

## Experiments:

Kernel Types: "Linear" and "Chi-Squared"; Number of Clusters: 50, 100, and 500

C Parameter: 10, 100, 200, 500; They can be changed on the code.

**Requirements:** Dataset must be downloaded in the same directory with the main.py

**Mean F1 Table(The CSV file is in the zip):**

	C: 10	C: 100	C: 200	C: 500
Kernel: Linear, Cluster Number: 50	0.29	0.34	0.3	0.31
Kernel: Linear, Cluster Number: 100	0.31	0.35	0.37	0.31
Kernel: Linear, Cluster Number: 500	0.12	0.22	0.25	0.29
Kernel: Chi-Squared, Cluster Number: 50	0.36	0.36	0.39	0.39
Kernel: Chi-Squared, Cluster Number: 100	0.41	0.4	0.37	0.42
Kernel: Chi-Squared, Cluster Number: 500	0.29	0.29	0.31	0.35

**Per Class F1 Table(The CSV file is in the zip):**

Title	Kernel: Linear, Cluster Number: 50, C Parameter: 10																					
Class	Faces	airplanes	anchor	backgrou	headphon	snoopy	soccer_ba	strawber	windsor	c_yin_yang	barrel	camera	car_side	dalmatian	ferry	lamp	pizza	pyramid	stop_sign	sunflower	water_lilly	Mean F1 Score
Value	0.41	0.22	0.29	0	0.4	0.56	0	0.5	0.1	0.44	0	0	0	0	0	0	0	0	0	0	0	0.29254
Title	Kernel: Linear, Cluster Number: 50, C Parameter: 100																					
Class	Faces	airplanes	anchor	backgrou	car_side	dalmatian	ferry	headphon	pyramid	snoopy	soccer_ba	stop_sign	strawber	sunflower	water_lilly	windsor	c_yin_yang	barrel	camera	lamp	pizza	Mean F1 Score
Value	0.39	0.32	0.42	0	0.63	0.33	0	0.4	0.14	0.63	0	0.4	0.4	0.4	0.17	0.57	0.58	0	0	0	0	0.34078
Title	Kernel: Linear, Cluster Number: 50, C Parameter: 200																					
Class	Faces	airplanes	anchor	backgrou	camera	car_side	dalmatian	headphon	pizza	pyramid	snoopy	soccer_ba	stop_sign	strawber	sunflower	water_lilly	windsor	c_yin_yang	barrel	ferry	lamp	Mean F1 Score
Value	0.36	0.3	0.44	0	0	0.45	0.38	0.49	0.17	0.08	0.59	0	0.48	0.32	0.32	0	0.58	0.52	0	0	0	0.30436
Title	Kernel: Linear, Cluster Number: 50, C Parameter: 500																					
Class	Faces	airplanes	anchor	backgrou	barrel	car_side	dalmatian	ferry	headphon	pizza	pyramid	snoopy	soccer_ba	stop_sign	strawber	sunflower	water_lilly	windsor	c_yin_yang	camera	lamp	Mean F1 Score
Value	0.46	0.27	0.19	0	0	0.68	0.48	0.1	0.36	0.25	0.14	0.6	0	0.32	0.52	0.36	0.24	0.48	0.48	0	0	0.31193
Title	Kernel: Linear, Cluster Number: 100, C Parameter: 10																					
Class	Faces	airplanes	anchor	backgrou	headphon	snoopy	strawber	yin_yang	barrel	camera	car_side	dalmatian	ferry	lamp	pizza	pyramid	soccer_ba	stop_sign	sunflower	water_lilly	windsor_c	Mean F1 Score
Value	0.39	0.22	0.19	0	0.29	0.33	0.43	0.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0.30673
Title	Kernel: Linear, Cluster Number: 100, C Parameter: 100																					
Class	Faces	airplanes	anchor	backgrou	car_side	dalmatian	headphon	pizza	pyramid	snoopy	soccer_ba	stop_sign	strawber	sunflower	water_lilly	windsor	c_yin_yang	barrel	camera	ferry	lamp	Mean F1 Score
Value	0.41	0.3	0.33	0	0.65	0.46	0.39	0.09	0.09	0.67	0	0.26	0.55	0.47	0.31	0.55	0.37	0	0	0	0	0.34688
