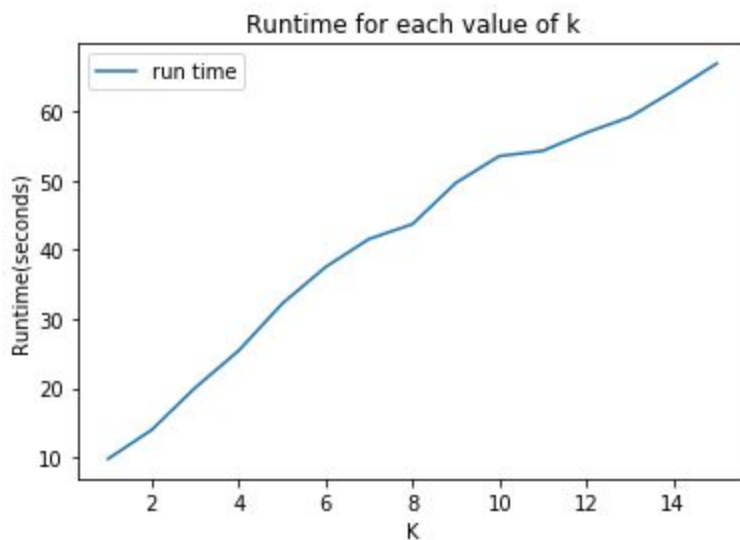


- 1.
2. Based on the SSE plot, the knee point would be $k=6$ due to the graph levelling off after that.



3.
 - a. The time to run seems to be very near linear with regards to k
4. Tables are at the bottom, since there is a lot there
5. My stopping criteria for the inner loop was "was the SSE last loop less than 10% larger than the new SSE?"
6. The hardest part of getting everything working was that i failed to see a solution i didnt hate to sort the clusters by size while tracking which cluster in the sorted list belongs to which "center"
7. I learned that running this code thousands of times takes a while. Yes i will likely remember kmeans at least until the end of the semester, maybe a few months longer.

ID	A1	A2	A3	A4	Size	SSE
1	53.5	53.5	53.5	53.5	836	1252267.8098600477

ID	A1	A2	A3	A4	Size	SSE
1	30.0	60.7	59.4	52.7	397	313223.33180352615
2	74.8	47.0	48.2	54.2	439	455329.4803881548

ID	A1	A2	A3	A4	Size	SSE
1	83.0	75.4	33.4	48.9	153	18027.415205228757
2	70.4	31.8	56.1	57.1	286	173960.97661678315
3	30.0	60.7	59.4	52.7	397	313223.33180352615

ID	A1	A2	A3	A4	Size	SSE
1	13.0	50.3	39.9	51.8	140	16961.011410000003
2	83.0	75.4	33.4	48.9	153	18027.415205228757
3	39.3	66.3	70.0	53.2	257	128069.9671463034
4	70.4	31.8	56.1	57.1	286	173960.97661678315

ID	A1	A2	A3	A4	Size	SSE
1	52.6	20.5	41.0	53.5	119	12902.902376470593
2	13.0	50.3	39.9	51.8	140	16961.011410000003
3	83.0	75.4	33.4	48.9	153	18027.415205228757
4	83.0	39.9	66.8	59.6	167	21866.23608862274
5	39.3	66.3	70.0	53.2	257	128069.9671463034

ID	A1	A2	A3	A4	Size	SSE
1	34.4	73.5	62.7	71.3	118	13198.9688059322
2	52.6	20.5	41.0	53.5	119	12902.902376470593
3	12.8	50.2	39.9	51.7	139	15924.037385611506
4	43.3	60.2	76.0	38.0	140	17246.54308142858
5	83.0	75.4	33.4	48.9	153	18027.415205228757
6	83.0	39.9	66.8	59.6	167	21866.23608862274

ID	A1	A2	A3	A4	Size	SSE
1	79.4	36.1	68.2	63.0	63	6572.416580952381
2	85.2	42.2	66.0	57.5	104	11075.111873076927
3	34.4	73.5	62.7	71.3	118	13198.9688059322
4	52.6	20.5	41.0	53.5	119	12902.902376470593
5	12.8	50.2	39.9	51.7	139	15924.037385611506
6	43.3	60.2	76.0	38.0	140	17246.54308142858
7	83.0	75.4	33.4	48.9	153	18027.415205228757

ID	A1	A2	A3	A4	Size	SSE
1	78.6	35.5	66.1	62.3	59	6685.9045080994865
2	82.7	76.8	35.3	44.5	74	7118.945968017776
3	83.4	74.1	31.5	53.2	79	7218.078265664037
4	85.2	42.1	67.2	58.3	108	11098.538035208168
5	34.4	73.5	62.7	71.3	118	13198.9688059322
6	52.6	20.5	41.0	53.5	119	12902.902376470593
7	12.8	50.2	39.9	51.7	139	15924.037385611506
8	43.3	60.2	76.0	38.0	140	17246.54308142858

ID	A1	A2	A3	A4	Size	SSE
1	39.6	63.7	75.1	40.7	61	6569.648649694444
2	82.6	76.8	34.9	43.8	69	6702.682576698598
3	46.1	57.6	76.7	36.0	79	7128.720866640626
4	81.9	38.6	62.9	62.7	81	8756.6448040927
5	83.4	74.3	32.1	52.9	84	7628.475573336943
6	84.0	41.0	70.3	56.9	86	9035.259146963763
7	34.4	73.5	62.7	71.3	118	13198.9688059322
8	52.6	20.5	41.0	53.5	119	12902.902376470593
9	12.8	50.2	39.9	51.7	139	15924.037385611506

