

Carbon fraction analyses

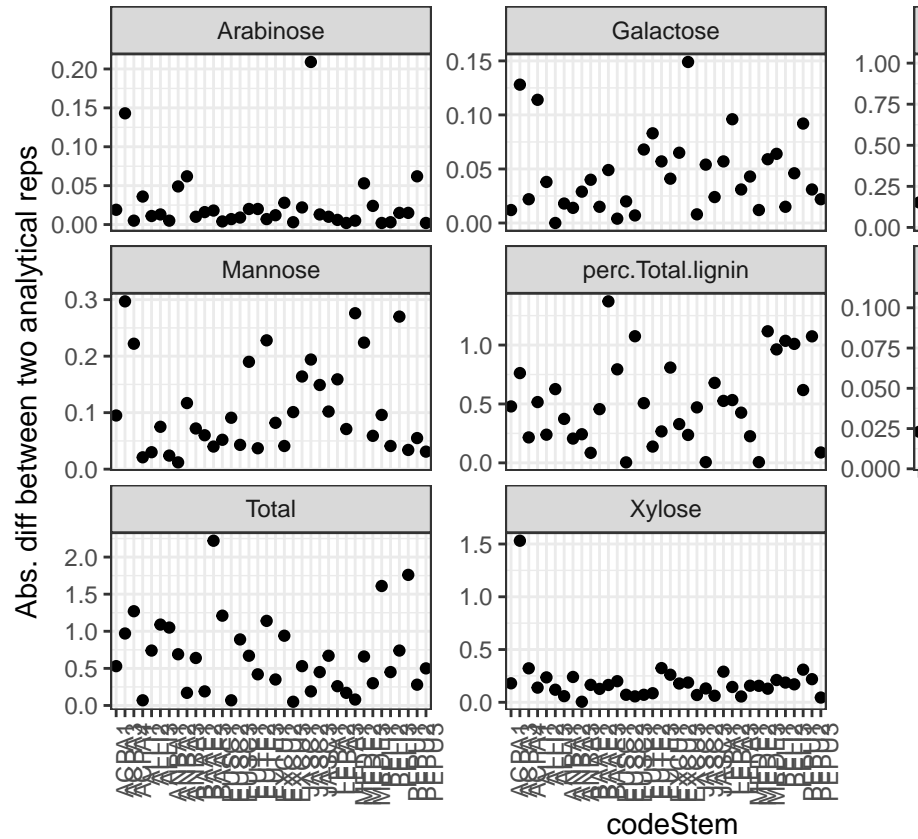
Marissa Lee

7/19/2019

```
## calc_distances.R :
## calc_diversity.R :
## helper_fxns.R :
## load_decayData.R :
## load_microbeData.R :
## load_traitData.R :
## make_figs_decayPatterns.R :
## make_figs_endoComp_explainDecay.R :
## make_figs_endoDiv_explainDecay.R :
## make_figs_woodTraits_explainDecay.R :
## make_summaryTables.R :
## roleOf_traits_on_fungi.R :
## shape_analysis_dataframes.R :
```



Load C fraction data



Check for analytical reps that are way different
Go back and investigate the JASC/Arabinose and ACPA/Xylose outliers.

Average the analytical reps

```
## [1] 36 12
```

Add existing trait data to this C fraction data. Exclude two samples for which there isn't waterperc data.
Remember that there is no stem-level barkthick or density data for large stem samples.

```
## [1] 36 15
```

```
## [1] 34 15
```

Check out correlations among C fractions and other traits.

```
## [1] "code"           "size"           "Stem"
## [4] "codeStem"       "C"              "Ca"
## [7] "Fe"             "K"              "Mn"
## [10] "N"              "P"              "Zn"
## [13] "waterperc"      "Arabinose"      "Galactose"
## [16] "Glucose"        "Mannose"        "perc.Total.lignin"
## [19] "Rhamnose"      "Xylose"
```

```
## pdf
```

