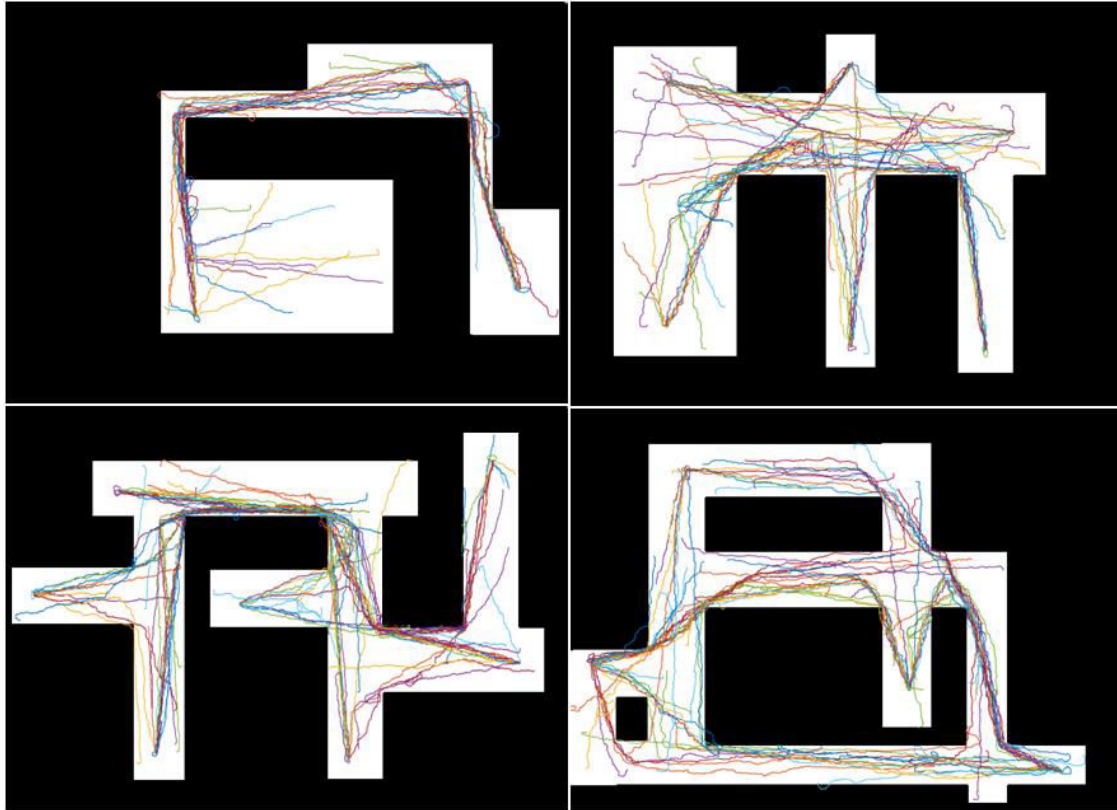


Movement simulator results

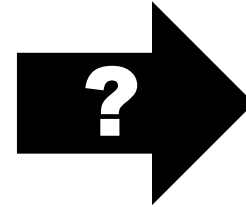
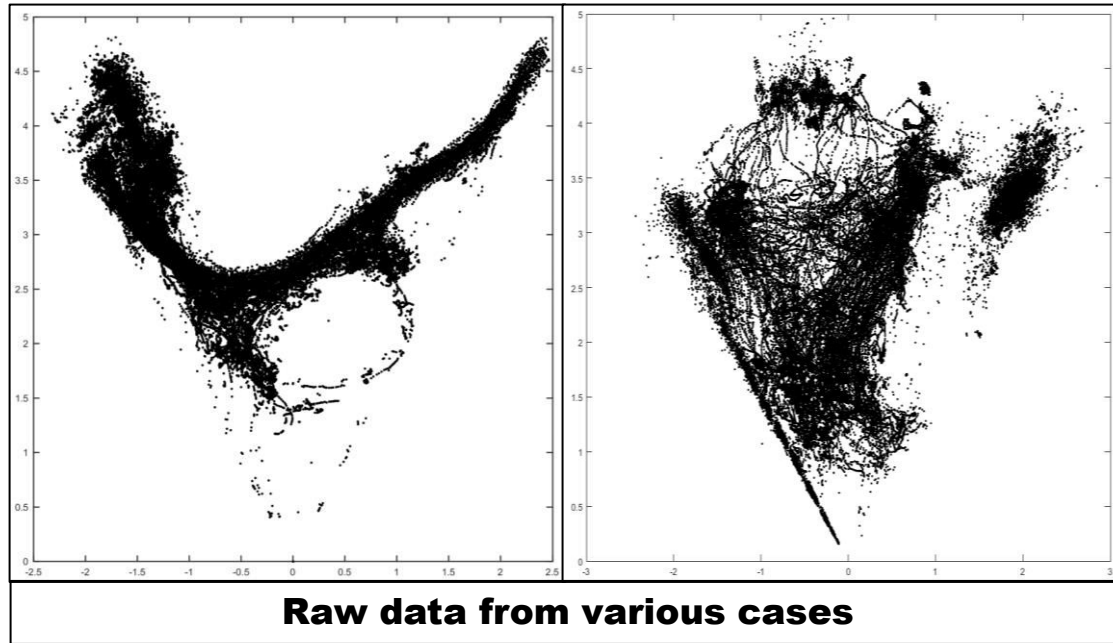
**Time step:
1 [s]**

**Dimensions:
15 x 20 [m]**

**A to B:
Random
position**



But why we move from A to B?



Survey

“Kitchen is the heart of the home” - survey

We would like to invite you to participate in a survey aiming to investigate your home space usage. The scope of this study seeks information regarding kitchen appliances placement and how it is organized. The goal is to check the diversity of kitchen space usage in residential buildings. Collected data will be used to investigate the possibility of generating a kitchen layout simulator.

1.1 Your gender/sex

- A. Female B. Male

1.2 Write your age in rectangle nr.1 below. If you are living with other occupants, write their age in the following squares. If you are uncertain about their age, write an approximate value.

--	--	--	--	--	--	--

2. The overview below lists appliances that may be located in kitchens. On the next page, they are presented by icon-graphics.

2.1 Put marks 'X' in squares with appliances that you have in your kitchen.