Title	Kernel: Linear, Cluster Number: 100, C Parameter: 200																					
Class	Faces	airplanes	anchor	backgrou	car_side	dalmatian	ferry	headphon	pizza	pyramid	snoopy	soccer_ba	stop_sign	strawber	sunflower	water_lilly	windsor	c_yin_yang	barrel	camera	lamp	Mean F1 Score
Value	0.41	0.3	0.42	0	0.7	0.38	0.17	0.49	0.09	0.17	0.5	0	0.46	0.58	0.5	0.4	0.53	0.58	0	0	0	0.37188
Title	Kernel: Linear, Cluster Number: 100, C Parameter: 500																					
Class	Faces	airplanes	anchor	backgrou	barrel	camera	car_side	dalmatian	ferry	headphon	lamp	pizza	pyramid	snoopy	soccer_ba	stop_sign	strawber	sunflower	water_lilly	windsor	c_yin_yang	Mean F1 Score
Value	0.43	0.32	0.32	0	0	0	0.6	0.62	0.25	0.51	0	0.31	0.3	0.5	0	0.4	0.42	0.57	0.2	0.55	0.31	0.31479
Title	Kernel: Linear, Cluster Number: 500, C Parameter: 10																					
Class	Faces	airplanes	anchor	backgrou	headphon	strawber	yin_yang	barrel	camera	car_side	dalmatian	ferry	lamp	pizza	pyramid	snoopy	soccer_ba	stop_sign	sunflower	water_lilly	windsor_c	Mean F1 Score
Value	0.29	0.12	0.09	0	0.06	0.1	0.17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.11813
Title	Kernel: Linear, Cluster Number: 500, C Parameter: 100																					
Class	Faces	airplanes	anchor	backgrou	car_side	dalmatian	headphon	snoopy	soccer_ba	stop_sign	strawber	sunflower	water_lilly	windsor	c_yin_yang	barrel	camera	ferry	lamp	pizza	pyramid	Mean F1 Score
Value	0.42	0.26	0.21	0	0.1	0.1	0.33	0.37	0	0.26	0.47	0.09	0	0.33	0.38	0	0	0	0	0	0	0.22129
Title	Kernel: Linear, Cluster Number: 500, C Parameter: 200																					
Class	Faces	airplanes	anchor	backgrou	camera	car_side	dalmatian	ferry	headphon	lamp	pyramid	snoopy	soccer_ba	stop_sign	strawber	sunflower	water_lilly	windsor	c_yin_yang	barrel	pizza	Mean F1 Score
Value	0.4	0.2	0.24	0	0	0.44	0.31	0	0.16	0	0.09	0.31	0	0.18	0.58	0.38	0.29	0.58	0.48	0	0	0.24526
Title	Kernel: Linear, Cluster Number: 500, C Parameter: 500																					
Class	Faces	airplanes	anchor	backgrou	camera	car_side	dalmatian	ferry	headphon	pizza	pyramid	snoopy	soccer_ba	stop_sign	strawber	sunflower	water_lilly	windsor	c_yin_yang	barrel	lamp	Mean F1 Score
Value	0.39	0.3	0.29	0	0.22	0.61	0.57	0	0.24	0.17	0.17	0.65	0	0.38	0.39	0.33	0.17	0.4	0.22	0	0	0.28981
Title	Kernel: Chi-Squared, Cluster Number: 50, C Parameter: 10																					
Class	Faces	airplanes	anchor	backgrou	barrel	camera	car_side	dalmatian	ferry	headphon	lamp	pizza	pyramid	snoopy	soccer_ba	stop_sign	strawber	sunflower	water_lilly	windsor	c_yin_yang	Mean F1 Score
Value	0.5	0.4	0.46	0	0	0.32	0.55	0.56	0.18	0.41	0	0.32	0.14	0.69	0	0.5	0.31	0.7	0.3	0.57	0.59	0.3565
Title	Kernel: Chi-Squared, Cluster Number: 50, C Parameter: 100																					
Class	Faces	airplanes	anchor	backgrou	camera	car_side	dalmatian	ferry	headphon	lamp	pizza	pyramid	snoopy	soccer_ba	stop_sign	strawber	sunflower	water_lilly	windsor	c_yin_yang	barrel	Mean F1 Score
Value	0.55	0.4	0.26	0	0.25	0.6	0.57	0.09	0.35	0	0.22	0.23	0.63	0	0.48	0.4	0.62	0.29	0.73	0.61	0	0.36357