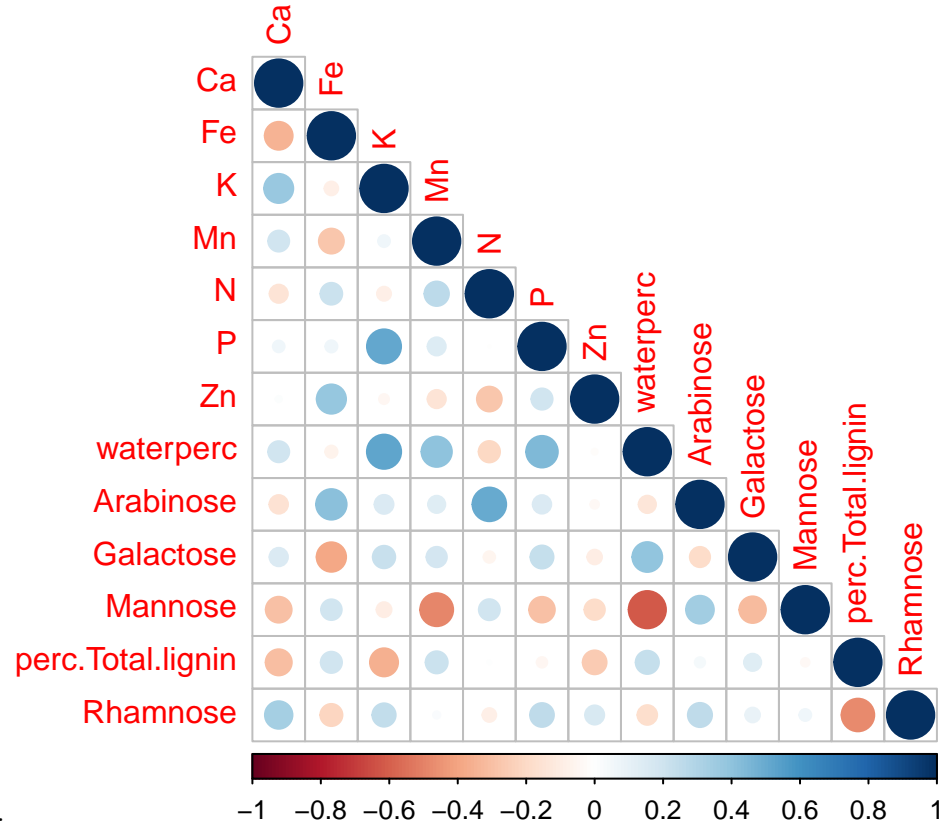
```
## 2
```

```
##           C           Ca           Fe           K
## C          1.00000000 -0.48192405  0.21339207 -0.56683407
## Ca        -0.48192405  1.00000000 -0.34581261  0.37676391
## Fe         0.21339207 -0.34581261  1.00000000 -0.08402084
## K        -0.56683407  0.37676391 -0.08402084  1.00000000
## Mn         0.10416781  0.19598959 -0.27650908  0.06289557
```