2.2 Give each marked appliance, importance numbering in an increasing order. No. 1 is the most important one, regarding your habits of the kitchen usage. If same appliances are combined, give them the same number. Write number inside the circle

- | | |
|---|--|
| <input type="checkbox"/> <input type="radio"/> Fridge | <input type="checkbox"/> <input type="radio"/> Toaster |
| <input type="checkbox"/> <input type="radio"/> Freezer | <input type="checkbox"/> <input type="radio"/> Blender |
| <input type="checkbox"/> <input type="radio"/> Cooker | <input type="checkbox"/> <input type="radio"/> Exhaust |
| <input type="checkbox"/> <input type="radio"/> Built-in Oven | <input type="checkbox"/> <input type="radio"/> Sink |
| <input type="checkbox"/> <input type="radio"/> Hob | <input type="checkbox"/> <input type="radio"/> Dishwasher |
| <input type="checkbox"/> <input type="radio"/> Microwave | <input type="checkbox"/> <input type="radio"/> Washing Machine |
| <input type="checkbox"/> <input type="radio"/> Espresso Machine | <input type="checkbox"/> <input type="radio"/> Tumble Dryer |
| <input type="checkbox"/> <input type="radio"/> Kettle | <input type="checkbox"/> <input type="radio"/> TV |
| <input type="checkbox"/> <input type="radio"/> Fryer | <input type="checkbox"/> <input type="radio"/> Radio |
| | <input type="checkbox"/> <input type="radio"/> Other |

