

Problem 1

```
In [2]: import numpy as np
from sklearn.datasets import fetch_20newsgroups
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.decomposition import LatentDirichletAllocation, NMF

# Load the 20NG dataset
newsgroups = fetch_20newsgroups(subset='all', remove=('headers', 'footers',

# Preprocess the text data
vectorizer = TfidfVectorizer(max_df=0.95, min_df=2, stop_words='english')
news_groups_tf = vectorizer.fit_transform(newsgroups.data)

def display_topics(model, feature_names, no_top_words):
    for topic_idx, topic in enumerate(model.components_):
        print(f"Topic {topic_idx + 1}:")
        print(" ".join([feature_names[i] + f"({topic[i]:.2f})"
                        for i in topic.argsort()[::-no_top_words - 1:-1]]))

no_top_words = 20

# Run LDA and NMF
for K in [10, 20, 50]:
    # LDA
    lda_news_groups = LatentDirichletAllocation(n_components=K, max_iter=10
    lda_news_groups.fit(news_groups_tf)

    # NMF
    nmf_news_groups = NMF(n_components=K, random_state=1)
    nmf_news_groups.fit(news_groups_tf)

    # Print the top 20 words for each topic
    print(f"\nLDA Topics for 20 NewsGroups with K={K}:")
    display_topics(lda_news_groups, vectorizer.get_feature_names_out(), no_

    print(f"\nNMF Topics for 20 NewsGroups with K={K}:")
    display_topics(nmf_news_groups, vectorizer.get_feature_names_out(), no_

# Visually inspect the results for the 20NG dataset
# After the topics are printed, you'd need to visually inspect them and see
print("\nOriginal 20 NewsGroups Labels:")
print(np.unique(newsgroups.target_names))
```

LDA Topics for 20 NewsGroups with K=10:

Topic 1:

bye(4.41) jimmy(2.89) motorcycling(2.70) straights(2.31) subscribe(2.19)
mcelwaine(2.11) lars(2.03) pneumonia(1.85) gel(1.77) jokerit(1.54) acne
(1.44) i486(1.43) vid(1.37) erythromycin(1.32) localhost(1.29) tappara(1.
28) timucin(1.23) tps(1.18) mithras(1.17) vasomotor(1.07)

Topic 2:

i(2.19) sutcliffe(1.79) nutek(1.74) refrigerator(1.50) f550i(1.48) matc
hups(1.06) ists(0.92) stpl(0.65) dchhabra(0.65) deformed(0.61) magnifique
(0.52) forecasting(0.48) jstmp(0.39) tco(0.33) internships(0.29) brener
(0.29) 2650(0.28) murawski(0.28) mieux(0.28) soixante(0.28)

Topic 3:

nanao(5.23) hepatitis(2.97) sore(2.95) asap(2.85) suv(1.82) congruent(1.6
4) cph(1.56) doubledisk(1.54) maharishi(1.41) boiler(1.26) prognosis(1.2
6) 550i(1.24) frode(1.20) beamers(1.17) ornaments(1.12) acheive(1.11) erl
(1.05) inquiry(1.05) eridan(1.05) chuvashia(1.05)

Topic 4:

ax(10.23) povray(4.38) yo(4.32) jb(4.03) netland(3.34) autodesk(3.21) s4
(2.93) mn(2.79) lp(2.14) p2(2.13) jh(2.09) x1(2.07) ik(1.97) td(1.96) qua
lcomm(1.95) animator(1.90) sy(1.90) knx(1.84) lq(1.84) gk(1.84)

Topic 5:

canon(9.38) feustel(7.56) sabbath(6.69) laserwriter(6.64) lib(6.09) manha
ttan(6.04) viper(5.45) countersteering(5.34) bronx(5.29) ico(5.27) beauch
aine(5.10) deskjet(5.07) sank(5.06) bobbe(5.05) tek(5.03) queens(4.91) ol
wm(4.83) umpire(4.79) imake(4.19) winmarks(4.13)

Topic 6:

tempest(7.23) antihistamines(2.08) semite(1.96) antihistamine(1.74) sedat
ive(1.71) acetaminophen(1.62) wetteland(1.48) astemizole(1.44) harvested
(1.17) specfp92(1.14) toxin(1.13) hbp(1.02) pri(1.00) rvenkate(1.00) venk
ateswar(1.00) hepatic(0.94) larouche(0.86) 01730(0.85) benadryl(0.84) rav
ikumar(0.82)

Topic 7:

sabres(10.56) fuhr(6.62) pts(6.02) det(5.56) bos(5.47) pit(5.45) chi(4.9
3) tor(4.60) canucks(4.53) yzerman(4.22) que(4.12) nyi(4.08) traded(3.89)
cal(3.82) steelers(3.77) powerplay(3.76) buf(3.69) defenseman(3.59) bruin
s(3.49) pica(3.43)

Topic 8:

corn(4.59) ingr(4.38) compaq(4.23) catbyte(4.23) dtmedin(4.23) b30(4.19)
sandberg(3.67) bel(3.61) huntsville(3.42) larc(3.19) centaur(2.86) ssd(2.
43) speedometer(2.40) csd(2.37) _____(2.34) 35894(2.32) medin(2.17) 3169(2.
17) gd3004(2.17) 1174(2.15)

Topic 9:

like(248.03) just(247.54) don(243.27) know(242.33) people(215.56) think(2
07.76) does(203.89) use(178.40) thanks(174.97) good(170.18) time(168.02)
ve(153.63) new(151.53) god(140.19) need(136.41) way(136.37) make(135.78)
edu(133.40) did(132.78) want(132.49)

Topic 10:

blah(6.69) conner(6.62) cruel(5.43) tga(5.06) rle(4.99) v6(4.93) projecto
r(4.89) 8177(4.72) upload(4.71) polygons(4.61) xloadimage(4.42) dxf(4.39)
iivx(3.90) w4wg(3.82) rosicrucian(3.76) camry(3.63) ghostscript(3.49) irw
in(3.35) comics(3.31) 8051(3.30)

NMF Topics for 20 NewsGroups with K=10:

Topic 1:

don(1.23) just(1.18) like(0.95) think(0.93) know(0.63) good(0.63) ve(0.6

1) time(0.51) really(0.49) want(0.46) people(0.43) say(0.42) ll(0.40) way
(0.39) right(0.38) make(0.38) thing(0.37) going(0.37) sure(0.37) things
(0.35)

Topic 2:
windows(1.63) dos(0.81) file(0.78) program(0.51) files(0.50) window(0.47)
use(0.38) using(0.35) run(0.34) running(0.34) os(0.33) version(0.33) ms
(0.33) problem(0.32) screen(0.26) pc(0.26) server(0.26) mouse(0.26) appli
cation(0.23) software(0.23)

Topic 3:
god(2.06) jesus(0.76) bible(0.45) believe(0.41) christ(0.40) faith(0.37)
christian(0.36) christians(0.34) sin(0.31) church(0.26) does(0.25) life
(0.24) say(0.23) belief(0.21) lord(0.21) heaven(0.21) love(0.21) man(0.2
1) christianity(0.19) hell(0.19)

Topic 4:
drive(1.80) scsi(1.18) ide(0.66) disk(0.60) card(0.57) controller(0.57) h
ard(0.56) drives(0.54) bus(0.42) floppy(0.36) mac(0.30) hd(0.25) meg(0.2
4) ram(0.23) apple(0.22) pc(0.21) isa(0.21) board(0.21) mb(0.21) cd(0.21)

Topic 5:
key(1.27) chip(0.91) encryption(0.72) clipper(0.70) keys(0.59) government
(0.46) escrow(0.44) use(0.40) algorithm(0.39) phone(0.36) nsa(0.30) law
(0.30) des(0.29) data(0.29) security(0.28) public(0.28) secure(0.27) numb
er(0.27) bit(0.26) encrypted(0.25)

Topic 6:
thanks(1.35) does(0.75) know(0.72) mail(0.64) advance(0.54) hi(0.44) info
(0.39) looking(0.38) information(0.35) help(0.33) anybody(0.31) email(0.3
0) address(0.29) appreciated(0.28) send(0.25) list(0.21) post(0.21) ftp
(0.20) edu(0.19) interested(0.19)

Topic 7:
00(1.13) new(0.62) 10(0.53) sale(0.53) car(0.51) price(0.46) 50(0.40) 20
(0.38) shipping(0.37) offer(0.37) 15(0.35) condition(0.33) 25(0.32) edu
(0.32) 30(0.27) asking(0.26) 12(0.26) interested(0.25) power(0.24) 11(0.2
4)

Topic 8:
game(1.25) games(0.69) team(0.68) year(0.43) hockey(0.42) baseball(0.37)
season(0.33) players(0.32) play(0.32) espn(0.31) win(0.28) league(0.22) t
eams(0.22) player(0.22) fans(0.21) nhl(0.21) series(0.19) pens(0.18) nigh
t(0.18) detroit(0.17)

