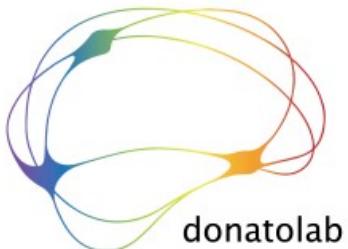


# Donato Lab - Block course

## Day 2, 24.05.2022

### Introduction

- 1-Photon imaging, the miniscope
- Animal recording and tracking in open arena
- Combining neuronal events with behavior
- Processing raw data with Matlab to find Place Cells



# Donato Lab - Block course

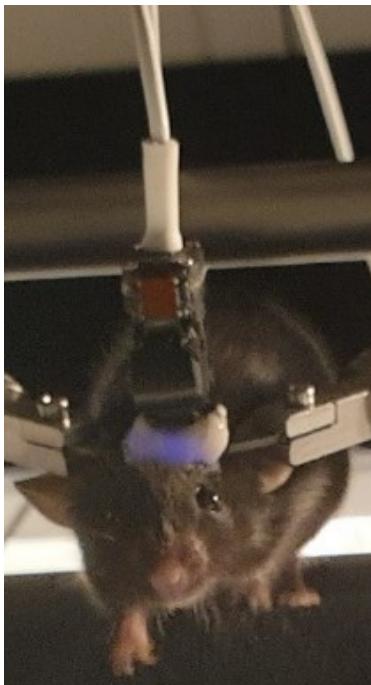
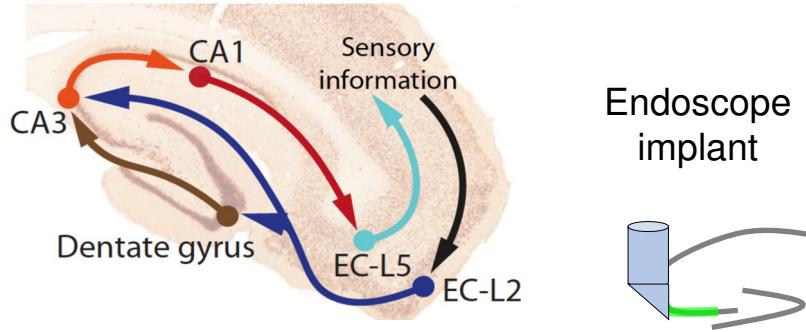
## Day 2, 24.05.2022

### Practical

- Matlab basics
- Breaking down raw data
- Tidying up the data
- Aligning behavior and neuronal data



# 1 Photon imaging, the miniscope



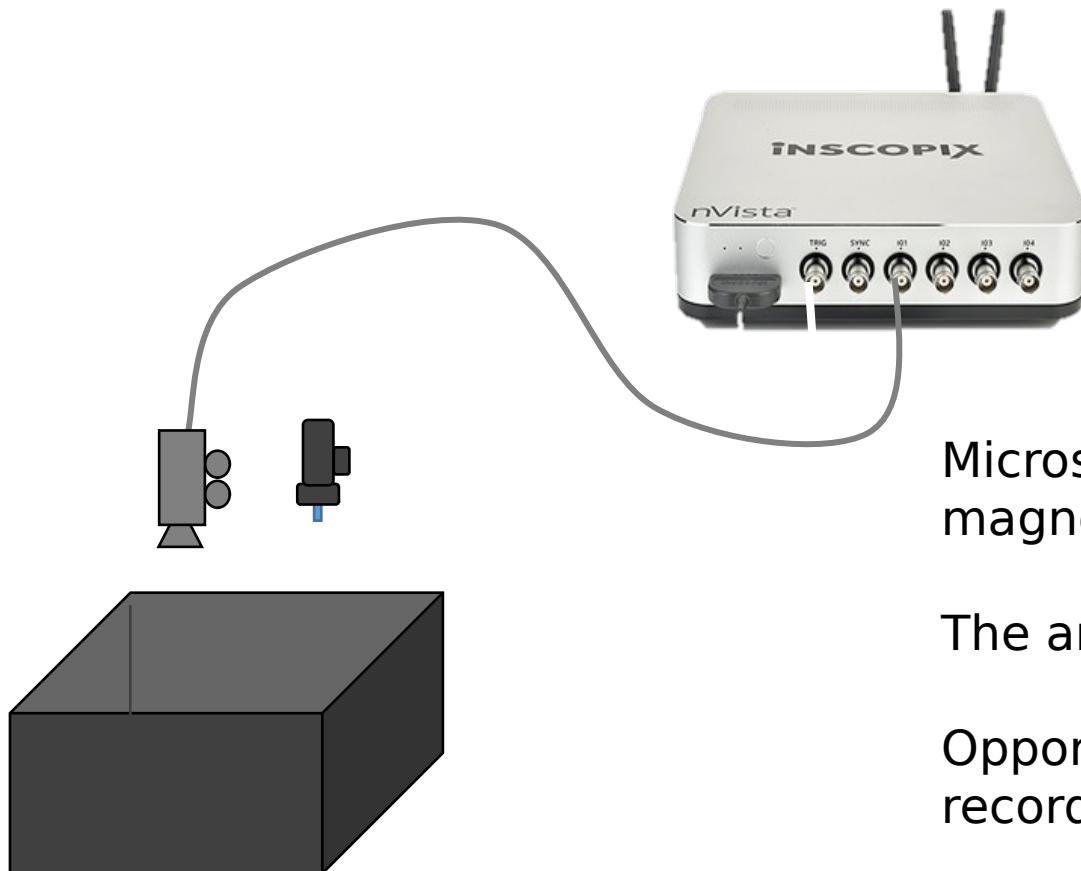
Microscope the size of a thumb attached onto a magnetic plate

The animal has the opportunity to freely move

Opportunity for 2 dimensional behavior during neuronal recording

Data acquisition box ensures synchronization of behavioral video recording  
miniscope neuronal recording  
other experimental controller or readouts

# 1 Photon imaging, the miniscope



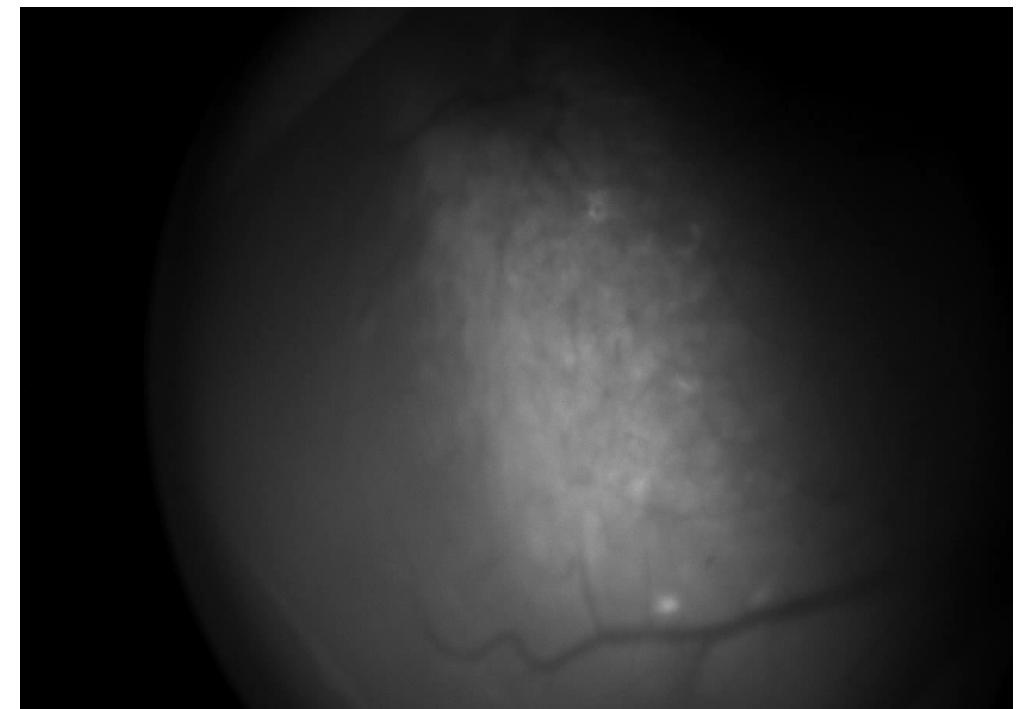
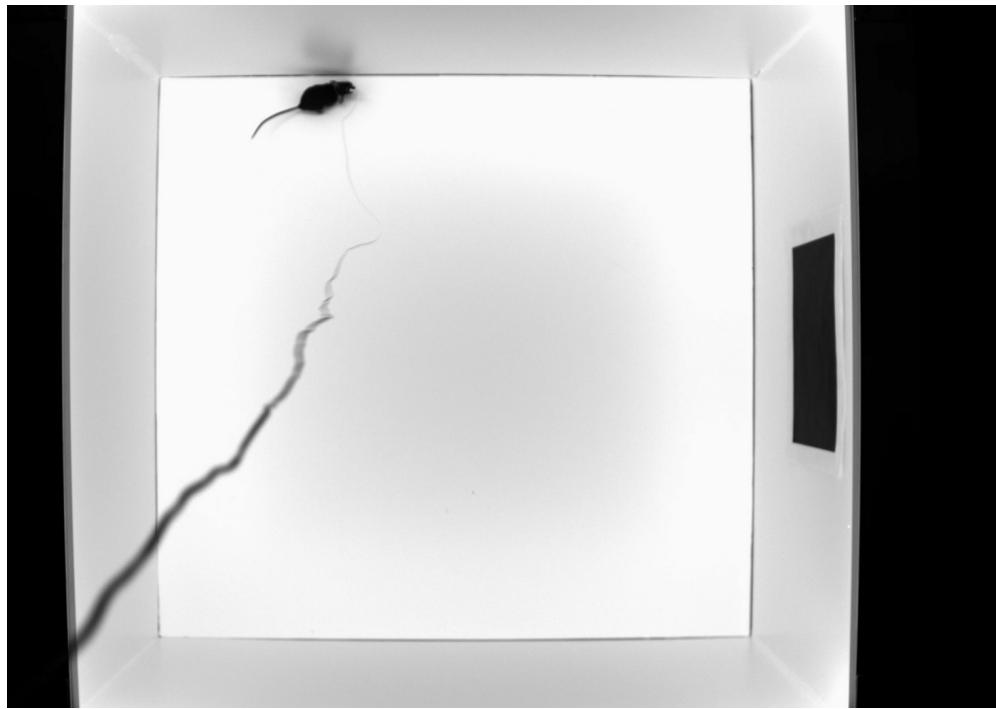
Microscope the size of a thumb attached onto an magnetic plate

