Question 1

Question 1(a)

In [9]:
```
get_top_teams(w_all, 10, 25)
```

Out[9]:

	Team	Weight
1	NorthCentral	0.012812
2	LSU	0.012578
3	Morningside	0.011511
4	Wheaton	0.011088
5	MinnSt-Mankato	0.009633
6	Muhlenberg	0.009507
7	OhioState	0.009241
8	UW-Whitewater	0.009165
9	NorthDakotaSt	0.009137
10	Clemson	0.008941
11	WestFlorida	0.008785
12	MarianIN	0.008515
13	StJohnsMN	0.008488
14	MountUnion	0.007653
15	FerrisSt	0.007122
16	GrandView	0.007114
17	Georgia	0.007013
18	MaryHardin-Baylor	0.006778
19	Lenoir-Rhyne	0.006163
20	SlipperyRock	0.006088
21	Oregon	0.005900
22	DelawareValley	0.005840
23	JamesMadison	0.005666
24	ValdostaSt	0.005544
25	Florida	0.005437

In [10]:

```
get_top_teams(w_all, 100, 25)
```

Out[10]:

	Team	Weight
1	LSU	0.043642
2	Wheaton	0.025822
3	NorthCentral	0.024442
4	Clemson	0.023704
5	OhioState	0.022688
6	Morningside	0.022621
7	Georgia	0.017165
8	StJohnsMN	0.014990
9	WestFlorida	0.013367
10	Alabama	0.012917
