**CURRENT K = 10; learning rate = 0.05; num\_epoch = 30**

Epoch: 0 Training Cost: 13801.997478 Valid Acc: 0.6045723962743438

Epoch: 1 Training Cost: 12617.604799 Valid Acc: 0.6274343776460627

Epoch: 2 Training Cost: 12032.140746 Valid Acc: 0.6383008749647192

Epoch: 3 Training Cost: 11635.892087 Valid Acc: 0.6447925486875529

Epoch: 4 Training Cost: 11293.601378 Valid Acc: 0.6532599491955969

Epoch: 5 Training Cost: 10979.485949 Valid Acc: 0.6622918430708439

Epoch: 6 Training Cost: 10695.036180 Valid Acc: 0.6652554332486593

Epoch: 7 Training Cost: 10437.874929 Valid Acc: 0.6716059836296924

Epoch: 8 Training Cost: 10207.969109 Valid Acc: 0.6762630539091166

Epoch: 9 Training Cost: 10001.196996 Valid Acc: 0.6804967541631386

Epoch: 10 Training Cost: 9813.535742 Valid Acc: 0.6806378775049393

Epoch: 11 Training Cost: 9642.609703 Valid Acc: 0.682895850973751

Epoch: 12 Training Cost: 9484.844201 Valid Acc: 0.6836014676827548

Epoch: 13 Training Cost: 9342.717687 Valid Acc: 0.6845893310753599

Epoch: 14 Training Cost: 9208.279271 Valid Acc: 0.6833192209991532

Epoch: 15 Training Cost: 9077.351049 Valid Acc: 0.6850127011007621

Epoch: 16 Training Cost: 8955.215958 Valid Acc: 0.6864239345187694

Epoch: 17 Training Cost: 8843.590014 Valid Acc: 0.6848715777589613

Epoch: 18 Training Cost: 8733.978567 Valid Acc: 0.6847304544171606

Epoch: 19 Training Cost: 8630.236831 Valid Acc: 0.6872706745695738

Epoch: 20 Training Cost: 8534.270914 Valid Acc: 0.6872706745695738

Epoch: 21 Training Cost: 8442.935480 Valid Acc: 0.6867061812023709

Epoch: 22 Training Cost: 8350.103143 Valid Acc: 0.6874117979113745

Epoch: 23 Training Cost: 8267.037264 Valid Acc: 0.6869884278859724

Epoch: 24 Training Cost: 8186.250030 Valid Acc: 0.6865650578605701

Epoch: 25 Training Cost: 8104.611820 Valid Acc: 0.6875529212531752

Epoch: 26 Training Cost: 8029.277272 Valid Acc: 0.6867061812023709

Epoch: 27 Training Cost: 7955.826485 Valid Acc: 0.6847304544171606

Epoch: 28 Training Cost: 7886.632914 Valid Acc: 0.6848715777589613

Epoch: 29 Training Cost: 7819.245581 Valid Acc: 0.6855771944679651

**CURRENT K = 50; learning rate = 0.05; num\_epoch = 30**

Epoch: 0 Training Cost: 13346.705131 Valid Acc: 0.6277166243296641

Epoch: 1 Training Cost: 12277.718360 Valid Acc: 0.6395709850409258

Epoch: 2 Training Cost: 11562.677505 Valid Acc: 0.6548123059554051

Epoch: 3 Training Cost: 10893.483244 Valid Acc: 0.6628563364380469

Epoch: 4 Training Cost: 10292.508431 Valid Acc: 0.6679367767428732

Epoch: 5 Training Cost: 9753.451141 Valid Acc: 0.6755574372001129

Epoch: 6 Training Cost: 9249.544018 Valid Acc: 0.6809201241885408

Epoch: 7 Training Cost: 8765.754132 Valid Acc: 0.6819079875811459

Epoch: 8 Training Cost: 8296.152081 Valid Acc: 0.6823313576065482

Epoch: 9 Training Cost: 7843.096940 Valid Acc: 0.6819079875811459

Epoch: 10 Training Cost: 7409.707426 Valid Acc: 0.6824724809483489

Epoch: 11 Training Cost: 6998.487468 Valid Acc: 0.6841659610499576

Epoch: 12 Training Cost: 6610.975196 Valid Acc: 0.6823313576065482