The animal has the opportunity to freely move

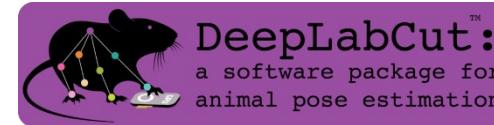
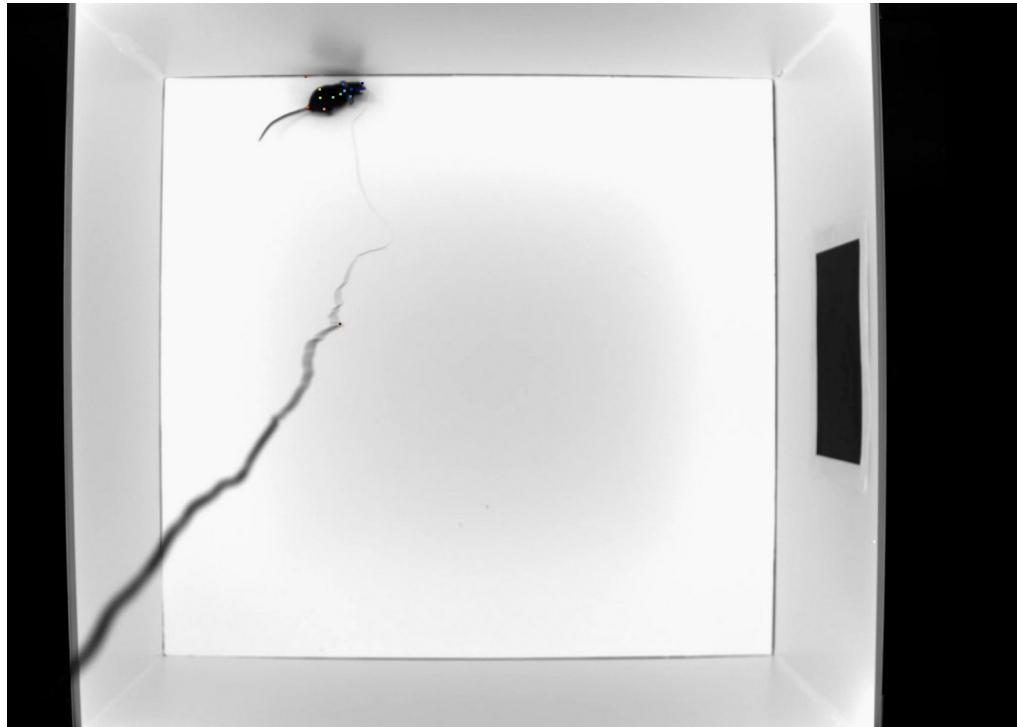
Opportunity for 2 dimensional behavior during neuronal recording

Data acquisition box ensures synchronization of behavioral video recording  
miniscope neuronal recording  
other experimental controller or readouts

# 1 Photon imaging, the miniscope



# Animal recording and tracking in open arena



Deep computational neuronal network for body part tracking

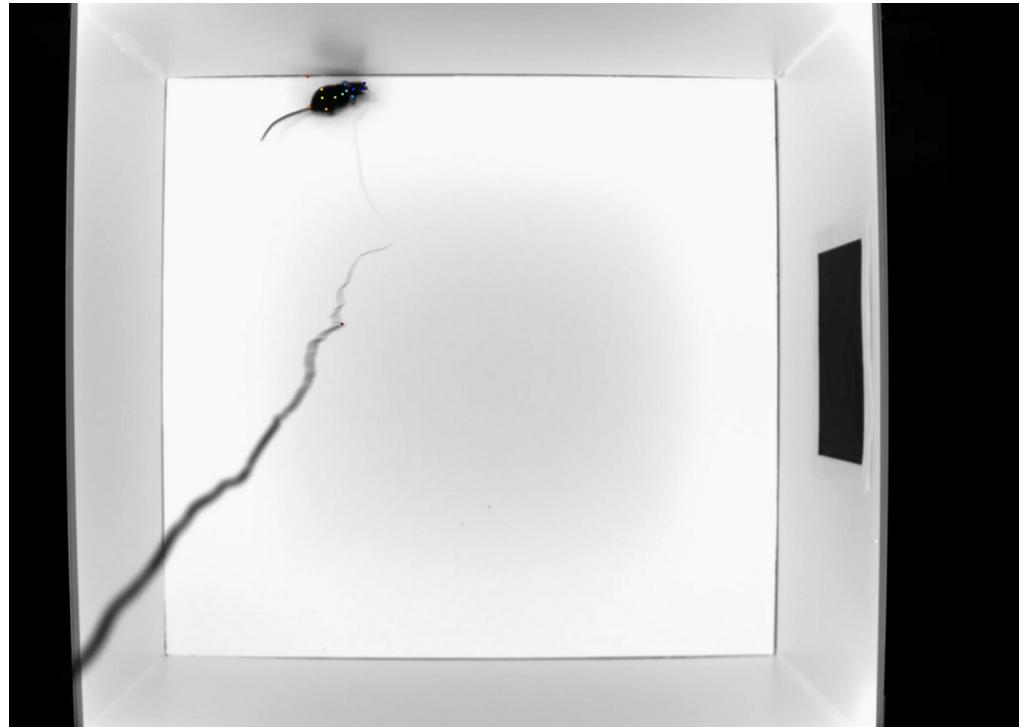
Train DLC neuronal network by marking body parts on ~200 frames manually

The trained neuronal network will then mark the body parts for each frame automatically

How many frames does get labeled ?  
30 min per Video with 20 frames per second

$$30 \text{ min} * 60 \text{ sec} * 20 = 36000 \text{ frames}$$

# Animal recording and tracking in open arena

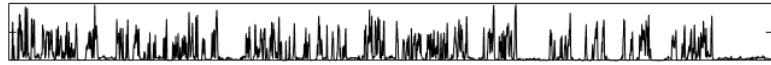


Snout  
Miniscope top  
Miniscope bottom  
Left ear  
Right ear  
Head/Neck  
Shoulders  
Body Center  
Hip center  
Hip left  
Hip right  
Base tail  
Center tail  
Tip tail

Blow up the mouse

# Combining neuronal events with behavior

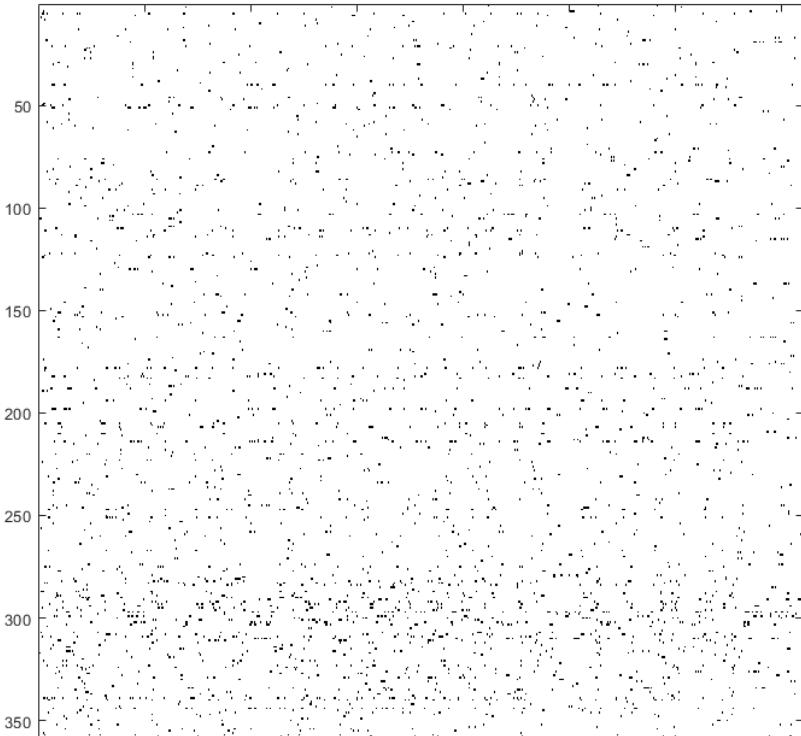
speed



Running or resting



Neuronal activity

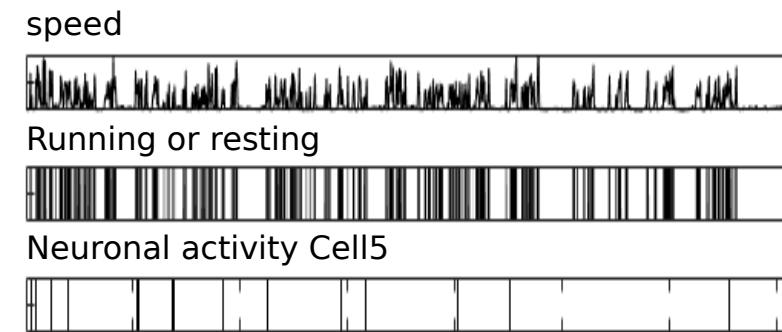
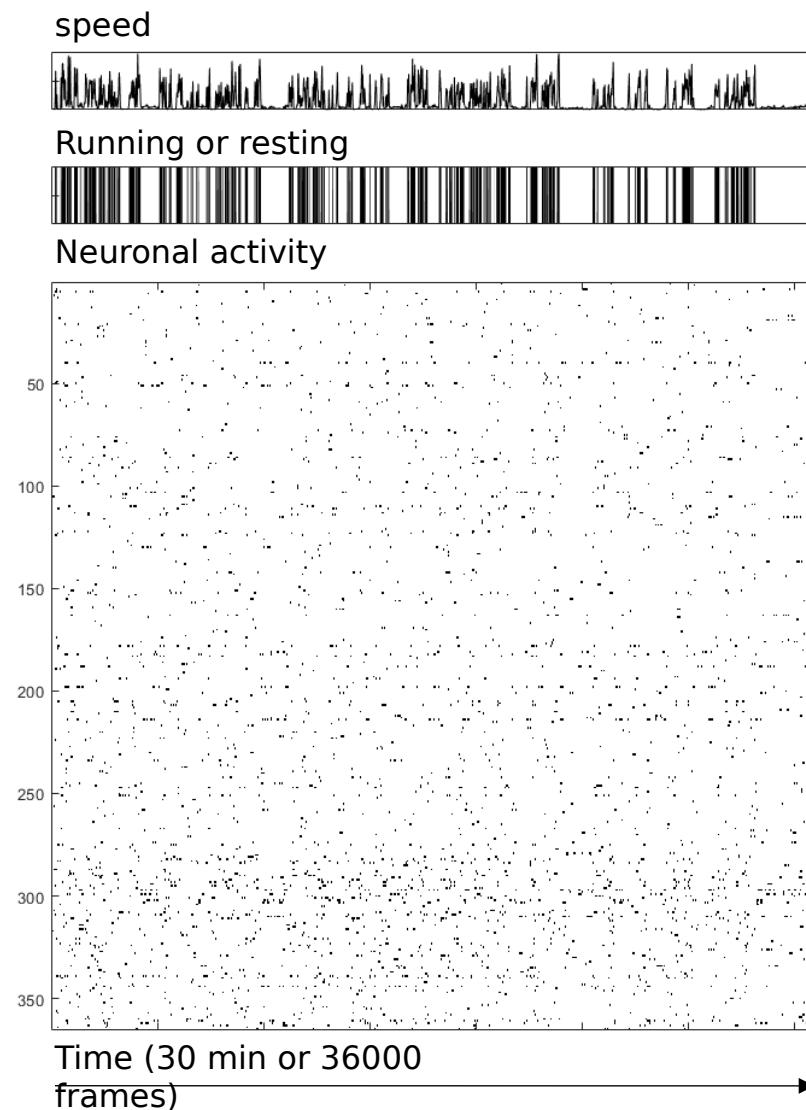


