



QUESTIONS

- How can Python be used to merge massive amounts of data (6 months), omit duplicate data rows, automatically calculate average accuracy and latency duration in each reversal, and sort by test parameters?
- Can the Python app be versatile to be applicable across different touchscreen tests?
- Can the Python app be utilizable by experiementers with limited programming knowledge by providing error handling for user inputs?

ABSTRACT

Touchscreen tests are one of the breakthrough models of measuring cognitive performance, such as pattern separation and cognitive flexibility, in both animal and human experiments. These tests are effective due to their translational nature and standardized data outputs. While touchscreen tests have standardized data outputs, there does not exist an automated process of easily cleaning raw touchscreen data. The data output file can easily contain thousands of rows and columns, which may take researchers weeks to months to completely analyze. Not only does manually analyzing raw touchscreen data take an unnecessary amount of time and resources, but also it will inevitably produce unwanted human errors. This research explored the question of can Python be used to simplify the touchscreen data analysis process for ABET data. We utilized Pandas, a software library built on top of Python used specifically for data analysis, as the foundation for the project. The DataFrame data structure and other useful functions were also used to extract important parameters from raw data and import them into a presentable comma separated values (CSV) file. The Tkinter package was used to construct a basic graphical user interface with a main menu, multiple sub-menu pages, easy-to-use buttons, and interchangeable criteria materials. As a result, the application significantly simplified and automated the touchscreen data analysis process for ABET touchscreen data. All the user has to do is click a button based on their desired functionality, locate the directory of the raw touchscreen data, and save the newly created CSV file in another directory. The newly created CSV file contains important parameters such as the percent correct, session duration, and number of trials for the first and second reversal. Additional parameters include the average latencies of reward collections, correct touches, and incorrect touches. The extracted CSV file can then be used to assess performance of tasks using graphing programmings such as Prism. The creation of a touchscreen data analysis application can transform the efficiency of data analysis within the touchscreen community. The data analysis application can be used across multiple ABET touchscreen tests such as General Touchscreen, Location Discrimination Reversal, Acquisition, and Extinction. Members of the touchscreen community who may not have programming experience can pilot the application and change the criterias to fit their own research. This data analysis application is available on my GitHub (raymon-shi) and may be downloaded and shared to members of the touchscreen community for their personal

The touchscreen (TS) operant chamber used to perform tests that measure rodent cognitive performance, such as pattern separation and cognitive flexibility.



Lafayette Instrument: Model 80614

An example of TS test paradigms is the location discrimination reversal (LDR) test. Rodents are challenged to choose the correct lit window in order to receive a reward. After a set amount of trials, the position of the correct side is reversed.



TS tests are effective due to their translational nature and standardized data outputs.



Experimental rodent touchscreen results can be used to solve similar cognitive problems in humans.

Long experiments generate raw output data that contains thousands of rows and columns. Manually analyzing the data takes a tremendous amount of time (weeks/months) and resources.

