Data Analysis in Seahaven

What do we get?

EyesOnScreen

(X , Y)
(0.504079, 0.488009)
(0.503920, 0.488931)
(0.505352, 0.490330)
(0.505815, 0.491436)
...

EyeBoxPos

Positions

Validation

Heatmap3D

ViewedHouses

All this data is saved in .txt files with 30 entries per second.

What do we get?

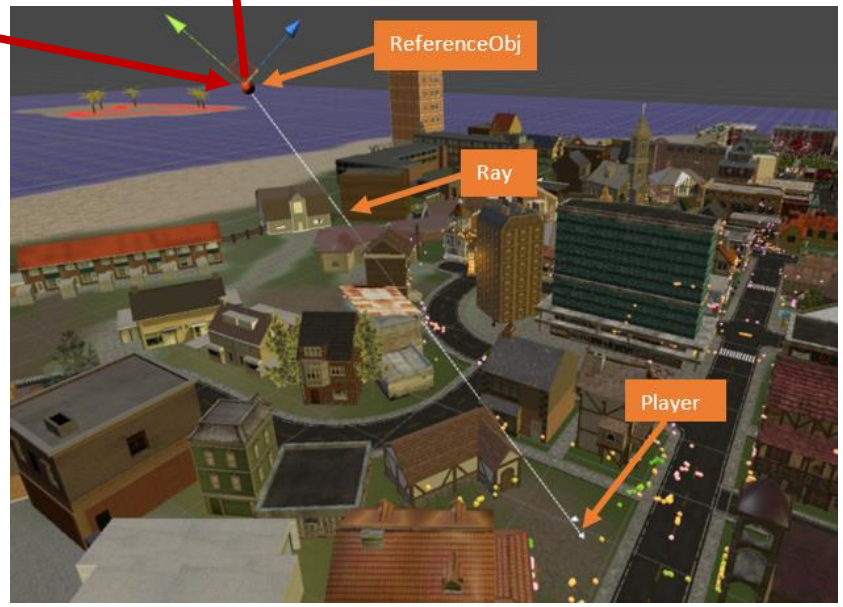
EyesOnScreen

EyeBoxPos

Positions

Validation

```
(      X      ,      Y      ,      Z      )
(307.892700, -19.235950, 675.491500)
(307.964100, -19.343940, 675.361300)
(307.890800, -19.092730, 675.454800)
(307.779800, -18.457430, 675.508800)
 ...
```



Heatmap3D

ViewedHouses

What do we get?

EyesOnScreen

Heatmap3D

EyeBoxPos

Positions

X	Y	Z	Rx	Ry	Rz	t(s)	Pupil-t
454.87,	2.21,	735.00,	7.02,	247.70,	1.52,	0.00,	1657907
454.87,	2.22,	735.00,	7.12,	247.66,	1.52,	0.03,	1657907
454.87,	2.22,	735.00,	7.11,	247.62,	1.49,	0.07,	1657907
454.87,	2.22,	735.00,	6.94,	247.63,	1.44,	0.10,	1657907

ViewedHouses

Validation

All this data is saved in .txt files with 30 entries per second.

What do we get?

EyesOnScreen

EyeBoxPos

Positions

Validation

0.2783625
0.7631016
0.7335538
1.445639
1.212246
1.700423
1.245212
1.160958
1.068262

Error per point

(-0.3, 4.1)
(14.3, -36.9)
(-2.4, -4.0)
(-1.7, -3.7)
(-1.4, -8.7)
(0.4, -1.8)
(0.6, 2.2)
(-2.6, -20.2)
(5.1, -1.8)

Error in X and Y direction

Heatmap3D

ViewedHouses

Average 2D Validation:
1.067529 Average error
4.545701 Time (min)
4.489803 Time of last Calibration (min)

0.5899802 Average error in X direction
-4.424825 Average error in Y direction

All this data is saved in .txt files with 30 entries per second.

What do we get?

EyesOnScreen

EyeBoxPos

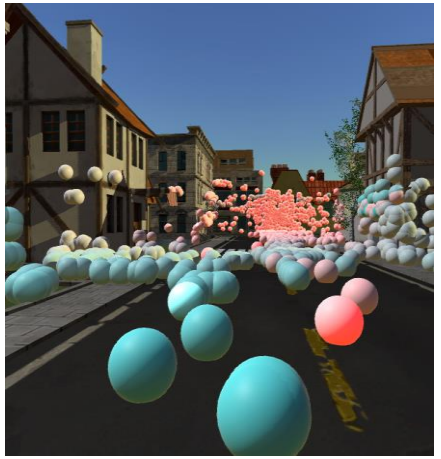
Positions

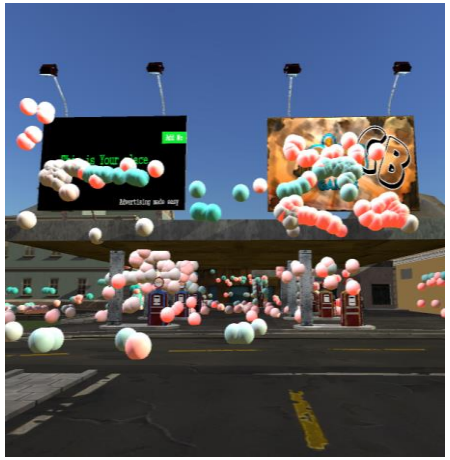
Validation

DrawViewingPath

Heatmap3D

ViewedHouses





All this data is saved in .txt files with 30 entries per second.

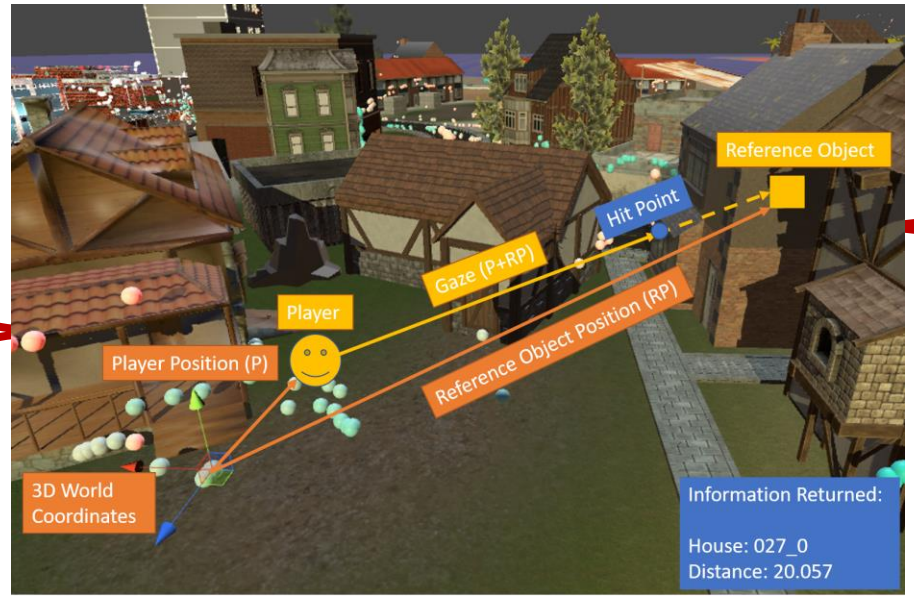
What do we get?

EyesOnScreen

EyeBoxPos

Positions

Validation



(X , Y , Distance)
(0.504079, 0.488009, 13.504640)
(0.503920, 0.488931, 13.504850)
(0.505352, 0.490330, 13.663930)
(0.505815, 0.491436, 14.083620)
...

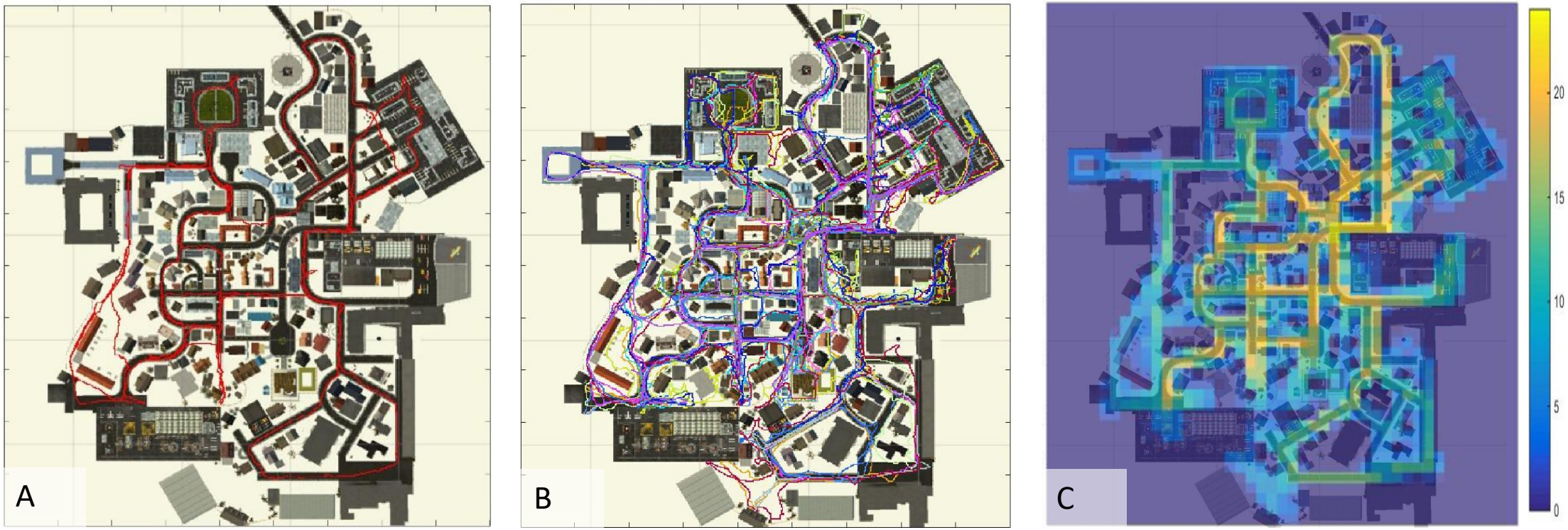
Heatmap3D

ViewedHouses

House, Distance, Timestamp
NH,13.50464, 1657907
NH,13.50485, 1657907
NH,13.66393, 1657907
NH,14.08362, 1657907
...