Topic 9:
edu(0.65) geb(0.62) dsl(0.61) cadre(0.61) n3jxp(0.61) chastity(0.61) pitt
(0.61) skepticism(0.61) intellect(0.61) shameful(0.60) surrender(0.60) ba
nks(0.59) gordon(0.59) soon(0.49) lyme(0.09) blood(0.08) medical(0.07) pa
tients(0.07) weight(0.07) probably(0.06)

Topic 10:
people(0.95) government(0.54) israel(0.52) armenian(0.40) jews(0.37) arme
nians(0.33) gun(0.32) state(0.31) did(0.30) children(0.30) rights(0.30) s
aid(0.30) israeli(0.28) law(0.28) war(0.27) fbi(0.27) turkish(0.27) right
(0.26) jewish(0.24) arab(0.24)

/usr/local/lib/python3.10/site-packages/sklearn/decomposition/_nmf.py:166
5: ConvergenceWarning: Maximum number of iterations 200 reached. Increase
it to improve convergence.
warnings.warn(

LDA Topics for 20 NewsGroups with K=20:

Topic 1:

pmetzger(5.15) sorta(3.40) unsubstantiated(2.07) fud(1.50) divya(1.49) 1776(1.29) untrustworthy(1.14) cave(0.95) behavoir(0.92) _think_(0.84) unalienable(0.64) flattered(0.50) 1787(0.30) techie(0.05) cation(0.05) munching(0.05) vis(0.05) misinformations(0.05) kiwis(0.05) peddling(0.05)

Topic 2:

leaf(7.38) nanao(5.18) oort(3.69) sore(2.90) grbs(2.18) lars(1.99) semite(1.92) crd(1.91) oplinger(1.68) acetaminophen(1.57) cph(1.51) w4w(1.49) crts(1.39) isotropic(1.32) vid(1.32) tappara(1.23) prognosis(1.21) 550i(1.19) touchy(1.18) tps(1.13)

Topic 3:

iff(3.91) subscribe(2.14) rows(1.95) iges(1.82) folded(1.81) proteins(1.76) bitzm(1.67) dsu(1.67) informations(1.57) hijaak(1.57) nanoseconds(1.24) haston(0.96) newspaper(0.90) gorgeous(0.83) resurrecting(0.81) magitronic(0.60) abiogenesis(0.54) jamesc(0.45) 1024kb(0.39) disgustingly(0.23)

Topic 4:

compaq(4.18) sandberg(3.62) tournament(2.46) hypercard(2.27) straights(2.26) tasking(2.25) pagemaker(1.89) gehrig(1.56) netlanders(1.49) encoders(1.33) walsh(1.32) ripken(1.29) mpce(1.27) notoriously(1.27) ellis(1.24) johnh(1.18) pathologist(1.10) quark(1.04) 100mhz(1.03) metacard(1.02)

Topic 5:

ax(10.18) yo(4.27) holland(4.07) jb(3.98) minors(3.65) defenseman(3.54) pica(3.38) tcora(3.36) coradeschi(3.36) s4(2.88) ww(2.69) rh(2.69) kariya(2.64) smile(2.47) ht(2.42) chriss(2.33) motorcyclist(2.25) parametric(2.16) iq(2.13) dobbs(2.10)

Topic 6:

tempest(7.18) rosicrucian(3.71) camry(3.58) bel(3.56) fl(3.31) mwm(3.13) xperts(2.76) fusi(2.47) rotor(2.41) cans(1.98) intrepid(1.95) rwf2(1.88) vans(1.84) pneumonia(1.81) minivan(1.77) goto(1.73) congruent(1.59) caere(1.47) wetteland(1.43) preamp(1.42)

Topic 7:

geico(4.51) shaftie(1.30) merrill(1.03) ramsden(0.92) deformed(0.58) scheduler(0.53) mercifully(0.53) khankandi(0.52) laboring(0.49) centigrade(0.48) fecal(0.46) destinations(0.45) hammered(0.33) dashnacks(0.27) 3621(0.25) hakki(0.25) 2905(0.25) inspectorate(0.25) 2907(0.25) taskilise(0.25)

Topic 8:

mobile(4.04) asap(2.80) migraines(2.74) dividians(2.67) illumination(1.76) possiblity(1.59) fmgs(1.34) buff(1.33) cyt(1.32) calculus(1.26) r12(1.25) enviroment(1.24) substitutes(1.21) callbacks(1.19) acquiring(1.18) feverfew(1.16) presupposes(0.98) parms(0.93) pittsburg(0.91) suing(0.87)

Topic 9:

flyers(8.83) gilmour(6.82) pit(5.52) det(5.51) bos(5.42) chi(4.92) cbc(4.85) tor(4.80) cal(4.22) yzerman(4.17) que(4.07) nyi(4.03) steelers(3.72) powerplay(3.71) buf(3.64) gloves(3.59) van(3.48) springfield(3.40) gainey(3.33) scorer(3.14)

Topic 10:

pov(7.55) povray(4.34) netland(3.29) publically(2.32) _i_(2.15) univesa(1.13) jaro(1.00) flaunt(0.71) prix(0.69) yaw(0.63) irt(0.54) simulating(0.47) modellers(0.46) 3dstudio(0.44) rnd(0.05) dirname(0.05) jem(0.05) appreciate(0.05) jaromir(0.05) hed(0.05)

Topic 11:

temp(8.38) seagate(8.20) sabbath(6.64) cruel(5.39) drunk(5.01) tga(4.86) hung(4.50) cview(4.29) autocad(4.03) porsche(3.79) sternlight(3.71) vv(3.66) inline(3.31) thy(3.28) uci(3.23) floptical(3.07) w4wg(3.00) 3401(2.84) dwi(2.79) bless(2.73)

Topic 12:

azerbaijan(4.83) 8177(4.67) azeri(3.71) azerbaijani(3.70) karabakh(3.21) lilley(3.21) azeris(2.76) armenia(2.69) motorcycling(2.65) sk(2.59) karabagh(2.43) nagorno(2.30) mower(2.26) sumgait(2.14) baku(2.14) manchester(1.91) dining(1.83) onur(1.83) yalcin(1.83) bust(1.65)

Topic 13:

anas(2.68) pctools(1.95) omran(1.64) corrupts(1.44) cardiac(1.23) jle(1.23) amipro(1.17) instinctively(1.13) arrhythmias(1.09) rhinitis(1.03) vaso motor(1.02) bounded(1.02) sprays(0.90) sta(0.88) abscond(0.77) desintegrated(0.75) wordbasic(0.75) inhaler(0.74) hamza(0.72) nursery(0.69)

Topic 14:

spice(3.84) lisa(2.97) rogue(1.67) rags(1.53) 412(1.51) ucc(1.43) feeder(1.35) sod(1.26) claudie(1.07) rowlands(0.99) uhhhh(0.88) 32mhz(0.71) cdp229(0.48) magnifique(0.47) 15213(0.42) predated(0.40) 3890(0.40) jstmp(0.34) tippman(0.34) correspondingly(0.33)

Topic 15:

feustel(7.51) n9myi(3.81) netcom(2.11) salvage(0.85) baserunners(0.76) rabies(0.59) rodriguez(0.53) hari(0.26) tatters(0.05) bludgeon(0.05) bully(0.05) 472(0.05) fox(0.05) nutcase(0.05) bury(0.05) resisting(0.05) benito(0.05) wsu(0.05) swat(0.05) ivan(0.05)

Topic 16:

xfree86(4.38) certified(2.56) helicopter(2.37) antihistamines(2.03) antihistamine(1.69) sedative(1.66) astemizole(1.39) coffin(1.10) infrequent(1.06) hojale(1.05) inquiry(1.00) eridan(1.00) chuvashia(1.00) erl(1.00) unidentified(1.00) stitches(0.97) pegs(0.97) antigens(0.95) keylock(0.91) 20w50(0.87)

Topic 17:

simms(20.76) widget(19.08) vlb(13.81) norton(12.20) bitmap(10.29) simm(9.39) pd(9.10) photography(8.25) win3(8.15) widgets(7.89) coprocessor(6.59) 800x600(6.57) conner(6.57) lmb(6.38) s3(6.30) atari(6.19) 256k(6.13) kirlan(6.07) 64k(6.00) powerpc(5.90)

Topic 18:

skeptics(1.86) xcreatewindow(1.59) telecasts(1.11) xmapwindow(0.95) complacency(0.82) xmovewindow(0.56) 120kvolt(0.52) eruption(0.51) xsetwmproper ties(0.36) pinautubo(0.26) atmoshpere(0.26) stickin(0.26) primal(0.25) oscillations(0.05) nino(0.05) santos(0.05) xsetwmhints(0.05) vostok(0.05) subtract(0.05) acres(0.05)

Topic 19:

leftover(4.22) truelove(4.00) christmas(3.60) autodesk(3.16) pizza(3.10) beyer(3.02) hut(2.66) solvent(2.51) carpet(2.29) gic(2.02) tlu(2.02) casserole(2.02) pom(2.02) animator(1.85) dryer(1.52) chopping(1.32) tracy(1.23) damico(1.07) bedrooms(1.01) 1276(0.96)

Topic 20:

like(247.98) just(247.49) don(243.22) know(242.28) people(215.51) think(207.71) does(203.84) use(178.35) thanks(174.92) good(170.13) time(167.97) ve(153.58) new(151.48) god(140.14) need(136.36) way(136.32) make(135.73) edu(133.22) did(132.73) want(132.44)

NMF Topics for 20 NewsGroups with K=20:

Topic 1:

people(2.01) don(1.97) think(1.73) say(0.63) want(0.58) believe(0.52) right(0.51) make(0.42) true(0.36) religion(0.35) read(0.34) agree(0.34) point(0.34) wrong(0.32) things(0.32) way(0.32) life(0.31) really(0.31) question(0.31) person(0.29)

Topic 2:

window(2.11) problem(0.85) server(0.77) application(0.69) motif(0.58) use(0.55) display(0.55) manager(0.53) using(0.53) screen(0.45) running(0.42)

widget(0.39) program(0.38) set(0.38) xterm(0.35) xllr5(0.34) code(0.33) run(0.33) mouse(0.31) error(0.28)

Topic 3:

god(2.37) jesus(0.86) bible(0.47) christ(0.45) faith(0.39) believe(0.38) christian(0.35) sin(0.35) christians(0.33) church(0.27) lord(0.25) heaven(0.24) life(0.24) man(0.23) love(0.22) hell(0.21) belief(0.21) say(0.19) eternal(0.18) spirit(0.18)

Topic 4:

drive(2.40) scsi(1.50) ide(0.80) disk(0.72) hard(0.70) drives(0.68) controller(0.61) floppy(0.40) hd(0.27) boot(0.22) cd(0.22) seagate(0.22) bios(0.21) bus(0.21) meg(0.20) problem(0.19) rom(0.18) tape(0.18) adaptec(0.17) mb(0.16)

Topic 5:

key(1.77) chip(1.27) encryption(0.99) clipper(0.98) keys(0.82) escrow(0.61) government(0.58) algorithm(0.53) phone(0.46) use(0.44) nsa(0.41) security(0.39) des(0.39) secure(0.37) public(0.36) number(0.35) bit(0.34) encrypted(0.34) law(0.33) chips(0.32)

Topic 6:

thanks(1.92) mail(0.91) advance(0.76) hi(0.51) looking(0.47) info(0.45) address(0.43) information(0.38) list(0.37) help(0.35) email(0.34) send(0.33) post(0.32) appreciated(0.28) reply(0.23) appreciate(0.22) hello(0.22) mailing(0.20) interested(0.19) need(0.18)

Topic 7:

00(2.48) 10(0.77) 50(0.59) 20(0.52) 15(0.48) 25(0.42) 11(0.38) 12(0.34) 30(0.31) 1st(0.29) 40(0.26) 13(0.25) 14(0.23) shipping(0.22) 16(0.22) 17(0.22) 18(0.22) sale(0.20) list(0.19) wolverine(0.19)

Topic 8:

game(1.43) games(0.79) team(0.78) year(0.52) hockey(0.49) baseball(0.43) season(0.38) players(0.37) play(0.37) espn(0.35) win(0.32) league(0.26) player(0.26) teams(0.25) fans(0.25) nhl(0.24) series(0.22) pens(0.21) night(0.20) detroit(0.20)

Topic 9:

geb(0.67) dsl(0.66) cadre(0.66) n3jxp(0.66) chastity(0.66) pitt(0.66) edu(0.65) skepticism(0.65) intellect(0.65) shameful(0.65) surrender(0.64) banks(0.64) gordon(0.63) soon(0.53) lyme(0.10) blood(0.09) medical(0.08) patients(0.08) weight(0.07) probably(0.07)

Topic 10:

armenian(1.52) armenians(1.23) turkish(0.92) genocide(0.62) turkey(0.58) armenia(0.56) muslim(0.51) turks(0.49) people(0.45) soviet(0.44) russian(0.41) population(0.38) government(0.36) muslims(0.34) war(0.32) 000(0.32) serdar(0.31) azerbaijan(0.31) said(0.30) ottoman(0.30)

Topic 11:

card(1.57) video(0.74) monitor(0.54) bus(0.49) cards(0.38) vga(0.38) drivers(0.35) driver(0.28) bit(0.28) color(0.24) ram(0.24) ati(0.24) board(0.23) isa(0.23) mode(0.23) graphics(0.23) diamond(0.22) vlb(0.22) local(0.22) memory(0.20)

Topic 12:

windows(2.43) dos(1.24) os(0.53) ms(0.49) nt(0.32) microsoft(0.31) run(0.31) running(0.29) version(0.24) apps(0.22) mouse(0.22) driver(0.21) drives(0.20) using(0.18) unix(0.17) mode(0.15) win(0.15) pc(0.15) memory(0.14) use(0.14)

Topic 13:

car(2.16) cars(0.51) bike(0.48) engine(0.45) miles(0.37) new(0.34) dealer(0.30) oil(0.25) speed(0.24) ford(0.23) insurance(0.23) buy(0.22) clutch(0.21) 000(0.20) rear(0.18) honda(0.18) power(0.18) good(0.17) year(0.17) tires(0.17)

Topic 14:

does(1.77) know(1.64) anybody(0.34) let(0.11) mean(0.11) work(0.11) appreciated(0.11) don(0.10) program(0.09) doesn(0.08) heard(0.08) info(0.07) help(0.07) like(0.06) exist(0.06) information(0.06) hi(0.06) sure(0.05) chips(0.05) question(0.05)

Topic 15:

space(1.60) nasa(0.63) shuttle(0.43) launch(0.34) orbit(0.32) earth(0.29) moon(0.28) data(0.27) science(0.25) mission(0.24) research(0.23) station(0.22) information(0.22) cost(0.21) gov(0.21) satellite(0.20) sci(0.20) lunar(0.20) solar(0.18) program(0.18)

Topic 16:

israel(1.28) jews(0.65) israeli(0.59) arab(0.52) jewish(0.43) arabs(0.37) peace(0.25) palestinian(0.23) state(0.23) palestinians(0.23) israelis(0.20) adam(0.20) war(0.19) lebanon(0.18) land(0.18) lebanese(0.17) palestine(0.15) rights(0.15) anti(0.14) killed(0.14)

Topic 17:

file(1.47) files(0.96) ftp(0.64) program(0.61) format(0.53) image(0.51) gif(0.47) graphics(0.41) edu(0.35) directory(0.31) zip(0.31) available(0.28) images(0.25) convert(0.25) pub(0.25) jpeg(0.24) bmp(0.23) version(0.21) formats(0.21) tiff(0.21)

Topic 18:

gun(0.68) fbi(0.67) government(0.54) batf(0.54) koresh(0.53) did(0.49) law(0.44) guns(0.40) children(0.34) compound(0.28) police(0.27) crime(0.26) weapons(0.25) federal(0.24) right(0.24) said(0.23) control(0.22) rights(0.22) waco(0.21) atf(0.21)

Topic 19:

just(1.42) like(1.10) ve(0.75) good(0.59) got(0.39) time(0.38) really(0.31) ll(0.31) thing(0.27) going(0.27) sure(0.26) didn(0.24) stuff(0.23) maybe(0.22) little(0.22) seen(0.21) bike(0.20) way(0.20) heard(0.20) look(0.20)

Topic 20:

mac(0.59) software(0.48) sale(0.47) modem(0.43) new(0.42) offer(0.41) price(0.40) apple(0.39) pc(0.32) computer(0.31) edu(0.31) shipping(0.30) printer(0.27) interested(0.26) email(0.26) use(0.26) used(0.25) sell(0.24) port(0.24) condition(0.24)

/usr/local/lib/python3.10/site-packages/sklearn/decomposition/_nmf.py:166
5: ConvergenceWarning: Maximum number of iterations 200 reached. Increase it to improve convergence.

warnings.warn(

LDA Topics for 20 NewsGroups with K=50:

Topic 1:

sabbath(6.61) gal(1.43) transgression(1.12) sola(1.10) fenholt(0.94) scriptura(0.70) adma(0.60) rebllled(0.60) cooperativley(0.60) musician(0.42) constructor(0.40) covenant(0.36) endorsing(0.02) suction(0.02) ceremonial(0.02) alcoholics(0.02) covenants(0.02) law(0.02) worship(0.02) headbanger(0.02)

Topic 2:

just(232.70) don(232.33) people(215.48) like(214.24) think(206.67) know(192.42) time(162.69) good(160.77) does(148.64) god(140.11) new(132.33) right(130.59) did(129.26) ve(128.65) way(127.05) make(126.89) say(125.87) really(116.48) want(113.08) use(110.44)

Topic 3:

sub(0.02) sorta(0.02) indian(0.02) eh(0.02) yeah(0.02) right(0.02) like(0.02) clarifies(0.02) hq(0.02) ambitious(0.02) compatible(0.02) microcontroller(0.02) fs2(0.02) sundry(0.02) hardplastic(0.02) 10012(0.02) robert_reichel(0.02) lucas(0.02) gvz(0.02) armageddon(0.02)

Topic 4:

70k(1.38) hams(1.07) locomotives(0.50) detectors(0.02) radar(0.02) detector(0.02) fusi(0.02) 609(0.02) mexico(0.02) rwf2(0.02) ginga(0.02) voila(0.02) inde(0.02) 2147(0.02) annulus(0.02) cunningham(0.02) buddy(0.02) 88003(0.02) pvo(0.02) subscription(0.02)