Epoch: 13 Training Cost: 6247.791504 Valid Acc: 0.6821902342647473

Epoch: 14 Training Cost: 5908.285028 Valid Acc: 0.6817668642393452

Epoch: 15 Training Cost: 5591.064257 Valid Acc: 0.6823313576065482

Epoch: 16 Training Cost: 5294.931092 Valid Acc: 0.6819079875811459

Epoch: 17 Training Cost: 5018.314434 Valid Acc: 0.6802145074795372

Epoch: 18 Training Cost: 4760.001872 Valid Acc: 0.6783799040361276

Epoch: 19 Training Cost: 4518.624839 Valid Acc: 0.677109793959921

Epoch: 20 Training Cost: 4293.037175 Valid Acc: 0.6745695738075078

Epoch: 21 Training Cost: 4082.034188 Valid Acc: 0.6742873271239063

Epoch: 22 Training Cost: 3884.518354 Valid Acc: 0.6756985605419137

Epoch: 23 Training Cost: 3699.349768 Valid Acc: 0.6747106971493085

Epoch: 24 Training Cost: 3525.529258 Valid Acc: 0.6747106971493085

Epoch: 25 Training Cost: 3362.666927 Valid Acc: 0.6735817104149027

Epoch: 26 Training Cost: 3209.751610 Valid Acc: 0.6734405870731018

Epoch: 27 Training Cost: 3065.964515 Valid Acc: 0.6721704769968952

Epoch: 28 Training Cost: 2930.683912 Valid Acc: 0.6717471069714931

Epoch: 29 Training Cost: 2803.617206 Valid Acc: 0.6706181202370872

**CURRENT K = 100; learning rate = 0.05; num\_epoch = 30**

Epoch: 0 Training Cost: 13462.254942 Valid Acc: 0.6250352808354502

Epoch: 1 Training Cost: 12405.426441 Valid Acc: 0.6411233418007338

Epoch: 2 Training Cost: 11610.972175 Valid Acc: 0.6532599491955969

Epoch: 3 Training Cost: 10865.167438 Valid Acc: 0.6610217329946373

Epoch: 4 Training Cost: 10171.166514 Valid Acc: 0.6689246401354784

Epoch: 5 Training Cost: 9505.636792 Valid Acc: 0.6747106971493085

Epoch: 6 Training Cost: 8845.895236 Valid Acc: 0.678662150719729

Epoch: 7 Training Cost: 8189.225060 Valid Acc: 0.6796500141123342

Epoch: 8 Training Cost: 7545.489637 Valid Acc: 0.6816257408975445

Epoch: 9 Training Cost: 6928.412852 Valid Acc: 0.6799322607959356

Epoch: 10 Training Cost: 6348.956705 Valid Acc: 0.6778154106689246

Epoch: 11 Training Cost: 5812.736557 Valid Acc: 0.6742873271239063

Epoch: 12 Training Cost: 5321.677005 Valid Acc: 0.6755574372001129

Epoch: 13 Training Cost: 4874.562171 Valid Acc: 0.6755574372001129

Epoch: 14 Training Cost: 4468.798023 Valid Acc: 0.6738639570985041

Epoch: 15 Training Cost: 4101.310925 Valid Acc: 0.6697713801862828

Epoch: 16 Training Cost: 3769.014686 Valid Acc: 0.6676545300592718

Epoch: 17 Training Cost: 3468.790895 Valid Acc: 0.6651143099068586

Epoch: 18 Training Cost: 3197.683716 Valid Acc: 0.6656788032740615

Epoch: 19 Training Cost: 2952.994724 Valid Acc: 0.66539655659046

Epoch: 20 Training Cost: 2732.135964 Valid Acc: 0.6648320632232572

Epoch: 21 Training Cost: 2532.688141 Valid Acc: 0.6646909398814564

Epoch: 22 Training Cost: 2352.456708 Valid Acc: 0.6641264465142535

Epoch: 23 Training Cost: 2189.424490 Valid Acc: 0.6637030764888513

Epoch: 24 Training Cost: 2041.717001 Valid Acc: 0.6628563364380469

Epoch: 25 Training Cost: 1907.680844 Valid Acc: 0.6631385831216483

Epoch: 26 Training Cost: 1785.947681 Valid Acc: 0.6634208298052497