3.1 Approximate size of your kitchen is _____ [m²]

3.2 Your kitchen is shaped like

- A. Square B. Rectangle C. L-Shaped D. Other

4. For all questions below, use the grid below to answer

4.1 If the answer from 3.2, was other than A, mark „X” on the squares to show proportional shape of your kitchen



4.2 Mark the location of windows in the kitchen, using the grey rectangles. Write "W" inside.



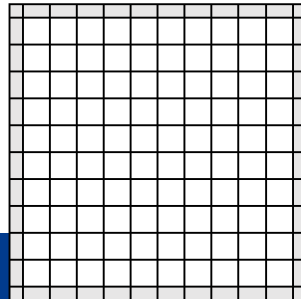
4.3 Mark the location of doorways in the kitchen, using the grey rectangles. Write "D" inside.



4.4 Draw an arrow pointing the direction of the north, inside the „N” circle,

4.5 Write numbers inside the squares to position all of the appliances in your kitchen. Use numbering from 2.2. One feature may take more than one rectangle.

4.6 Color the squares representing positions of other kitchen features like drawers, tables, chairs etc.



Fridge

Freezer

Cooker

Built-in Oven

Hob

Microwave

Espresso Machine

Kettle

Fryer



Toaster

Blender

Exhaust

Sink

Dishwasher

Washing Machine

Tumble Dryer

TV

Radio

Other



Survey – part 1

1.1 Your gender/sex

A. Female

B. Male

1.2 Write your age in rectangle nr.1 below. If you are living with other occupants, write their age in the following squares. If you are uncertain about their age, write an approximate value.

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| <input type="checkbox"/> <input type="radio"/> Freezer | <input type="checkbox"/> <input type="radio"/> Blender |
| <input type="checkbox"/> <input type="radio"/> Cooker | <input type="checkbox"/> <input type="radio"/> Exhaust |
| <input type="checkbox"/> <input type="radio"/> Built-in Oven | <input type="checkbox"/> <input type="radio"/> Sink |
| <input type="checkbox"/> <input type="radio"/> Hob | <input type="checkbox"/> <input type="radio"/> Dishwasher |
| <input type="checkbox"/> <input type="radio"/> Microwave | <input type="checkbox"/> <input type="radio"/> Washing Machine |
| <input type="checkbox"/> <input type="radio"/> Espresso Machine | <input type="checkbox"/> <input type="radio"/> Tumble Dryer |
| <input type="checkbox"/> <input type="radio"/> Kettle | <input type="checkbox"/> <input type="radio"/> TV |
| <input type="checkbox"/> <input type="radio"/> Fryer | <input type="checkbox"/> <input type="radio"/> Radio |
| | <input type="checkbox"/> <input type="radio"/> Other |

3.1 Approximate size of your kitchen is _____ [m²]

3.2 Your kitchen is shaped like

- A. Square B. Rectangle C. L-Shaped D. Other

Survey – part 2

4. For all questions below, use the grid below to answer

4.1 If the answer from 3.2, was other than A, mark „X” on the squares to show proportional shape of your kitchen



4.2 Mark the location of windows in the kitchen, using the grey rectangles. Write "W" inside.



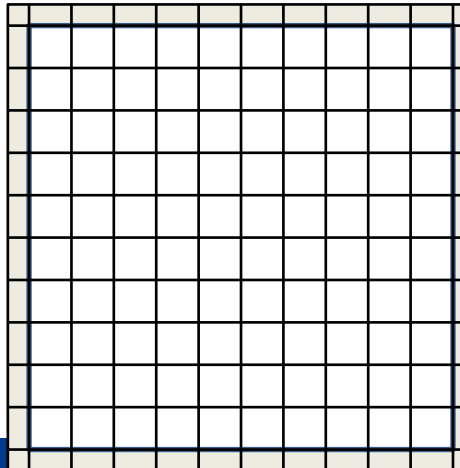
4.3 Mark the location of doorways in the kitchen, using the grey rectangles. Write "D" inside.