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9 24	213.339	195.443	169.102	109.09	90.557	1	18	9	4	2	0	50	1800	38	1800		:37.175	-16T08:36:3	1800 2021-06	81	006Ket1	To Ket1 L	1 ABET II TO	8:36	6/16/2021 8:	use LD Chamber1
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5 21	170.245	147.32	88.029	59.935	29,447	0	19	21	13	10	6	45	1800	40	1800		:13.285	-15T08:38:1	1800 2021-06	81	00€Ket1	To Ket1 L	1 ABET II TO	8:37	6/15/2021 8:	use LD Chamber1
7 1	108.597	87.133	64.547	44.534	28.785	1	24	10	5	2	2	57.143	1800	49	1800		:47.731	-14T08:55:4	1800 2021-06	81	00fKet1	o Keti L	1 ABET II TO	8:55	6/14/2021 8:	use LD Chamber1
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6 1	126.996	103.599	70.942	50.53	29.379	1	135	20	12	20	1	54.839	1800	31	1800		:50.508	-17T08:37:5	1800 2021-06	81	00 Ket1	To Ket1 L	2 ABET II TO	8:37	6/17/2021 8:	ouse LD Chamber2
4 14	121.864	99.631	64.627	50.2	25.101	1	101	19	27	9	8	41.463	1800	41	1800		:37.275	-16T08:36:3	1800 2021-06	81	00 Ket1	o Ket1_L	2 ABET II TO	8:36	6/16/2021 8:	use LD Chamber2
						0	0	0	0	0	0	0	145.47	0	145.47		:32.588	-16T08:29:3	1800 2021-06	81	00 Ket1	To Ket1 L	2 ABET II TO	3:29	6/16/2021 8:	use LD Chamber2
5 20	173.65	151.767	52.281	36.403	21.279	2	37	8	5	6	13	42.222	1800	45	1800		:13.386	-15T08:38:1	1800 2021-06	81	006Ket1	o Keti L	2 ABET II TO	8:38	6/15/2021 8:	use LD Chamber2
4 20	178.224	158.636	135.065	48.213	29.167	0	24	5	12	4	5	57.895	1800	38	1800		:47.831	-14T08:55:4	1800 2021-06	81	00 Ket1	To Ket1_U	2 ABET II TO	8:55	6/14/2021 8:	use LD Chamber2
						0	0	0	0	0	0	0	117.266	0	117.266		:53.758	-17108:26:5	1800 2021-06	81	00€Ket1	To Ket1 L	2 ABET II TO	8:26	6/17/2021 8:	use LD Chamber2
8 21	169.638	132.846	110.497	70.827	29.35	2	61	31	74	21	16	60.976	1800	41	1800		:50.609	-17T08:37:5	1800 2021-06	81	00 Ket1	o Ket1 L	3 ABET II TO	B:37	6/17/2021 8:	use LD Chamber3
8 128	1218.128	472.519	431.307	189.247	115.983	0	67	17	46	9	4	38,462	1800	13	1800		:37.376	-16T08:36:?	1800 2021-00	81	OCKet1	To Ket1 L	3 ABET II TO	3:36	6/16/2021 8:	use LD Chamber3
			125,441	96.762	49.012	0	0	3	0	2	0	66.667	145.373	3	145.373		:32.689	-16T08:29:?	1800 2021-06	81	006Ket1	To Ket1 L	3 ABET II TO	8:29	6/16/2021 8:	ouse LD Chamber3
2 24	221.012	203.184	184.809	52.011	27.257	0	69	15	25	5	14	14.286	1800	21	1800		:13.486	-15T08:38:7	1800 2021-00	81	OCKet1	o Ket1 L	3 ABET II TO	8:38	6/15/2021 8:	use LD Chamber3
7 26	236.87	212.562	157.209	121.118	79.699	1	57	30	61	20	32	35.897	1800	39	1800		:47.931	-14T08:55:4	1800 2021-06	81	00€Ket1	To Ket1 L	3 ABET II TO	8:55	6/14/2021 8:	use LD Chamber3
					25.948	0	0	0	0	0	0	0	117.165	1	117.165		:53.858	-17T08:26:5	1800 2021-06	81	006 Ket1	o Keti L	3 ABET II TO	8:26	6/17/2021 8:	use LD Chamber3
4 23	200.104	178.997	157.64	90.127	61.954	0	61	68	25	1	10	60.526	1800	38	1800		:50.710	-17108:37:5	1800 2021-00	81	00 Ketl	To Ket1 L	4 ABET II TO	3:37	6/17/2021 8:	use LD Chamber4
9 27	255.119	222.804	174,465	59,423	30.343	2	31	64	43	14	15	56.863	1800	51	1800		:37.477	-16T08:36:3	1800 2021-06	81	006 Ket1	To Ket1 L	4 ABET II TO	8:36	6/16/2021 8:	use LD Chamber4
						0	0	0	0	0	0	0	145.264	0	145.264		:32.790	-16T08:29:?	1800 2021-06	81	00 Ket1	o Ket1 L	4 ABET II TO	3:29	6/16/2021 8:	use LD Chamber4
5 26	235,425	209,46	140,23	69,714	38.828	0	47	31	33	26	4	42.5	1800	40	1800		:13.587	-15T08:38:1	1800 2021-06	81	006Ket1	To Ket1 L	4 ABET II TO	3:38	6/15/2021 8:	use LD Chamber4
7 15	139.47	106.343	89.091	63,939	37.098	1	32	16	29	11	33	59.091	1800	44	1800		:48.032	-14T08:55:4	1800 2021-00	81	00fKet1	o Keti L	4 ABET II TO	8:55	6/14/2021 8:	use LD Chamber4
					0.001	0	0	0	0	0	0	0	117.091	0	117.091		:53.958	-17108:26:5	1800 2021-00	81	OCKet1	To Ket1 L	4 ABET II TO	3:26	6/17/2021 8:	use LD Chamber4
2 33	140,802	116.54	91.855	78,761	20,907	1	10	9	10	6	5	31.818	1800	44	1800		:48,411	-17109:19:4	1800 2021-06	81	00€Ket3	To Ket3 L	9 ABET II TO	9:19	6/17/2021 9:	use LD Chamber
8 15	131.78	106.341	62.309	43.603	25.929	1	25	30	17	5	4	50.943	1800	53	1800		:23.220	-16T09:18:2	1800 2021-06	81	00 Ket3	To Ket3 L	9 ABET II TO	9:18	6/16/2021 9:	use LD Chamber1
5 12	102.645	82.054	65.096	42,421	23.887	1	57	31	33	24	11	52.941	1800	68	1800		:55,908	-15T09:19:5	1800 2021-00	81	00€Ket3	To Ket3 L	9 ABET II TO	9:19	6/15/2021 9:	use LD Chamber]
7 10	92.087	74,466	60.327	41.385	22,389	2	35	33	39	39	21	52.857	1800	70	1800		:38,476	-14T09:40:?	1800 2021-00	81	006 Ket3	To Ket3 L	9 ABET II TO	9:40	6/14/2021 9:4	use LD Chamber1
8 48	362.018	220.595	190.033	132.731	103.81	0	10	11	6	4	5	54.545	1800	22	1800		:48.512	-17109:19:4	1800 2021-00	81	OC Ket3	To Ket3 L	10 ABET II TO	9:19	6/17/2021 9:	use LD Chamber2
4 40	385,114	309,446	193,753	48,603	23.869	1	15	4	10	0	8	36,364	1800	22	1800		:23,320	-16T09:18:7	1800 2021-06	81	00€Ket3	To Ket3 L	10 ABET II TO	9:18	6/16/2021 9:	use LD Chamber2
8 45	418.688	261.391	230.717	186.559	33.036	1	13	4	19	1	0	52.381	1800	21	1800		:56.009	-15T09:19:5	1800 2021-06	81	00 Ket3	To Ket3 L	10 ABET II TO	9:19	6/15/2021 9:	use LD Chamber2
3 17	152.073	127.334	98.174	72.835	16.135	0	25	11	5	8	2	32.143	1800	28	1800		:38.577	-14109:40:2	1800 2021-00	81	OCEKet3	To Ket3 L	10 ABET II TO	9:40	6/14/2021 9:4	use LD Chamber2
4 45	344,944	295.014	221.337	176.93	56.821	1	58	18	10	9	10	52	1800	25	1800		:48.613	-17109:19:4	1800 2021-06	81	00€Ket3	To Ket3 L	11 ABET II TO	9:19	6/17/2021 9::	use LD Chamber3
1 36	340.01	307.451	113.522	66.553	35.001	1	153	14	11	5	1	56.522	1800	23	1800		:23.420	-16T09:18:2	1800 2021-00	81	OC Ket3	To Ket3 L	11 ABET II TO	9:18	6/16/2021 9:	ouse LD Chamber3
5 1	136,785	110.287	84.858	55,347	32.15	1	230	94	29	21	0	57,143	1800	28	1800		:56,109	-15T09:19:5	1800 2021-06	81	00€Ket3	To Ket3 L	11 ABET II TO	9:19	6/15/2021 9:	use LD Chamber3
5 17	119.875	96.215	70.627	42,768	27,155	0	174	88	27	14	4	34,375	1800	32	1800		:38.677	-14T09:40:?	1800 2021-00	81	00 Ket3	lo Ket3 L	11 ABET II TO	9:40	6/14/2021 9:4	use LD Chamber3
7 2	224.227	196.37	155.193	76.076	47.313	2	18	10	11	1	4	64.583	1800	48	1800		:48.713	-17109:19:4	1800 2021-00	81	00 Ket3	To Ket3 L	12 ABET II TO	9:19	6/17/2021 9:	use LD Chamber4
2 18	151.322	102.026	50.082	28,961	0.001	1	21	23	57	0	2	51.02	1800	49	1800		:23,520	-16T09:18:2	1800 2021-06	81	00€Ket3	To Ket3 L	12 ABET II TO	9:18	6/16/2021 9::	use LD Chamber4
7 28	259.137	201.785	157.963	27.988	0.001	1	43	16	35	12	3	46.939	1800	49	1800		:56.209	-15T09:19:5	1800 2021-00	81	00 Ket3	To Ket3 L	12 ABET II TO	9:19	6/15/2021 9:	use LD Chamber4
9 15	95.189	63.081	42.806	23.012	0.001	1	18	3	14	2	7	40,909	1800	44	1800		:38,777	-14T09:40:?	1800 2021-00	81	00€Ket3	To Ket3 L	12 ABET II TO	9:40	6/14/2021 9:4	use LD Chamber4
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					0.001	0	0	0	0	0	0	0	1800	0	1800		:03.942	-16T10:08:0	1800 2021-00	81	OCKet5	To Ket5 L	17 ABET II TO	0:07	6/16/2021 10:0	use LD Chamber]
						0	0	0	0	0	0	0	1800	0	1800		17.649	-15T10:01:1	1800 2021-06	81	Of Ket5	To Kets II	17 ABET IL TO	0:01	6/15/2021 10:1	use ID Chamber1