Topic 5:

surprises(1.22) adhere(0.02) acquitted(0.02) brake(0.02) rear(0.02) riding(0.02) ed(0.02) decreasing(0.02) countersteering(0.02) test(0.02) rider(0.02) corner(0.02) applied(0.02) official(0.02) gyroscopes(0.02) include(0.02) countersteer(0.02) woefully(0.02) throughly(0.02) line(0.02)

Topic 6:

crt(3.54) autodesk(3.13) contempt(2.45) trodwell(2.12) animator(1.82) clones(1.58) i486(1.35) addresses(1.31) blake(1.17) aiaa(1.13) jaw(1.08) unclassified(0.97) reuss(0.92) mayhem(0.68) ordo(0.64) auspices(0.63) 150lb(0.59) setter(0.58) ounce(0.53) aawin(0.44)

Topic 7:

asap(2.77) skeptics(1.81) congruent(1.56) caere(1.44) lsl(0.88) zia(0.53) corporation(0.02) competitors(0.02) postal(0.02) snail(0.02) uk(0.02) address(0.02) supportive(0.02) e_mail(0.02) opened(0.02) send(0.02) distribution(0.02) thank(0.02) printer(0.02) gatos(0.02)

Topic 8:

windows(127.45) thanks(102.82) file(80.76) card(80.19) dos(70.62) program(70.29) use(67.90) software(63.58) pc(61.41) files(61.04) using(59.41) graphics(57.20) does(55.19) drive(55.16) window(54.82) edu(54.24) disk(52.64) help(52.32) hi(52.27) mail(51.65)

Topic 9:

armenian(24.89) armenians(22.53) turkish(19.85) skepticism(14.33) intellect(14.10) pitt(13.93) shameful(13.85) geb(13.83) gordon(13.69) chastity(13.65) cadre(13.57) banks(13.44) n3jxp(13.41) dsl(13.37) surrender(13.17) muslim(12.63) turkey(12.33) genocide(12.20) muslims(12.07) turks(11.64)

Topic 10:

discoveries(1.22) 28dp(0.89) rumblings(0.72) kfc(0.66) lube(0.60) adaptors(0.53) recommendations(0.43) performers(0.41) interlaced(0.02) pseudo(0.02) mistake(0.02) monitor(0.02) 1024x768(0.02) svga(0.02) compatible(0.02) non(0.02) wonder(0.02) proponents(0.02) constitutes(0.02) reading(0.02)

Topic 11:

informations(1.54) amiga(0.02) sys(0.02) comp(0.02) therapy(0.02) pc(0.02) flame(0.02) created(0.02) ibm(0.02) great(0.02) 3d(0.02) group(0.02) i

dea(0.02) imagine(0.02) think(0.02) graphics(0.02) silicon(0.02) new(0.02) r3d(0.02) softimage(0.02)

Topic 12:

baden(5.20) sega(4.47) mobile(3.97) bison(3.68) bel(3.53) magnet(2.41) crossed(2.39) sys6626(2.18) bari(1.85) ca(1.79) mb(1.73) inqmind(1.54) amper(1.23) ohmite(1.21) woofers(1.09) reactive(1.03) _____(1.02) upbringing(0.92) abbreviation(0.85) res
instances(0.84)

Topic 13:

panasonic(4.89) scanning(4.28) micron(3.71) migraines(2.71) 32bit(2.49) micronics(2.06) negatives(2.04) f550iw(1.65) jvc(1.43) f550i(1.40) jetta(1.16) aldus(1.14) highlight(1.10) photostyler(1.03) aquired(1.00) micropolis(1.00) sportscenter(0.81) screeching(0.70) gli(0.69) dart(0.69)

Topic 14:

photography(8.18) kirlian(6.04) geico(4.48) rosicrucian(3.68) patrol(2.66) mcelwaine(2.01) callbacks(2.01) feeder(1.32) silencer(0.89) subscribing(0.78) dispose(0.77) disbeliever(0.57) sceptics(0.36) resedit(0.32) tippman(0.31) radiologist(0.02) barrel(0.02) composite(0.02) potato(0.02) 100(0.02)

Topic 15:

gloves(3.55) goggles(1.41) appropriately(1.37) fuchs(1.06) corrosion(0.58) tsar(0.54) aything(0.39) ira(0.02) kaufman(0.02) desperate(0.02) selfish(0.02) selections(0.02) oilers(0.02) excruciating(0.02) deserves(0.02) childbirth(0.02) princeton(0.02) bitch(0.02) send(0.02) labor(0.02)

Topic 16:

unjustified(0.87) tass(0.67) mercenaries(0.55) leniency(0.49) archangel(0.39) intensify(0.33) servicemen(0.25) moscow(0.02) baku(0.02) karabakh(0.02) azeri(0.02) gratitude(0.02) azerbaijan(0.02) polocias(0.02) russian(0.02) heaven(0.02) lord(0.02) yerevan(0.02) nagorno(0.02) god(0.02)

Topic 17:

crt(1.35) pick(0.02) emissions(0.02) because(0.02) refute(0.02) tempest(0.02) verify(0.02) picked(0.02) necessarily(0.02) controller(0.02) monitor(0.02) screen(0.02) video(0.02) chip(0.02) difference(0.02) anybody(0.02) source(0.02) kind(0.02) heard(0.02) true(0.02)

Topic 18:

medicines(1.23) newly(0.02) bathsheba(0.02) optional(0.02) care(0.02) labeled(0.02) dionne(0.02) fastball(0.02) theseas(0.02) serialized(0.02) meteorologists(0.02) intermarriage(0.02) handbook(0.02) replaceable(0.02) fallopian(0.02) malena(0.02) uniformity(0.02) firefighters(0.02) harbinger(0.02) rib(0.02)

Topic 19:

corrupts(1.41) instinctively(1.10) nursery(0.64) farmland(0.46) jerk(0.02) dissolved(0.02) fats(0.02) sam(0.02) zbib(0.02) nonsensical(0.02) cooling(0.02) reasoned(0.02) confused(0.02) warrant(0.02) infertile(0.02) david(0.02) reservoir(0.02) deleted(0.02) response(0.02) subsidies(0.02)

Topic 20:

povray(4.30) sandberg(3.59) netland(3.26) inject(2.72) ripken(1.26) aliasing(1.02) tribute(0.88) 1993apr22(0.78) gwynn(0.62) injections(0.56) pov(0.02) qrt(0.02) microsoft(0.02) tech(0.02) mediocre(0.02) support(0.02) pitchers(0.02) 241(0.02) sheffield(0.02) boggs(0.02)

Topic 21:

mozumder(3.57) latch(2.84) sc300(2.08) infiniti(1.95) unlock(1.57) tatoos(1.43) virile(1.39) intending(1.08) gs300(1.07) cheesy(1.04) es300(0.89) flick(0.70) feminists(0.65) betcha(0.59) ls400(0.59) krypto(0.43) cadillacs(0.41) strands(0.36) sc400(0.32) hart(0.02)

Topic 22:

critically(1.50) insulted(1.36) wuz(0.02) independent(0.02) thinker(0.02)

choosing(0.02) government(0.02) facts(0.02) plastered(0.02) allowance(0.02) hallmark(0.02) thinkers(0.02) sucking(0.02) depart(0.02) hypotheses(0.02) coupled(0.02) plausible(0.02) clothes(0.02) earn(0.02) tips(0.02)

Topic 23:

jle(1.20) distributes(0.83) ro(0.02) xterm(0.02) dinner(0.02) phone(0.02) address(0.02) lights(0.02) clock(0.02) mail(0.02) hours(0.02) 24(0.02) symantec(0.02) actually(0.02) looking(0.02) number(0.02) patches(0.02) thanks(0.02) xllr5(0.02) norton(0.02)

Topic 24:

uhhhh(0.85) marilyn(0.02) ring(0.02) mitigate(0.02) kurtz(0.02) duped(0.02) anthropologists(0.02) able(0.02) impatient(0.02) sabra(0.02) archangel(0.02) ao(0.02) robocop(0.02) rescheduled(0.02) barbi(0.02) catholic(0.02) augment(0.02) lamented(0.02) mobs(0.02) promiscuous(0.02)

Topic 25:

steam(4.76) 8177(4.64) ingr(4.30) catbyte(4.15) dtmedin(4.15) b30(4.11) fever(3.48) lawn(3.01) jimmy(2.85) luckily(2.76) taxpayers(2.67) motorcycling(2.62) technician(2.56) bake(2.42) bothering(2.39) ssd(2.32) kelley(2.29) corp(2.28) 35894(2.24) mower(2.22)

Topic 26:

60ns(2.31) rvenkate(0.92) venkateswar(0.92) optilink(0.92) corresponds(0.85) ravikumar(0.74) 32mb(0.74) guarantee(0.42) galileo(0.02) pentium(0.02) excused(0.02) elliott(0.02) newspeak(0.02) soldered(0.02) appropriated(0.02) 66mhz(0.02) mafia(0.02) 8514(0.02) batteries(0.02) memory(0.02)