4.4 Draw an arrow pointing the direction of the north, inside the „N” circle,

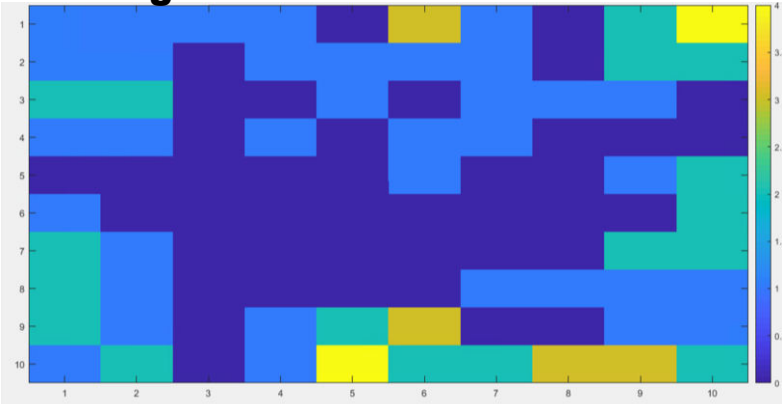
4.5 Write numbers inside the squares to position all of the appliances in your kitchen. Use numbering from 2.2.
One feature may take more than one rectangle.

4.6 Color the squares representing positions of other kitchen features like drawers, tables, chairs etc.

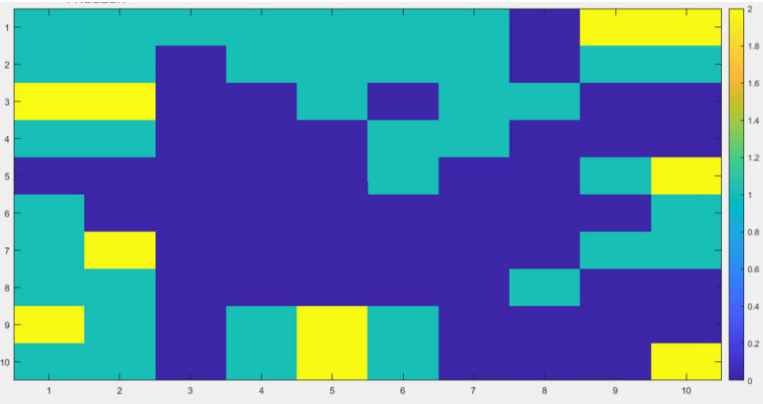


Device placement results sample

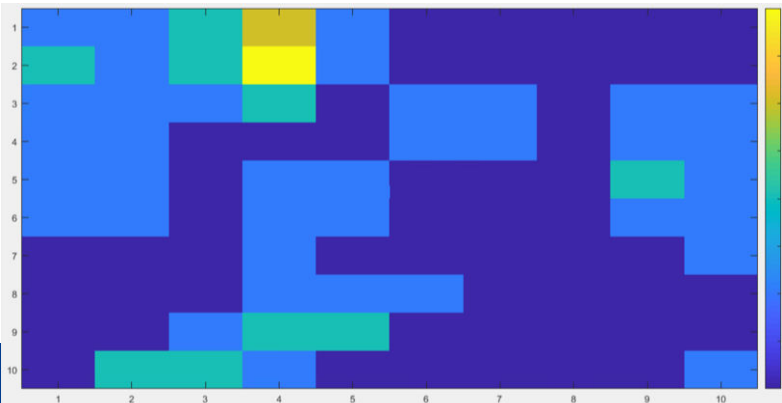