Title	Kernel: Chi-Squared, Cluster Number: 50, C Parameter: 200																			
Class	Faces	airplanes	anchor	backgrou	barrel	camera	car_side	dalmatian	ferry	headphon	lamp	pizza	pyramid	snoopy	soccer_ba	stop_sign	strawber	sunflower	water_lilly	windsor_c
Value	0.58	0.33	0.33	0	0	0.17	0.68	0.72	0.18	0.34	0	0.52	0.4	0.72	0	0.71	0.33	0.56	0.21	0.79
																				0.61
																				0.39033
Title	Kernel: Chi-Squared, Cluster Number: 50, C Parameter: 500																			
Class	Faces	airplanes	anchor	backgrou	barrel	camera	car_side	dalmatian	ferry	headphon	lamp	pizza	pyramid	snoopy	soccer_ba	stop_sign	strawber	sunflower	water_lilly	windsor_c
Value	0.5	0.43	0.38	0	0	0.33	0.7	0.76	0.08	0.43	0	0.38	0.25	0.65	0	0.55	0.41	0.63	0.3	0.69
																				0.76
																				0.39229
Title	Kernel: Chi-Squared, Cluster Number: 100, C Parameter: 10																			
Class	Faces	airplanes	anchor	backgrou	camera	car_side	dalmatian	ferry	headphon	lamp	pizza	pyramid	snoopy	soccer_ba	stop_sign	strawber	sunflower	water_lilly	windsor_c	barrel
Value	0.49	0.39	0.41	0	0.17	0.67	0.73	0.26	0.57	0	0.09	0.24	0.84	0	0.55	0.41	0.79	0.21	0.67	0.71
																				0
																				0.41008
Title	Kernel: Chi-Squared, Cluster Number: 100, C Parameter: 100																			
Class	Faces	airplanes	anchor	backgrou	camera	car_side	dalmatian	ferry	headphon	lamp	pizza	pyramid	snoopy	soccer_ba	stop_sign	strawber	sunflower	water_lilly	windsor_c	barrel
Value	0.49	0.39	0.41	0	0.17	0.67	0.73	0.26	0.57	0	0.09	0.24	0.84	0	0.55	0.41	0.79	0.21	0.67	0.71
																				0
																				0.40334
Title	Kernel: Chi-Squared, Cluster Number: 100, C Parameter: 200																			
Class	Faces	airplanes	anchor	backgrou	camera	car_side	dalmatian	ferry	headphon	lamp	pizza	pyramid	snoopy	soccer_ba	stop_sign	strawber	sunflower	water_lilly	windsor_c	barrel
Value	0.53	0.36	0.38	0	0.09	0.63	0.62	0.1	0.36	0	0.17	0.17	0.74	0	0.62	0.31	0.69	0.32	0.75	0.56
																				0
																				0.3702
Title	Kernel: Chi-Squared, Cluster Number: 100, C Parameter: 500																			
Class	Faces	airplanes	anchor	backgrou	barrel	camera	car_side	dalmatian	ferry	headphon	lamp	pizza	pyramid	snoopy	soccer_ba	stop_sign	strawber	sunflower	water_lilly	windsor_c
Value	0.6	0.35	0.42	0	0.18	0.31	0.67	0.82	0.1	0.43	0.38	0.2	0.55	0	0.62	0.48	0.74	0.52	0.62	0.45
																				0
																				0.42187
Title	Kernel: Chi-Squared, Cluster Number: 500, C Parameter: 10																			
Class	Faces	airplanes	anchor	backgrou	car_side	dalmatian	headphon	pizza	snoopy	stop_sign	strawber	sunflower	water_lilly	windsor_c	yin_yang	barrel	camera	ferry	lamp	pyramid
Value	0.53	0.26	0.32	0	0.57	0.1	0.31	0.17	0.34	0.26	0.14	0.65	0.14	0.18	0.38	0	0	0	0	0
																				0
																				0.29093
Title	Kernel: Chi-Squared, Cluster Number: 500, C Parameter: 100																			
Class	Faces	airplanes	anchor	backgrou	car_side	dalmatian	headphon	pizza	snoopy	stop_sign	strawber	sunflower	water_lilly	windsor_c	yin_yang	barrel	camera	ferry	lamp	pyramid
Value	0.48	0.22	0.22	0	0.69	0.4	0.18	0.26	0.53	0.26	0.32	0.25	0.12	0.18	0.18	0	0	0	0	0
																				0
																				0.287
Title	Kernel: Chi-Squared, Cluster Number: 500, C Parameter: 200																			
Class	Faces	airplanes	anchor	backgrou	car_side	dalmatian	headphon	pizza	pyramid	snoopy	soccer_ba	stop_sign	strawber	sunflower	water_lilly	windsor_c	yin_yang	barrel	camera	ferry
Value	0.57	0.2	0.18	0	0.7	0.52	0.2	0.33	0.1	0.3	0	0.26	0.37	0.59	0.3	0.26	0.46	0	0	0
																				0
																				0.31351
Title	Kernel: Chi-Squared, Cluster Number: 500, C Parameter: 500																			
Class	Faces	airplanes	anchor	backgrou	car_side	dalmatian	headphon	pizza	snoopy	stop_sign	strawber	sunflower	windsor_c	yin_yang	barrel	camera	ferry	lamp	pyramid	soccer_ba
Value	0.47	0.28	0.26	0	0.55	0.52	0.37	0.09	0.52	0.33	0.22	0.53	0.52	0.26	0	0	0	0	0	0
																				0
																				0.35243

### Misclassified Test Images(Best: Chi Squared, C:500, Cluster#: 500):



### BONUS:

I added extra four descriptors(SURF, FAST, ORB, BRISK) and three additional clustering approaches (GMM, Spectral Clustering, MiniBatchKMeans) but I did not get significant improvement.

Confusion Matrices are below. I also added jpg files to the zip file because they can not be read on the pdf report.

## Multi-Class Confusion Matrices:





