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Part II. Multi-level analysis
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# now do the within-school regressions, math on SES, via OLS, for each sector in turn
# and show coeficients. Using lmList
# Best to use cses as the indiv predictor, as then the intercept
# of each regression would be the mean mathach
# lmList (see docs) is the tool for doing all the within-school regressions in one pass
# here we do the within-school regression for each sector (and then compare)
# cathRegC = lmList(mathach ~ cses| school, subset = sector == "Catholic", data = Bryk)
# pubRegC = lmList(mathach ~ cses| school, subset = sector == "Public", data = Bryk)
> table(MathAchSchool$Sector)
```

```
Public Catholic
    90         70
```

```
> cathRegC = lmList(mathach ~ cses| school, subset = sector == "Catholic", data = Bryk)
> pubRegC = lmList(mathach ~ cses| school, subset = sector == "Public", data = Bryk)
```

```
> coef(pubRegC) #lists intercept (mean(mathach) and slope for each of the 90 Public schools
```

	(Intercept)	cses
8367	4.552786	0.25037481
8854	4.239781	1.93884461
4458	5.811396	1.13183718
5762	4.324865	-1.01409923
6990	5.976792	0.94769026
5815	7.271360	3.01800184
7341	9.794176	1.70370049
1358	11.206233	5.06800874
4383	11.465680	6.18019316
3088	9.145846	1.79134272
8775	9.467000	1.00145622
7890	8.341098	-0.65596791
6144	8.545070	2.77027083
6443	9.475533	-0.74334668
6808	9.286114	2.27610417
2818	13.872833	2.80240778
9340	11.178552	3.30949739
5783	13.150345	3.11405659
3013	12.610830	3.83979913
7101	11.849929	1.29545472
2639	6.615476	-0.63010463
3377	9.186711	-0.74685357
1296	7.635958	1.07595915
4350	11.855424	4.37191824
9397	10.355468	2.44644371
2655	12.345173	5.22703806
9292	10.279632	0.75867588
8983	10.992000	1.38594141
8188	12.740967	4.39759465
4410	13.472976	2.76019657
8707	12.883938	3.39153230
1499	7.660358	3.63473417
8477	12.522243	3.81215624
1288	13.510800	3.25544868
6291	10.107314	3.98086905
1224	9.715447	2.50858170
3967	12.035077	3.31106817
6415	11.860204	3.53007531
9550	11.089138	3.89193777
6464	7.091621	1.00349366
5937	16.775966	1.03961575
7919	14.849973	3.98937031
3716	10.368659	5.86378696
1909	14.423321	2.85479025
2651	11.084316	4.89905964

2467	10.147519	3.13713485
1374	9.728464	3.85432284
6600	11.703893	4.70428938
3881	11.949220	2.39070579
2995	9.546109	1.43231309
5838	13.689613	1.85305195
9158	8.545170	3.86121158
8946	10.375086	1.69048215
7232	12.542635	5.00160032
2917	7.978953	1.13585350
6170	14.181048	4.81178434
2030	12.078191	1.41198038
8357	14.381852	2.67578156
8531	13.528683	3.31822792
4420	13.874156	2.95866415
3999	10.944043	3.56697524
4325	13.240000	2.75604958
6484	12.912400	0.60567730
6897	15.097633	3.58048769
7734	10.559636	6.03522862
8175	11.698091	1.61237121
8874	12.055028	4.09630389
9225	14.667333	2.88589215
5640	13.160105	3.82774230
6089	15.569576	1.69245494
2768	10.886920	3.51228023
5819	12.138900	1.97252104
6397	12.796100	2.75900524
1461	16.842636	6.26649691
1637	7.024111	3.11680644
1942	18.110897	0.08938349
1946	12.908436	3.58583321
2336	16.517702	1.90497358
2626	13.396605	4.09967961
2771	11.844109	4.26818800
3152	13.209038	2.76824957
3332	14.278158	2.03095286
3351	11.465179	2.45503986
3657	9.521176	3.73590722
4642	14.599033	3.27238611
7276	12.679396	3.77336399
7345	11.338554	4.21192377
7697	15.721781	3.13621972
8202	11.712429	3.70590198
8627	10.883717	1.86955959

```
> coef(cathRegC) #lists intercept (mean(mathach) and slope for each of the 70 Cath schools
```

	(Intercept)	cses
7172	8.066818	0.99448053
4868	12.310176	1.28647122
2305	11.137761	-0.78211116
8800	7.335937	2.56812536
5192	10.409500	1.60349497
4523	8.351745	2.38078920
6816	14.538236	1.35271694
2277	9.297607	-2.01502640
8009	14.084723	1.55687204
4530	9.055698	1.64742597
9021	14.696661	2.52415849
4511	13.409034	0.04251038
6578	11.994000	2.39054400
9347	13.538754	2.68599393
3705	10.331689	1.15849738
3533	10.409042	-0.31177009
4253	9.412862	-0.39954421
7342	11.166414	1.01245787

3499	13.276526	0.99238234
7364	14.172136	0.25949653
5650	14.273533	0.68061888
2658	13.396156	2.62990138
9508	13.574657	3.95379067
4292	12.864354	-0.16060800
8857	15.296938	0.80222326
1317	13.177688	1.27391282
2629	14.907772	0.22234915
4223	14.622622	2.48658514
1462	10.495561	-0.82880861
4931	13.790810	0.91184501
5667	13.778230	3.52296571
5720	14.282302	2.46630669
3498	16.390453	-0.13108527
3688	14.656256	1.53672220
8165	16.451224	1.80224301
9104	16.832109	1.49398346
8150	14.852364	-0.18571088
4042	14.315422	1.69362361
6074	13.779089	1.52908771
1906	15.983170	2.14550546
3992	14.645208	0.53787533
4173	12.724659	3.36567036
5761	11.138058	3.10801055
7635	15.065529	2.44847402
2458	13.985684	2.95669443
3610	15.354953	2.95584910
3838	16.062815	0.59789922
9359	15.270623	-0.83347896
2208	15.404667	2.63664069
1477	14.228468	1.23060592
3039	16.963857	2.95566676
1308	16.255500	0.12602422
1433	19.719143	1.85429439
1436	18.111614	1.60056175
2526	17.053000	0.15950396
2755	16.476511	0.56049993
2990	18.447917	1.32453982
3020	14.395271	1.65367684
3427	19.715592	-0.48816617
5404	15.414982	1.21423377
5619	15.416242	5.25753341
6366	15.656397	1.51752409
6469	18.455719	1.75528869
7011	13.813576	5.07465093
7332	14.636104	2.46320360
7688	18.422315	0.11634493
8193	16.232256	2.33521174
8628	16.528377	1.23139333
9198	19.092290	2.61054903
9586	14.863695	1.67208118