Time (30 min or 36000

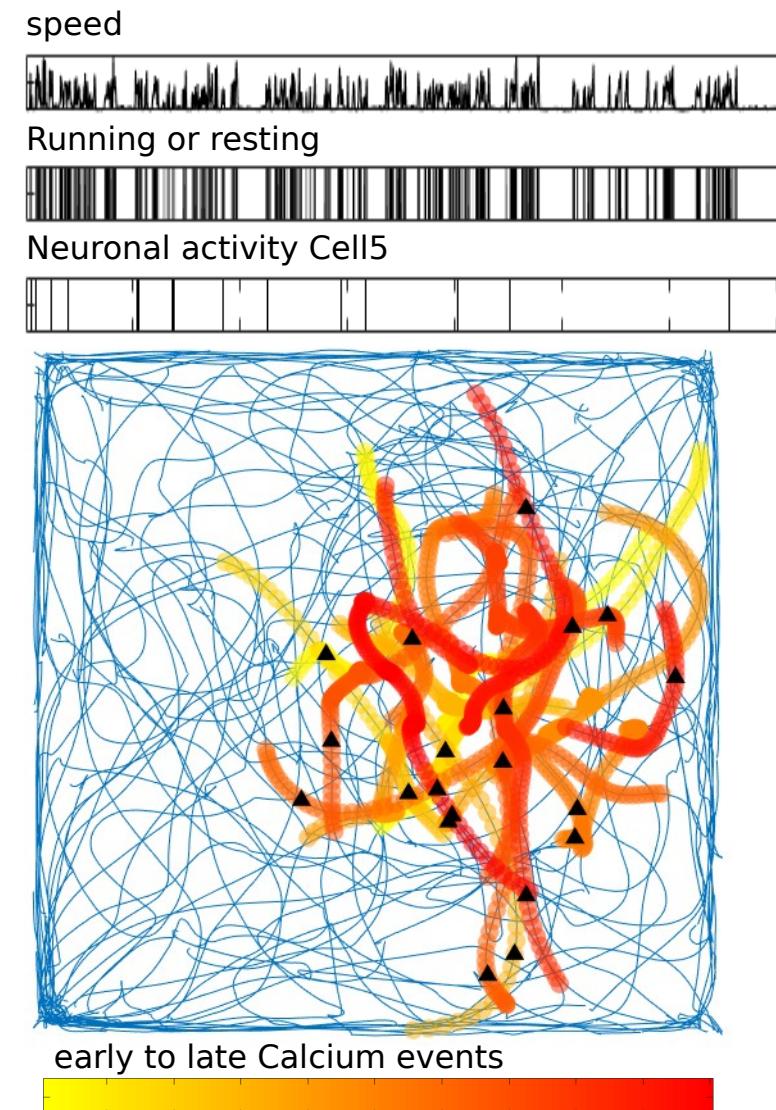
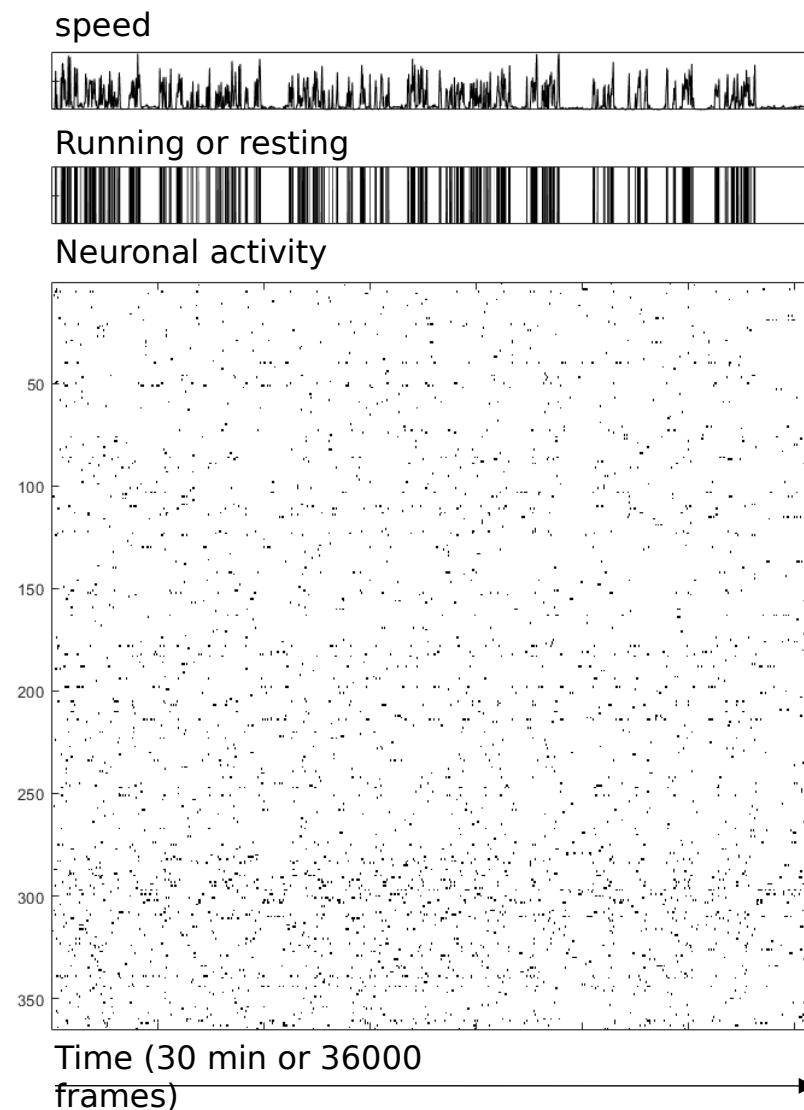
frames)