Epoch: 27 Training Cost: 1675.214237 Valid Acc: 0.6627152130962461

Epoch: 28 Training Cost: 1574.261415 Valid Acc: 0.6634208298052497

Epoch: 29 Training Cost: 1482.028391 Valid Acc: 0.6629974597798476

**CURRENT K = 200; learning rate = 0.05; num\_epoch = 30**

Epoch: 0 Training Cost: 13804.337303 Valid Acc: 0.6148744002257973

Epoch: 1 Training Cost: 12679.312912 Valid Acc: 0.6353372847869038

Epoch: 2 Training Cost: 11830.252136 Valid Acc: 0.65001411233418

Epoch: 3 Training Cost: 11088.007691 Valid Acc: 0.658058142816822

Epoch: 4 Training Cost: 10380.317130 Valid Acc: 0.6641264465142535

Epoch: 5 Training Cost: 9656.886494 Valid Acc: 0.6706181202370872

Epoch: 6 Training Cost: 8890.838593 Valid Acc: 0.6711826136042901

Epoch: 7 Training Cost: 8090.207982 Valid Acc: 0.6742873271239063

Epoch: 8 Training Cost: 7285.370820 Valid Acc: 0.6747106971493085

Epoch: 9 Training Cost: 6513.509711 Valid Acc: 0.6759808072255151

Epoch: 10 Training Cost: 5801.332830 Valid Acc: 0.6755574372001129

Epoch: 11 Training Cost: 5159.849009 Valid Acc: 0.674428450465707

Epoch: 12 Training Cost: 4589.825163 Valid Acc: 0.6704769968952865

Epoch: 13 Training Cost: 4087.819641 Valid Acc: 0.6692068868190799

Epoch: 14 Training Cost: 3648.355473 Valid Acc: 0.6690657634772792

Epoch: 15 Training Cost: 3265.277681 Valid Acc: 0.668077900084674

Epoch: 16 Training Cost: 2932.180283 Valid Acc: 0.6675134067174711

Epoch: 17 Training Cost: 2642.501461 Valid Acc: 0.6658199266158623

Epoch: 18 Training Cost: 2390.062895 Valid Acc: 0.6652554332486593

Epoch: 19 Training Cost: 2169.509598 Valid Acc: 0.6637030764888513

Epoch: 20 Training Cost: 1976.268305 Valid Acc: 0.6628563364380469

Epoch: 21 Training Cost: 1806.364603 Valid Acc: 0.6631385831216483

Epoch: 22 Training Cost: 1656.380302 Valid Acc: 0.6620095963872424

Epoch: 23 Training Cost: 1523.452540 Valid Acc: 0.6620095963872424

Epoch: 24 Training Cost: 1405.234549 Valid Acc: 0.6618684730454417

Epoch: 25 Training Cost: 1299.776482 Valid Acc: 0.6622918430708439

Epoch: 26 Training Cost: 1205.437268 Valid Acc: 0.6637030764888513

Epoch: 27 Training Cost: 1120.784784 Valid Acc: 0.6631385831216483

Epoch: 28 Training Cost: 1044.540400 Valid Acc: 0.6629974597798476

Epoch: 29 Training Cost: 975.610089 Valid Acc: 0.6622918430708439

**CURRENT K = 500; learning rate = 0.05; num\_epoch = 30**

Epoch: 0 Training Cost: 14905.884590 Valid Acc: 0.6047135196161445

Epoch: 1 Training Cost: 13509.245268 Valid Acc: 0.6230595540502399

Epoch: 2 Training Cost: 12525.369292 Valid Acc: 0.6337849280270956

Epoch: 3 Training Cost: 11739.580983 Valid Acc: 0.645780412080158

Epoch: 4 Training Cost: 11031.852853 Valid Acc: 0.657493649449619

Epoch: 5 Training Cost: 10334.642101 Valid Acc: 0.6594693762348293

Epoch: 6 Training Cost: 9594.814002 Valid Acc: 0.6641264465142535

Epoch: 7 Training Cost: 8789.364452 Valid Acc: 0.6704769968952865

Epoch: 8 Training Cost: 7931.928397 Valid Acc: 0.6692068868190799

Epoch: 9 Training Cost: 7060.139538 Valid Acc: 0.6666666666666666