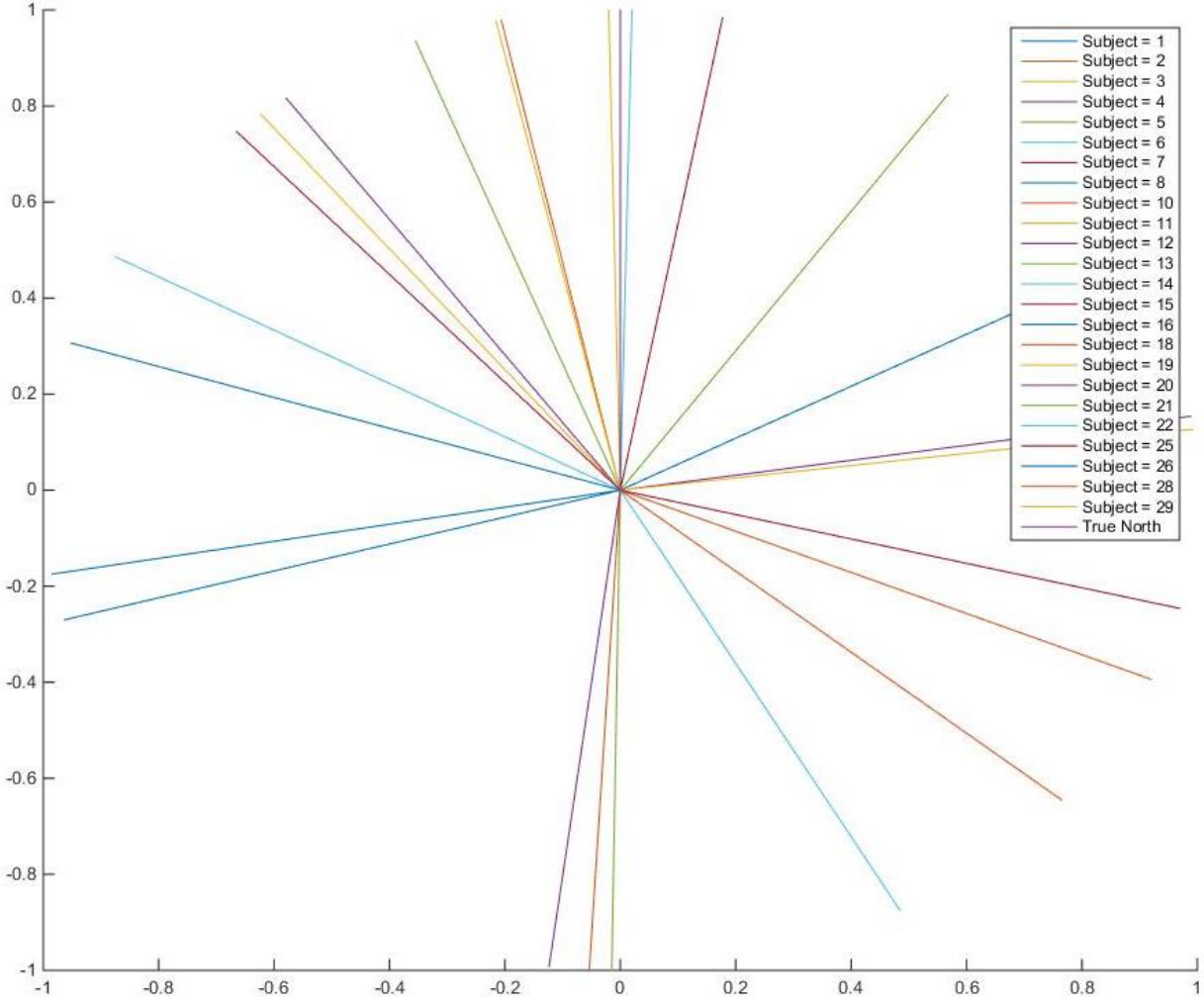
The Analysis

Position



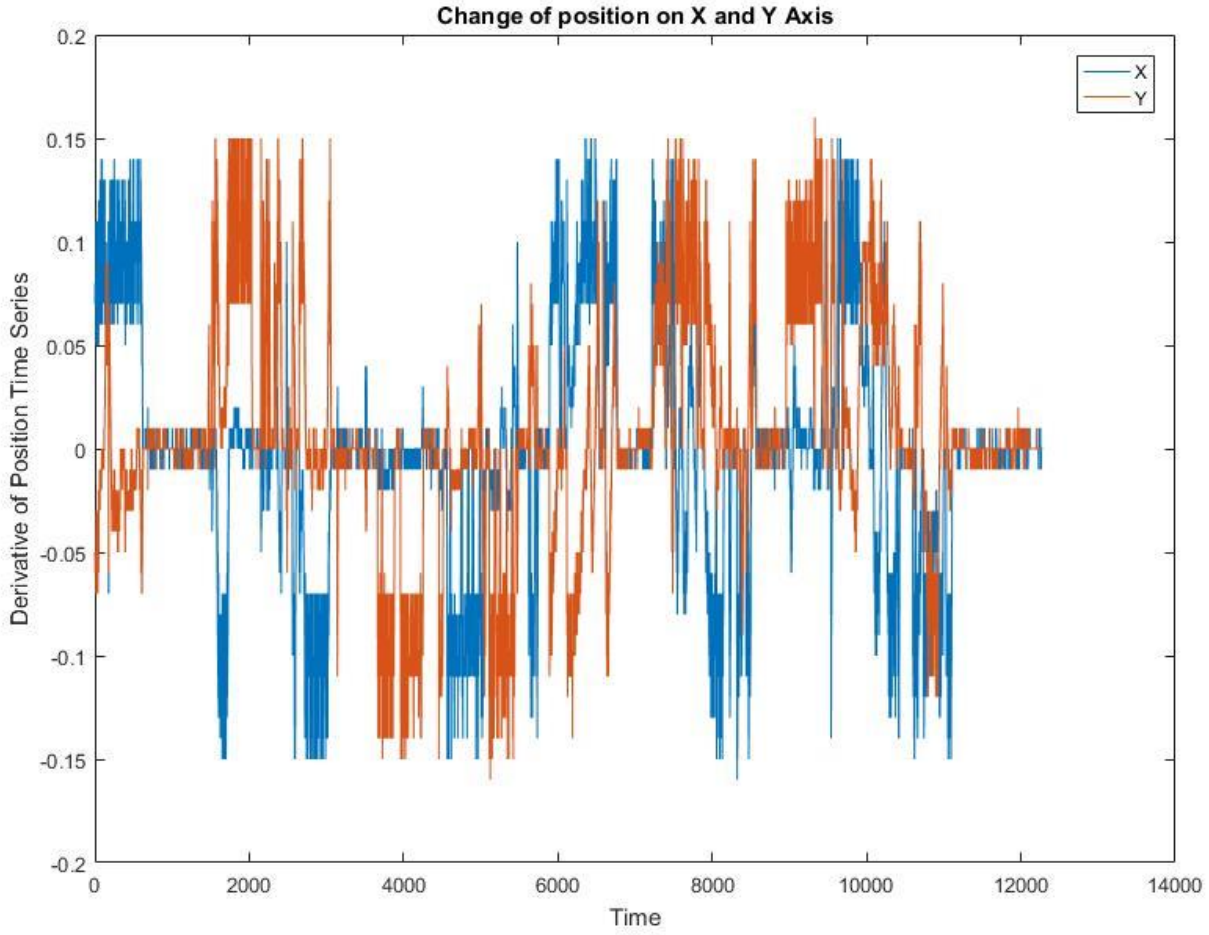
(A) Map of a single subject's walking path during a 30-minute session. (B) Map with walking path of 17 subjects. (C) Number of subjects that visited a certain area of the city.