ID	A1	A2	A3	A4	Size	SSE
1	79.3	35.7	68.1	64.0	48	4331.230084319524
2	40.2	65.0	75.6	42.2	48	5197.2454391304345
3	83.4	40.5	60.9	57.7	52	4226.970565282583
4	85.7	42.9	70.5	57.6	67	6386.898878100589
5	80.6	72.5	31.3	52.2	69	6552.109192273672
6	84.7	77.4	34.8	46.7	84	8318.226944970414
7	44.8	57.9	76.2	36.0	92	8607.69962842915
8	34.4	73.5	62.7	71.3	118	13198.9688059322
9	52.6	20.5	41.0	53.5	119	12902.902376470593
10	12.8	50.2	39.9	51.7	139	15924.037385611506

ID	A1	A2	A3	A4	Size	SSE
1	41.7	66.5	76.9	42.5	42	4013.675892105264
2	14.3	44.5	38.1	50.5	48	3755.3906125396093
3	31.1	74.9	60.8	73.9	56	5841.566388892846
4	37.2	72.4	64.3	69.2	62	4898.223969159763
5	82.3	77.5	35.1	44.4	71	6884.216067254776
6	85.1	44.0	67.9	57.5	80	8022.99557973081
7	83.6	73.7	31.9	52.7	82	7497.1136214852595
8	81.1	36.2	65.8	61.5	87	9759.167996720043
9	12.1	53.1	40.8	52.3	91	9389.103372164462
10	43.9	57.9	75.7	36.3	98	9929.376379565556
11	52.6	20.5	41.0	53.5	119	12902.902376470593

ID	A1	A2	A3	A4	Size	SSE
1	14.9	43.6	36.6	53.8	41	3022.909064516129
2	88.0	74.3	36.4	51.8	48	4041.7556124999987
3	80.4	74.3	29.7	52.2	51	3476.181799482249
4	81.1	77.5	34.2	43.1	54	4447.908493698826
5	78.8	36.2	67.4	63.8	56	6089.000273214285
6	54.5	18.9	41.8	49.2	56	4782.592517983471
7	48.9	59.2	74.9	37.7	57	5907.639208826448
8	51.0	22.0	40.3	57.2	63	5493.361541357422
9	39.6	60.9	76.7	38.2	83	8223.001556332181
10	12.2	52.1	40.8	51.1	98	10185.302368621396
11	85.1	41.8	66.5	57.5	111	11574.405010810813
12	34.4	73.5	62.7	71.3	118	13198.9688059322

ID	A1	A2	A3	A4	Size	SSE
1	42.2	52.5	77.3	37.5	34	2782.565922666666
2	50.0	61.0	75.2	37.0	42	3284.530467519333
3	80.7	39.2	60.2	58.5	46	4198.168669938015
4	32.9	68.9	66.6	68.1	48	3981.082042187499
5	81.4	38.8	69.0	65.5	51	4943.440893223139
6	80.3	77.4	33.9	43.3	56	4964.037570487717
7	15.7	52.5	39.6	55.6	61	6146.850134423308
8	39.8	63.1	76.0	38.8	64	5814.648957466919
9	85.7	41.3	69.3	55.6	70	5921.236841695505
10	35.0	75.2	61.2	72.5	70	6826.6661240670655
11	10.8	48.5	40.1	48.9	78	6920.802491358025
12	84.5	74.3	33.0	51.9	97	9493.739445089997
13	52.6	20.5	41.0	53.5	119	12902.902376470593

ID	A1	A2	A3	A4	Size	SSE
1	16.5	57.5	41.3	56.7	27	2514.398561111112
2	78.6	36.3	60.6	57.7	31	2664.4798369897953
3	79.4	38.5	69.0	67.0	37	2854.623125154321
4	86.2	74.9	35.8	43.2	38	3671.1501892176198
5	14.3	45.5	37.6	54.6	45	3175.5425768220925
6	84.8	38.0	72.3	55.6	45	3339.9884977777774
7	86.0	43.9	64.2	59.1	54	3995.397760701544
8	79.6	76.7	29.7	47.5	56	4234.621782142858
9	41.4	65.4	75.6	39.8	58	5910.467648836542
10	84.2	74.5	35.3	54.2	59	4614.085573483946
11	11.0	51.4	41.0	48.6	67	5401.005417622351
12	44.6	56.5	76.4	36.7	82	7916.1250653863735
13	34.4	73.5	62.7	71.3	118	13198.9688059322
14	52.6	20.5	41.0	53.5	119	12902.902376470593

ID	A1	A2	A3	A4	Size	SSE
1	51.7	57.8	78.8	35.4	29	2227.9582435
2	50.0	25.3	42.3	59.5	33	2557.1438604800005
3	89.5	75.2	35.6	50.2	45	3690.3297556811413
4	39.5	62.2	78.9	36.3	50	4134.047014266118
5	37.0	70.3	64.9	66.8	50	3514.017160640496
6	82.0	38.8	66.0	65.0	53	4971.250861534042
7	80.6	74.4	30.7	53.6	53	4080.115532075473
8	80.7	76.5	34.2	43.9	55	4323.540557224933
9	84.7	39.5	72.6	56.9	56	5158.798224961525
10	82.3	41.6	61.3	56.4	58	5006.747637024219
11	13.5	55.3	42.1	51.8	60	6318.970087611249
12	43.9	59.1	73.1	40.1	61	6139.428781609466
13	33.1	75.4	61.4	73.6	68	7002.617067164445
14	12.4	47.0	38.5	51.7	79	6816.1971178339645
15	53.3	19.3	40.7	51.9	86	8137.51260586238