Epoch: 10 Training Cost: 6219.598843 Valid Acc: 0.6679367767428732

Epoch: 11 Training Cost: 5445.424064 Valid Acc: 0.668077900084674

Epoch: 12 Training Cost: 4755.899048 Valid Acc: 0.6677956534010725

Epoch: 13 Training Cost: 4154.557327 Valid Acc: 0.6670900366920689

Epoch: 14 Training Cost: 3637.219893 Valid Acc: 0.6661021732994638

Epoch: 15 Training Cost: 3196.242102 Valid Acc: 0.66539655659046

Epoch: 16 Training Cost: 2822.001421 Valid Acc: 0.6666666666666666

Epoch: 17 Training Cost: 2504.225506 Valid Acc: 0.6670900366920689

Epoch: 18 Training Cost: 2233.449922 Valid Acc: 0.6658199266158623

Epoch: 19 Training Cost: 2001.928702 Valid Acc: 0.6648320632232572

Epoch: 20 Training Cost: 1803.115927 Valid Acc: 0.6637030764888513

Epoch: 21 Training Cost: 1631.476145 Valid Acc: 0.6621507197290432

Epoch: 22 Training Cost: 1482.365741 Valid Acc: 0.6614451030200396

Epoch: 23 Training Cost: 1351.855797 Valid Acc: 0.6600338696020321

Epoch: 24 Training Cost: 1237.021659 Valid Acc: 0.6586226361840248

Epoch: 25 Training Cost: 1135.702001 Valid Acc: 0.6586226361840248

Epoch: 26 Training Cost: 1045.920057 Valid Acc: 0.65961049957663

Epoch: 27 Training Cost: 965.932681 Valid Acc: 0.6593282528930285

Epoch: 28 Training Cost: 894.364055 Valid Acc: 0.659046006209427

Epoch: 29 Training Cost: 830.108586 Valid Acc: 0.6589048828676263

based on the result, k\*=10, with peak accuracy >68.5

**k\* = 10; learning rate = 0.05; num\_epoch = 30**

Epoch: 0 Training Cost: 13799.517483 Valid Acc: 0.6061247530341518

Epoch: 1 Training Cost: 12618.220373 Valid Acc: 0.6305390911656789

Epoch: 2 Training Cost: 12029.315564 Valid Acc: 0.642111205193339

Epoch: 3 Training Cost: 11621.770951 Valid Acc: 0.6491673722833756

Epoch: 4 Training Cost: 11271.146879 Valid Acc: 0.6581992661586227

Epoch: 5 Training Cost: 10958.190243 Valid Acc: 0.6644086931978549

Epoch: 6 Training Cost: 10678.862895 Valid Acc: 0.6690657634772792

Epoch: 7 Training Cost: 10429.504921 Valid Acc: 0.6710414902624894

Epoch: 8 Training Cost: 10210.248293 Valid Acc: 0.6717471069714931

Epoch: 9 Training Cost: 10011.804049 Valid Acc: 0.6741462037821055

Epoch: 10 Training Cost: 9832.661932 Valid Acc: 0.6755574372001129

Epoch: 11 Training Cost: 9666.324876 Valid Acc: 0.6802145074795372

Epoch: 12 Training Cost: 9512.470229 Valid Acc: 0.6826136042901496

Epoch: 13 Training Cost: 9369.601696 Valid Acc: 0.6841659610499576

Epoch: 14 Training Cost: 9237.405078 Valid Acc: 0.6861416878351679

Epoch: 15 Training Cost: 9111.537675 Valid Acc: 0.6860005644933672

Epoch: 16 Training Cost: 8988.086352 Valid Acc: 0.6838837143663562

Epoch: 17 Training Cost: 8874.541341 Valid Acc: 0.6837425910245555

Epoch: 18 Training Cost: 8765.427292 Valid Acc: 0.6836014676827548

Epoch: 19 Training Cost: 8662.212636 Valid Acc: 0.6833192209991532

Epoch: 20 Training Cost: 8564.892365 Valid Acc: 0.6820491109229466

Epoch: 21 Training Cost: 8470.604007 Valid Acc: 0.6831780976573525

Epoch: 22 Training Cost: 8381.092429 Valid Acc: 0.681343494213943

Epoch: 23 Training Cost: 8294.176440 Valid Acc: 0.6814846175557437

