

Data preprocessing

We got all the data in txt format recorded by Fractions Lab. These txt files were loaded in 6 folders. Respectively, these files in 6 folders corresponded to the behavior records of students in 6 classes.

Here I aggregated behavior records for all students in each class, and finally got 6 data frames in python. All these data frames were used for the further analysis and the preliminary results are showing below.

I found some students' online duration is weird. For example, in Yanshan School, student Ya-4 had only one record in DataFrame, so I deleted this student. Besides, I found some students' behaviors happened in March, I revised these date time to fit into April for data in Changping school (the first school).

Basic statistic for student and behavior in each class

School	Class	No. of student	No. of behavior	No. of behavior per student
Changping	Class A	30	41617	1387.23
	Class B	26	26419	1016.12
Jinding	Class A	35	48924	1397.83
	Class B	33	46558	1410.85
Yanshan	Class A	33	43938	1331.45
	Class B	32	54079	1689.97

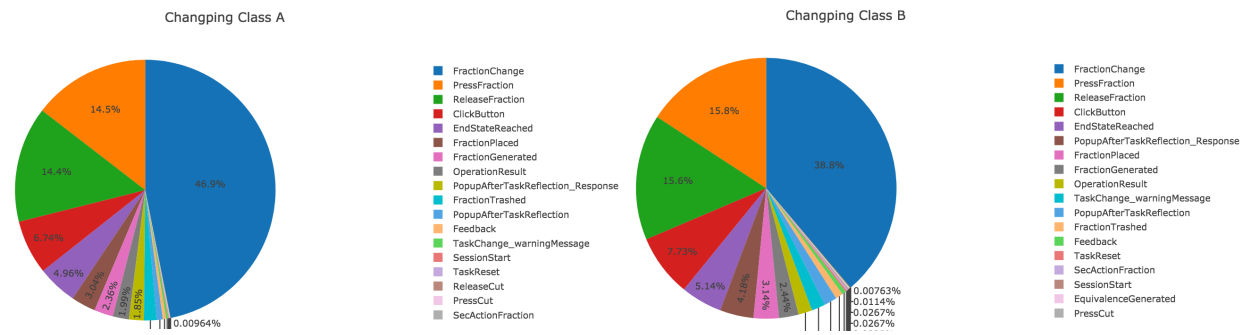
Type of fraction tool student used most

We found that 'Liquid' fraction is the most popular in student choice. They tried to use this type of fraction (with water in beaker) to understand the meaning of fraction, to see the relationship between value and volume. It probably this kind of component is closer to their real life. Besides, 'Line' and 'Rectangle' are also chosen by many students.

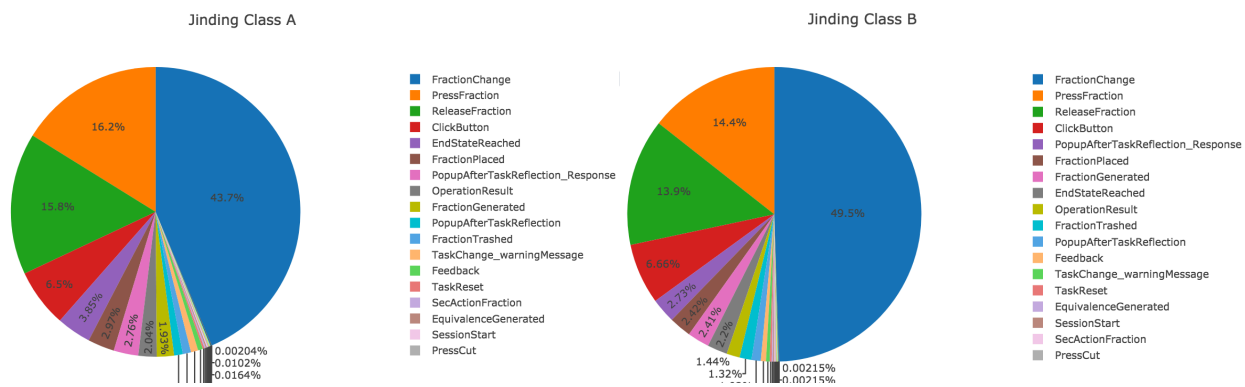
School	Class	No. of FractionGenerated	Top 3 type of fraction tool	No. (%) of fraction tool
Changping	Class A	978	Liquid	417 (42.6%)
			Line	290 (29.7%)
			Heartset	79 (8.1%)
	Class B	641	Vrect	195 (30.4%)
			Liquid	154 (24.0%)
			Line	136 (21.2%)
Jinding	Class A	942	Liquid	250 (26.5%)
			Vrect	246 (26.1%)
			Line	227 (24.1%)
	Class B	1122	Liquid	443 (39.5%)
			Line	264 (23.5%)