- **Fridge**



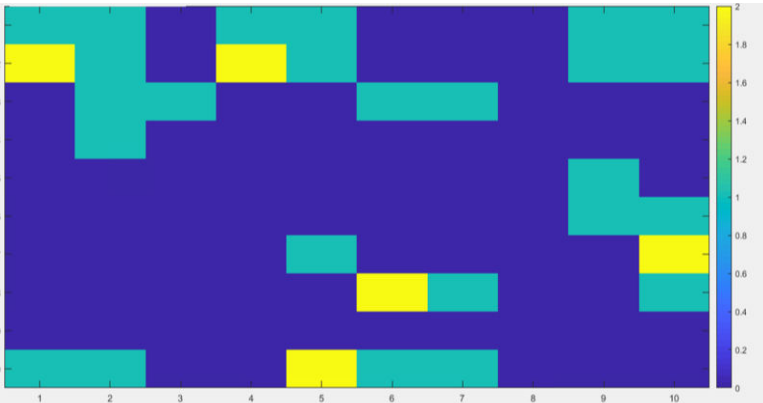
- **Freezer**



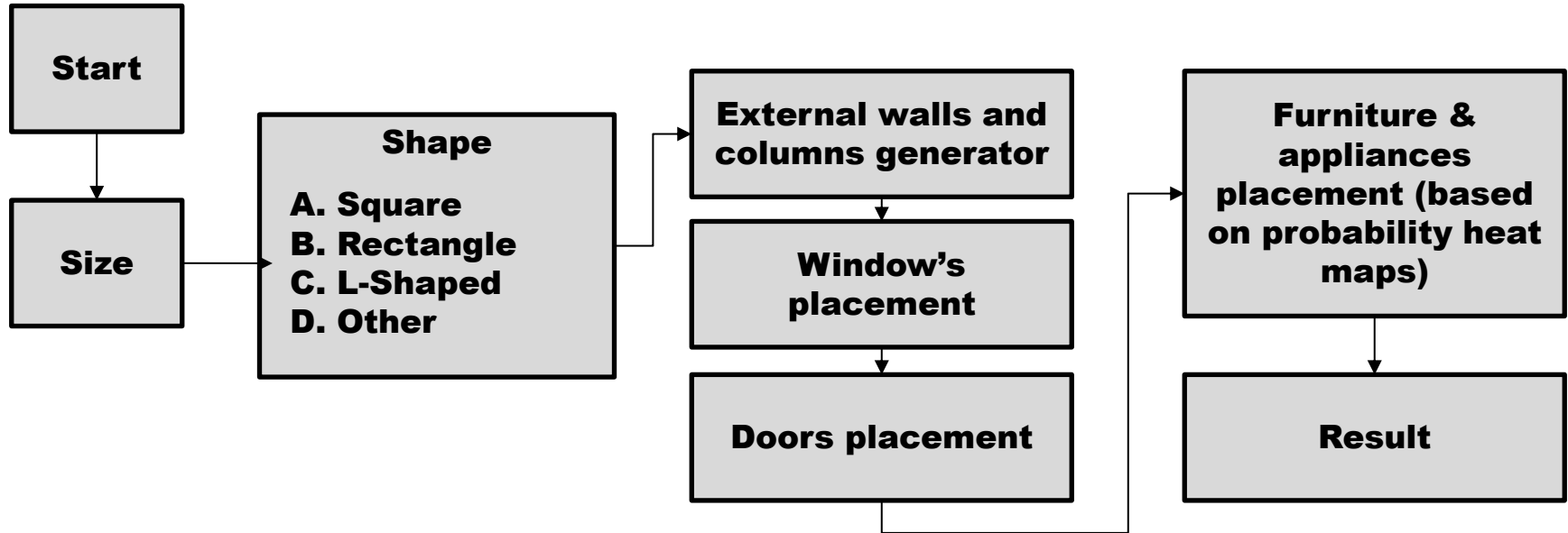
- **Cooker**



- **Built-in Oven**



Flow chart of the layout simulator



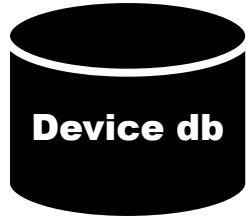
Layout simulator results sample

1. Fridge
2. Freezer
3. Cooker
4. Built-in Oven
5. Hob
6. Microwave
7. Espresso Machine
8. Kettle
9. Toaster
10. Blender
11. Exhaust
12. Sink
13. Dishwasher
14. Tumble Dryer
15. TV
16. Radio
17. Other