11	UW-Whitewater	0.012836
12	Florida	0.012440
13	Muhlenberg	0.011238
14	Oregon	0.010530
15	Auburn	0.010021
16	Oklahoma	0.010012
17	MinnSt-Mankato	0.009752
18	MarianIN	0.009583
19	PennState	0.009534
20	ValdostaSt	0.008894
21	Lenoir-Rhyne	0.008070
22	Wisconsin	0.008019
23	NotreDame	0.007866
24	Minnesota	0.007532
25	GrandView	0.007521

In [11]:
```python
get_top_teams(w_all, 1000, 25)
```

Out[11]:

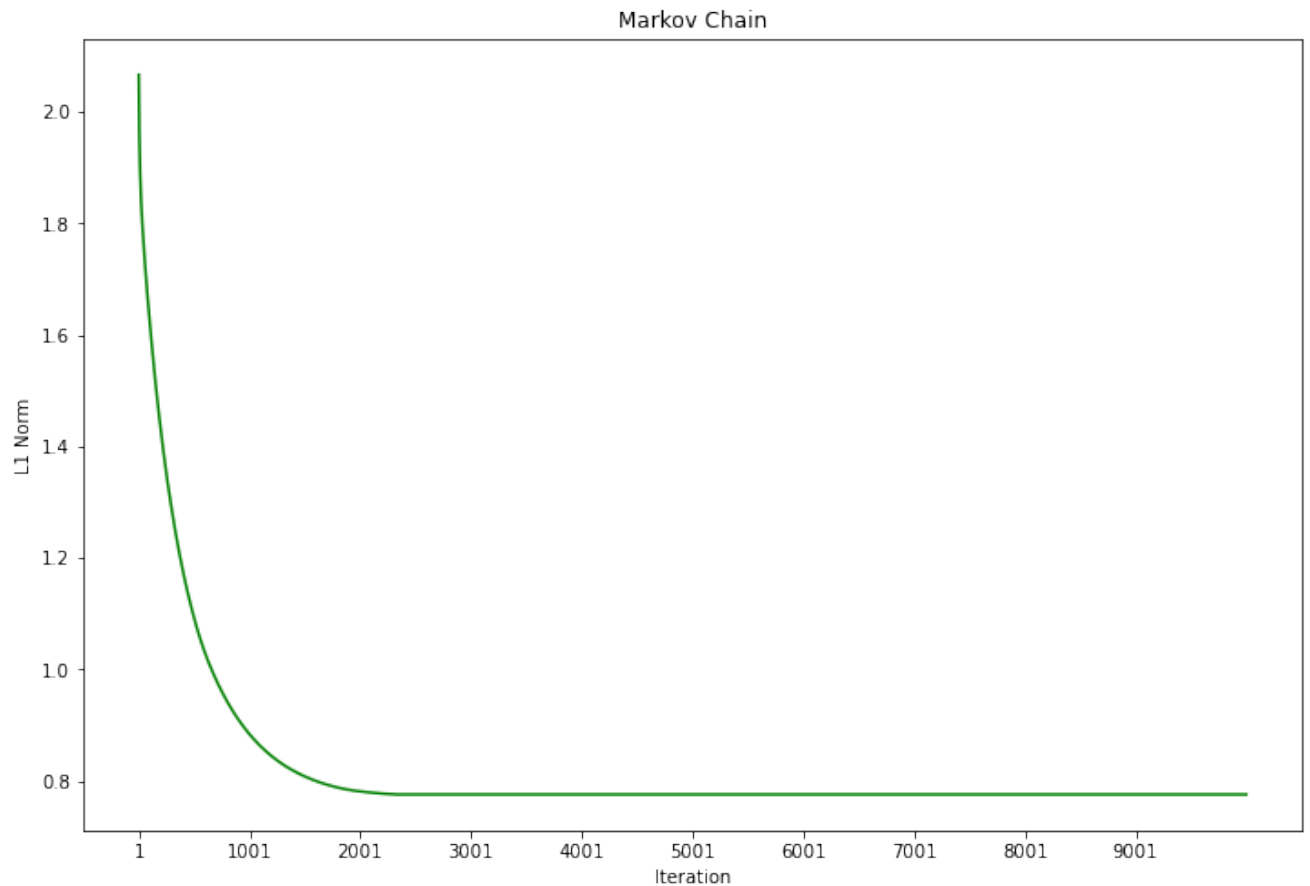|	Team	Weight
1	LSU	0.084419
2	Clemson	0.045527
3	OhioState	0.043452
4	Georgia	0.032720
5	Alabama	0.024679
6	Florida	0.023696
7	Oregon	0.019266
8	Auburn	0.019037
9	Oklahoma	0.018703
10	PennState	0.017974
11	Wisconsin	0.015165
12	NotreDame	0.014647
13	Minnesota	0.014201
14	Baylor	0.012704
15	Michigan	0.012045
16	Utah	0.011703
17	Memphis	0.011663
18	Iowa	0.011006
19	AppalachianSt	0.010923
20	Texas	0.010187
21	NorthDakotaSt	0.009224
22	Navy	0.009071
23	TexasA&M	0.008933
24	BoiseSt	0.008306
25	KansasSt	0.007334