A screenshot of a small portion of raw touchscreen data.

Python is a high-level versatile scripting language used for web development, data analysis and visualization, machine learning, desktop graphic user interfaces (GUIs), and software development.



Pandas is an open source data analysis library available on the Python platform. It has many useful features such as the DataFrame data structure, the ability to read and write data from multiple sources, and the ability to easily manipulate data.



Streamlined Analysis for Convoluted Rodent Touchscreen Data by Building a Customized Python Application

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APPROACH

- Built in coding for merging raw data files, omitting duplicate data, extracting and calculating parameters from raw data, and producing a CSV file with the organized data using <u>Pandas</u>.
- Built a graphical user interface with a main menu, sub-menus per touchscreen test paradigm, and multiple buttons with different functionalities using the <u>Tkinter package</u>.
- Provided error handling by anticipating user input errors and providing descriptive explanations for the cause of errors using **Python** error exception handling.

A Brand New Automa Simply provide the application with raw save the organized CSV file in a 19.447 59.935 88.029 147 18.785 44.534 64.547 87. 9.379 50.53 70.942 103.599 5.101 50.2 64.627 99.631 279 36.403 52.281 151.767 167 48.213 135.065 158.636 ↑ 📑 → This PC → Documents → CHOP Related Work → TS Raw Data → Habituation → 🔹 🛧 📙 > This PC > Documents > Test 4/1/20 4/5/20 3/6/2021 2:21 PM 3/3/2021 6:03 PM Microsoft Exce 4/19/20 4/19/20 4/20/20 4/21/20 4/22/20 4/22/20 4/23/20 4/26/20 4/27/20 3/19/20 8/2/2021 12:21 AM Microsoft Excel C 💻 This PC test15 new version 8/2/2021 12:01 AM Microsoft Excel C 🚔 Network Folder: Hab 1 Save Cance **Analyzes Several Different Touck General TS Training** LDR Train and Enter the criteria as n days/n+1 days: Habituation Enter the min reversal number req: Habituation 2 Initial Touch (All) LD Train (All) Initial Touch (First Day) LD Train (Select Day) Must Touch (All) LD Probe (Last Day Difficulty All) Must Touch (First Day) LD Probe (Select Day) Enter the min reg trial amount LD Probe (Select ID) Enter the min % correct for first day: LD Probe (Select Block) Enter the min % correct for second day Punish Incorrect (All) LD Probe (Last Day All Avg) Punish Incorrect (First Day) LD Probe (Block Avg) Punish Incorrect (Last Day)

Specialized Data Sorting Based on Difficulty, Test Trial Day, and Animal ID

Main Menu

LD Probe (ID Avg)

NumberO	PercentCo	NumberO	Day	Туре	ID	Date
2	59.649	57	2	easy	1	5/18/2021
1	38.776	49	2	hard	2	5/18/2021
0	51.351	37	2	hard	3	5/18/2021
0	58.14	43	2	easy	4	5/18/2021
2	59.42	69	2	easy	5	5/18/2021
1	55.405	74	2	hard	6	5/18/2021
0	24.528	53	2	hard	7	5/18/2021
1	50	54	2	easy	8	5/18/2021
2	56.757	74	2	easy	9	5/18/2021
1	64.286	14	2	hard	10	5/18/2021
0	38.462	26	2	hard	11	5/18/2021
1	58.333	60	2	easy	12	5/18/2021
2	65.217	46	2	easy	13	5/18/2021
2	51.429	70	2	hard	14	5/18/2021
1	53.333	45	2	hard	15	5/18/2021
0	25	24	2	easy	16	5/18/2021
5	64.103	78	2	easy	17	5/18/2021
2	66.667	42	2	hard	18	5/18/2021
1	55.882	34	2	hard	19	5/18/2021
2	50	60	2	easy	20	5/18/2021
2	53.191	47	2	easy	21	5/18/2021
2	53.165	79	2	hard	22	5/18/2021
1	41.667	48	2	hard	23	5/18/2021
1	40	20	2	easy	24	5/18/2021
1	46.296	54	2	easy	25	5/18/2021
1	65.217	23	2	hard	26	5/18/2021
0	40.909	22	2	hard	27	5/18/2021
0	33.333	27	2	easy	28	5/18/2021
1	42.105	38	2	easy	29	5/18/2021
1	48	50	2	hard	30	5/18/2021

Punish Incorrect (Select Day)

Punish Incorrect (Select ID)

Sorting by uniculty separates the LDR **Probe difficulties (easy/hard) and the LDR** Train difficulty (intermediate).