Epoch: 24 Training Cost: 8214.707455 Valid Acc: 0.6800733841377364

Epoch: 25 Training Cost: 8135.245561 Valid Acc: 0.6809201241885408

Epoch: 26 Training Cost: 8061.262873 Valid Acc: 0.6795088907705334

Epoch: 27 Training Cost: 7989.631109 Valid Acc: 0.6785210273779283

Epoch: 28 Training Cost: 7921.121505 Valid Acc: 0.6779565340107254

Epoch: 29 Training Cost: 7851.035455 Valid Acc: 0.6772509173017217

**Test Acc: 0.6872706745695738**

k\* = 10; learning rate = 0.05; num\_epoch = 30; lamb=0.001

Epoch: 0 Training Cost: 13950.420588 Valid Acc: 0.5999153259949196

Epoch: 1 Training Cost: 12807.509748 Valid Acc: 0.6268698842788597

Epoch: 2 Training Cost: 12265.253308 Valid Acc: 0.6387242449901214

Epoch: 3 Training Cost: 11894.300226 Valid Acc: 0.6481795088907706

Epoch: 4 Training Cost: 11574.848706 Valid Acc: 0.6562235393734124

Epoch: 5 Training Cost: 11295.885699 Valid Acc: 0.6637030764888513

Epoch: 6 Training Cost: 11057.848827 Valid Acc: 0.6699125035280835

Epoch: 7 Training Cost: 10856.244357 Valid Acc: 0.67499294383291

Epoch: 8 Training Cost: 10681.689364 Valid Acc: 0.6799322607959356

Epoch: 9 Training Cost: 10535.309260 Valid Acc: 0.68077900084674

Epoch: 10 Training Cost: 10407.977655 Valid Acc: 0.6836014676827548

Epoch: 11 Training Cost: 10296.723489 Valid Acc: 0.6836014676827548

Epoch: 12 Training Cost: 10197.954362 Valid Acc: 0.6854360711261642

Epoch: 13 Training Cost: 10109.596175 Valid Acc: 0.6867061812023709

Epoch: 14 Training Cost: 10029.946649 Valid Acc: 0.6858594411515665

Epoch: 15 Training Cost: 9957.623691 Valid Acc: 0.6875529212531752

Epoch: 16 Training Cost: 9891.461035 Valid Acc: 0.6879762912785775

Epoch: 17 Training Cost: 9830.508379 Valid Acc: 0.6886819079875811

Epoch: 18 Training Cost: 9774.417986 Valid Acc: 0.688258537962179

Epoch: 19 Training Cost: 9722.398890 Valid Acc: 0.6888230313293818

Epoch: 20 Training Cost: 9674.227718 Valid Acc: 0.689810894721987

Epoch: 21 Training Cost: 9629.275007 Valid Acc: 0.6899520180637877

Epoch: 22 Training Cost: 9587.723142 Valid Acc: 0.69037538808919

Epoch: 23 Training Cost: 9548.837107 Valid Acc: 0.6891052780129834

Epoch: 24 Training Cost: 9512.854059 Valid Acc: 0.6912221281399944

Epoch: 25 Training Cost: 9479.619415 Valid Acc: 0.6892464013547841

Epoch: 26 Training Cost: 9447.845010 Valid Acc: 0.6902342647473892

Epoch: 27 Training Cost: 9417.570414 Valid Acc: 0.6886819079875811

Epoch: 28 Training Cost: 9390.981921 Valid Acc: 0.6893875246965848

Epoch: 29 Training Cost: 9364.073129 Valid Acc: 0.6886819079875811

Test Acc: 0.681343494213943

k\* = 10; learning rate = 0.05; num\_epoch = 30; lamb=0.01

Epoch: 0 Training Cost: 15063.149404 Valid Acc: 0.609229466553768

Epoch: 1 Training Cost: 13614.347628 Valid Acc: 0.6291278577476714

Epoch: 2 Training Cost: 13061.603169 Valid Acc: 0.6368896415467118

Epoch: 3 Training Cost: 12746.509252 Valid Acc: 0.6432401919277448

Epoch: 4 Training Cost: 12537.341361 Valid Acc: 0.6528365791701948

Epoch: 5 Training Cost: 12391.441459 Valid Acc: 0.6572114027660175