			Vrect	189 (16.8%)
Yanshan	Class A	1103	Vrect	486 (44.1%)
			Liquid	261 (23.7%)
			Hrect	112 (10.2%)
	Class B	882	Liquid	285 (32.3%)
			Vrect	200 (22.7%)
			Line	115 (13.0%)

% of behavior type in Changping school

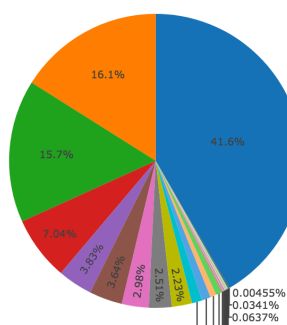


% of behavior type in Jinding school

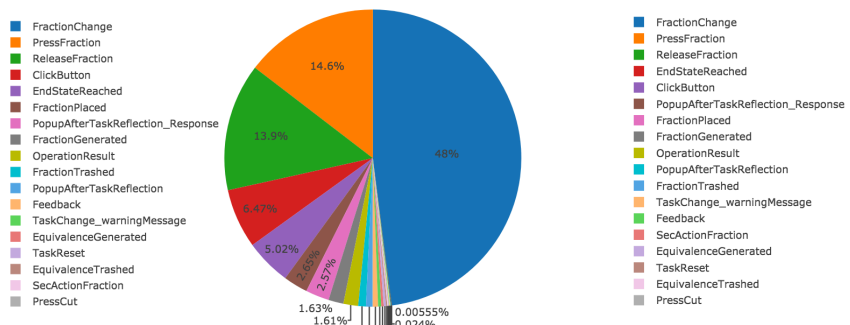


% of behavior type in Yanshan school