Position/Rotation



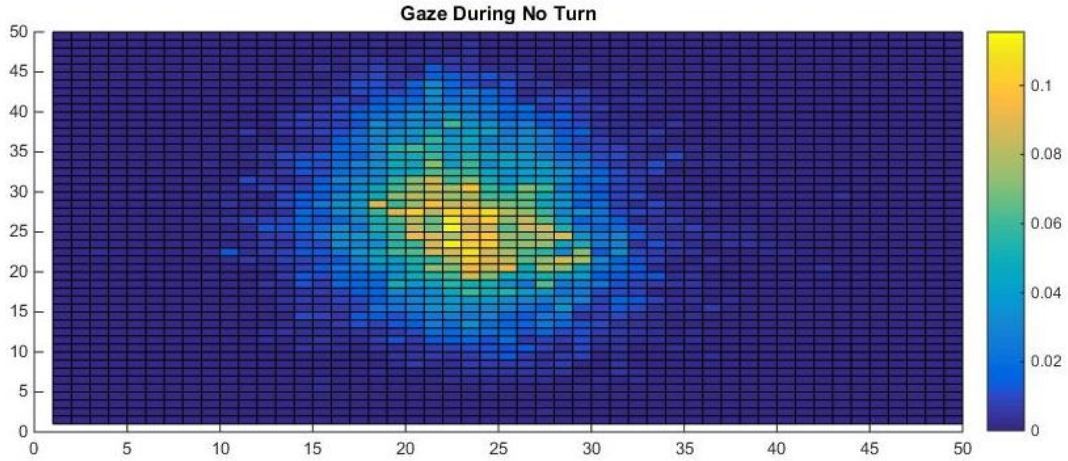
From the subjects rotation we can deduce where it thinks north is. We can also color the map according to rotation.

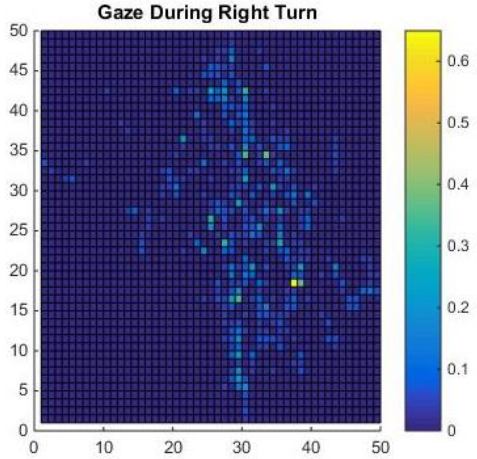
Position/Rotation

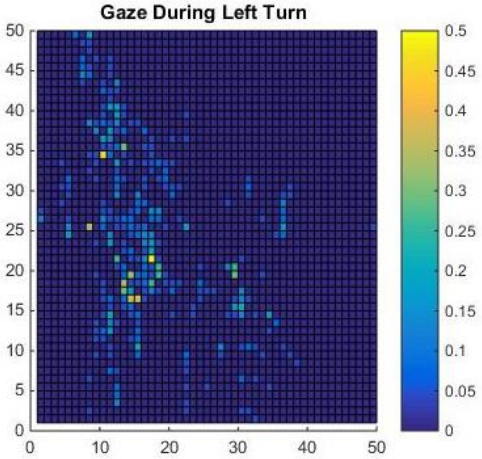


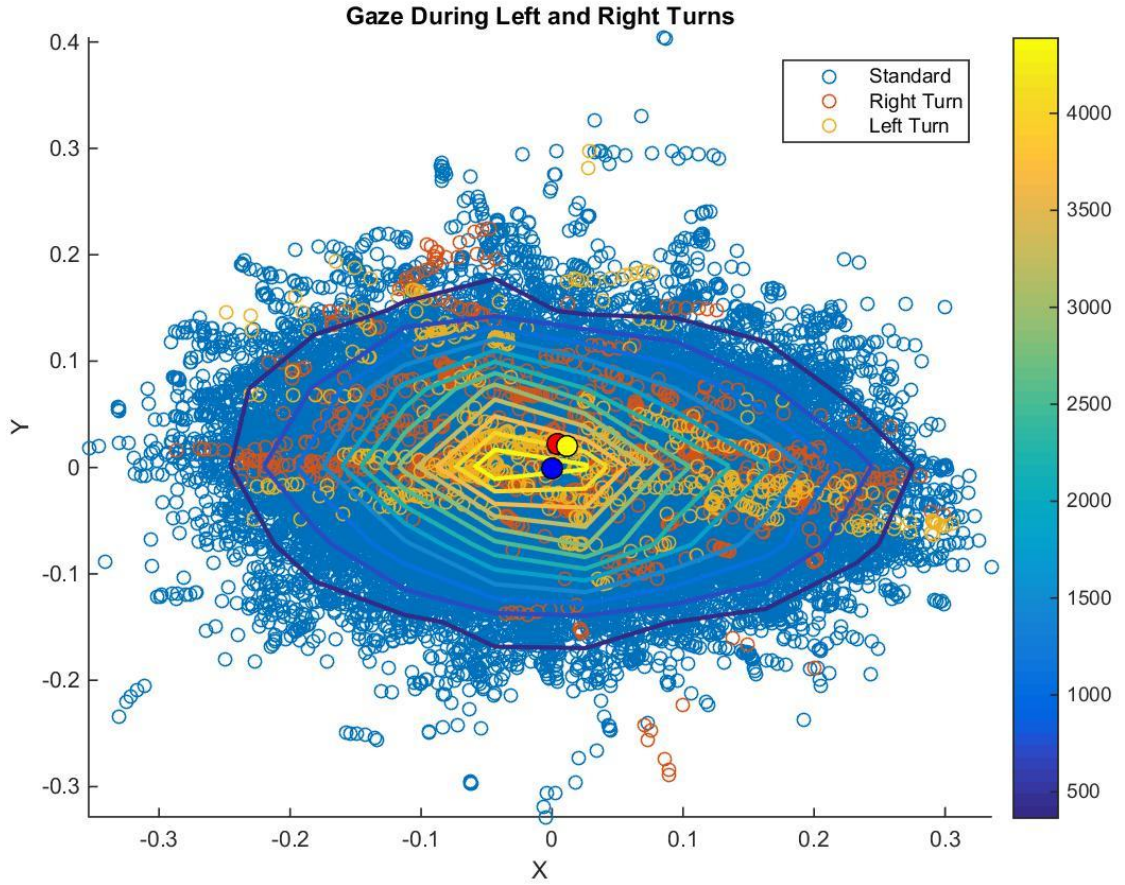
We can also look at the change in X and Y direction over time. However, I'm not sure if this is very interesting.