# Combining neuronal events with behavior



# Combining neuronal events with behavior



# Processing raw data with Matlab to find Place Cells

43 columns

36000 rows

36000x43 double																					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
1	0	1.4810e+03	1.3898e+03	0.2334	1.4752e+03	1.3855e+03	0.9794	1.4945e+03	1.3642e+03	0.9903	1.5093e+03	1.3697e+03	0.9947	1.4823e+03	1.3524e+03	0.9791	1.5012e+03	1.3543e+03	0.9872	1.5057e+03	1.3438e+^
2	1	1.4641e+03	1.3683e+03	0.3785	1.4645e+03	1.3638e+03	0.9248	1.4995e+03	1.3611e+03	0.9404	1.5096e+03	1.3749e+03	0.9271	1.4856e+03	1.3454e+03	0.9863	1.5049e+03	1.3537e+03	0.9866	1.5107e+03	1.3491e+
3	2	1.4664e+03	1.3647e+03	0.3885	1.4658e+03	1.3603e+03	0.8853	1.5003e+03	1.3585e+03	0.9300	1.5111e+03	1.3710e+03	0.9413	1.4874e+03	1.3437e+03	0.9840	1.5064e+03	1.3522e+03	0.9903	1.5118e+03	1.3481e+
4	3	1.4667e+03	1.3634e+03	0.4300	1.4668e+03	1.3590e+03	0.9143	1.5005e+03	1.3565e+03	0.9408	1.5107e+03	1.3700e+03	0.9449	1.4874e+03	1.3432e+03	0.9843	1.5066e+03	1.3515e+03	0.9893	1.5120e+03	1.3475e+
5	4	1.4662e+03	1.3623e+03	0.4723	1.4666e+03	1.3582e+03	0.8992	1.5002e+03	1.3559e+03	0.9283	1.5111e+03	1.3695e+03	0.9504	1.4852e+03	1.3428e+03	0.9867	1.5065e+03	1.3512e+03	0.9847	1.5119e+03	1.3472e+
6	5	1.4636e+03	1.3617e+03	0.4895	1.4634e+03	1.3576e+03	0.9119	1.4991e+03	1.3552e+03	0.9230	1.5093e+03	1.3695e+03	0.9504	1.4850e+03	1.3419e+03	0.9870	1.5051e+03	1.3510e+03	0.9845	1.5111e+03	1.3478e+
7	6	1.4640e+03	1.3626e+03	0.4716	1.4635e+03	1.3587e+03	0.9112	1.4952e+03	1.3566e+03	0.9235	1.5090e+03	1.3696e+03	0.9292	1.4862e+03	1.3421e+03	0.9850	1.5047e+03	1.3516e+03	0.9843	1.5104e+03	1.3484e+
8	7	1.4645e+03	1.3646e+03	0.4868	1.4659e+03	1.3600e+03	0.9310	1.4953e+03	1.3576e+03	0.9584	1.5091e+03	1.3717e+03	0.9229	1.4859e+03	1.3424e+03	0.9878	1.5055e+03	1.3522e+03	0.9899	1.5109e+03	1.3489e+
9	8	1.4643e+03	1.3682e+03	0.3549	1.4635e+03	1.3633e+03	0.8660	1.5001e+03	1.3607e+03	0.9553	1.5102e+03	1.3738e+03	0.9260	1.4846e+03	1.3461e+03	0.9862	1.5059e+03	1.3533e+03	0.9891	1.5115e+03	1.3492e+
10	9	1.4636e+03	1.3724e+03	0.3680	1.4631e+03	1.3660e+03	0.9143	1.4992e+03	1.3616e+03	0.9677	1.5083e+03	1.3746e+03	0.9267	1.4851e+03	1.3480e+03	0.9875	1.5053e+03	1.3533e+03	0.9888	1.5109e+03	1.3492e+
11	10	1.4630e+03	1.3749e+03	0.3256	1.4618e+03	1.3710e+03	0.9046	1.4997e+03	1.3634e+03	0.9710	1.5108e+03	1.3758e+03	0.9275	1.4841e+03	1.3505e+03	0.9870	1.5053e+03	1.3555e+03	0.9855	1.5109e+03	1.3505e+
12	11	1.4630e+03	1.3753e+03	0.3120	1.4624e+03	1.3708e+03	0.9172	1.4999e+03	1.3635e+03	0.9718	1.5089e+03	1.3756e+03	0.9406	1.4854e+03	1.3507e+03	0.9773	1.5052e+03	1.3553e+03	0.9860	1.5109e+03	1.3505e+
13	12	1.4630e+03	1.3763e+03	0.2635	1.4626e+03	1.3724e+03	0.8879	1.4995e+03	1.3636e+03	0.9669	1.5092e+03	1.3754e+03	0.9420	1.4862e+03	1.3509e+03	0.9721	1.5051e+03	1.3557e+03	0.9820	1.5108e+03	1.3509e+
14	13	1.4635e+03	1.3763e+03	0.2528	1.4630e+03	1.3721e+03	0.8722	1.4994e+03	1.3637e+03	0.9497	1.5087e+03	1.3759e+03	0.9191	1.4866e+03	1.3502e+03	0.9718	1.5054e+03	1.3579e+03	0.9744	1.5111e+03	1.3497e+
15	14	1.4609e+03	1.3757e+03	0.3452	1.4615e+03	1.3713e+03	0.9295	1.4980e+03	1.3629e+03	0.9556	1.5076e+03	1.3756e+03	0.9298	1.4852e+03	1.3499e+03	0.9804	1.5039e+03	1.3550e+03	0.9811	1.5102e+03	1.3494e+
16	15	1.4622e+03	1.3728e+03	0.3549	1.4634e+03	1.3662e+03	0.8860	1.4973e+03	1.3621e+03	0.9561	1.5067e+03	1.3752e+03	0.9260	1.4843e+03	1.3482e+03	0.9897	1.5032e+03	1.3541e+03	0.9826	1.5099e+03	1.3491e+
17	16	1.4608e+03	1.3682e+03	0.3660	1.4619e+03	1.3630e+03	0.9037	1.4978e+03	1.3603e+03	0.9489	1.5063e+03	1.3746e+03	0.9422	1.4834e+03	1.3455e+03	0.9878	1.5036e+03	1.3535e+03	0.9857	1.5100e+03	1.3482e+
18	17	1.4631e+03	1.3652e+03	0.3878	1.4641e+03	1.3598e+03	0.8424	1.4946e+03	1.3570e+03	0.9581	1.5034e+03	1.3715e+03	0.9319	1.4850e+03	1.3419e+03	0.9865	1.5038e+03	1.3522e+03	0.9856	1.5097e+03	1.3466e+
19	18	1.4634e+03	1.3605e+03	0.4831	1.4631e+03	1.3560e+03	0.9236	1.4957e+03	1.3571e+03	0.9454	1.5084e+03	1.3707e+03	0.9525	1.4860e+03	1.3413e+03	0.9855	1.5052e+03	1.3520e+03	0.9871	1.5109e+03	1.3471e+
20	19	1.4620e+03	1.3587e+03	0.5391	1.4627e+03	1.3546e+03	0.9374	1.4935e+03	1.3565e+03	0.9509	1.5074e+03	1.3691e+03	0.9587	1.4838e+03	1.3392e+03	0.9892	1.5045e+03	1.3518e+03	0.9837	1.5108e+03	1.3488e+
21	20	1.4622e+03	1.3588e+03	0.4762	1.4622e+03	1.3548e+03	0.9376	1.4946e+03	1.3569e+03	0.9428	1.5074e+03	1.3695e+03	0.9461	1.4828e+03	1.3415e+03	0.9841	1.5044e+03	1.3521e+03	0.9810	1.5109e+03	1.3473e+
22	21	1.4636e+03	1.3629e+03	0.4606	1.4632e+03	1.3581e+03	0.9050	1.4952e+03	1.3575e+03	0.9490	1.5091e+03	1.3707e+03	0.9376	1.4838e+03	1.3431e+03	0.9861	1.5055e+03	1.3526e+03	0.9872	1.5115e+03	1.3474e+
23	22	1.4634e+03	1.3656e+03	0.4116	1.4659e+03	1.3615e+03	0.8039	1.4941e+03	1.3587e+03	0.9530	1.5082e+03	1.3728e+03	0.9006	1.4843e+03	1.3448e+03	0.9904	1.5051e+03	1.3535e+03	0.9844	1.5111e+03	1.3486e+
24	23	1.4638e+03	1.3727e+03	0.3301	1.4644e+03	1.3658e+03	0.8831	1.4992e+03	1.3625e+03	0.9628	1.5085e+03	1.3748e+03	0.9361	1.4850e+03	1.3482e+03	0.9903	1.5075e+03	1.3542e+03	0.9881	1.5112e+03	1.3501e+
25	24	1.4638e+03	1.3737e+03	0.3608	1.4641e+03	1.3697e+03	0.8747	1.4989e+03	1.3629e+03	0.9620	1.5069e+03	1.3754e+03	0.9251	1.4853e+03	1.3490e+03	0.9877	1.5052e+03	1.3545e+03	0.9844	1.5106e+03	1.3505e+
26	25	1.4637e+03	1.3744e+03	0.3382	1.4641e+03	1.3704e+03	0.8980	1.4985e+03	1.3627e+03	0.9596	1.5066e+03	1.3757e+03	0.9207	1.4859e+03	1.3490e+03	0.9872	1.5049e+03	1.3545e+03	0.9835	1.5110e+03	1.3490e+
27	26	1.4636e+03	1.3733e+03	0.3380	1.4639e+03	1.3695e+03	0.8658	1.4987e+03	1.3627e+03	0.9574	1.5067e+03	1.3759e+03	0.9107	1.4852e+03	1.3490e+03	0.9865	1.5047e+03	1.3552e+03	0.9828	1.5109e+03	1.3495e+
28	27	1.4622e+03	1.3718e+03	0.3447	1.4634e+03	1.3656e+03	0.9080	1.4984e+03	1.3626e+03	0.9491	1.5071e+03	1.3761e+03	0.9075	1.4835e+03	1.3488e+03	0.9887	1.5043e+03	1.3551e+03	0.9845	1.5107e+03	1.3498e+
29	28	1.4620e+03	1.3677e+03	0.3478	1.4633e+03	1.3630e+03	0.8716	1.4939e+03	1.3599e+03	0.9435	1.5066e+03	1.3748e+03	0.8900	1.4832e+03	1.3463e+03	0.9901	1.5041e+03	1.3543e+03	0.9826	1.5105e+03	1.3492e+
30	29	1.4612e+03	1.3677e+03	0.3711	1.4623e+03	1.3626e+03	0.9305	1.4935e+03	1.3598e+03	0.9395	1.5069e+03	1.3748e+03	0.9053	1.4828e+03	1.3464e+03	0.9905	1.5041e+03	1.3538e+03	0.9839	1.5104e+03	1.3487e+
31	30	1.4619e+03	1.3678e+03	0.3472	1.4627e+03	1.3631e+03	0.9092	1.4942e+03	1.3596e+03	0.9472	1.5063e+03	1.3744e+03	0.9160	1.4836e+03	1.3461e+03	0.9885	1.5039e+03	1.3539e+03	0.9863	1.5103e+03	1.3487e+
32	31	1.4630e+03	1.3715e+03	0.3569	1.4635e+03	1.3650e+03	0.9155	1.4989e+03	1.3612e+03	0.9578	1.5070e+03	1.3746e+03	0.9375	1.4846e+03	1.3473e+03	0.9899	1.5047e+03	1.3538e+03	0.9889	1.5111e+03	1.3483e+
33	32	1.4637e+03	1.3722e+03	0.3460	1.4643e+03	1.3658e+03	0.8945	1.4992e+03	1.3619e+03	0.9548	1.5064e+03	1.3752e+03	0.9276	1.4850e+03	1.3478e+03	0.9889	1.5047e+03	1.3543e+03	0.9859	1.5111e+03	1.3489e+
34	33	1.4634e+03	1.3733e+03	0.3680	1.4634e+03	1.3693e+03	0.8925	1.4990e+03	1.3622e+03	0.9630	1.5063e+03	1.3753e+03	0.9347	1.4857e+03	1.3481e+03	0.9891	1.5049e+03	1.3541e+03	0.9875	1.5113e+03	1.3487e+
35	34	1.4635e+03	1.3731e+03	0.3505	1.4636e+03	1.3693e+03	0.8819	1.4988e+03	1.3624e+03	0.9595	1.5066e+03	1.3756e+03	0.9227	1.4851e+03	1.3485e+03	0.9891	1.5045e+03	1.3542e+03	0.9861	1.5109e+03	1.3489e+