Topic 27:

rows(1.91) 486dx33(1.15) winmarks(0.02) 1280(0.02) ver(0.02) resurrecting(0.02) beast(0.02) steve(0.02) 11(0.02) vlb(0.02) curious(0.02) stealth(0.02) card(0.02) mercury(0.02) factory(0.02) 24(0.02) calls(0.02) bus(0.02) built(0.02) conference(0.02)

Topic 28:

acetone(1.06) methyl(0.89) mek(0.89) ethyl(0.61) formulae(0.50) remover(0.42) impedance(0.36) unmistakable(0.28) irq(0.02) safty(0.02) fibreglass(0.02) anssi(0.02) os(0.02) assert(0.02) use(0.02) share(0.02) dog(0.02) bond(0.02) adapter(0.02) kind(0.02)

Topic 29:

centaur(1.82) possibility(1.56) xremote(1.35) ping(1.10) rocking(0.48) lhe(0.29) proton(0.02) cryo(0.02) stabilized(0.02) trash(0.02) combo(0.02) went(0.02) environment(0.02) looked(0.02) gse(0.02) cleanliness(0.02) propellants(0.02) instability(0.02) say(0.02) test(0.02)

Topic 30:

reformat(1.73) inexpensive(0.02) formatters(0.02) drive(0.02) jasmine(0.02) utility(0.02) tape(0.02) know(0.02) use(0.02) reinstall(0.02) compatibility(0.02) freezes(0.02) compress(0.02) format(0.02) ancient(0.02) work(0.02) tapes(0.02) mechanism(0.02) dos(0.02) gain(0.02)

Topic 31:

claudio(1.04) newspaper(0.87) bulging(0.63) esteemed(0.60) veins(0.51) magnificent(0.44) deducted(0.39) 15213(0.38) 268(0.02) 412(0.02) 6868(0.02) soixante(0.02) jjm(0.02) 2650(0.02) mieux(0.02) murawski(0.02) ucc(0.02) 4910(0.02) matchups(0.02) forbes(0.02)

Topic 32:

1110(0.02) preconceived(0.02) maciisi(0.02) thorn(0.02) resist(0.02) bgn(0.02) edmoore(0.02) 2o(0.02) tyre(0.02) books(0.02) arden(0.02) 35(0.02) space(0.02) totalled(0.02) reactionaries(0.02) portacio(0.02) blackmail(0.02) guided(0.02) mike_modano(0.02) defer(0.02)

Topic 33:

ax(10.15) yo(4.24) jb(3.95) winfield(3.20) lx(3.17) s4(2.85) telix(2.76) ww(2.66) rh(2.66) smile(2.43) iq(2.10) p2(2.05) lp(2.05) x1(1.99) uw(1.98) hs(1.95) td(1.88) ro(1.76) gk(1.76) cx(1.74)

Topic 34:

leaf(7.35) sore(2.87) milliseconds(1.08) knots(0.91) jamesc(0.02) steal
(0.02) apparatus(0.02) powerbook(0.02) clean(0.02) disappears(0.02) iisi
(0.02) muscles(0.02) massage(0.02) effect(0.02) lip(0.02) centerfielder
(0.02) ls(0.02) pb(0.02) crashing(0.02) shoulder(0.02)

Topic 35:

oxide(2.36) qualcomm(1.87) cylink(1.55) ocd(1.38) summarise(1.35) optimum
(1.14) erosion(1.13) turbine(1.11) reinstalled(1.11) cdma(1.10) feeds(1.0
9) beamers(1.09) ornaments(1.04) acheive(1.03) relevent(1.02) ctp(0.78) i
is(0.73) quiche(0.70) psychoactives(0.65) ned(0.64)

Topic 36:

clan(0.02) judgement(0.02) orest(0.02) reaped(0.02) elvis(0.02) congressp
ersons(0.02) ssn(0.02) ma4(0.02) overreaction(0.02) hrubin(0.02) bullies
(0.02) xterms(0.02) dead(0.02) m7c(0.02) 30f(0.02) inspiration(0.02) mana
ges(0.02) 5011(0.02) jemison(0.02) 512k(0.02)

Topic 37:

certified(2.52) helicopter(2.34) ghetto(2.32) intersections(1.39) coffin
(1.06) hojali(1.02) unidentified(0.96) stitches(0.94) diplomats(0.80) sun
y(0.74) 636(0.73) 580(0.71) medically(0.70) bensen(0.67) trousers(0.61) s
adikov(0.60) deportations(0.58) militiamen(0.56) corridor(0.51) blurred
(0.50)

Topic 38:

poke(2.25) boynton(0.02) blue(0.02) _ai(0.02) vja(0.02) hqf(0.02) tgcx(0.
02) rayssd(0.02) bigelow(0.02) moniterm(0.02) classmate(0.02) 2to(0.02) l
qvg(0.02) heterogeneity(0.02) pgt(0.02) weathered(0.02) fountain(0.02) ma
nu(0.02) hitherto(0.02) gai44(0.02)

Topic 39:

disadvantages(1.70) thickness(1.37) notoriously(1.21) insulate(0.02) hock
ey(0.02) pcb(0.02) traces(0.02) laying(0.02) equipment(0.02) boards(0.02)
having(0.02) low(0.02) played(0.02) anton(0.02) suggestions(0.02) great
(0.02) plunking(0.02) resistors(0.02) maker(0.02) designing(0.02)

Topic 40:

detach(0.36) inefficient(0.02) multitask(0.02) aquire(0.02) dma(0.02) scs
i(0.02) bus(0.02) transfers(0.02) dos(0.02) data(0.02) provider(0.02) vas
tly(0.02) devices(0.02) oops(0.02) ads(0.02) sector(0.02) uses(0.02) tran
sfer(0.02) insurance(0.02) ide(0.02)

Topic 41:

cocked(0.02) targeting(0.02) launchpad(0.02) eckankar(0.02) strangers(0.0
2) assent(0.02) adher(0.02) cheating(0.02) percussion(0.02) olchow(0.02)
penalties(0.02) hes(0.02) baddrawable(0.02) goalie(0.02) peopel(0.02) ve
7gda(0.02) dns(0.02) desmond(0.02) electrician(0.02) xclosedisplay(0.02)

Topic 42:

inconsistent(2.09) vans(1.79) nutritional(1.01) _think_(0.81) hyperspace
(0.70) 732(0.67) tercels(0.41) farber(0.02) binney(0.02) cancer(0.02) byp
ass(0.02) consumer(0.02) source(0.02) beta(0.02) data(0.02) papers(0.02)
course(0.02) relative(0.02) colon(0.02) comparing(0.02)

Topic 43:

immunization(1.30) touchy(1.15) dal(0.95) havemann(0.89) hsh(0.89) immuni
zed(0.58) eyebrows(0.02) iowa(0.02) xtree(0.02) sauce(0.02) motor(0.02) p
agnozzi(0.02) skinned(0.02) average(0.02) influence(0.02) danforth(0.02)
operating(0.02) owi(0.02) boats(0.02) old(0.02)

Topic 44:

bowman(4.00) freewill(3.67) gnp(2.59) straights(2.23) pneumonia(1.77) coe
rcion(1.74) scorers(1.41) surgeon(1.30) nationally(1.29) erythromycin(1.2
4) pathologist(1.07) laura(0.96) complications(0.91) dismissal(0.91) disi
llusionment(0.84) boredom(0.82) conservation(0.81) ungodly(0.79) cato(0.7
5) subsidized(0.73)

Topic 45:

feustel(7.48) n9myi(3.78) netcom(3.53) suv(1.74) netlanders(1.46) typhoon
(1.44) realistically(1.02) salvage(0.81) kari(0.78) dohc(0.72) netcomsv
(0.53) directives(0.02) blazer(0.02) hari(0.02) hypercard(0.02) crushed
(0.02) survivors(0.02) dave(0.02) pathfinder(0.02) metacard(0.02)

Topic 46:

cbc(4.80) spice(3.81) hrs(2.51) unsubstantiated(2.03) eeprom(1.92) sutcli
ffe(1.71) fud(1.47) divya(1.46) ciao(1.39) bankrupt(1.38) consecutive(1.3
4) buff(1.30) meme(1.27) worden(1.26) premier(1.25) breed(1.19) lynch(1.1
5) raj(1.01) hesitant(0.99) ruu(0.99)

Topic 47:

drinking(5.57) holland(4.03) sternlight(3.68) alabama(3.29) lilley(3.18)
sk(2.90) lisa(2.90) dwi(2.76) manchester(2.58) ht(2.38) rolls(2.37) unreg
istered(2.35) jaguar(2.24) parametric(2.12) charon(2.11) lud(2.10) 1069
(2.10) rectangular(2.03) jh(2.01) lars(1.95)

Topic 48:

fuhr(8.28) gilmour(6.79) shearson(5.65) pit(5.56) det(5.46) bos(5.39) pme
tzger(5.12) chi(4.89) tor(4.77) period(4.34) cal(4.22) yzerman(4.14) que
(4.04) nyi(4.00) 11(3.93) 503(3.82) powerplay(3.68) oort(3.66) buf(3.61)
102(3.51)