EyesOnScreen & Position



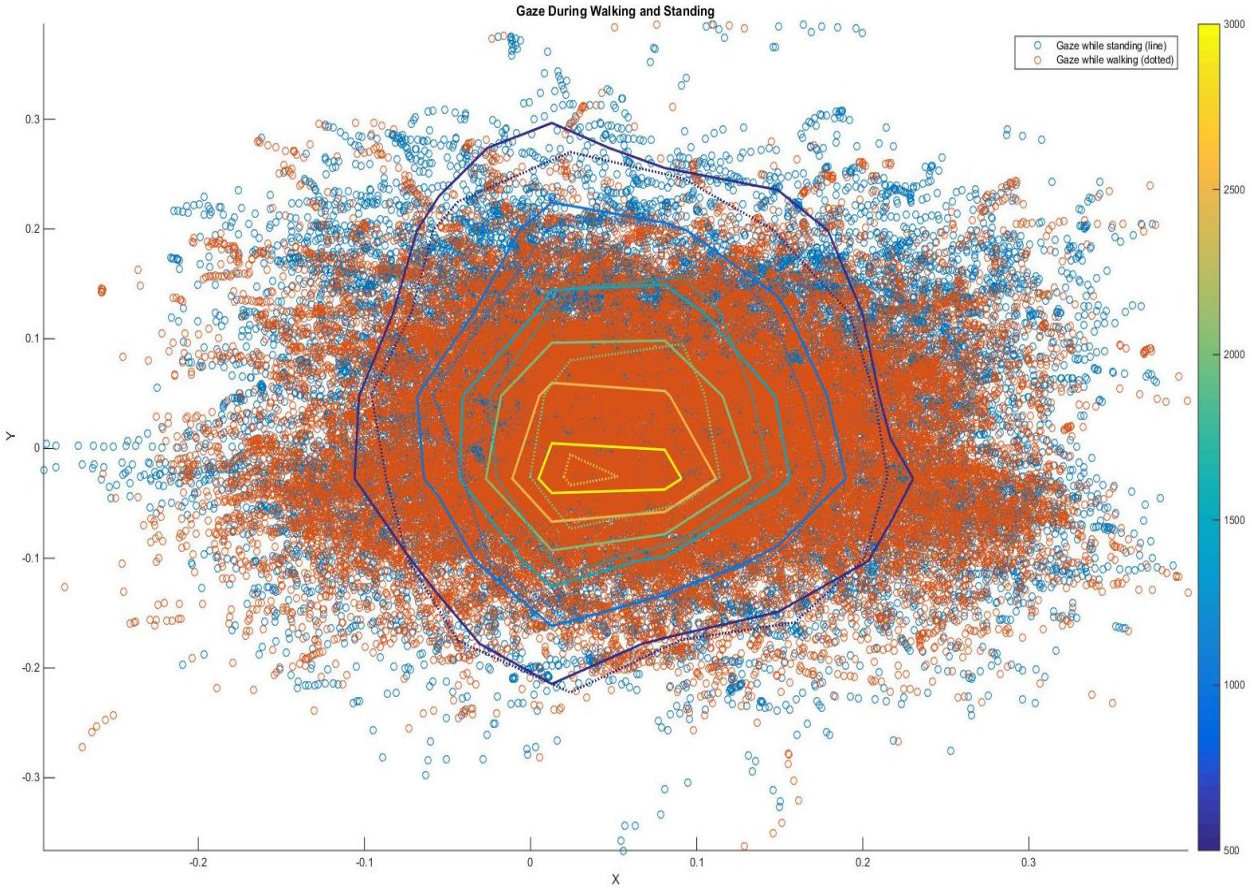


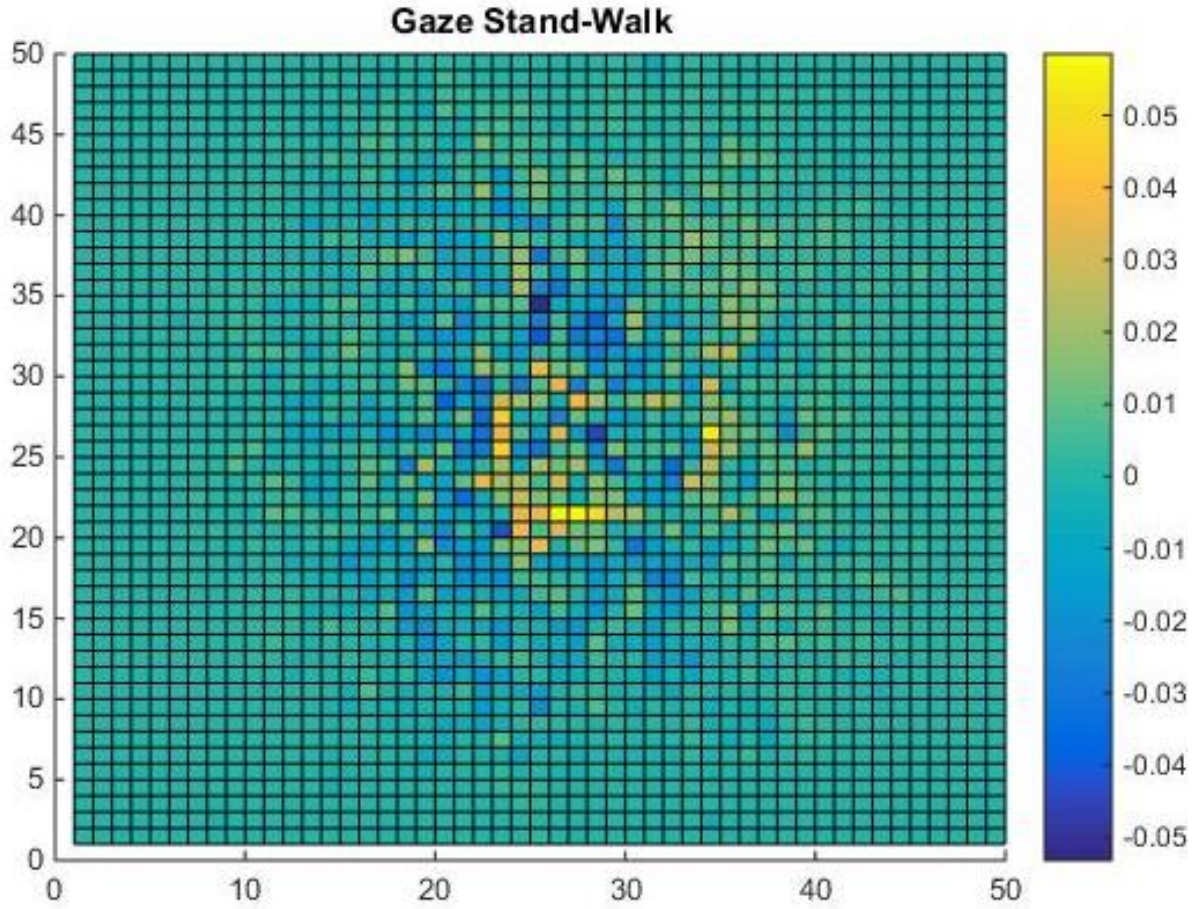




Gazes depending on other factors like player movements can be visualized. In this case we compare gazes during turns to no turns. The graphic on the left is the newest version.

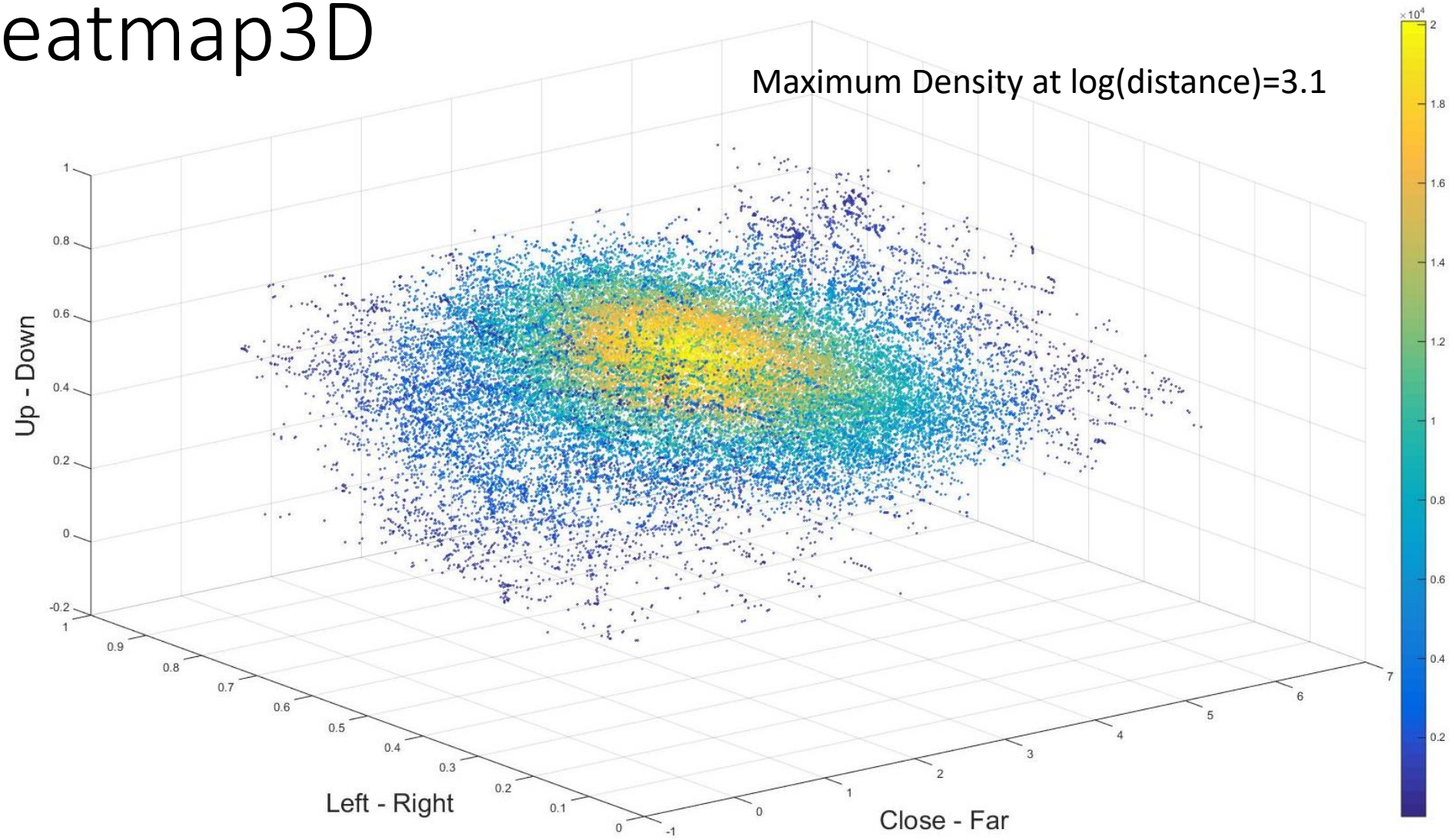
EyesOnScreen & Position





Gazes depending on other factors like player movements can be visualized. In this case we compare gazes during standing to gazes during walking. It seems like there is a higher density of gaze in the center while standing.