Epoch: 6 Training Cost: 12288.248665 Valid Acc: 0.6581992661586227

Epoch: 7 Training Cost: 12214.498436 Valid Acc: 0.661727349703641

Epoch: 8 Training Cost: 12160.803335 Valid Acc: 0.6634208298052497

Epoch: 9 Training Cost: 12120.206595 Valid Acc: 0.6661021732994638

Epoch: 10 Training Cost: 12087.940600 Valid Acc: 0.6666666666666666

Epoch: 11 Training Cost: 12061.987170 Valid Acc: 0.6675134067174711

Epoch: 12 Training Cost: 12040.341223 Valid Acc: 0.6686423934518769

Epoch: 13 Training Cost: 12021.583019 Valid Acc: 0.6683601467682755

Epoch: 14 Training Cost: 12004.858040 Valid Acc: 0.6685012701100762

Epoch: 15 Training Cost: 11989.795265 Valid Acc: 0.6683601467682755

Epoch: 16 Training Cost: 11976.308768 Valid Acc: 0.6685012701100762

Epoch: 17 Training Cost: 11964.306900 Valid Acc: 0.6687835167936776

Epoch: 18 Training Cost: 11953.626300 Valid Acc: 0.6693480101608806

Epoch: 19 Training Cost: 11944.048718 Valid Acc: 0.6690657634772792

Epoch: 20 Training Cost: 11935.383362 Valid Acc: 0.6694891335026814

Epoch: 21 Training Cost: 11927.480472 Valid Acc: 0.6696302568444821

Epoch: 22 Training Cost: 11920.226830 Valid Acc: 0.6700536268698842

Epoch: 23 Training Cost: 11913.545661 Valid Acc: 0.6697713801862828

Epoch: 24 Training Cost: 11907.384913 Valid Acc: 0.6697713801862828

Epoch: 25 Training Cost: 11901.704879 Valid Acc: 0.6692068868190799

Epoch: 26 Training Cost: 11896.476297 Valid Acc: 0.6692068868190799

Epoch: 27 Training Cost: 11891.673193 Valid Acc: 0.6699125035280835

Epoch: 28 Training Cost: 11887.259484 Valid Acc: 0.6701947502116851

Epoch: 29 Training Cost: 11883.189746 Valid Acc: 0.6693480101608806

Test Acc: 0.663844199830652

k\* = 10; learning rate = 0.05; num\_epoch = 30; lamb=0.1

Epoch: 0 Training Cost: 16919.744607 Valid Acc: 0.6051368896415467

Epoch: 1 Training Cost: 13558.197840 Valid Acc: 0.6123341800733841

Epoch: 2 Training Cost: 13332.077889 Valid Acc: 0.6161445103020039

Epoch: 3 Training Cost: 13165.649106 Valid Acc: 0.6195314705052216

Epoch: 4 Training Cost: 13028.072517 Valid Acc: 0.6243296641264465

Epoch: 5 Training Cost: 12907.893818 Valid Acc: 0.6257408975444538

Epoch: 6 Training Cost: 12799.877153 Valid Acc: 0.6268698842788597

Epoch: 7 Training Cost: 12705.052471 Valid Acc: 0.6265876375952583

Epoch: 8 Training Cost: 12629.873336 Valid Acc: 0.6271521309624611

Epoch: 9 Training Cost: 12572.702683 Valid Acc: 0.6247530341518487

Epoch: 10 Training Cost: 12529.003108 Valid Acc: 0.6258820208862546

Epoch: 11 Training Cost: 12495.112424 Valid Acc: 0.6257408975444538

Epoch: 12 Training Cost: 12468.454686 Valid Acc: 0.6257408975444538

Epoch: 13 Training Cost: 12447.227310 Valid Acc: 0.6257408975444538

Epoch: 14 Training Cost: 12430.138091 Valid Acc: 0.6270110076206604

Epoch: 15 Training Cost: 12416.239854 Valid Acc: 0.6264465142534575

Epoch: 16 Training Cost: 12404.828599 Valid Acc: 0.6257408975444538

Epoch: 17 Training Cost: 12395.374542 Valid Acc: 0.6253175275190517

Epoch: 18 Training Cost: 12387.475240 Valid Acc: 0.6253175275190517