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Sorting by day will show all the animal data rows for the selected day.

RESULTS

- Programmed a user-friendly app that can analyze different touchscreen tests (i.e. general touchscreen train, location discrimination train and test, extinction tests).
- Sorting output based on test parameters (i.e. difficulty, test day, animal ID, or block number) within the same test paradigm. • The app has the ability to have interchangeable criteria values
- for different test paradigms (i.e. completed days, omission #, or reversal #).
- The app explicitly handles input errors via descriptive error messages.

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nberO	PercentCc Nu	NumberO	Day	Туре	ID	Date	NumberO	PercentCc	berO
4	57.895	57	1	easy	21	5/17/2021	0	45	40
2	53.191	47	2	easy	21	5/18/2021	2	42.222	45
0	33.333	27	3	hard	21	5/19/2021	0	14.286	21
0	59.375	32	4	hard	21	5/20/2021	0	42.5	40
3	60.784	51	5	easy	21	5/21/2021	2	50.943	53
2	55.385	65	6	easy	21	5/24/2021	1	40.58	69
1	54.286	35	7	hard	21	5/25/2021	1	49.091	55
1	34.884	43	8	hard	21	5/26/2021	2	54.545	44
4	61.765	68	9	easy	21	6/14/2021	1	52.941	68
1	29.63	27	10	easy	21	6/15/2021	1	52,381	21
0	58.824	34	11	hard	21	6/16/2021	1	57,143	28
1	35.294	34	12	hard	21	6/17/2021	1	46,939	49
2	45.455	44	13	easy	21	6/18/2021	2	41.026	39
3	60.317	63	14	easy	21	6/21/2021	1	42 593	54
0	37.5	24	15	hard	21	6/22/2021	1	50	36
0	36	25	16	hard	21	6/23/2021	1	19	25
2	68.182	44	17	easy	21	6/24/2021	1	90	45
2	56.522	46	18	easy	21	6/25/2021	1	57.770	24
1	45.283	53	19	hard	21	6/28/2021	2	52,541	54
2	50.909	55	20	hard	21	6/29/2021	3	52.032	57
3	58.182	55	21	easy	21	6/30/2021	1	29.63	27
4	71.014	69	22	easy	21	7/1/2021	2	56.962	/9
2	50	66	23	hard	21	7/2/2021	2	52.83	53
2	54.286	70	24	hard	21	7/5/2021	0	56	25
5	59.459	74	25	easy	21	7/7/2021	3	57.778	45
4	70.769	65	26	easy	21	7/8/2021	0	10	10
2	58.182	55	27	hard	21	7/9/2021	1	62.791	43
2	47.541	61	28	hard	21	7/12/2021	0	37.5	24
5	61.667	60	29	easy	21	7/13/2021	0	32	25
6	70.13	77	30	easy	21	7/15/2021	1	42.857	56

Sorting by animal ID will show all the data rows for the selected animal ID

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Conclusions/Future Directions

- A formal automated process for cleaning touchscreen data can significantly improve productivity within the touchscreen community.
- The creation of a manuscript to introduce the automated process with the rest of the touchscreen community.
- (i.e. MouseBytes)
- (raymon-shi)

We acknowledge the support of former and current members of the Eisch Lab. SY was supported by an NIH Institutional Training Grant (MH076690, PI: CA Tamminga), NNX15AE09G (PI AJE), MH107945 (PI AJE), a 2018 PENN McCabe Pilot grant, a 2019 IBRO travel grant, and is currently supported by 2019 NARSAD Young Investigator Grant from the Brain and Behavior Research Foundation, 2020 a PENN Undergraduate Research Foundation grant, and a 2021 NASA HERO grant (80NSSC21K0814)."

- References (2021): 107443. https://doi.org/10.1038/nprot.2013.124
- Lafayette Instruments, . 80614-LD Location Discrimination (LD) Task for Mouse Touch Screen Systems and ABET II (2 x 6 Mask Version). 2011





IMPLICATION

- Significantly reduced the amount of time and resources used for the touchscreen data analysis.
- Minimized human errors produced during manual calculations.
- Enabled easy data sharing with the organized output as a CSV file.

terchangeable Test Criterias





• Sharing the application and code with the open-science touchscreen data platform

• The code is open-source and available for anyone on my personal GitHub

ACKNOWLEDGEMENTS/REFERENCES

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