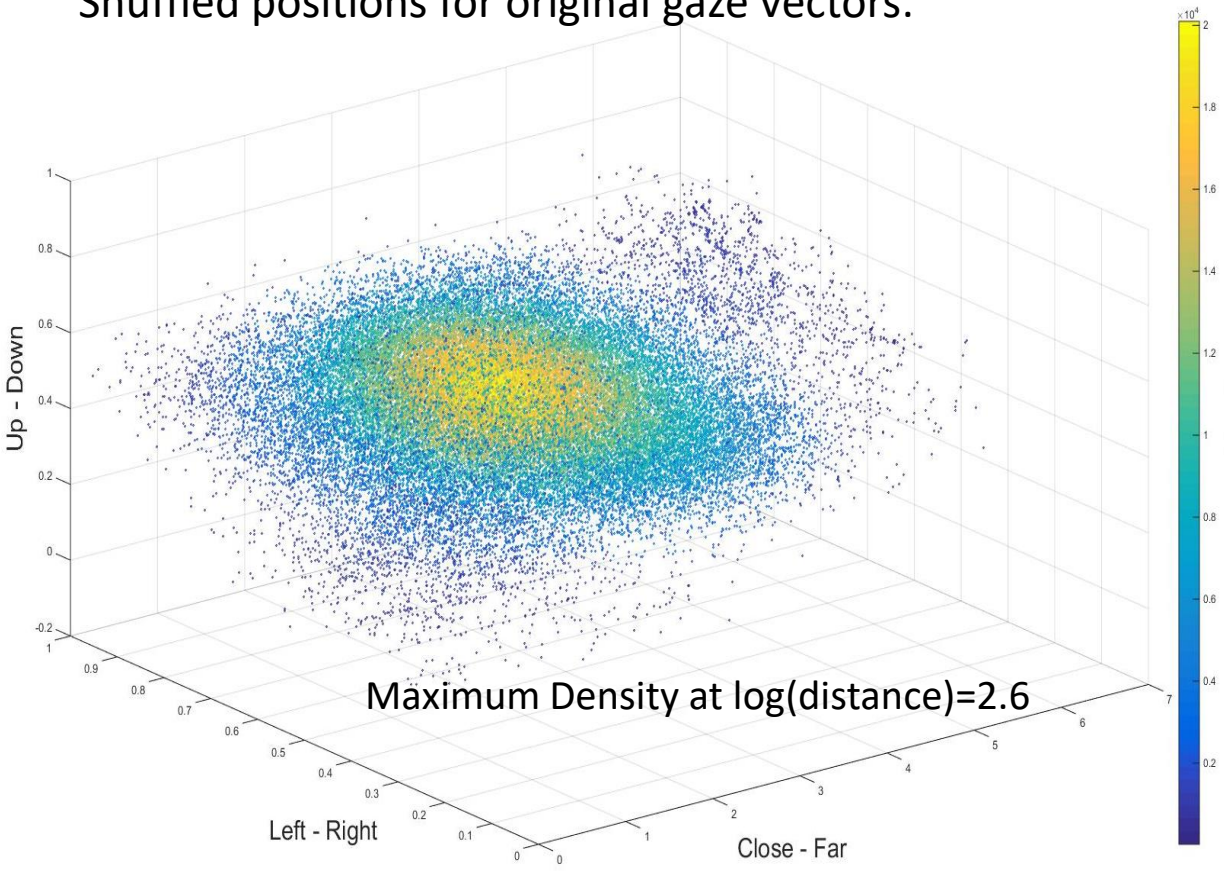
Heatmap3D



Since we can calculate the distance of each hit point we can add a third dimension to our heatmaps.

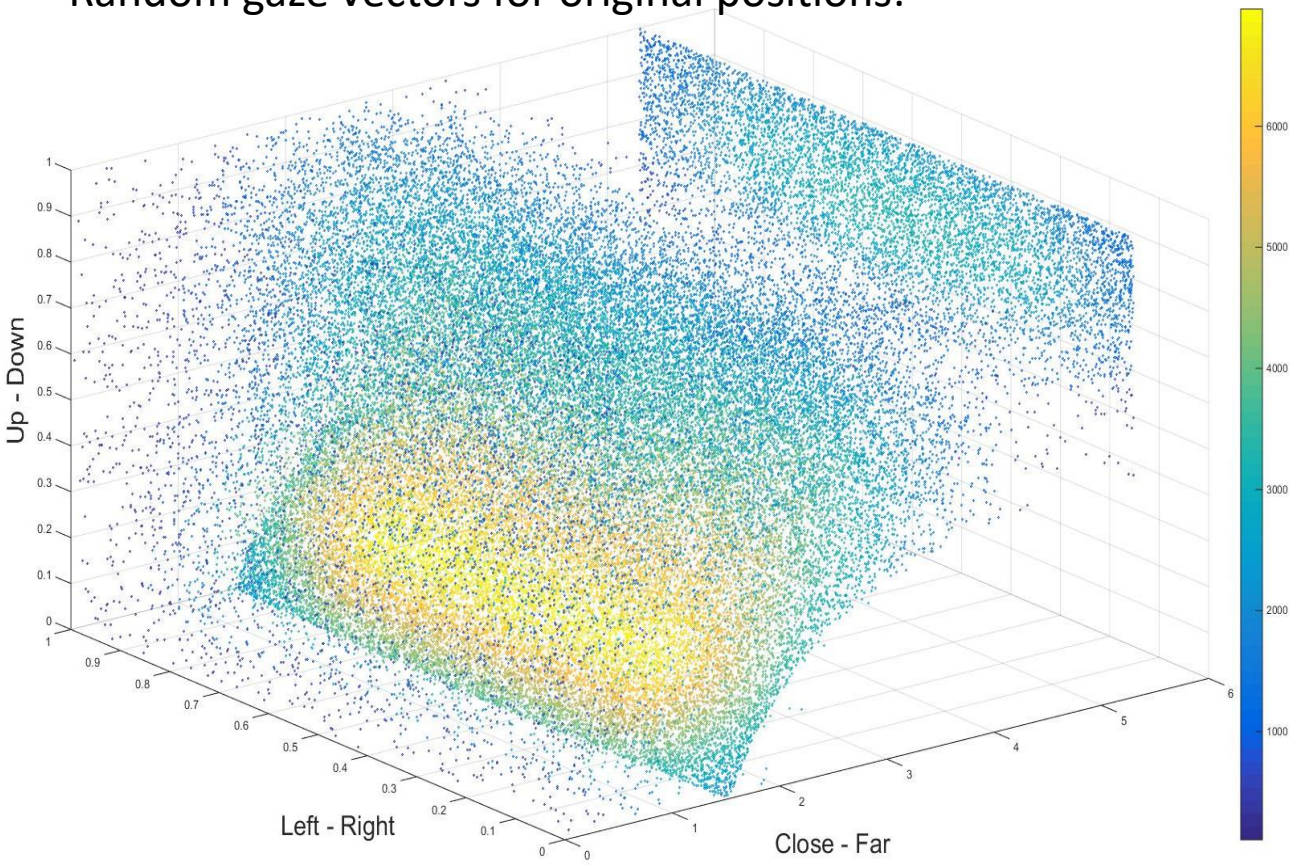
Heatmap3D

Shuffled positions for original gaze vectors:



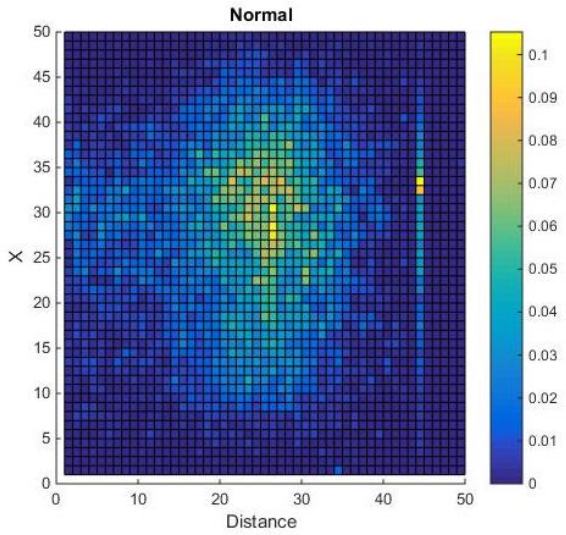
Maximum Density at log(distance)=2.6

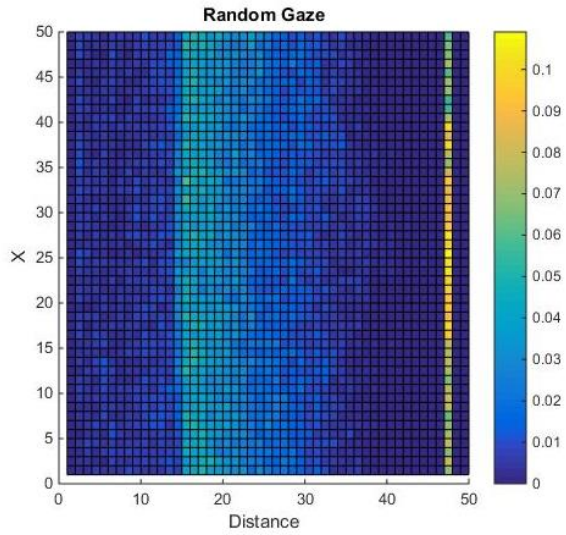
Random gaze vectors for original positions:

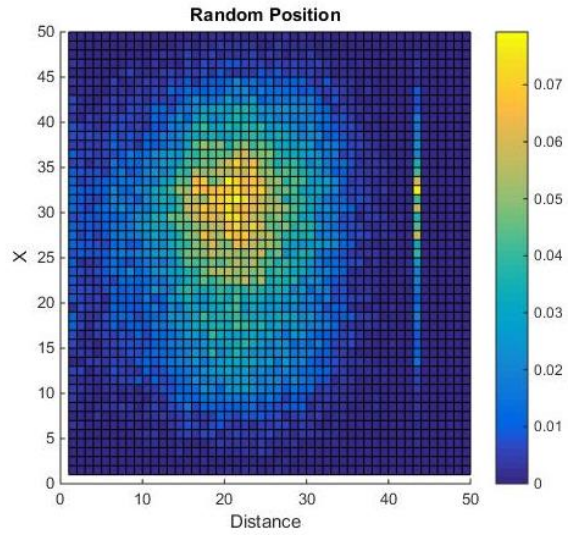


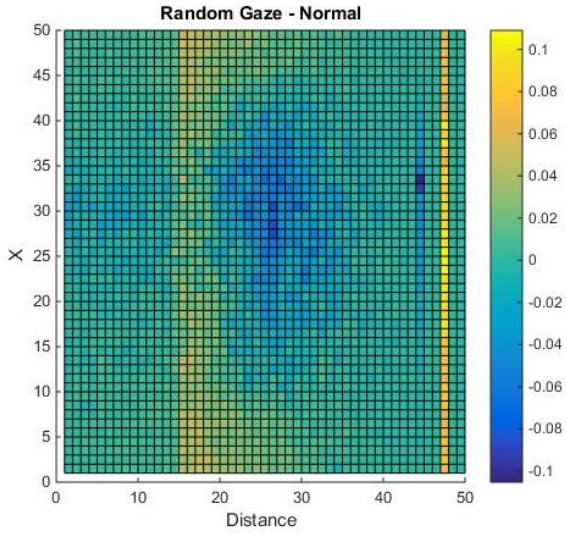
Maximum Density at log(distance)=2.9

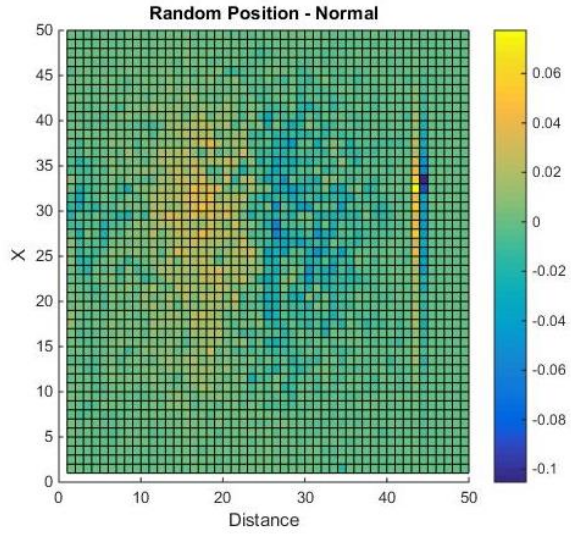
To check of patterns come from human behavior or properties of the environment we can perform some randomizations.







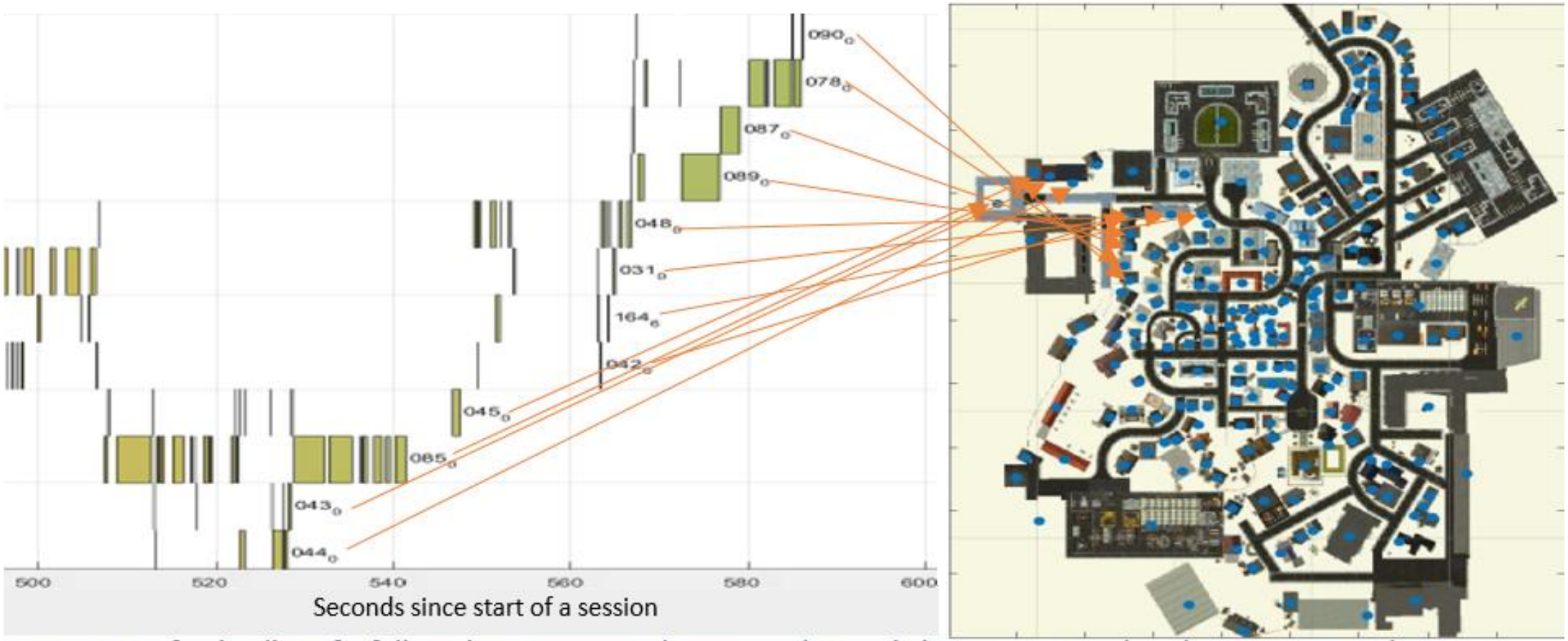




Heatmap3D

We can now compare the original heatmap to the randomized heatmaps. We see that this subject look systematically at objects which are further away then when shuffling the gazes.

Viewed Houses



Excerpt out of a timeline of a full session. Represents houses on the x-Axis (Names are numbers between 001 and 200 + a rotation of 0, 3 or 6). Yellow blocks represent timespans during which a certain house was looked at. Orange arrows point to the house on the map.

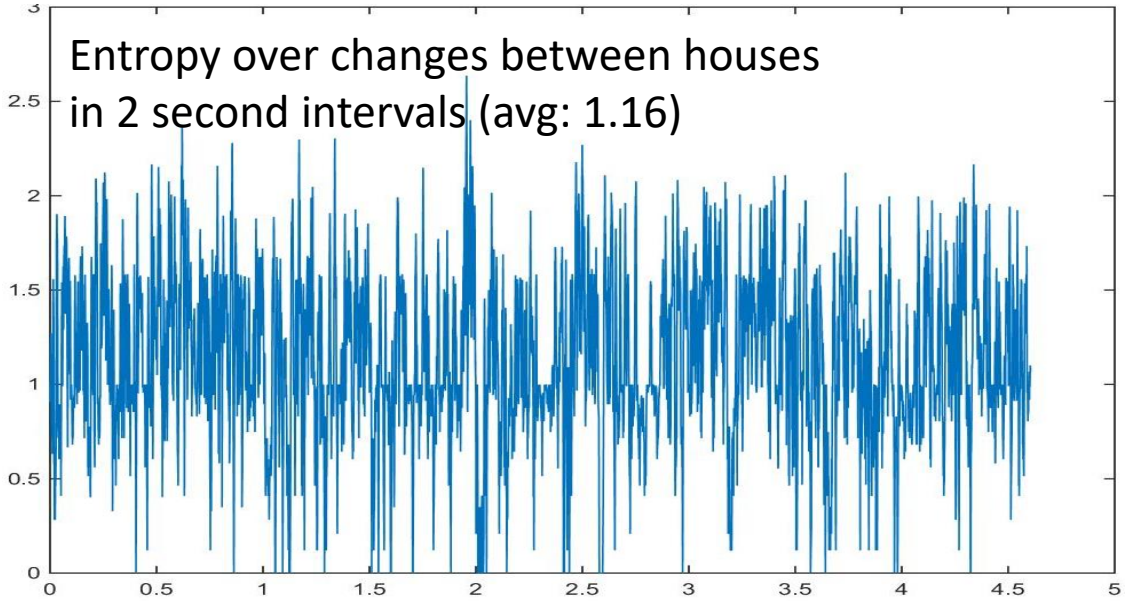
The timeline shows blocks during which a certain house was looked at. It is so far just for visualization.

Viewed Houses

House	occ	DistanceMean	DistanceVariance	numVP	avgocc
'NH'	1.0506e+03	43.6632	4.3181e+03	2	525.3000
'015_0'	50.8000	49.6500	12.5102	2	25.4000
'033_0'	27.5667	28.7937	137.2446	2	13.7833
'021_0_1'	26.1000	9.9431	105.1935	2	13.0500
'085_0'	24.5667	75.4482	1.5449e+03	2	12.2833
'151_6'	21.1000	50.5136	273.3877	2	10.5500
'069_0'	20.5000	70.8927	707.7118	2	10.2500
'201_3'	20.4000	16.2846	172.6649	2	10.2000
'022_0'	18.0333	55.5778	1.2693e+03	2	9.0167
'023_0'	15.3333	30.0583	430.2063	2	7.6667
'086_0'	15.1000	17.5815	192.5201	2	7.5500
'175_6'	15.0333	132.4353	2.9087e+03	2	7.5167
'066_0'	14.6667	23.4602	45.4449	2	7.3333
'081_0'	14.5667	77.5480	4.6259e+03	2	7.2833
'059_0'	13.7000	18.9837	319.5052	2	6.8500

(in this case over 2 subjects)