Topic 49:

publically(2.29) _i_(2.12) seas(1.79) eniac(0.64) scheduler(0.50) diary
(0.02) investments(0.02) bds(0.02) heliocentric(0.02) notion(0.02) eridan
(0.02) chuvashia(0.02) erl(0.02) inquiry(0.02) address(0.02) su(0.02) org
anizer(0.02) caused(0.02) suicide(0.02) upenn(0.02)

Topic 50:

harley(7.40) tempest(7.14) iff(3.96) dock(3.84) jsc(3.34) tamu(3.08) core
ldraw(2.49) humorous(2.04) iges(1.80) napalm(1.70) rogue(1.62) numlock(1.
60) differs(1.58) hijaak(1.54) rags(1.50) kjenks(1.40) wetteland(1.40) go
thamcity(1.38) gm2(1.38) jenkins(1.35)

NMF Topics for 20 NewsGroups with K=50:

Topic 1:

don(8.48) know(1.97) want(1.84) need(0.54) read(0.44) oh(0.40) care(0.38)
sure(0.36) tell(0.36) understand(0.34) believe(0.32) say(0.32) live(0.30)
sorry(0.29) ll(0.29) ask(0.29) really(0.27) little(0.24) work(0.24) make
(0.24)

Topic 2:

mac(5.13) modem(2.67) software(2.43) pc(2.24) apple(1.64) port(1.25) hard
ware(1.05) serial(0.95) fax(0.78) ibm(0.71) internal(0.71) se(0.69) ii(0.
69) cable(0.59) external(0.59) work(0.54) baud(0.54) buy(0.53) board(0.5
2) lc(0.50)

Topic 3:

god(3.95) believe(0.33) hell(0.27) faith(0.27) sin(0.25) lord(0.25) existence(0.23) love(0.23) bible(0.23) man(0.22) eternal(0.19) belief(0.19) heaven(0.17) satan(0.17) son(0.16) life(0.14) spirit(0.14) truth(0.14) exist(0.14) created(0.13)

Topic 4:

drive(4.96) hard(1.43) disk(1.40) drives(1.14) floppy(0.89) ide(0.65) controller(0.49) boot(0.41) meg(0.39) cd(0.36) bios(0.36) hd(0.35) slave(0.31) internal(0.31) seagate(0.31) external(0.30) rom(0.28) mb(0.27) tape(0.27) dos(0.26)

Topic 5:

government(4.88) law(1.82) right(1.60) rights(1.24) encryption(1.04) state(0.81) federal(0.78) private(0.74) clinton(0.73) president(0.71) constitution(0.70) court(0.66) citizens(0.66) privacy(0.63) amendment(0.62) public(0.53) enforcement(0.53) administration(0.52) legal(0.50) security(0.50)

Topic 6:

thanks(4.41) advance(1.72) hi(1.22) looking(0.82) help(0.73) info(0.69) appreciated(0.62) email(0.51) information(0.49) hello(0.42) appreciate(0.40) wondering(0.39) anybody(0.34) tell(0.31) greatly(0.30) need(0.27) reply(0.25) question(0.22) responses(0.20) know(0.20)

Topic 7:

10(3.11) 11(1.87) 12(1.76) 15(1.72) 25(1.50) 16(1.37) 14(1.36) 13(1.29) 20(1.24) 17(1.17) 18(1.07) 19(1.00) 30(1.00) 24(0.96) 23(0.94) 21(0.92) 50(0.86) period(0.86) 22(0.85) 28(0.79)

Topic 8:

key(2.24) chip(1.46) clipper(0.96) keys(0.95) encryption(0.82) escrow(0.65) algorithm(0.59) des(0.46) bit(0.41) chips(0.38) nsa(0.38) encrypted(0.37) security(0.35) secure(0.34) public(0.34) secret(0.33) bits(0.27) message(0.27) session(0.26) serial(0.25)

Topic 9:

geb(0.73) dsl(0.72) cadre(0.72) n3jxp(0.72) chastity(0.72) pitt(0.72) skepticism(0.71) intellect(0.71) shameful(0.71) surrender(0.70) banks(0.69) gordon(0.69) soon(0.58) edu(0.38) lyme(0.11) blood(0.09) medical(0.08) patients(0.08) weight(0.08) probably(0.07)

Topic 10:

team(4.59) year(3.02) players(2.07) season(1.71) teams(1.26) player(1.24) win(1.23) league(1.20) play(1.09) nhl(1.08) hockey(0.97) better(0.97) best(0.89) games(0.83) runs(0.76) pitching(0.73) braves(0.73) morris(0.71) won(0.67) toronto(0.65)

Topic 11:

card(2.55) video(0.91) bus(0.66) cards(0.53) drivers(0.39) ati(0.35) vlb(0.32) ram(0.32) isa(0.32) local(0.31) diamond(0.31) board(0.30) driver(0.28) vesa(0.26) motherboard(0.26) vga(0.25) eisa(0.23) mode(0.23) slot(0.22) controller(0.22)

Topic 12:

windows(4.03) dos(1.98) os(0.87) ms(0.80) nt(0.53) microsoft(0.47) run(0.38) running(0.36) apps(0.35) unix(0.25) mode(0.22) 386(0.21) win(0.21) using(0.19) version(0.17) pc(0.15) network(0.15) font(0.14) comp(0.14) software(0.14)

Topic 13:

problem(6.82) problems(1.14) fix(0.64) screen(0.51) fixed(0.47) having(0.46) fine(0.45) using(0.39) error(0.39) dealer(0.36) cause(0.35) try(0.35) solution(0.34) help(0.33) works(0.33) duo(0.32) battery(0.30) solve(0.28) patch(0.28) new(0.27)

Topic 14:

does(2.93) know(2.13) anybody(0.51) mean(0.18) work(0.15) let(0.13) appreciated(0.13) info(0.12) heard(0.10) information(0.10) doesn(0.09) chips

(0.08) exist(0.08) new(0.06) happen(0.06) exactly(0.06) company(0.06) getting(0.06) board(0.05) thank(0.05)

Topic 15:

edu(5.19) cs(0.96) university(0.81) article(0.56) email(0.51) david(0.51) mit(0.46) uiuc(0.45) cc(0.38) colorado(0.37) virginia(0.33) internet(0.31) au(0.30) adam(0.30) send(0.29) lcs(0.28) apr(0.27) news(0.26) 1993(0.26) michael(0.25)

Topic 16:

fbi(1.64) koresh(1.24) batf(1.14) children(0.69) compound(0.66) gas(0.50) davidians(0.39) warrant(0.39) agents(0.37) atf(0.36) waco(0.35) bd(0.34) started(0.32) david(0.32) tear(0.31) evidence(0.30) said(0.30) cult(0.29) assault(0.26) building(0.24)

Topic 17:

ftp(2.68) version(1.79) drivers(1.14) zip(1.00) site(0.96) circa(0.86) available(0.77) pub(0.73) sites(0.55) driver(0.53) indiana(0.49) pc(0.49) directory(0.46) bbs(0.46) win3(0.44) anonymous(0.37) files(0.35) latest(0.31) shareware(0.24) try(0.22)

Topic 18:

armenian(1.75) armenians(1.42) turkish(1.05) genocide(0.71) turkey(0.66) armenia(0.64) muslim(0.58) turks(0.56) soviet(0.49) russian(0.47) population(0.42) muslims(0.39) serdar(0.36) war(0.36) azerbaijan(0.35) ottoman(0.35) argic(0.34) 000(0.33) million(0.31) greek(0.29)

Topic 19:

israel(3.84) jews(1.89) israeli(1.77) arab(1.55) jewish(1.24) arabs(1.11) peace(0.71) palestinian(0.68) palestinians(0.67) state(0.60) israelis(0.60) adam(0.56) war(0.55) lebanon(0.54) lebanese(0.52) land(0.52) palestine(0.43) killed(0.42) anti(0.41) gaza(0.39)

Topic 20:

00(5.32) 50(0.79) 20(0.55) 1st(0.46) wolverine(0.37) 10(0.32) comics(0.32) hulk(0.31) cover(0.31) dos(0.30) 15(0.29) shipping(0.27) 30(0.26) man(0.26) sabretooth(0.25) art(0.24) spider(0.22) liefeld(0.22) 25(0.21) 01(0.19)

Topic 21:

server(1.52) memory(1.16) running(0.82) motif(0.81) run(0.73) display(0.53) x11r5(0.51) sun(0.48) using(0.44) code(0.42) error(0.41) mit(0.40) machine(0.40) application(0.40) client(0.38) widget(0.38) need(0.33) x11(0.30) xterm(0.30) openwindows(0.30)

Topic 22:

time(1.96) 11(0.69) going(0.61) years(0.59) long(0.54) ago(0.51) said(0.46) didn(0.43) right(0.41) really(0.38) way(0.34) maybe(0.31) day(0.26) old(0.26) thing(0.25) remember(0.24) little(0.24) went(0.23) left(0.23) couple(0.22)