Yanshan Class A



Yanshan Class B



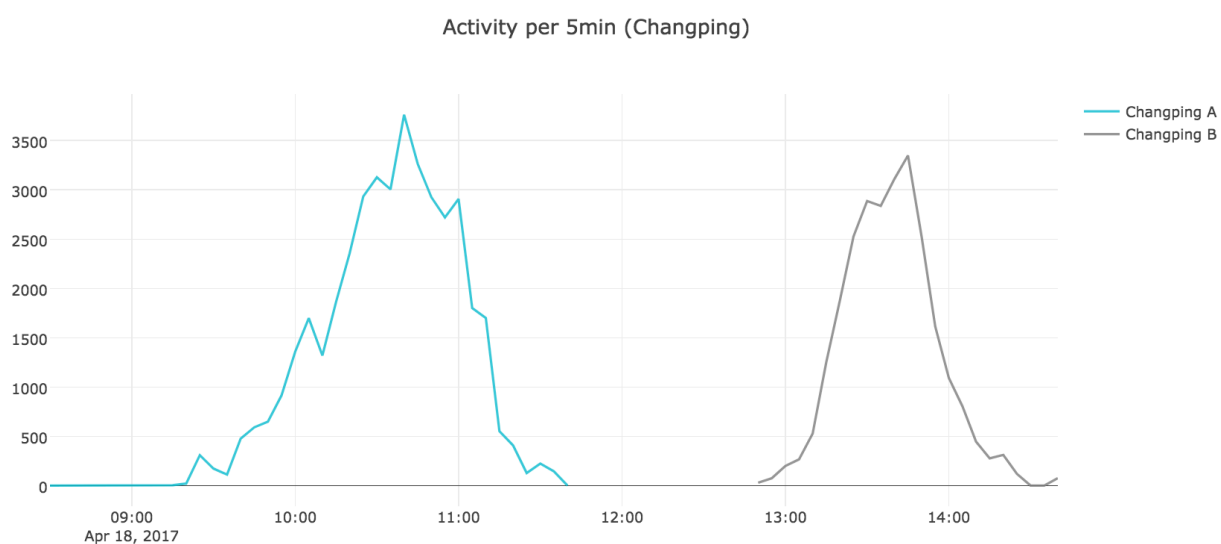
Activity in class

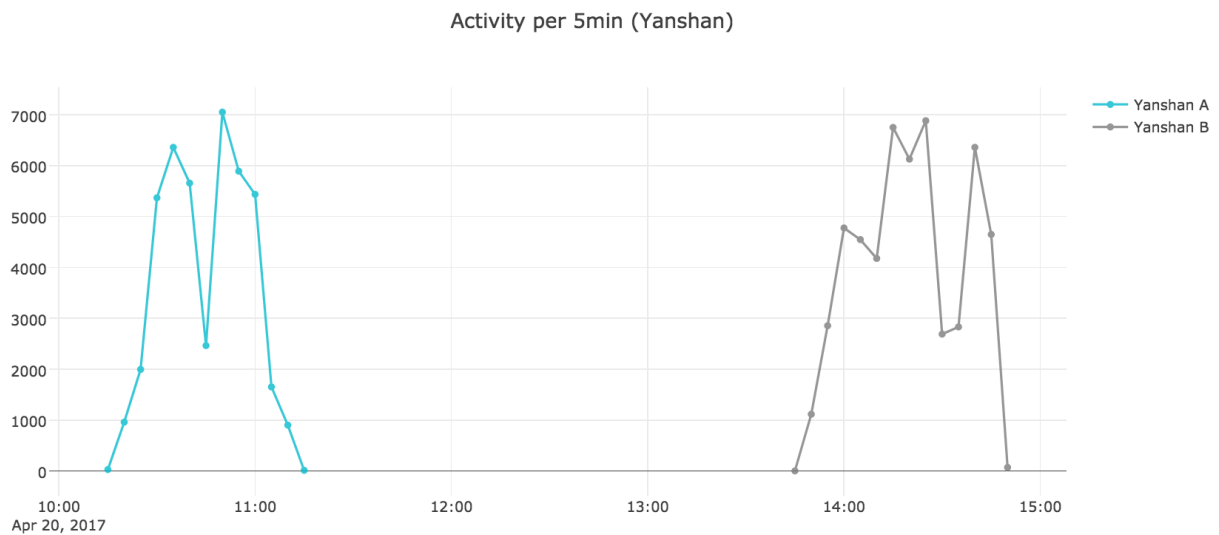
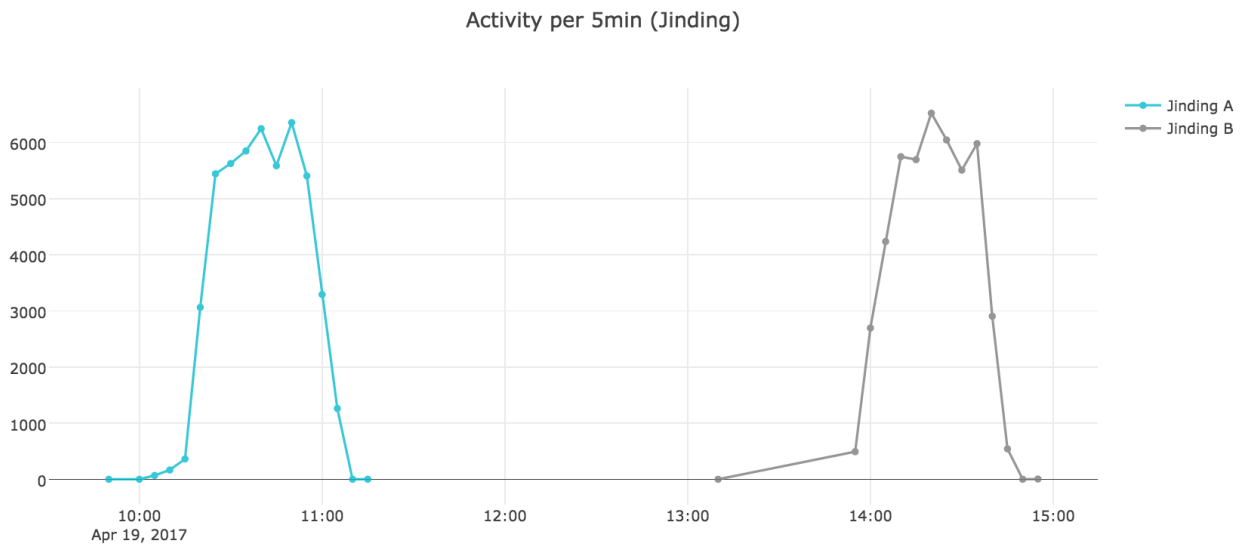
We calculate the degree of students' activity by sum up the number of behavior per 5 min for each class. Blue lines represent the morning classes and grey lines represent the afternoon classes.