```
> tapply(mathach, school, mean) # check that intercepts from lmList are group outcome means
```

8367	8854	4458	5762	6990	5815	7172	4868	7341	135
4.552786	4.239781	5.811396	4.324865	5.976792	7.271360	8.066818	12.310176	9.794176	11.20623
4383	2305	8800	3088	8775	7890	6144	6443	5192	680
11.465680	11.137761	7.335938	9.145846	9.467000	8.341098	8.545070	9.475533	10.409500	9.28611
2818	9340	4523	6816	2277	8009	5783	3013	7101	453
13.872833	11.178552	8.351745	14.538236	9.297607	14.084723	13.150345	12.610830	11.849929	9.05569
9021	4511	2639	3377	6578	9347	3705	3533	1296	435
14.696661	13.409034	6.615476	9.186711	11.994000	13.538754	10.331689	10.409042	7.635958	11.85542
9397	4253	2655	7342	9292	3499	7364	8983	5650	265
10.355468	9.412862	12.345173	11.166414	10.279632	13.276526	14.172136	10.992000	14.273533	13.39615
8188	4410	9508	8707	1499	8477	1288	6291	1224	429

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12.740967 13.472976 13.574657 12.883938 7.660358 12.522243 13.510800 10.107314 9.715447 12.86435
8857 3967 6415 1317 2629 4223 1462 9550 6464 493
15.296938 12.035077 11.860204 13.177687 14.907772 14.622622 10.495561 11.089138 7.091621 13.79081
5937 7919 3716 1909 2651 2467 1374 6600 5667 572
16.775966 14.849973 10.368659 14.423321 11.084316 10.147519 9.728464 11.703893 13.778230 14.28230
3498 3881 2995 5838 3688 9158 8946 7232 2917 617
16.390453 11.949220 9.546109 13.689613 14.656256 8.545170 10.375086 12.542635 7.978953 14.18104
8165 9104 2030 8150 4042 8357 8531 6074 4420 190
16.451224 16.832109 12.078191 14.852364 14.315422 14.381852 13.528683 13.779089 13.874156 15.98317
3992 3999 4173 4325 5761 6484 6897 7635 7734 817
14.645208 10.944043 12.724659 13.240000 11.138058 12.912400 15.097633 15.065529 10.559636 11.69809
8874 9225 2458 3610 5640 3838 9359 2208 6089 147
12.055028 14.667333 13.985684 15.354953 13.160105 16.062815 15.270623 15.404667 15.569576 14.22846
2768 3039 5819 6397 1308 1433 1436 1461 1637 194
10.886920 16.963857 12.138900 12.796100 16.255500 19.719143 18.111614 16.842636 7.024111 18.11089
1946 2336 2526 2626 2755 2771 2990 3020 3152 333
12.908436 16.517702 17.053000 13.396605 16.476511 11.844109 18.447917 14.395271 13.209038 14.27815
3351 3427 3657 4642 5404 5619 6366 6469 7011 727
11.465179 19.715592 9.521176 14.599033 15.414982 15.416242 15.656397 18.455719 13.813576 12.67939
7332 7345 7688 7697 8193 8202 8627 8628 9198 958
14.636104 11.338554 18.422315 15.721781 16.232256 11.712429 10.883717 16.528377 19.092290 14.86369

```

```

>
> length(cathRegC); length(pubRegC)
[1] 70
[1] 90

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```

# you can treat the output of lmList as if it were data--i.e., attributes
# of each school; that's what we called the "smart-first-year-student" approach
# and we can imitate the results of the full lme analysis

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```

> pubcoef= coef(pubRegC)
> cathcoef= coef(cathRegC)
> summary(pubcoef)
(Intercept)          cses
Min.   : 4.240   Min.   : -1.014
1st Qu.: 9.719   1st Qu.:  1.695
Median :11.708   Median :  2.922
Mean   :11.389   Mean    :  2.772
3rd Qu.:13.197   3rd Qu.:  3.824
Max.   :18.111   Max.    :  6.266

```

```

> summary(cathcoef)
(Intercept)          cses
Min.   : 7.336   Min.   : -2.0150
1st Qu.:13.202   1st Qu.:  0.5698
Median :14.467   Median :  1.5233
Mean   :14.204   Mean    :  1.4685
3rd Qu.:15.901   3rd Qu.:  2.4595
Max.   :19.719   Max.    :  5.2575

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```

> # so we see Cath has higher typical (mean or median) outcome and lower slope
> # Cath good on both counts

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> #now create boxplots of level and slope side-by-side for each sector, shown in class
> # boxplot posted at http://www-stat.stanford.edu/~rag/stat209/hsbsfysboxplotC.pdf
> par( mfrow = c(1,2)) # opens a graphics window, creates the figure shown in lecture
> boxplot(cathcoef[,1], pubcoef[,1], main = 'Intercepts', names = c('Catholic', 'Public'))
> boxplot(cathcoef[,2], pubcoef[,2], main = 'Slopes', names = c('Catholic', 'Public'))

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