Topic 23:

space(2.82) nasa(1.08) shuttle(0.74) launch(0.59) orbit(0.53) moon(0.45) earth(0.45) station(0.39) mission(0.39) gov(0.34) cost(0.33) satellite(0.32) lunar(0.32) sci(0.32) science(0.31) solar(0.30) data(0.30) research(0.29) hst(0.26) spacecraft(0.25)

Topic 24:

window(3.89) manager(0.87) application(0.66) way(0.26) event(0.26) display(0.26) size(0.24) position(0.24) set(0.24) expose(0.23) root(0.23) user(0.21) xterm(0.21) want(0.20) right(0.19) font(0.19) title(0.19) tvtwm(0.18) olwm(0.17) app(0.17)

Topic 25:

just(3.36) wondering(0.29) oh(0.17) wanted(0.17) thought(0.14) little(0.12) yeah(0.11) curious(0.11) test(0.10) got(0.10) doing(0.10) group(0.10) work(0.10) way(0.09) maybe(0.09) bit(0.09) mean(0.09) thing(0.09) guess(0.08) kidding(0.08)

Topic 26:

game(2.79) games(1.11) espn(0.73) baseball(0.60) hockey(0.55) night(0.33) pens(0.30) series(0.26) caps(0.26) fans(0.25) sabres(0.24) play(0.24) goal(0.23) devils(0.23) coverage(0.22) buffalo(0.22) blues(0.19) abc(0.19) isles(0.19) watch(0.19)

Topic 27:

car(3.24) cars(0.70) engine(0.55) dealer(0.39) miles(0.36) ford(0.33) oil(0.29) speed(0.27) power(0.26) buy(0.25) insurance(0.24) clutch(0.23) driving(0.20) 000(0.20) owner(0.20) tires(0.19) rear(0.18) mileage(0.18) auto(0.17) convertible(0.17)

Topic 28:

file(3.77) files(1.53) format(0.61) gif(0.41) directory(0.39) convert(0.31) bmp(0.30) exe(0.24) manager(0.24) ini(0.24) read(0.22) utility(0.21) postscript(0.20) rle(0.20) cview(0.20) tiff(0.19) win(0.19) swap(0.19) disk(0.18) tga(0.17)

Topic 29:

people(3.95) life(0.24) person(0.23) things(0.22) gay(0.20) world(0.19) live(0.18) lot(0.16) want(0.16) make(0.15) love(0.14) associate(0.13) real(0.13) right(0.12) bad(0.12) msg(0.12) homosexuals(0.11) militia(0.11) stop(0.11) kill(0.11)

Topic 30:

jesus(2.53) christ(0.97) church(0.80) christian(0.79) bible(0.69) christians(0.52) sin(0.52) law(0.35) paul(0.35) faith(0.35) heaven(0.34) mary(0.32) john(0.32) christianity(0.28) life(0.27) father(0.26) says(0.26) lord(0.25) catholic(0.25) spirit(0.24)

Topic 31:

bike(2.30) ride(0.55) bikes(0.44) riding(0.43) dod(0.35) motorcycle(0.32) dog(0.25) road(0.24) honda(0.22) miles(0.21) helmet(0.20) advice(0.19) rear(0.18) rider(0.18) bmw(0.17) turn(0.16) speed(0.16) insurance(0.15) countersteering(0.14) passenger(0.14)

Topic 32:

like(3.14) sounds(0.43) looks(0.31) look(0.19) sound(0.18) things(0.17) really(0.15) sure(0.14) yeah(0.14) doesn(0.13) lot(0.13) make(0.11) hear(0.11) sell(0.10) feel(0.10) nice(0.10) post(0.08) doing(0.08) pretty(0.08) idea(0.08)

Topic 33:

scsi(3.10) ide(0.92) controller(0.69) bus(0.61) isa(0.32) bit(0.29) data(0.26) devices(0.25) dma(0.24) transfer(0.24) adaptec(0.22) device(0.21) interface(0.21) drives(0.20) sec(0.19) pc(0.19) fast(0.18) faster(0.17) hard(0.16) chip(0.15)

Topic 34:

use(2.72) used(0.34) using(0.17) need(0.15) data(0.13) way(0.12) device(0.11) instead(0.11) drug(0.11) want(0.11) type(0.10) better(0.09) able(0.09) uses(0.09) available(0.09) encryption(0.09) low(0.09) make(0.08) easy(0.08) heat(0.08)

Topic 35:

mail(1.94) list(1.44) address(0.95) send(0.71) post(0.58) mailing(0.58) interested(0.25) info(0.24) reply(0.21) subscribe(0.20) information(0.20) message(0.19) newsgroup(0.19) ll(0.19) news(0.19) faq(0.18) request(0.17) group(0.17) thank(0.16) copy(0.15)

Topic 36:

monitor(2.86) vga(0.79) apple(0.65) color(0.52) power(0.51) monitors(0.45) video(0.44) screen(0.39) computer(0.22) cable(0.22) svga(0.19) centris(0.19) switch(0.19) nec(0.19) display(0.19) resolution(0.19) mag(0.18) sony(0.18) 16(0.17) colors(0.17)

Topic 37:

printer(1.97) print(0.83) driver(0.64) fonts(0.62) laser(0.45) postscript

(0.44) hp(0.39) font(0.35) printers(0.31) printing(0.29) paper(0.26) ink
(0.25) deskjet(0.25) port(0.23) truetype(0.20) using(0.18) bj(0.18) dot
(0.16) 200(0.15) quality(0.14)

Topic 38:

ve(2.52) got(0.67) seen(0.63) heard(0.60) tried(0.17) haven(0.16) used(0.
13) months(0.13) recently(0.12) past(0.10) times(0.09) thing(0.09) actual
ly(0.09) read(0.09) problems(0.08) cheers(0.08) couple(0.07) noticed(0.0
7) pretty(0.06) sure(0.05)

Topic 39:

think(2.93) really(0.24) let(0.14) right(0.12) thought(0.11) wrong(0.10)
mr(0.09) fact(0.08) didn(0.08) lot(0.08) sorry(0.08) kind(0.08) important
(0.07) agree(0.07) motto(0.07) saying(0.07) try(0.07) president(0.07) wou
ldn(0.07) better(0.06)

Topic 40:

deleted(1.73) stuff(1.44) turkey(0.12) article(0.09) day(0.08) posting(0.
08) lots(0.07) truelove(0.07) mithras(0.07) message(0.07) leftover(0.07)
atheist(0.07) served(0.06) christmas(0.06) paranoia(0.06) lot(0.05) hard
(0.05) near(0.05) agree(0.05) guess(0.05)

Topic 41:

com(1.80) tek(0.40) bob(0.39) bobbe(0.38) ico(0.38) beauchaine(0.38) bron
x(0.37) queens(0.37) sank(0.37) manhattan(0.37) blew(0.35) said(0.35) vic
e(0.34) sea(0.32) stay(0.30) away(0.29) netcom(0.26) feustel(0.24) handhe
ld(0.17) jmd(0.17)

Topic 42:

graphics(1.40) image(1.02) color(0.53) bit(0.51) images(0.47) comp(0.38)
format(0.37) gif(0.34) computer(0.32) software(0.30) data(0.30) jpeg(0.2
8) display(0.26) 24(0.26) information(0.23) processing(0.23) 3d(0.22) cod
e(0.22) package(0.22) formats(0.20)

Topic 43:

good(2.72) luck(0.36) bad(0.25) pretty(0.23) book(0.19) idea(0.15) lookin
g(0.13) point(0.12) thing(0.11) quality(0.10) better(0.09) little(0.09) b
ooks(0.09) things(0.08) look(0.08) make(0.08) chemistry(0.07) buying(0.0
7) worth(0.07) buy(0.07)

Topic 44:

say(0.74) believe(0.70) religion(0.58) evidence(0.50) true(0.50) point(0.
42) question(0.40) argument(0.32) objective(0.32) belief(0.32) claim(0.3
2) truth(0.31) moral(0.31) morality(0.30) christian(0.29) religious(0.29)
christians(0.29) beliefs(0.28) christianity(0.28) way(0.27)

Topic 45:

program(2.13) copy(0.34) disk(0.21) called(0.19) help(0.18) programs(0.1
5) files(0.15) manager(0.13) disks(0.12) need(0.09) code(0.09) able(0.09)
shareware(0.09) write(0.09) protection(0.08) using(0.08) run(0.08) pc(0.0
8) gif(0.07) change(0.07)

Topic 46:

new(1.07) sale(0.94) offer(0.76) price(0.69) shipping(0.58) condition(0.5
1) interested(0.41) asking(0.41) sell(0.41) email(0.35) best(0.34) brand
(0.31) original(0.28) used(0.27) excellent(0.26) old(0.23) cd(0.21) model
(0.21) selling(0.20) manuals(0.20)

Topic 47:

did(2.20) didn(0.24) say(0.15) got(0.10) wrong(0.09) sure(0.08) claim(0.0
7) thought(0.06) news(0.06) notice(0.06) said(0.06) told(0.06) ask(0.06)
watch(0.06) asked(0.06) puck(0.06) string(0.06) know(0.05) mind(0.05) que
stion(0.05)

Topic 48:

number(1.70) phone(1.37) line(0.39) company(0.27) 800(0.27) dial(0.22) se
rial(0.22) computer(0.20) address(0.19) numbers(0.16) phones(0.16) inform
ation(0.15) fax(0.15) book(0.12) modem(0.12) bbs(0.12) calls(0.12) tap(0.