# Processing raw data with Matlab to find Place Cells

## Breaking down raw data

43 columns = coordinates each body part

36000 rows  
= frames



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	0	1.4810e+03	1.3898e+03	0.2334	1.4752e+03	1.3855e+03	0.9794	1.4945e+03	1.3642e+03	0.9903	1.5093e+03	1.3697e+03	0.9947	1.4823e+03	1.3524e+03	0.9791	1.5012e+03	1.3543e+03	0.9872	1.5057e+03	1.3438e+03
2	1	1.4641e+03	1.3683e+03	0.3785	1.4645e+03	1.3638e+03	0.9248	1.4995e+03	1.3611e+03	0.9404	1.5096e+03	1.3749e+03	0.9271	1.4856e+03	1.3454e+03	0.9863	1.5049e+03	1.3537e+03	0.9866	1.5107e+03	1.3491e+03
3	2	1.4664e+03	1.3647e+03	0.3885	1.4658e+03	1.3603e+03	0.8853	1.5003e+03	1.3585e+03	0.9300	1.5111e+03	1.3710e+03	0.9413	1.4874e+03	1.3437e+03	0.9840	1.5064e+03	1.3522e+03	0.9903	1.5118e+03	1.3481e+03
4	3	1.4667e+03	1.3634e+03	0.4300	1.4668e+03	1.3590e+03	0.9143	1.5005e+03	1.3565e+03	0.9408	1.5107e+03	1.3700e+03	0.9449	1.4874e+03	1.3432e+03	0.9843	1.5066e+03	1.3515e+03	0.9893	1.5120e+03	1.3475e+03
5	4	1.4662e+03	1.3623e+03	0.4723	1.4666e+03	1.3582e+03	0.9092	1.5002e+03	1.3559e+03	0.9283	1.5111e+03	1.3695e+03	0.9504	1.4852e+03	1.3428e+03	0.9867	1.5065e+03	1.3512e+03	0.9847	1.5119e+03	1.3472e+03
6	5	1.4636e+03	1.3617e+03	0.4895	1.4634e+03	1.3576e+03	0.9119	1.4991e+03	1.3552e+03	0.9230	1.5093e+03	1.3695e+03	0.9504	1.4850e+03	1.3419e+03	0.9870	1.5051e+03	1.3510e+03	0.9845	1.5111e+03	1.3478e+03
7	6	1.4640e+03	1.3626e+03	0.4716	1.4635e+03	1.3587e+03	0.9112	1.4952e+03	1.3566e+03	0.9235	1.5090e+03	1.3696e+03	0.9292	1.4862e+03	1.3421e+03	0.9850	1.5047e+03	1.3516e+03	0.9843	1.5104e+03	1.3484e+03
8	7	1.4645e+03	1.3646e+03	0.4868	1.4659e+03	1.3600e+03	0.9310	1.4953e+03	1.3576e+03	0.9584	1.5091e+03	1.3717e+03	0.9229	1.4859e+03	1.3424e+03	0.9878	1.5055e+03	1.3522e+03	0.9899	1.5109e+03	1.3489e+03
9	8	1.4643e+03	1.3682e+03	0.3549	1.4635e+03	1.3633e+03	0.8660	1.5001e+03	1.3607e+03	0.9553	1.5102e+03	1.3738e+03	0.9260	1.4846e+03	1.3461e+03	0.9862	1.5059e+03	1.3533e+03	0.9891	1.5115e+03	1.3492e+03
10	9	1.4636e+03	1.3724e+03	0.3680	1.4631e+03	1.3660e+03	0.9143	1.4992e+03	1.3618e+03	0.9677	1.5083e+03	1.3746e+03	0.9267	1.4851e+03	1.3480e+03	0.9875	1.5053e+03	1.3533e+03	0.9888	1.5109e+03	1.3492e+03
11	10	1.4630e+03	1.3749e+03	0.3256	1.4618e+03	1.3710e+03	0.9046	1.4997e+03	1.3634e+03	0.9710	1.5108e+03	1.3758e+03	0.9275	1.4841e+03	1.3505e+03	0.9870	1.5053e+03	1.3555e+03	0.9855	1.5109e+03	1.3505e+03
12	11	1.4630e+03	1.3753e+03	0.3120	1.4624e+03	1.3708e+03	0.9172	1.4999e+03	1.3635e+03	0.9718	1.5089e+03	1.3756e+03	0.9406	1.4854e+03	1.3507e+03	0.9773	1.5052e+03	1.3553e+03	0.9860	1.5109e+03	1.3505e+03
13	12	1.4630e+03	1.3763e+03	0.2635	1.4626e+03	1.3724e+03	0.8879	1.4995e+03	1.3636e+03	0.9669	1.5092e+03	1.3754e+03	0.9420	1.4862e+03	1.3509e+03	0.9721	1.5051e+03	1.3557e+03	0.9820	1.5108e+03	1.3509e+03
14	13	1.4635e+03	1.3763e+03	0.2528	1.4630e+03	1.3721e+03	0.8722	1.4994e+03	1.3637e+03	0.9497	1.5087e+03	1.3759e+03	0.9191	1.4866e+03	1.3502e+03	0.9718	1.5054e+03	1.3579e+03	0.9744	1.5111e+03	1.3497e+03
15	14	1.4609e+03	1.3757e+03	0.3452	1.4615e+03	1.3713e+03	0.9295	1.4980e+03	1.3629e+03	0.9556	1.5076e+03	1.3756e+03	0.9298	1.4852e+03	1.3499e+03	0.9804	1.5039e+03	1.3550e+03	0.9811	1.5102e+03	1.3494e+03
16	15	1.4622e+03	1.3728e+03	0.3549	1.4634e+03	1.3662e+03	0.8860	1.4973e+03	1.3621e+03	0.9561	1.5067e+03	1.3752e+03	0.9260	1.4843e+03	1.3482e+03	0.9897	1.5032e+03	1.3541e+03	0.9826	1.5099e+03	1.3491e+03
17	16	1.4608e+03	1.3682e+03	0.3660	1.4619e+03	1.3630e+03	0.9037	1.4978e+03	1.3603e+03	0.9489	1.5063e+03	1.3746e+03	0.9422	1.4843e+03	1.3455e+03	0.9878	1.5036e+03	1.3535e+03	0.9857	1.5100e+03	1.3482e+03
18	17	1.4631e+03	1.3652e+03	0.3878	1.4641e+03	1.3598e+03	0.8424	1.4946e+03	1.3570e+03	0.9581	1.5034e+03	1.3715e+03	0.9319	1.4850e+03	1.3419e+03	0.9865	1.5038e+03	1.3522e+03	0.9856	1.5097e+03	1.3466e+03
19	18	1.4634e+03	1.3605e+03	0.4831	1.4631e+03	1.3560e+03	0.9236	1.4957e+03	1.3571e+03	0.9454	1.5084e+03	1.3707e+03	0.9525	1.4860e+03	1.3413e+03	0.9855	1.5052e+03	1.3520e+03	0.9871	1.5109e+03	1.3471e+03
20	19	1.4620e+03	1.3587e+03	0.5391	1.4627e+03	1.3546e+03	0.9374	1.4951e+03	1.3565e+03	0.9509	1.5074e+03	1.3691e+03	0.9587	1.4838e+03	1.3392e+03	0.9892	1.5045e+03	1.3518e+03	0.9837	1.5108e+03	1.3488e+03
21	20	1.4622e+03	1.3588e+03	0.4762	1.4622e+03	1.3548e+03	0.9376	1.4946e+03	1.3569e+03	0.9428	1.5074e+03	1.3695e+03	0.9461	1.4828e+03	1.3415e+03	0.9841	1.5044e+03	1.3521e+03	0.9810	1.5109e+03	1.3473e+03
22	21	1.4636e+03	1.3629e+03	0.4606	1.4632e+03	1.3581e+03	0.9050	1.4952e+03	1.3575e+03	0.9490	1.5091e+03	1.3707e+03	0.9376	1.4838e+03	1.3431e+03	0.9861	1.5055e+03	1.3526e+03	0.9872	1.5115e+03	1.3474e+03
23	22	1.4634e+03	1.3656e+03	0.4116	1.4659e+03	1.3615e+03	0.8939	1.4941e+03	1.3587e+03	0.9530	1.5082e+03	1.3728e+03	0.9006	1.4843e+03	1.3484e+03	0.9904	1.5051e+03	1.3535e+03	0.9844	1.5111e+03	1.3486e+03
24	23	1.4638e+03	1.3727e+03	0.3301	1.4644e+03	1.3658e+03	0.8831	1.4992e+03	1.3625e+03	0.9628	1.5085e+03	1.3748e+03	0.9361	1.4850e+03	1.3482e+03	0.9903	1.5057e+03	1.3542e+03	0.9881	1.5112e+03	1.3501e+03
25	24	1.4638e+03	1.3737e+03	0.3608	1.4641e+03	1.3697e+03	0.8747	1.4989e+03	1.3626e+03	0.9620	1.5069e+03	1.3754e+03	0.9251	1.4853e+03	1.3490e+03	0.9877	1.5052e+03	1.3545e+03	0.9844	1.5106e+03	1.3505e+03
26	25	1.4637e+03	1.3744e+03	0.3382	1.4641e+03	1.3704e+03	0.9880	1.4985e+03	1.3627e+03	0.9596	1.5066e+03	1.3757e+03	0.9207	1.4859e+03	1.3490e+03	0.9872	1.5049e+03	1.3545e+03	0.9835	1.5110e+03	1.3490e+03
27	26	1.4636e+03	1.3733e+03	0.3380	1.4639e+03	1.3695e+03	0.8658	1.4987e+03	1.3627e+03	0.9574	1.5067e+03	1.3759e+03	0.9107	1.4852e+03	1.3490e+03	0.9865	1.5047e+03	1.3552e+03	0.9828	1.5109e+03	1.3495e+03
28	27	1.4622e+03	1.3718e+03	0.3447	1.4634e+03	1.3656e+03	0.9080	1.4984e+03	1.3626e+03	0.9491	1.5071e+03	1.3761e+03	0.9075	1.4835e+03	1.3488e+03	0.9887	1.5043e+03	1.3551e+03	0.9845	1.5107e+03	1.3498e+03
29	28	1.4620e+03	1.3677e+03	0.3478	1.4633e+03	1.3630e+03	0.8716	1.4939e+03	1.3599e+03	0.9435	1.5066e+03	1.3748e+03	0.8900	1.4832e+03	1.3463e+03	0.9901	1.5041e+03	1.3543e+03	0.9826	1.5105e+03	1.3492e+03
30	29	1.4612e+03	1.3677e+03	0.3711	1.4623e+03	1.3626e+03	0.9305	1.4935e+03	1.3598e+03	0.9395	1.5069e+03	1.3748e+03	0.9053	1.4828e+03	1.3464e+03	0.9905	1.5041e+03	1.3538e+03	0.9839	1.5104e+03	1.3487e+03
31	30	1.4619e+03	1.3678e+03	0.3472	1.4627e+03	1.3631e+03	0.9092	1.4942e+03	1.3596e+03	0.9472	1.5063e+03	1.3744e+03	0.9160	1.4835e+03	1.3461e+03	0.9885	1.5039e+03	1.3539e+03	0.9863	1.5103e+03	1.3487e+03
32	31	1.4630e+03	1.3715e+03	0.3569	1.4635e+03	1.3650e+03	0.9155	1.4989e+03	1.3612e+03	0.9578	1.5070e+03	1.3746e+03	0.9375	1.4846e+03	1.3473e+03	0.9899	1.5047e+03	1.3538e+03	0.9889	1.5111e+03	1.3483e+03
33	32	1.4637e+03	1.3722e+03	0.3460	1.4643e+03	1.3658e+03	0.8945	1.4992e+03	1.3619e+03	0.9548	1.5064e+03	1.3752e+03	0.9276	1.4850e+03	1.3478e+03	0.9889	1.5047e+03	1.3543e+03	0.9859	1.5111e+03	1.3489e+03
34	33	1.4634e+03	1.3733e+03	0.3680	1.4634e+03	1.3693e+03	0.8925	1.4990e+03	1.3622e+03	0.9630	1.5063e+03	1.3753e+03	0.9347	1.4857e+03	1.3481e+03	0.9891	1.5049e+03	1.3541e+03	0.9875	1.5113e+03	1.3487e+03
35	34	1.4635e+03	1.3731e+03	0.3505	1.4636e+03	1.3693e+03	0.8819	1.4988e+03	1.3624e+03	0.9595	1.5066e+03	1.3756e+03	0.9227	1.4851e+03	1.3485e+03	0.9891	1.5045e+03	1.3542e+03	0.9861	1.5109e+03	1.3489e+03

Snout  
Miniscope top  
Miniscope bottom  
Left ear  
Right ear  
Head/Neck  
Shoulders  
Body Center  
Hip center  
Hip left  
Hip right  
Base tail  
Center tail  
Tip tail