In [12]:

```
get_top_teams(w_all, 10000, 25)
```

`Out[12]:`

	Team	Weight
1	LSU	0.091366
2	Clemson	0.049262
3	OhioState	0.047009
4	Georgia	0.035382
5	Alabama	0.026695
6	Florida	0.025624
7	Oregon	0.020779
8	Auburn	0.020582
9	Oklahoma	0.020202
10	PennState	0.019429
11	Wisconsin	0.016392
12	NotreDame	0.015820
13	Minnesota	0.015347
14	Baylor	0.013716
15	Michigan	0.013023
16	Utah	0.012617
17	Memphis	0.012590
18	Iowa	0.011894
19	AppalachianSt	0.011792
20	Texas	0.011003
21	Navy	0.009785
22	NorthDakotaSt	0.009717
23	TexasA&M	0.009658
24	BoiseSt	0.008943
25	KansasSt	0.007916

Question 1(b)

In [24]:
```python
fig = plt.figure()
ax = plt.axes()
fig.set_size_inches(12, 8)
ax.xaxis.set_major_locator(MaxNLocator(integer=True))
plt.title('Markov Chain')
plt.xlabel('Iteration')
plt.ylabel('L1 Norm')
plt.plot(norm_difference, label = 'Objective', color = 'green')
plt.xticks(np.arange(1, 10001, 1000))
plt.show()
```
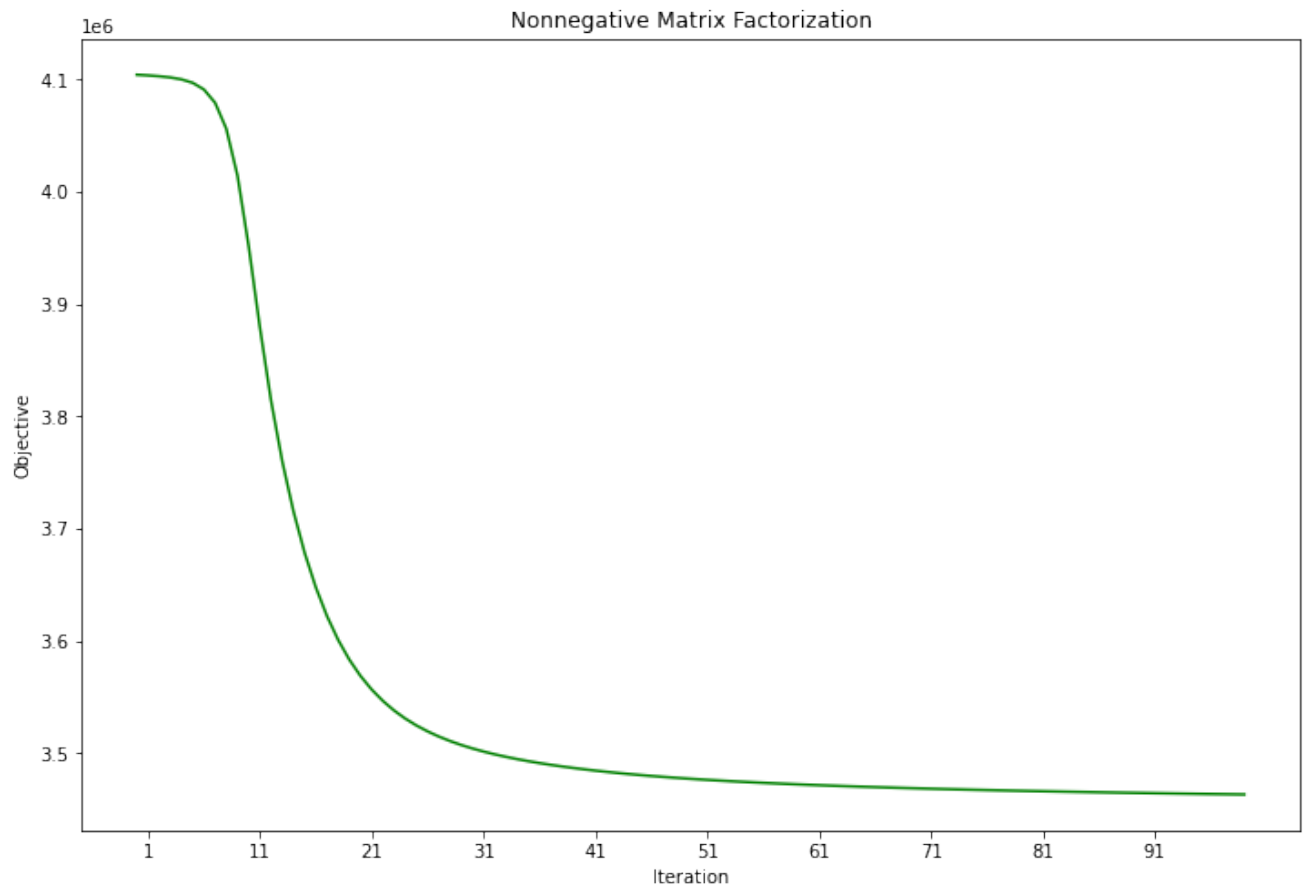

Question 2

Question 2(a)

In [23]:
```python
fig = plt.figure()
ax = plt.axes()
fig.set_size_inches(12, 8)
ax.xaxis.set_major_locator(MaxNLocator(integer=True))
plt.title('Nonnegative Matrix Factorization')
plt.xlabel('Iteration')
plt.ylabel('Objective')
plt.plot(objective, label = 'Objective', color = 'green')
plt.xticks(np.arange(1, 101, 10))
plt.show()
```

Question 2(b)