Epoch: 19 Training Cost: 12380.821835 Valid Acc: 0.6254586508608524

Epoch: 20 Training Cost: 12375.175334 Valid Acc: 0.6254586508608524

Epoch: 21 Training Cost: 12370.349350 Valid Acc: 0.625176404177251

Epoch: 22 Training Cost: 12366.196976 Valid Acc: 0.6247530341518487

Epoch: 23 Training Cost: 12362.601580 Valid Acc: 0.6244707874682472

Epoch: 24 Training Cost: 12359.470212 Valid Acc: 0.6244707874682472

Epoch: 25 Training Cost: 12356.727996 Valid Acc: 0.6244707874682472

Epoch: 26 Training Cost: 12354.314061 Valid Acc: 0.6244707874682472

Epoch: 27 Training Cost: 12352.178807 Valid Acc: 0.6244707874682472

Epoch: 28 Training Cost: 12350.281305 Valid Acc: 0.6244707874682472

Epoch: 29 Training Cost: 12348.587761 Valid Acc: 0.6244707874682472

Test Acc: 0.6226361840248377

k\* = 10; learning rate = 0.05; num\_epoch = 30; lamb=1

Epoch: 0 Training Cost: 17160.404080 Valid Acc: 0.5791701947502117

Epoch: 1 Training Cost: 13589.937201 Valid Acc: 0.6065481230595541

Epoch: 2 Training Cost: 13243.315281 Valid Acc: 0.6162856336438047

Epoch: 3 Training Cost: 13014.481433 Valid Acc: 0.6199548405306238

Epoch: 4 Training Cost: 12859.168366 Valid Acc: 0.6239062941010444

Epoch: 5 Training Cost: 12750.790679 Valid Acc: 0.6248941574936494

Epoch: 6 Training Cost: 12673.174013 Valid Acc: 0.6255997742026531

Epoch: 7 Training Cost: 12616.238126 Valid Acc: 0.6254586508608524

Epoch: 8 Training Cost: 12573.537383 Valid Acc: 0.6248941574936494

Epoch: 9 Training Cost: 12540.847927 Valid Acc: 0.6244707874682472

Epoch: 10 Training Cost: 12515.339322 Valid Acc: 0.6247530341518487

Epoch: 11 Training Cost: 12495.075200 Valid Acc: 0.6243296641264465

Epoch: 12 Training Cost: 12478.706537 Valid Acc: 0.6241885407846458

Epoch: 13 Training Cost: 12465.277009 Valid Acc: 0.6247530341518487

Epoch: 14 Training Cost: 12454.097957 Valid Acc: 0.624611910810048

Epoch: 15 Training Cost: 12444.666365 Valid Acc: 0.624611910810048

Epoch: 16 Training Cost: 12436.609917 Valid Acc: 0.6248941574936494

Epoch: 17 Training Cost: 12429.649055 Valid Acc: 0.6253175275190517

Epoch: 18 Training Cost: 12423.571883 Valid Acc: 0.6253175275190517

Epoch: 19 Training Cost: 12418.215820 Valid Acc: 0.6253175275190517

Epoch: 20 Training Cost: 12413.454146 Valid Acc: 0.6253175275190517

Epoch: 21 Training Cost: 12409.188080 Valid Acc: 0.624611910810048

Epoch: 22 Training Cost: 12405.338926 Valid Acc: 0.624611910810048

Epoch: 23 Training Cost: 12401.844058 Valid Acc: 0.624611910810048

Epoch: 24 Training Cost: 12398.652818 Valid Acc: 0.624611910810048

Epoch: 25 Training Cost: 12395.723833 Valid Acc: 0.624611910810048

Epoch: 26 Training Cost: 12393.023428 Valid Acc: 0.624611910810048

Epoch: 27 Training Cost: 12390.523161 Valid Acc: 0.624611910810048

Epoch: 28 Training Cost: 12388.199708 Valid Acc: 0.624611910810048

Epoch: 29 Training Cost: 12386.033423 Valid Acc: 0.624611910810048

Test Acc: 0.6229184307084392

**Our model performed worse with L2 Regularization, and it worsens as the lambda value increased.**