# Processing raw data with Matlab to find Place Cells

## Breaking down raw data

43 columns = coordinates each body part

36000 rows  
= frames

→

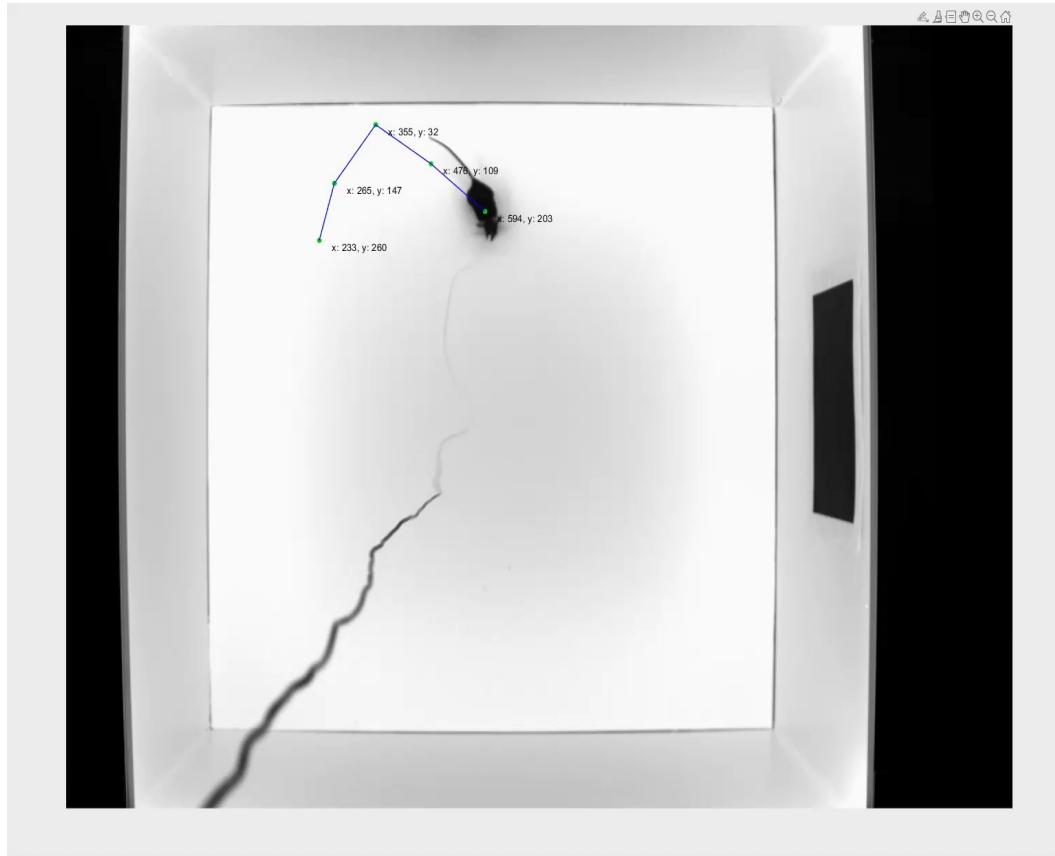
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	0	1.4810e+03	1.3898e+03	0.2334	1.4752e+03	1.3855e+03	0.9794	1.4945e+03	1.3642e+03	0.9903	1.5093e+03	1.3697e+03	0.9947	1.4823e+03	1.3524e+03	0.9791	1.5012e+03	1.3543e+03	0.9872	1.5057e+03	1.3438e+03
2	1	1.4641e+03	1.3683e+03	0.3785	1.4645e+03	1.3638e+03	0.9248	1.4995e+03	1.3611e+03	0.9404	1.5096e+03	1.3749e+03	0.9271	1.4856e+03	1.3454e+03	0.9863	1.5049e+03	1.3537e+03	0.9866	1.5107e+03	1.3491e+03
3	2	1.4664e+03	1.3647e+03	0.3885	1.4658e+03	1.3603e+03	0.8853	1.5003e+03	1.3585e+03	0.9300	1.5111e+03	1.3710e+03	0.9413	1.4874e+03	1.3437e+03	0.9840	1.5064e+03	1.3522e+03	0.9903	1.5118e+03	1.3481e+03
4	3	1.4667e+03	1.3634e+03	0.4300	1.4668e+03	1.3590e+03	0.9143	1.5005e+03	1.3565e+03	0.9408	1.5107e+03	1.3700e+03	0.9449	1.4874e+03	1.3432e+03	0.9843	1.5066e+03	1.3515e+03	0.9893	1.5120e+03	1.3475e+03
5	4	1.4662e+03	1.3623e+03	0.4723	1.4666e+03	1.3582e+03	0.9092	1.5002e+03	1.3559e+03	0.9283	1.5111e+03	1.3695e+03	0.9504	1.4852e+03	1.3428e+03	0.9867	1.5065e+03	1.3512e+03	0.9847	1.5119e+03	1.3472e+03
6	5	1.4636e+03	1.3617e+03	0.4895	1.4634e+03	1.3576e+03	0.9119	1.4991e+03	1.3552e+03	0.9230	1.5093e+03	1.3695e+03	0.9504	1.4850e+03	1.3510e+03	0.9870	1.5051e+03	1.3510e+03	0.9845	1.5111e+03	1.3478e+03
7	6	1.4640e+03	1.3626e+03	0.4716	1.4635e+03	1.3587e+03	0.9112	1.4952e+03	1.3566e+03	0.9235	1.5090e+03	1.3696e+03	0.9292	1.4862e+03	1.3421e+03	0.9850	1.5047e+03	1.3516e+03	0.9843	1.5104e+03	1.3484e+03
8	7	1.4645e+03	1.3646e+03	0.4868	1.4659e+03	1.3600e+03	0.9310	1.4953e+03	1.3576e+03	0.9584	1.5091e+03	1.3717e+03	0.9229	1.4859e+03	1.3424e+03	0.9878	1.5055e+03	1.3522e+03	0.9899	1.5109e+03	1.3489e+03
9	8	1.4643e+03	1.3682e+03	0.3549	1.4653e+03	1.3633e+03	0.8660	1.5001e+03	1.3607e+03	0.9553	1.5102e+03	1.3738e+03	0.9260	1.4846e+03	1.3461e+03	0.9862	1.5059e+03	1.3533e+03	0.9891	1.5115e+03	1.3492e+03
10	9	1.4636e+03	1.3724e+03	0.3680	1.4631e+03	1.3660e+03	0.9143	1.4992e+03	1.3616e+03	0.9677	1.5083e+03	1.3746e+03	0.9267	1.4851e+03	1.3480e+03	0.9875	1.5053e+03	1.3533e+03	0.9888	1.5109e+03	1.3492e+03
11	10	1.4630e+03	1.3749e+03	0.3256	1.4618e+03	1.3710e+03	0.9046	1.4997e+03	1.3634e+03	0.9710	1.5108e+03	1.3758e+03	0.9275	1.4841e+03	1.3505e+03	0.9870	1.5053e+03	1.3555e+03	0.9855	1.5109e+03	1.3505e+03
12	11	1.4630e+03	1.3753e+03	0.3120	1.4624e+03	1.3708e+03	0.9172	1.4999e+03	1.3635e+03	0.9718	1.5089e+03	1.3756e+03	0.9406	1.4854e+03	1.3507e+03	0.9773	1.5052e+03	1.3553e+03	0.9860	1.5109e+03	1.3505e+03
13	12	1.4630e+03	1.3763e+03	0.2635	1.4626e+03	1.3724e+03	0.8879	1.4995e+03	1.3636e+03	0.9669	1.5092e+03	1.3754e+03	0.9420	1.4862e+03	1.3509e+03	0.9721	1.5051e+03	1.3557e+03	0.9820	1.5108e+03	1.3509e+03
14	13	1.4635e+03	1.3763e+03	0.2528	1.4630e+03	1.3721e+03	0.8722	1.4994e+03	1.3637e+03	0.9497	1.5087e+03	1.3759e+03	0.9191	1.4866e+03	1.3502e+03	0.9718	1.5054e+03	1.3579e+03	0.9744	1.5111e+03	1.3497e+03
15	14	1.4609e+03	1.3757e+03	0.3452	1.4615e+03	1.3713e+03	0.9295	1.4980e+03	1.3629e+03	0.9556	1.5076e+03	1.3756e+03	0.9298	1.4852e+03	1.3499e+03	0.9804	1.5039e+03	1.3550e+03	0.9811	1.5102e+03	1.3494e+03
16	15	1.4622e+03	1.3728e+03	0.3549	1.4634e+03	1.3662e+03	0.8860	1.4973e+03	1.3621e+03	0.9561	1.5067e+03	1.3752e+03	0.9260	1.4843e+03	1.3482e+03	0.9897	1.5032e+03	1.3541e+03	0.9826	1.5099e+03	1.3491e+03
17	16	1.4608e+03	1.3682e+03	0.3660	1.4619e+03	1.3630e+03	0.9037	1.4978e+03	1.3603e+03	0.9489	1.5063e+03	1.3746e+03	0.9422	1.4843e+03	1.3455e+03	0.9878	1.5036e+03	1.3535e+03	0.9857	1.5100e+03	1.3482e+03
18	17	1.4631e+03	1.3652e+03	0.3878	1.4641e+03	1.3598e+03	0.8424	1.4946e+03	1.3570e+03	0.9581	1.5034e+03	1.3715e+03	0.9319	1.4850e+03	1.3419e+03	0.9865	1.5038e+03	1.3522e+03	0.9856	1.5097e+03	1.3466e+03
19	18	1.4634e+03	1.3605e+03	0.4831	1.4631e+03	1.3560e+03	0.9236	1.4957e+03	1.3571e+03	0.9454	1.5084e+03	1.3707e+03	0.9525	1.4860e+03	1.3413e+03	0.9855	1.5052e+03	1.3520e+03	0.9871	1.5109e+03	1.3471e+03
20	19	1.4620e+03	1.3587e+03	0.5391	1.4627e+03	1.3546e+03	0.9374	1.4951e+03	1.3565e+03	0.9509	1.5074e+03	1.3691e+03	0.9587	1.4838e+03	1.3392e+03	0.9893	1.5045e+03	1.3518e+03	0.9837	1.5108e+03	1.3488e+03
21	20	1.4622e+03	1.3588e+03	0.4762	1.4622e+03	1.3548e+03	0.9376	1.4946e+03	1.3569e+03	0.9428	1.5074e+03	1.3695e+03	0.9461	1.4828e+03	1.3415e+03	0.9841	1.5044e+03	1.3521e+03	0.9810	1.5109e+03	1.3473e+03
22	21	1.4636e+03	1.3629e+03	0.4606	1.4632e+03	1.3581e+03	0.9050	1.4952e+03	1.3575e+03	0.9490	1.5091e+03	1.3707e+03	0.9376	1.4838e+03	1.3431e+03	0.9861	1.5055e+03	1.3526e+03	0.9872	1.5115e+03	1.3474e+03
23	22	1.4634e+03	1.3656e+03	0.4116	1.4659e+03	1.3615e+03	0.8039	1.4941e+03	1.3587e+03	0.9530	1.5082e+03	1.3728e+03	0.9006	1.4843e+03	1.3484e+03	0.9904	1.5051e+03	1.3535e+03	0.9844	1.5111e+03	1.3486e+03
24	23	1.4638e+03	1.3727e+03	0.3301	1.4644e+03	1.3658e+03	0.8831	1.4992e+03	1.3625e+03	0.9628	1.5085e+03	1.3748e+03	0.9361	1.4850e+03	1.3482e+03	0.9903	1.5057e+03	1.3542e+03	0.9881	1.5112e+03	1.3501e+03
25	24	1.4636e+03	1.3737e+03	0.3608	1.4641e+03	1.3697e+03	0.8747	1.4989e+03	1.3626e+03	0.9620	1.5069e+03	1.3754e+03	0.9251	1.4853e+03	1.3490e+03	0.9877	1.5052e+03	1.3545e+03	0.9844	1.5106e+03	1.3505e+03
26	25	1.4637e+03	1.3744e+03	0.3382	1.4641e+03	1.3704e+03	0.9880	1.4985e+03	1.3627e+03	0.9596	1.5066e+03	1.3757e+03	0.9207	1.4859e+03	1.3490e+03	0.9873	1.5049e+03	1.3545e+03	0.9835	1.5110e+03	1.3490e+03
27	26	1.4636e+03	1.3733e+03	0.3380	1.4639e+03	1.3695e+03	0.8658	1.4987e+03	1.3627e+03	0.9574	1.5067e+03	1.3759e+03	0.9107	1.4852e+03	1.3490e+03	0.9865	1.5047e+03	1.3552e+03	0.9828	1.5109e+03	1.3495e+03
28	27	1.4622e+03	1.3718e+03	0.3447	1.4634e+03	1.3656e+03	0.9080	1.4984e+03	1.3626e+03	0.9491	1.5071e+03	1.3761e+03	0.9075	1.4835e+03	1.3488e+03	0.9887	1.5043e+03	1.3551e+03	0.9845	1.5107e+03	1.3498e+03
29	28	1.4620e+03	1.3677e+03	0.3478	1.4633e+03	1.3630e+03	0.8716	1.4939e+03	1.3599e+03	0.9435	1.5066e+03	1.3748e+03	0.8900	1.4832e+03	1.3463e+03	0.9901	1.5041e+03	1.3543e+03	0.9826	1.5105e+03	1.3492e+03
30	29	1.4612e+03	1.3677e+03	0.3711	1.4623e+03	1.3626e+03	0.9305	1.4935e+03	1.3598e+03	0.9395	1.5069e+03	1.3748e+03	0.9053	1.4828e+03	1.3464e+03	0.9905	1.5041e+03	1.3538e+03	0.9839	1.5104e+03	1.3487e+03
31	30	1.4619e+03	1.3678e+03	0.3472	1.4627e+03	1.3631e+03	0.9092	1.4942e+03	1.3596e+03	0.9472	1.5063e+03	1.3744e+03	0.9160	1.4836e+03	1.3461e+03	0.9883	1.5039e+03	1.3539e+03	0.9863	1.5103e+03	1.3487e+03
32	31	1.4630e+03	1.3715e+03	0.3569	1.4635e+03	1.3650e+03	0.9155	1.4989e+03	1.3612e+03	0.9578	1.5070e+03	1.3746e+03	0.9375	1.4846e+03	1.3473e+03	0.9899	1.5047e+03	1.3538e+03	0.9889	1.5111e+03	1.3483e+03
33	32	1.4637e+03	1.3722e+03	0.3460	1.4643e+03	1.3658e+03	0.8945	1.4992e+03	1.3619e+03	0.9548	1.5064e+03	1.3752e+03	0.9276	1.4850e+03	1.3478e+03	0.9889	1.5047e+03	1.3543e+03	0.9859	1.5111e+03	1.3489e+03
34	33	1.4634e+03	1.3733e+03	0.3680	1.4634e+03	1.3693e+03	0.8925	1.4990e+03	1.3622e+03	0.9630	1.5063e+03	1.3753e+03	0.9347	1.4857e+03	1.3481e+03	0.9891	1.5049e+03	1.3541e+03	0.9875	1.5113e+03	1.3487e+03
35	34	1.4635e+03	1.3731e+03	0.3505	1.4636e+03	1.3693e+03	0.8819	1.4988e+03	1.3624e+03	0.9595	1.5066e+03	1.3756e+03	0.9227	1.4851e+03	1.3485e+03	0.9891	1.5045e+03	1.3542e+03	0.9861	1.5109e+03	1.3489e+03