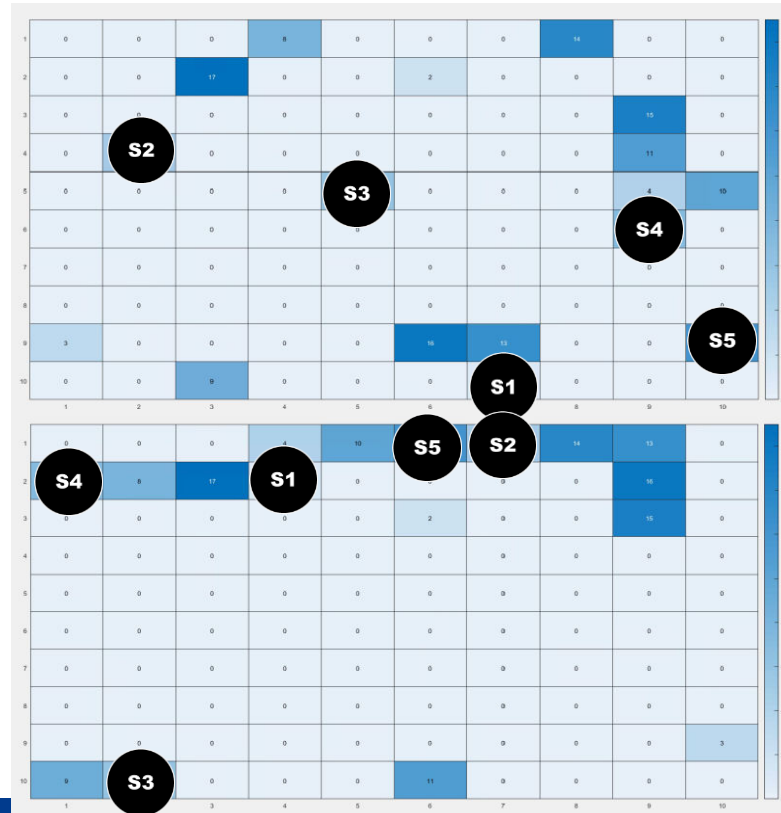
1	6	0	0	4	0	14	5	0	13	0
2	0	0	17	0	0	0	2	0	0	0
3	0	0	0	0	0	0	0	0	15	0
4	10	0	0	0	0	0	0	0	0	0
5	9	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	7
8	0	0	0	0	0	0	0	0	3	0
9	0	12	0	0	0	0	0	0	11	0
10	0	8	0	0	0	16	1	0	0	0
	1	2	3	4	5	6	7	8	9	10

Usability of the proposed solution

Layout Simulator

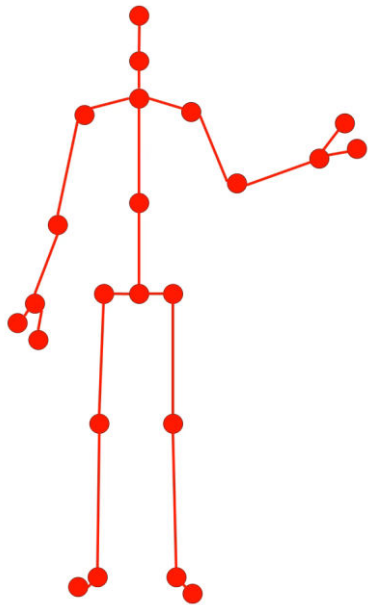


- Step 1. Fridge [1]
- Step 2. Hob [5]
- Step 3. Microwave [6]
- Step 4. Espresso Machine [7]
- Step 6. Sink [12]



Summary

- **Plug load and occupancy simulation based on an activity protocol**
- **Parametrical studies can highlight the spectrum of the best setup conditions**
- **Possibility to evaluate the cost of “bypassing” of the proposed scenario**
- **Extra information package for BIM platform**
- **Simplified process of geometry development for CFD studies.**



Thank you
谢谢

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