In [32]:
```python
print(table.draw())
```

```
+---------------------+---------------------+---------------------+--------
--------------+---------------------+
|      yesterday:     |         art:        |        editor:      |        f
amily:       |        speak:       |
| 0.023784159394675677 | 0.019077526676087996 | 0.022302065506333346 | 0.03299
036334788057   | 0.009787299844219098 |
|        fire:        |        artist:      |        write:       |
child:          |        ask:         |
```

```
| 0.02263035745566964  | 0.011381822431513566 | 0.0177480351005546   | 0.03073
9709342185638 | 0.009516485654474044 |
|        police:       |        design:       |       article:       |
life:        |         feel:        |
| 0.022311522204318757 | 0.009187625978713925 | 0.015362076291174537 | 0.02332
6400328324136 | 0.009276581246702123 |
|       official:      |      collection:     |         book:        |
wife:        |         thing:       |
| 0.021119429227254988 | 0.00914196972781155  | 0.01438146591088693  | 0.01862
8834991615016 | 0.008915657494052162 |
|         city:        |        museum:       |         page:        |        f
riend:        |       question:      |
| 0.020249597408329878 | 0.008944998870116903 | 0.010759175736163473 | 0.01856
5417820032813 | 0.008237067100280524 |
|         night:       |        century:      |        publish:      |
home:        |         tell:        |
| 0.015464712551511495 | 0.007740728067748241 | 0.009572806379359762 | 0.01846
5579733427405 | 0.008033399982357982 |
|          news:       |      exhibition:     |        writer:       |
live:        |         word:        |
| 0.013630655008183664 | 0.007705711768742967 | 0.009530687426887346 | 0.01749
9169072740548 | 0.007957528065937794 |
|        morning:      |       photograph:    | read: 0.007169136897 |        m
other:        | talk: 0.007317535944 |
| 0.013335960370532184 | 0.007548183937859727 |       1820366        | 0.01718
5229027490635 |       9238545        |
|         report:      |         image:       |         world:       |        f
ather:        |        moment:       |
| 0.013018568310350302 | 0.007403505580474315 | 0.006835391088116169 | 0.01444
8579926524138 | 0.006481264951566601 |
|        officer:      | painting: 0.00655062 |       american:      |
die:         |         point:       |
| 0.01171581043249322  |      96240810105     | 0.006826253298165895 | 0.01421
204042464666 | 0.006164409891091062 |
+======================+======================+======================+========
==============+======================+
|         water:       |       building:      |       company:       |        pr
esident:        |        court:        |
| 0.01609383314555113  | 0.025184833367232918 | 0.016702118207581572 | 0.05190
5832346438974 | 0.023549937622384696 |
|         pound:       |         city:        |       computer:      |        ex
ecutive:        |         case:        |
| 0.013077898254493394 | 0.022574964784638257 | 0.01558858500708064  |  0.0358
660998942737 |   0.0228803124155863  |
|          inch:       |       resident:      |        system:       |
vice:        |        charge:        |
| 0.009957443046286209 | 0.016514661632771984 | 0.012843149220931037 | 0.03080
6139216812797 | 0.021313187003807448 |
|          heat:       |          area:       |      technology:     |        di
rector:        |        lawyer:       |
| 0.009859758934145754 | 0.014310204439940452 | 0.012641107108344487 | 0.02408
5866596941896 |  0.0208754659982851  |
|          cut:        |         house:       |         site:        |        f
ather:        |         law:         |
|  0.0089541832328588  | 0.013270267347471377 | 0.012413012225930399 | 0.02322
7939603889688 | 0.016213089459644534 |
|          add:        |         build:       |         plant:       |        gr
```

aduate:		judge:	
0.00853958698045001	0.012993049289692953	0.010161226245363674	0.02278889151043903	0.016119718276160745

dry:		community:		program:	
mrs:		crime:	
0.008521667267095457	0.01140323814622506	0.008947519226103833	0.020513654770588224	0.012221283934545532

large:		property:		develop:	
chief:		police:	
0.008459511714622685	0.011223104419594385	0.008793608027108778	0.020117173456047834	0.012096567136512226

minute:		live:		build:	
name:		trial:	
0.008446929819985011	0.010387596382258682	0.008396325892833132	0.01917854252558632	0.012017624708172107

oil:		local:		industry:		c
ompany:		arrest:	
0.008131344181072109	0.009902507358644933	0.007947394605607524	0.018268325100296585	0.011496328106962066

+---------------------+---------------------+---------------------+---------------------+---------------------+

music:		film:		american:		c
ompany:		drug:	
0.026525437791651275	0.01814268956528599	0.014529403667074779	0.02804258596860126	0.013931891032291158

performance:		movie:		states:		bu
siness:		health:	
0.014976397727933997	0.01643958313340022	0.013880622564954507	0.017456588517939627	0.013375369228686944

play:		character:		government:	
pay:		study:	
0.014967664249240951	0.016018879069453883	0.013450589502040975	0.017073378125780896	0.01259533147383857

perform:		story:		military:	
deal:		doctor:	
0.012240250138869395	0.015626219044934293	0.013087108925389111	0.014600040414933055	0.010656123875637606

dance:		television:		country:		ex
ecutive:		cause:	
0.01118739660754753	0.014717879652278243	0.012884737886824005	0.011782033886181674	0.010608377570763564

song:		play:		war:	
sell:		medical:	
0.011067039847077699	0.011665241629823131	0.01286539563619148	0.011619722399169915	0.00983457912055364

sound:		man:		force:		fi
nancial:		patient:	
0.008916062487956448	0.010547535991618033	0.009808239373909605	0.01131948410701026	0.009811460520851002

audience:		star:		leader:	
offer:		treatment:	
0.008884875463509904	0.009320353694214861	0.009642069542257365	0.010955773166605426	0.00894043021312616