11) service(0.10) cellular(0.10)

Topic 49:

gun(1.68) guns(0.82) crime(0.46) control(0.44) police(0.34) firearms(0.30) weapons(0.27) criminals(0.26) laws(0.23) criminal(0.20) law(0.20) rate(0.18) weapon(0.18) violent(0.17) carry(0.16) self(0.16) defense(0.16) handgun(0.15) firearm(0.15) nra(0.15)

Topic 50:

mouse(1.82) keyboard(0.55) driver(0.33) serial(0.27) port(0.26) button(0.17) cursor(0.14) microsoft(0.14) computer(0.13) com1(0.13) ports(0.12) dos(0.12) sys(0.12) adb(0.12) bus(0.10) ball(0.10) com3(0.10) mice(0.09) irq(0.09) click(0.09)

Original 20 NewsGroups Labels:

```
['alt.atheism' 'comp.graphics' 'comp.os.ms-windows.misc'
 'comp.sys.ibm.pc.hardware' 'comp.sys.mac.hardware' 'comp.windows.x'
 'misc.forsale' 'rec.autos' 'rec.motorcycles' 'rec.sport.baseball'
 'rec.sport.hockey' 'sci.crypt' 'sci.electronics' 'sci.med' 'sci.space'
 'soc.religion.christian' 'talk.politics.guns' 'talk.politics.mideast'
 'talk.politics.misc' 'talk.religion.misc']
```

Problem 2

Note: only did this problem on 20G dataset. DUC not available online


```

In [9]: from sklearn.datasets import fetch_20newsgroups

newsgroups = fetch_20newsgroups(subset='all', remove=('headers', 'footers'),
data = newsgroups.data

import nltk
from nltk.tokenize import word_tokenize, sent_tokenize

def preprocess(text):
    sentences = sent_tokenize(text)
    words = [word_tokenize(sent) for sent in sentences]
    return sentences, words

from collections import defaultdict
import numpy as np

def word_frequencies(texts):
    freqs = defaultdict(int)
    for text in texts:
        for word in word_tokenize(text):
            freqs[word.lower()] += 1
    total_words = sum(freqs.values())
    for word in freqs:
        freqs[word] /= total_words
    return freqs

def KL_divergence(P, Q):
    return sum(P[word] * np.log(P[word] / Q[word]) for word in P if word in

def KL_summary(text, n_sentences=5):
    sentences, tokenized_sentences = preprocess(text)
    PD = word_frequencies(sentences)

    summary = []
    for _ in range(n_sentences):
        remaining_sentences = list(set(sentences) - set(summary))

        # Check if we've run out of sentences to summarize
        if not remaining_sentences:
            break

        next_sentence = min(remaining_sentences, key=lambda s: KL_divergence
summary.append(next_sentence)

    return ' '.join(summary)

from gensim.corpora import Dictionary
from gensim.models import LdaModel

def LDA_topics(texts, num_topics=10):
    # Only get the tokenized texts (a flat list of words for each text)
    tokenized_texts = [word_tokenize(text) for text in texts]

    dictionary = Dictionary(tokenized_texts)
    corpus = [dictionary.doc2bow(text) for text in tokenized_texts]

    lda = LdaModel(corpus, num_topics=num_topics, id2word=dictionary)

```

```

word_probs = defaultdict(float)
for topic_id in range(num_topics):
    for word, prob in lda.show_topic(topic_id, topn=len(dictionary)):
        word_probs[word] += prob
total = sum(word_probs.values())
for word in word_probs:
    word_probs[word] /= total
return word_probs

def LDA_summary(text, n_sentences=5):
    sentences, _ = preprocess(text)
    PD = LDA_topics(sentences)

    summary = []
    for _ in range(n_sentences):
        remaining_sentences = list(set(sentences) - set(summary))

        # Check if we've run out of sentences to summarize
        if not remaining_sentences:
            break

        next_sentence = min(remaining_sentences, key=lambda s: KL_divergence(s, summary))
        summary.append(next_sentence)

    return ' '.join(summary)

```

```

In [10]: # Load the dataset
from sklearn.datasets import fetch_20newsgroups
newsgroups = fetch_20newsgroups(subset='all', remove=('headers', 'footers'),
documents = newsgroups.data

# just a few documents for demo purposes
num_docs_to_summarize = 5

# Summarizing using KL based on word frequencies
print("\nSummarizing using KL based on word frequencies:")
for i in range(num_docs_to_summarize):
    print(f"\nDocument {i + 1} Original:")
    print(documents[i][:500] + "...") # Printing just the beginning for brevity
    print(f"\nDocument {i + 1} KL Summary:")
    print(KL_summary(documents[i]))
    print("="*80)

# Summarizing using KL based on LDA topics
print("\nSummarizing using KL based on LDA topics:")
for i in range(num_docs_to_summarize):
    print(f"\nDocument {i + 1} Original:")
    print(documents[i][:500] + "...") # Printing just the beginning for brevity
    print(f"\nDocument {i + 1} LDA Summary:")
    print(LDA_summary(documents[i]))
    print("="*80)

```

Summarizing using KL based on word frequencies:

Document 1 Original:

I am sure some bashers of Pens fans are pretty confused about the lack of any kind of posts about the recent Pens massacre of the Devils. Actually, I am bit puzzled too and a bit relieved. However, I am going to put an end to non-Pittsburghers' relief with a bit of praise for the Pens. Man, they are killing those Devils worse than I thought. Jagr just showed you why he is much better than his regular season stats. He is also a lot fo fun to watch in the playoffs. Bowman should let JAgr have a...

Document 1 KL Summary:

I am sure some bashers of Pens fans are pretty confused about the lack of any kind of posts about the recent Pens massacre of the Devils. Bowman should let JAgr have a lot of fun in the next couple of games since the Pens are going to beat the pulp out of Jersey anyway. I was very disappointed not to see the Islanders lose the final regular season game. Actually, I am bit puzzled too and a bit relieved. He is also a lot fo fun to watch in the playoffs.

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Document 2 Original:

My brother is in the market for a high-performance video card that supports VESA local bus with 1-2MB RAM. Does anyone have suggestions/ideas on:

- Diamond Stealth Pro Local Bus
- Orchid Farenheit 1280
- ATI Graphics Ultra Pro
- Any other high-performance VLB card

Please post or email. Thank you!

- Matt
...

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Document 3 Original:

Finally you said what you dream about. Mediterranean???? That was new....

The area will be "greater" after some years, like your "holocaust" numbers.....

Is't July in USA now????? Here in Sweden it's April and still cold.

Or have you changed your calendar???

NOTHING OF THE MENTIONED IS TRUE, BUT LET SAY IT'S TRUE.

SHALL THE AZERI WOMEN AND CHILDREN GOING TO PAY THE PRICE WITH
***...

Document 3 KL Summary:

SHALL THE AZERI WOMEN AND CHILDREN GOING TO PAY THE PRICE WITH

BEING RAPED, KILLED AND TORTURED BY THE ARMENIANS?????????? We have the right (and we do)

to give weapons to the Azeris, since Armenians started the fight in Azerbadjan! *****

NOTHING OF THE MENTIONED IS TRUE, BUT LET SAY IT'S TRUE. What ever you say
"regional killer", if you don't like the person then shoot him that's your policy.....1

i

i

i

Confused????? HAVE YOU HEARDED SOMETHING CALLED: "GENEVA CONVENTI
ON"???????

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Document 4 Original:

Think!

It's the SCSI card doing the DMA transfers NOT the disks...

The SCSI card can do DMA transfers containing data from any of the SCSI d
evices
it is attached when it wants to.

An important feature of SCSI is the ability to detach a device. This free
s the
SCSI bus for other devices. This is typically used in a multi-tasking OS
to
start transfers on several devices. While each device is seeking the data
the
bus is free for other commands and data transfers. When the devices are
ready to tr...

Document 4 KL Summary:

When the devices are
ready to transfer the data they can aquire the bus and send the data. I
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Document 5 Original:

1) I have an old Jasmine drive which I cannot use with my new system.
My understanding is that I have to upstate the driver with a more modern
one in order to gain compatability with system 7.0.1. does anyone know
of an inexpensive program to do this? (I have seen formatters for <\$20
buit have no idea if they will work)

2) I have another ancient device, this one a tape drive for which
the back utility freezes the system if I try to use it. THE drive is a
jasmine direct tape (bought ...

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1) I have an old Jasmine drive which I cannot use with my new system.
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Is't July in USA now????? i

Turkey's government has announced that it's giving weapons <----
-----i
to Azerbadjan since Armenia started to attack Azerbadjan
it self, not the Karabag province. So why search a plane for weap
ons

since it's content is announced to be weapons? SHALL THE AZERI WO
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When the devices are
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an IDE bus when you start a transfer the bus is busy until the disk has s
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-20ms second lock out for other
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