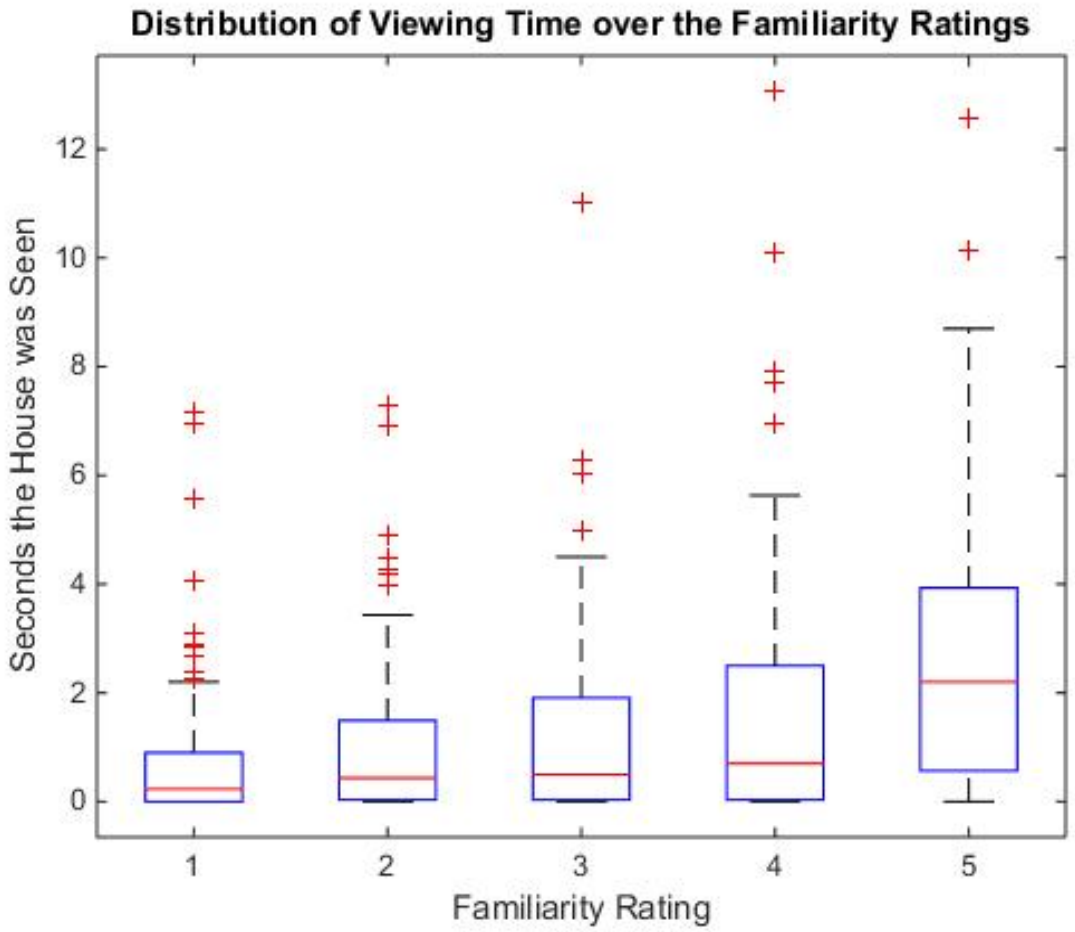
	1 VP3755	2 VP6876	3 Overall
1 NumHousesSeen	170	198	184
2 PercentHousesSeen	0.7944	0.9252	0.8598
3 AverageTimeLookedAtOneHouse (s)	6.4249	5.5163	5.5334
4 TimeLookedAtHouses (min)	18.2039	18.2039	18.9058



We get statistics over all houses and all subjects. Occ gives the number of seconds a house was looked at overall

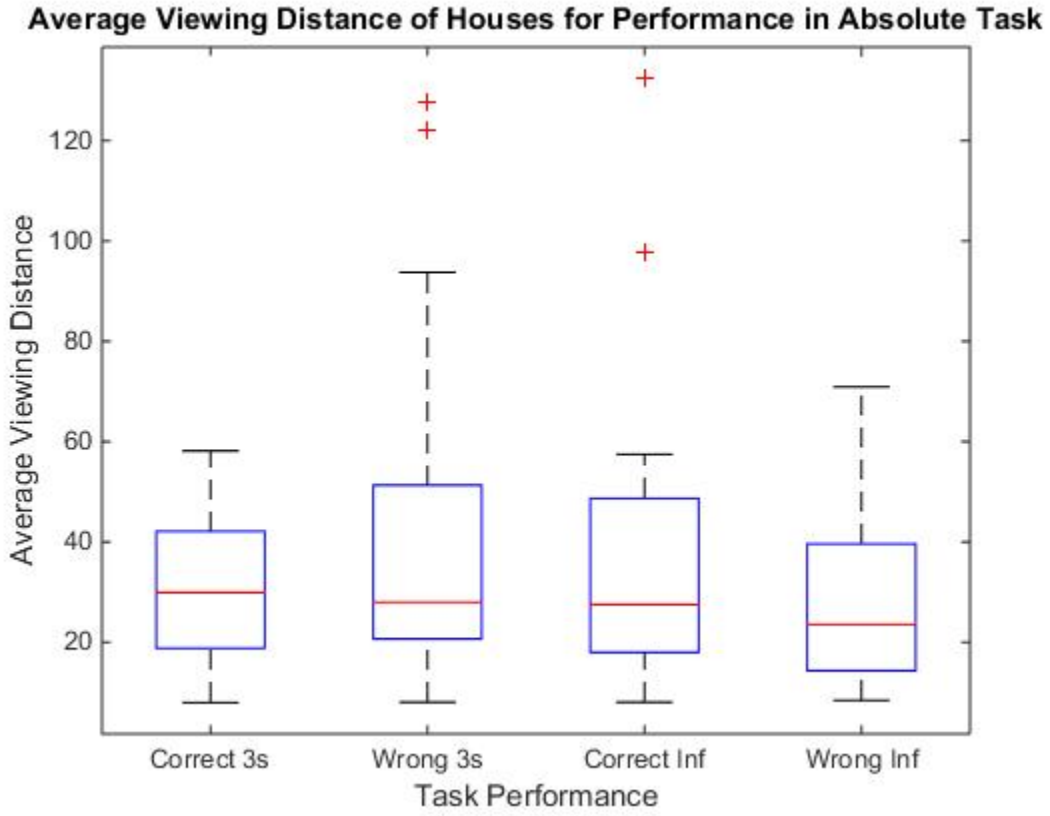
Viewed Houses – Task Performance

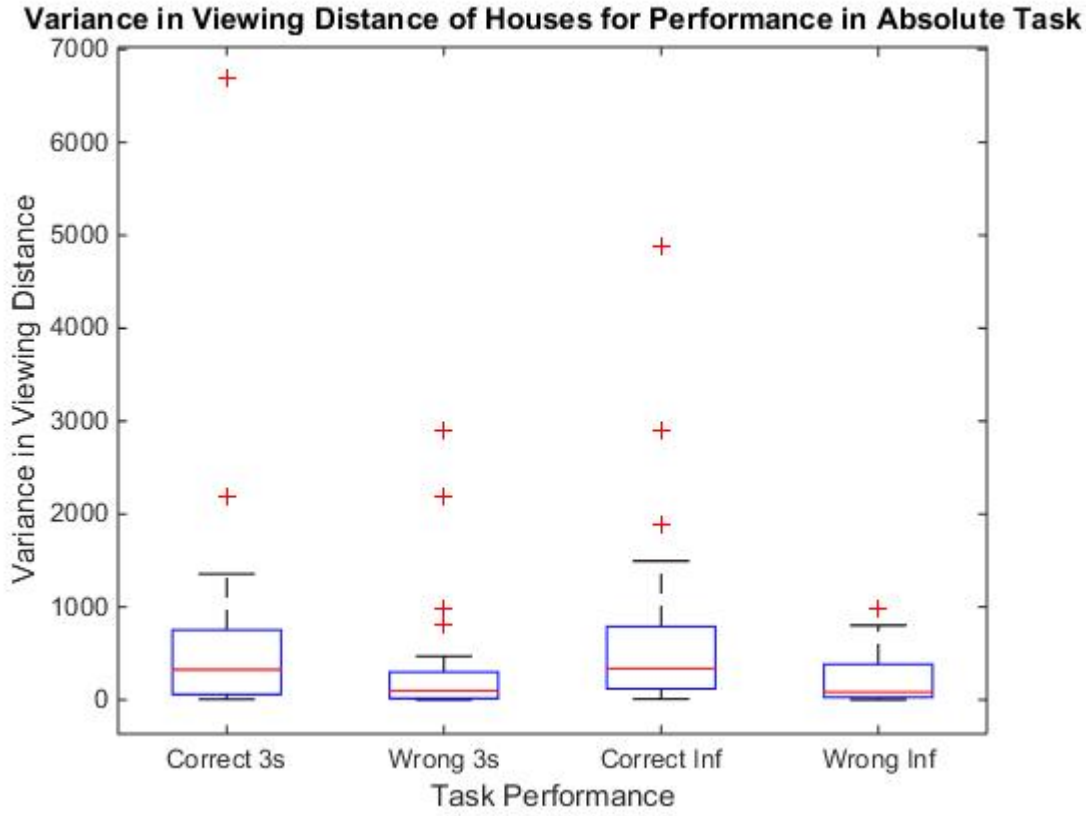
How should we analyze the other two tasks?



The viewed houses info can then be used to analyze the task performance. The pilot study has shown that the longer a house was seen, the more familiar it gets rated.