stage:		woman:		official:	
money:		report:	
0.008815257302745653	0.009037461022028218	0.009301058229351825	0.01089752476433113	0.008723957326420225

```
|       concert:       |       novel:        |       attack:       |
buy:        |       problem:      |
| 0.008356744379349261 | 0.008874466496194578 | 0.007367024704601507 | 0.01075
797445668913 | 0.008199197193347788 |
+---------------------+---------------------+---------------------+--------
-------------+---------------------+
|        game:         |      campaign:      |        car:         |
food:       |        thing:       |
| 0.02362444950728304  | 0.021989039554235083 | 0.022080008517385556 | 0.02318
563046960519 | 0.01645678981694708  |
|        team:         |      political:     |        mile:        |       res
taurant:    |        lot:         |
| 0.020196423476886716 | 0.020733814761441354 | 0.016296369301793 69 | 0.01859
3496369700212 | 0.013144551229588885 |
|        play:         |        vote:        |       travel:       |        d
inner:      |        job:         |
| 0.019520967911527905 | 0.01737119793666533 | 0.011961254817883639 | 0.01474
3370545273188 | 0.010979180053472405 |
|        win:          |       party:        |       train:        |
table:      |       really:       |
| 0.016097752335585053 | 0.01606180320611102 | 0.010576794650476048 | 0.01302
5559630672331 | 0.010340119001787924 |
|       season:        |      election:      |        hour:        |
room:       |       change:       |
| 0.01574379185126495  | 0.015509125802838999 | 0.010247648240034253 | 0.01255
967638372973 |   0.010290326267996  |
|       player:        |     candidate:      |       driver:       |
eat:        |       little:       |
| 0.015729969304867312 | 0.014625942681112721 | 0.009825815022615215 | 0.01207
1469431831211 | 0.009473304302579493 |
|       second:        |     republican:     |       drive:        |
serve:      |        put:         |
| 0.013536325223659107 | 0.013946892951831975 | 0.009804005862977704 | 0.01022
6583420853115 | 0.009353196653132894 |
|       victory:       |       leader:       |        air:         |
lunch:      |        big:         |
| 0.009750936165073193 | 0.012308035307669423 | 0.00908774862017637 | 0.01019
5757285237153 | 0.009072828684014081 |
|        score:        |     democratic:     |        trip:        |
price:      |      different:      |
| 0.008827209139978748 | 0.012104174415754452 | 0.008844106404408646 | 0.00932
7763505694864 | 0.008681135882500775 |
|        coach:        |       state:        |        fly:         |
drink:      |       problem:      |
| 0.008532900898942031 | 0.009939731936613988 | 0.00879373691582958 | 0.00834
8661618899833 | 0.008473988762849145 |
+---------------------+---------------------+---------------------+--------
-------------+---------------------+
|       percent:       |      official:      |        wear:        |
state:      |       school:       |
| 0.028456846208675078 | 0.01820507015215349 | 0.011373385996716001 | 0.01660
4416686553103 | 0.04770445488351718  |
|       market:        |       issue:        |        man:         |        b
udget:      |       student:      |
| 0.021930165521879586 | 0.011101907094126015 | 0.009953816895512394 | 0.01256
1508251018202 | 0.03356941765227699  |
|        price:        |       member:       |       thing:        |
```

bill: 0.019324647276940565	program: 0.010372816216833338	0.00900402755482827	0.011496592905220145	0.018217331703450773
stock: 0.012817053268214463	report: 0.009643760574370717	sit: 0.007053615936564553	proposal: 0.011385596075792393	child: 0.016529232082140157
rate: 0.012692041390622757	comment: 0.00898213472942703	woman: 0.006967666461882015	program: 0.010808831017915597	education: 0.016456855493573782
rise: 0.011634927971989095	statement: 0.008661606350491775	stand: 0.0067712173824571445	plan: 0.010596440520410767	class: 0.015313710663321977
sale: 0.010658069822814323	office: 0.008268215671897687	little: 0.006572384832195352	propose: 0.010286860789491552	college: 0.015209815583365979
increase: 0.009812090081994832	ask: 0.008044382202978704	dress: 0.006428869556709589	government: 0.010158732219207624	teacher: 0.013066256515939036
fall: 0.009444783745502429	investigation: 0.00776308504840588	eye: 0.006420722349117735	tax: 0.009839260938791344	group: 0.010690511581885415
analyst: 0.009296947287675217	decision: 0.007609461652715065	ask: 0.006414747829547444	cut: 0.009808953019042827	parent: 0.00974779994037651