head/neck coordinates

17 - X-direction

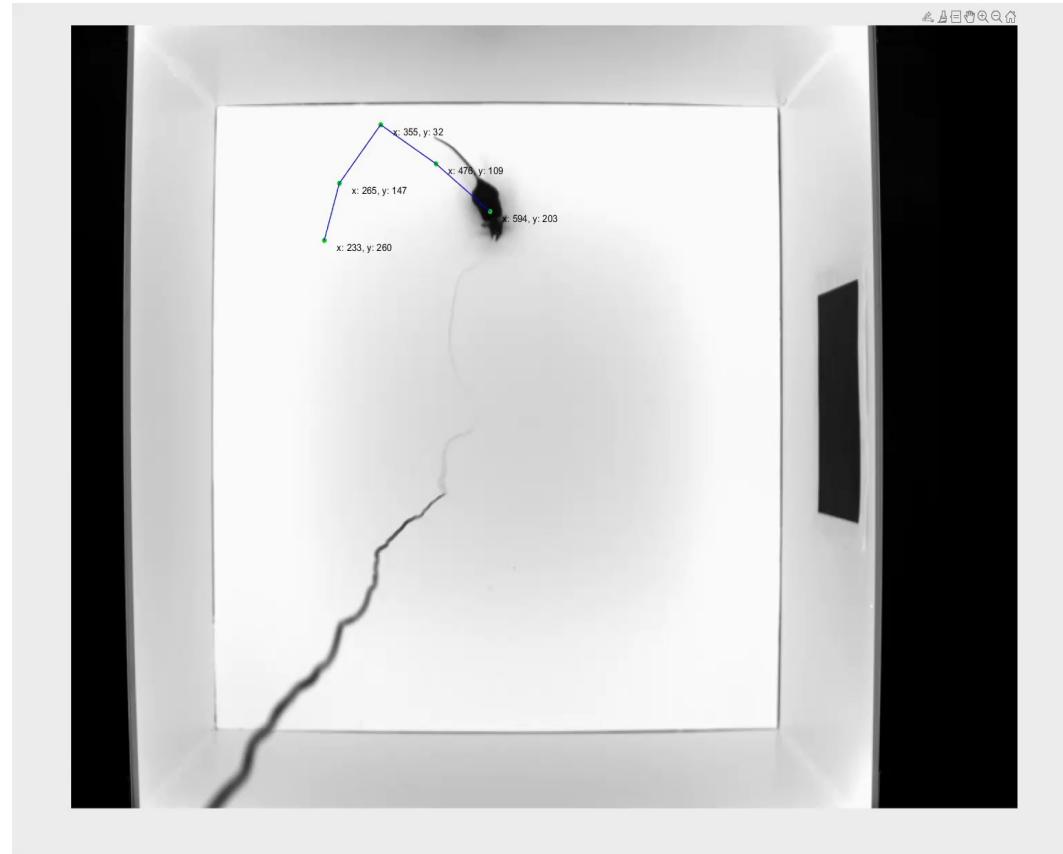
18 - Y-direction

# Processing raw data with Matlab to find Place Cells



sec: 1, x: 233, y: 260, estimator: 0.976
sec: 2, x: 265, y: 147, estimator: 0.971
sec: 3, x: 355, y: 32, estimator: 0.949
sec: 4, x: 476, y: 109, estimator: 0.976
sec: 5, x: 594, y: 203, estimator: 0.986
sec: 6, x: 661, y: 434, estimator: 0.989
sec: 7, x: 545, y: 564, estimator: 0.974
sec: 8, x: 400, y: 640, estimator: 0.815
sec: 9, x: 237, y: 646, estimator: 0.939
sec: 10, x: 92, y: 441, estimator: 0.987
sec: 11, x: 51, y: 265, estimator: 0.991

# Processing raw data with Matlab to find Place Cells

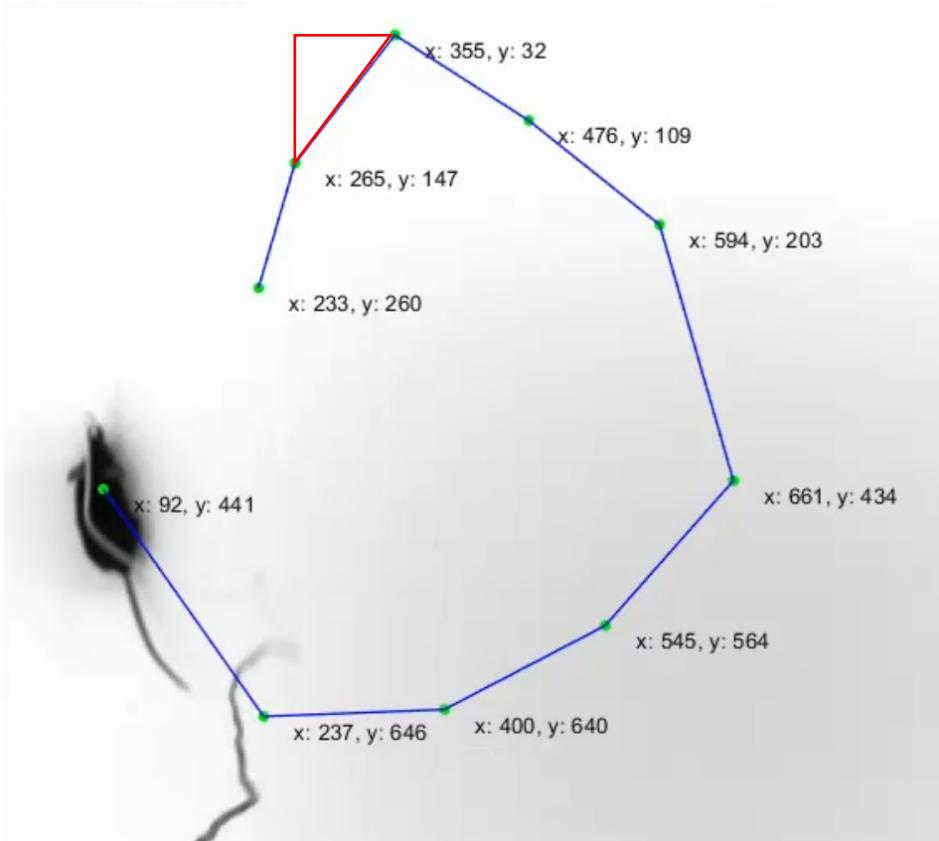


sec: 1, x: 233, y: 260, estimator: 0.976
sec: 2, x: 265, y: 147, estimator: 0.971
sec: 3, x: 355, y: 32, estimator: 0.949
sec: 4, x: 476, y: 109, estimator: 0.976
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sec: 8, x: 400, y: 640, estimator: 0.815
sec: 9, x: 237, y: 646, estimator: 0.939
sec: 10, x: 92, y: 441, estimator: 0.987
sec: 11, x: 51, y: 265, estimator: 0.991

**1 Task:**  
**using the estimator to**  
**find the most promising**  
**body part to plot the**  
**trajectory**

- Index raw matrix to create a matrix that contains the estimator values only
- Find a math/statistical operator to find the best body part to track
- Draw correct X- and Y-coordinates from raw matrix
- Plot the running trajectory

# Processing raw data with Matlab to find Place Cells

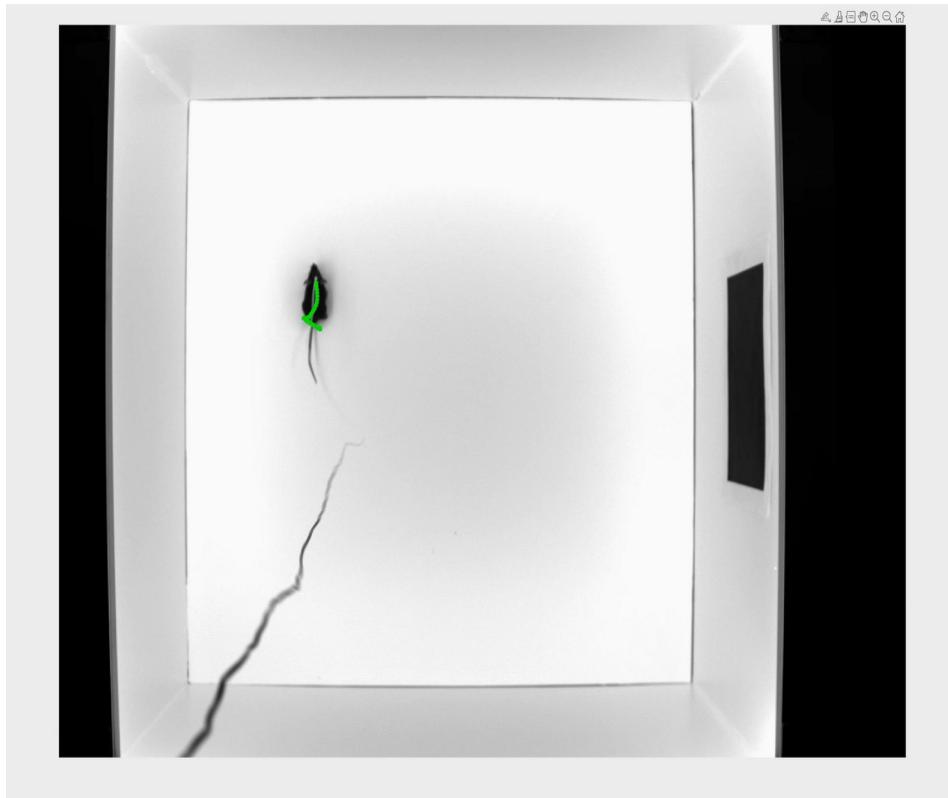


sec: 1, x: 233, y: 260, estimator: 0.976
sec: 2, x: 265, y: 147, estimator: 0.971
sec: 3, x: 355, y: 32, estimator: 0.949
sec: 4, x: 476, y: 109, estimator: 0.976
sec: 5, x: 594, y: 203, estimator: 0.986
sec: 6, x: 661, y: 434, estimator: 0.989
sec: 7, x: 545, y: 564, estimator: 0.974
sec: 8, x: 400, y: 640, estimator: 0.815
sec: 9, x: 237, y: 646, estimator: 0.939
sec: 10, x: 92, y: 441, estimator: 0.987
sec: 11, x: 51, y: 265, estimator: 0.991