Viewed Houses – Task Performance



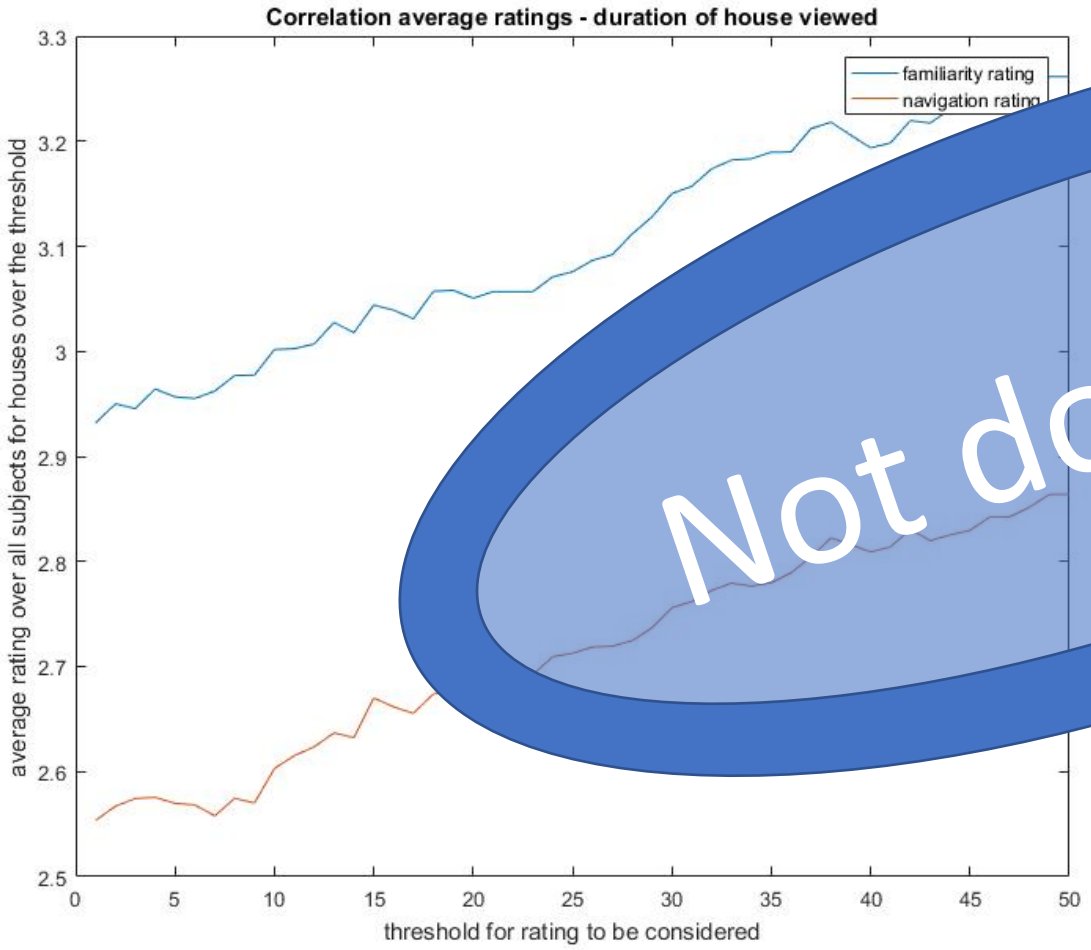


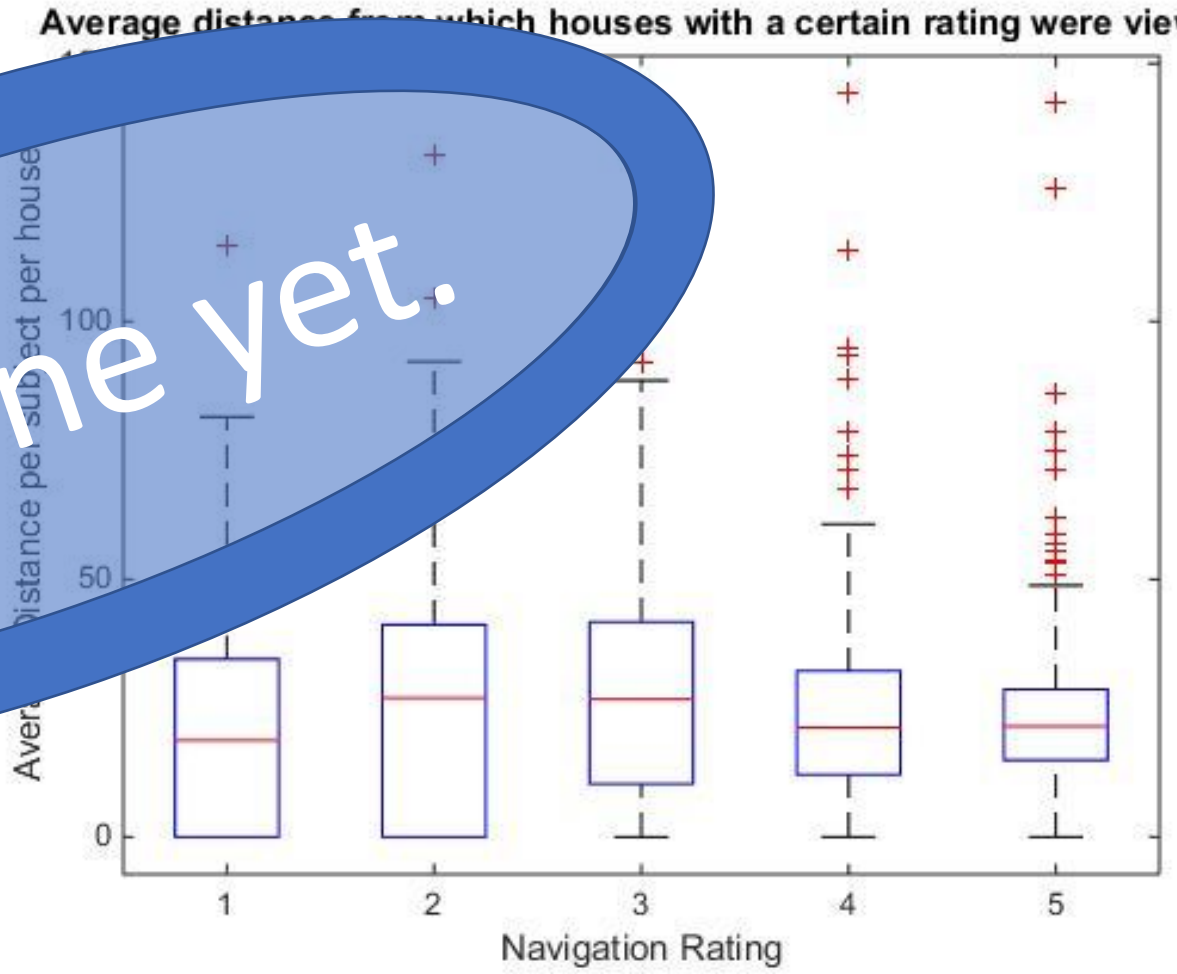
The pilot study has shown that the distance from which a house was seen as well as the variance in distance doesn't significantly influence the familiarity or navigation rating.

Walk-Stand Ratio – Task Performance

(Only for 2 subjects, not really plottable)

Entropy, Spatial Bias, Head/Controller Ratio – Task Performance





Not done yet.

Further ideas are there but not implemented yet. Do you have more ideas?

Validation

OverallMeanPoints	OverallMeanSubjects	OverallVariancePoints
2.7661	4.7026	12.8091

		SujStats1	SujStats2
1	Subject Number	3755	6876
2	Average of Subject Means	3.3226	2.2944
3	Average of all Data Points	5.5872	3.8179
4	Variance in Data Points	15.4392	10.3147

Research Question(s)

- How do people visually explore three dimensional environments?
- How is visual exploration related to spatial navigation?

Hypotheses

1) Similar to looking at 2D stimuli, people have a fixation bias towards the center of the visual field and for a medium distance.
   - 3D Heatmap + randomizations

2) Head turns are preceded by eye movements to the periphery.
   - Colored walking path by variance in gaze direction -> Turns at cross roads
   - Average gazes before head turns

3) There is more explorative gaze behavior during walking than during standing
   - Divide gaze data into walking and standing and compare gaze eccentricity

Hypotheses

4) Increase visual exploration benefits spatial navigation.

a) Task performance is better for houses that were looked at for a longer amount of time.

- Correlate time looked at house with task performance

b) Task performance is better for houses that were looked at from different distances (bigger variance in distance).

- Correlate variance in distance house was looked at with task performance

c) People with wider spatial bias and more changes in depth of fixated objects have better spatial task performance.

- Calculate spatial bias
- Calculate eccentricity of spatial bias and correlate with task performance
- Separate head and eye movements, Fourier transform -> power spectrum

Hypotheses

d) Task performance is better if the subject often switched gaze between houses (-> learned the relation between them better)

- Take time interval, add up frames different houses were looked at, calculate entropy of probability distribution

e) The more subjects walked in the city the better is their overall task performance

- To measure amount of walking we take the split of gaze data into walking and standing mentioned above and calculate the relation. Overall measurement of task performance needs to be decided.

f) Subjects with a higher ratio of head movements compared to walking via controller have a better allocentric representation of Seahaven

- Calculate ratio of head to controller movements, correlate relation with allocentric task performance

Seahaven – Analysis Pipeline

8.2.2018
Viviane Kakerbeck