I found that dataset of 'Changping A' contained some behavior records in 2017/3/18, and dataset of 'Changping B' contained some behavior records in 2017/3/18 and 2017/5/19. Thus, in the part of data cleaning, I summed up the number of behaviors after deleting these records (rows).

Commonly, students' activities reached a peak in the second half of the courses (See Changping and Jinding). However, it is interesting that students' activity in Yanshan school had two peaks, that might cause by the instruction of teachers or experimenter.

It is worth noting that active level in Jinding school keep a high degree for about half an hour after reaching a peak. Meanwhile, active level in other schools fell down very fast once it reached a peak.





Achievement in different school

In the experiment in school, we had two quizzes, pre-quiz and post-quiz. Each quiz had 6 items. Experimenter asked each student to choose one right answer. If student had taken the right answer, they would have gotten one point. Thus, for each quiz, the highest score was 6 and the lowest score is 0.

Here I summed up the total score for each student in each quiz, named these two variables as sum_A (pre-quiz) and sum_B (post-quiz). Then I compared these values in same school respectively, and also compared between different school. The descriptive statistic is showed in the descriptive table.

Descriptives

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
sum_A Changping Machikou Central Primary School	64	1.688	1.2068	.1508	1.386	1.989	.0	5.0
No.2 Primary School in Jinding Street	68	2.529	1.3211	.1602	2.210	2.849	.0	5.0
Yanshan Qianjin No.2 Primary School	65	2.631	1.1802	.1464	2.338	2.923	.0	5.0
Total	197	2.289	1.3025	.0928	2.106	2.472	.0	5.0
sum_B Changping Machikou Central Primary School	64	3.109	1.5748	.1968	2.716	3.503	.0	5.0
No.2 Primary School in Jinding Street	68	3.044	1.3652	.1656	2.714	3.375	.0	5.0
Yanshan Qianjin No.2 Primary School	65	3.477	1.2388	.1537	3.170	3.784	.0	6.0
Total	197	3.208	1.4042	.1000	3.011	3.405	.0	6.0

In the one-way ANOVA analysis for students' pre-quiz score in different schools, the results showed that $F_{(2,194)} = 11.294$, $P < 0.001$. It means students' pre-quiz scores differ significantly from different schools. But in the one-way ANOVA analysis for students' post-quiz score in different schools, the result showed that $F_{(2,194)} = 1.828$, $P > 0.05$. It means that students' post-quiz score had no significant difference between different schools (See ANOVA table).

As for pre-quiz, score of students in Machikou Central Primary school is significantly lower than the other two schools. Between No.2 Primary School in Jinding Street and Yanshan Qianjin No.2 Primary School, score of students have no significant difference (See multiple comparisons table).

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
sum_A Between Groups	34.678	2	17.339	11.294	.000
Within Groups	297.830	194	1.535		
Total	332.508	196			
sum_B Between Groups	7.150	2	3.575	1.828	.163
Within Groups	379.317	194	1.955		
Total	386.467	196			

Multiple Comparisons

Dependent Variable	(I) School	(J) School	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
sum_A LSD	Changping Machikou Central Primary School	No.2 Primary School in Jinding Street	-.8419 [*]	.2158	.000	-1.268	-.416
		Yanshan Qianjin No.2 Primary School	-.9433 [*]	.2182	.000	-1.374	-.513
	No.2 Primary School in Jinding Street	Changping Machikou Central Primary School	.8419 [*]	.2158	.000	.416	1.268
		Yanshan Qianjin No.2 Primary School	-.1014	.2149	.638	-.525	.323
	Yanshan Qianjin No.2 Primary School	Changping Machikou Central Primary School	.9433 [*]	.2182	.000	.513	1.374
		No.2 Primary School in Jinding Street	.1014	.2149	.638	-.323	.525