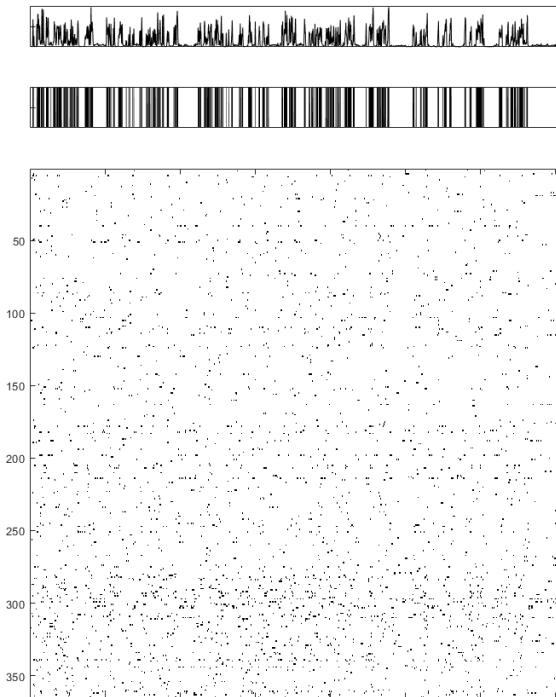
**2 Task:  
using the correct body part to calculate the speed of the animal and the total distance travels**

- Adjust coordinates for better plotting (find point (0|0) and use moving mean)
  - Find the size of the arena in pixel and convert it in cm
  - Find the distance traveled in per frame
  - Calculate the animals speed
- Distance  $C = \sqrt{a^2 + b^2}$   
Distance/time = speed

# Processing raw data with Matlab to find Place Cells



2 x  
speed

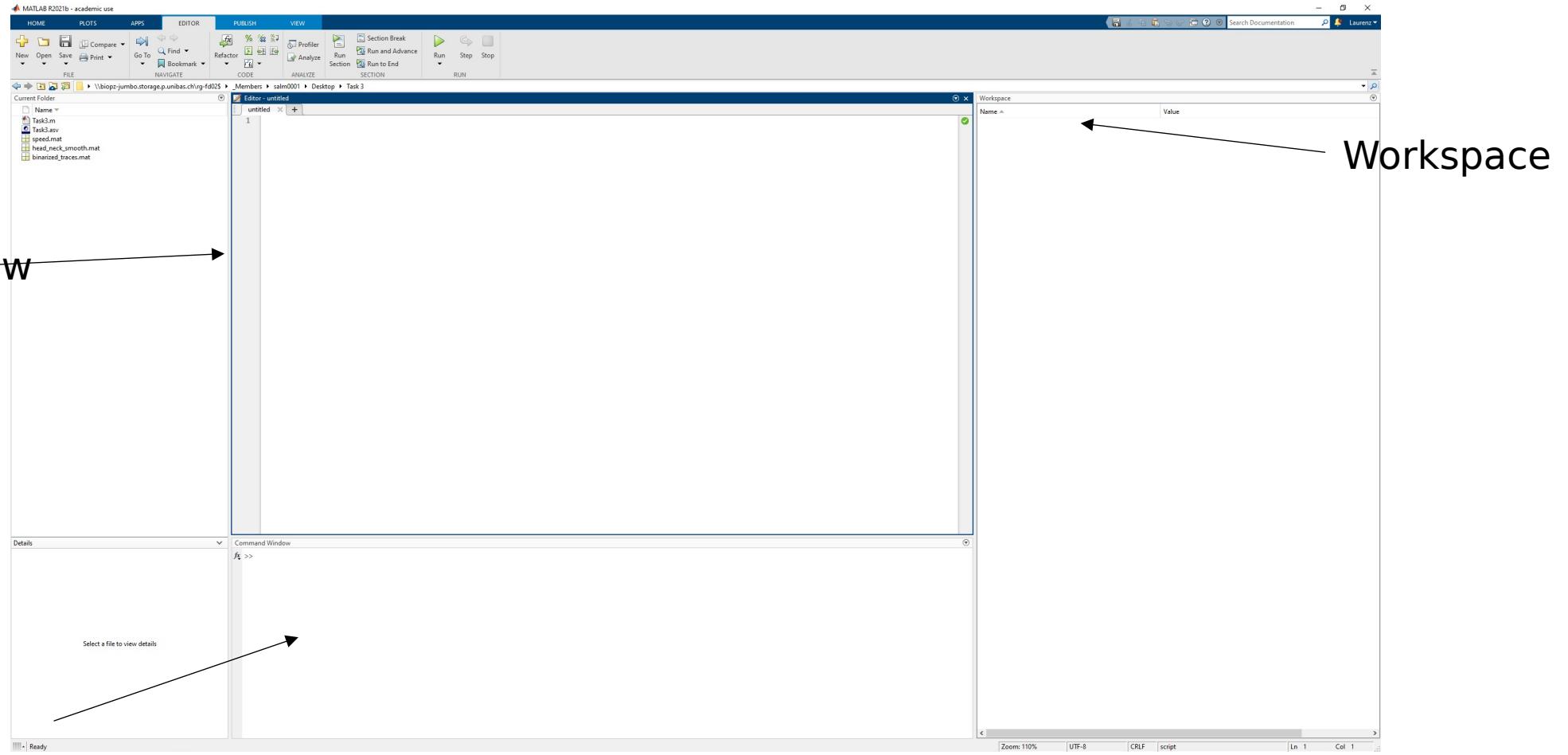


**3 Task:**  
**Track the animals behavior, read out neuronal data to the animals behavior and plot single neuron activity to running trajectory**

- Find resting and running epochs
- Read out neuronal activity correlated to behavior

# Processing raw data with Matlab to find Place Cells

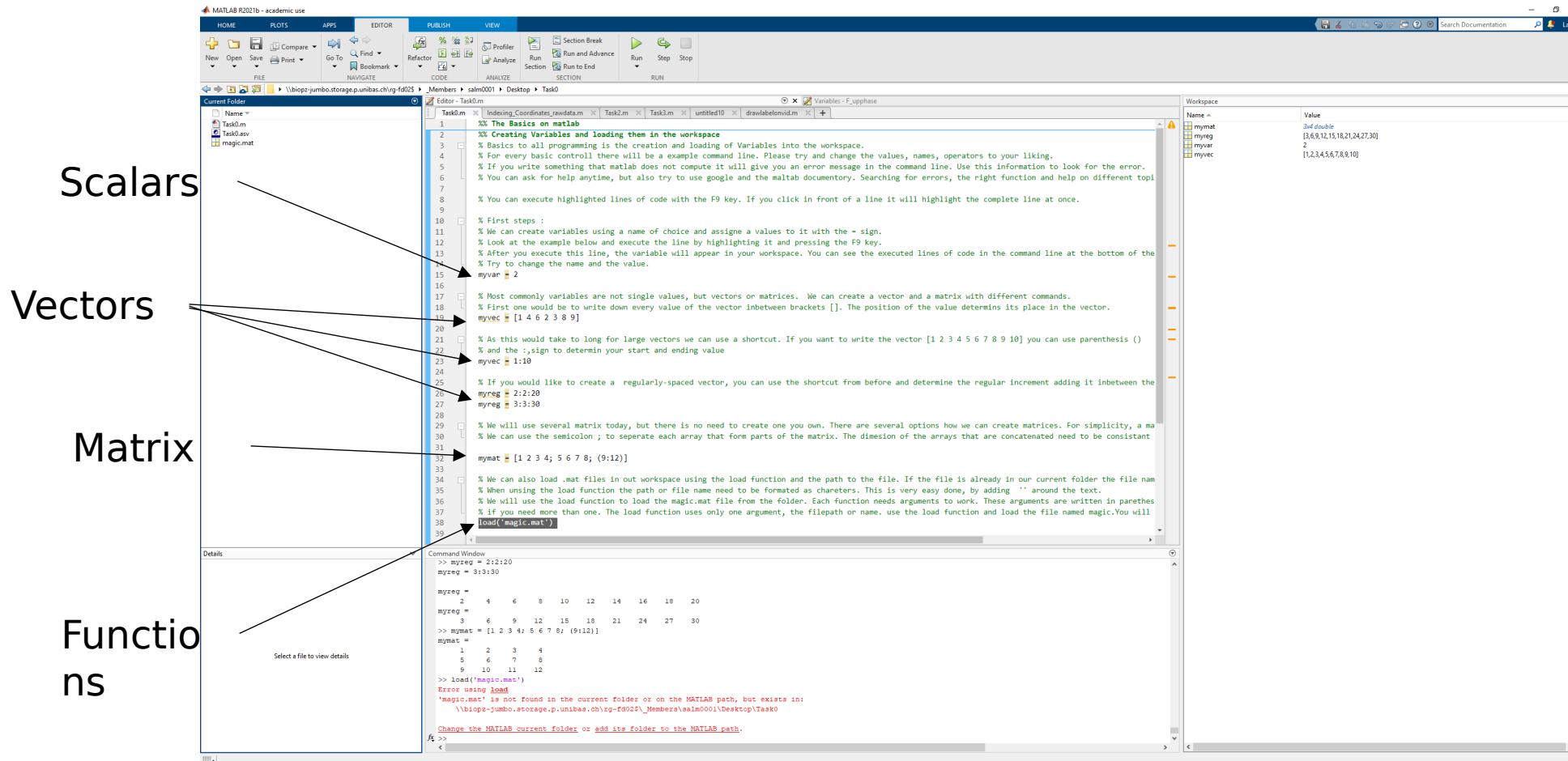
Current folder



Editor window

Command  
window

# Processing raw data with Matlab to find Place Cells



- Find github link here