## N	0.16707236	-0.14752012	0.21097383	-0.08752664
## P	-0.22722074	0.06119671	0.06511098	0.51653216
## Zn	-0.18886654	0.01714642	0.38090784	-0.04407730
## waterperc	-0.13188332	0.19688890	-0.06702428	0.52077621
## Arabinose	0.14591435	-0.15339938	0.41450144	0.15968397
## Galactose	0.06517262	0.15086712	-0.38587935	0.22407822
## Glucose	-0.73885384	0.19235508	-0.19670088	0.17333926
## Mannose	0.22558608	-0.29756338	0.19005214	-0.09955850
## perc.Total.lignin	0.86328834	-0.30258675	0.19999598	-0.35056354
## Rhamnose	-0.36718634	0.33675261	-0.21781332	0.24118762
## Xylose	-0.58472552	0.05756832	0.08373210	0.15105826
##	Mn	N	P	Zn
## C	0.10416781	0.16707236	-0.22722074	-0.18886654
## Ca	0.19598959	-0.14752012	0.06119671	0.01714642
## Fe	-0.27650908	0.21097383	0.06511098	0.38090784
## K	0.06289557	-0.08752664	0.51653216	-0.04407730
## Mn	1.00000000	0.26602320	0.14635054	-0.14778498
## N	0.26602320	1.00000000	-0.00179316	-0.27418722
## P	0.14635054	-0.00179316	1.00000000	0.19943103
## Zn	-0.14778498	-0.27418722	0.19943103	1.00000000
## waterperc	0.40918234	-0.20298667	0.44412039	-0.01573664
## Arabinose	0.13151941	0.50437095	0.15178920	-0.03326204
## Galactose	0.18391483	-0.05886260	0.23588945	-0.09546717
## Glucose	-0.19724656	0.14975675	-0.02228067	0.17836946
## Mannose	-0.48356548	0.19603140	-0.29217825	-0.18492797
## perc.Total.lignin	0.21712559	0.00661144	-0.04916041	-0.25312787
## Rhamnose	0.02329422	-0.08463428	0.25274418	0.16278547
## Xylose	-0.36872746	-0.33536147	-0.09122524	0.43456371
##	waterperc	Arabinose	Galactose	Glucose
## C	-0.13188332	0.14591435	0.06517262	-0.73885384
## Ca	0.19688890	-0.15339938	0.15086712	0.19235508
## Fe	-0.06702428	0.41450144	-0.38587935	-0.19670088
## K	0.52077621	0.15968397	0.22407822	0.17333926
## Mn	0.40918234	0.13151941	0.18391483	-0.19724656
## N	-0.20298667	0.50437095	-0.05886260	0.14975675
## P	0.44412039	0.15178920	0.23588945	-0.02228067
## Zn	-0.01573664	-0.03326204	-0.09546717	0.17836946
## waterperc	1.00000000	-0.13363171	0.39630166	-0.23293616
## Arabinose	-0.13363171	1.00000000	-0.18170967	-0.19806850
## Galactose	0.39630166	-0.18170967	1.00000000	-0.11817050
## Glucose	-0.23293616	-0.19806850	-0.11817050	1.00000000
## Mannose	-0.61853204	0.34426991	-0.31391893	-0.02468229
## perc.Total.lignin	0.23972388	0.04729579	0.13170023	-0.87635939
## Rhamnose	-0.17236076	0.25958594	0.09683404	0.12867908
## Xylose	-0.33373629	0.05452203	-0.42624164	0.46495096
##	Mannose	perc.Total.lignin	Rhamnose	Xylose
## C	0.22558608	0.86328834	-0.36718634	-0.58472552
## Ca	-0.29756338	-0.30258675	0.33675261	0.05756832
## Fe	0.19005214	0.19999598	-0.21781332	0.08373210
## K	-0.09955850	-0.35056354	0.24118762	0.15105826
## Mn	-0.48356548	0.21712559	0.02329422	-0.36872746
## N	0.19603140	0.00661144	-0.08463428	-0.33536147
## P	-0.29217825	-0.04916041	0.25274418	-0.09122524
## Zn	-0.18492797	-0.25312787	0.16278547	0.43456371

```
## waterperc      -0.61853204      0.23972388 -0.17236076 -0.33373629
## Arabinose      0.34426991      0.04729579  0.25958594  0.05452203
## Galactose     -0.31391893      0.13170023  0.09683404 -0.42624164
## Glucose       -0.02468229     -0.87635939  0.12867908  0.46495096
## Mannose        1.00000000     -0.03272294  0.06321777  0.17665905
## perc.Total.lignin -0.03272294      1.00000000 -0.47548640 -0.73937597
## Rhamnose       0.06321777     -0.47548640  1.00000000  0.50786871
## Xylose         0.17665905     -0.73937597  0.50786871  1.00000000
```

Kick out traits that are highly correlated - C and perc.Total.lignin are highly positive correlated (0.8); keep perc.Total.lignin - Glucose+Xylose and perc.Total.lignin are highly negatively correlated (-.8, -.7); keep



```
## Ca      1.00000000 -0.34581261  0.37676391  0.19598959
## Fe     -0.34581261  1.00000000 -0.08402084 -0.27650908
## K       0.37676391 -0.08402084  1.00000000  0.06289557
## Mn      0.19598959 -0.27650908  0.06289557  1.00000000
## N      -0.14752012  0.21097383 -0.08752664  0.26602320
## P       0.06119671  0.06511098  0.51653216  0.14635054
## Zn      0.01714642  0.38090784 -0.04407730 -0.14778498
## waterperc 0.19688890 -0.06702428  0.52077621  0.40918234
## Arabinose -0.15339938  0.41450144  0.15968397  0.13151941
## Galactose 0.15086712 -0.38587935  0.22407822  0.18391483
## Mannose  -0.29756338  0.19005214 -0.09955850 -0.48356548
## perc.Total.lignin -0.30258675  0.19999598 -0.35056354  0.21712559
## Rhamnose  0.33675261 -0.21781332  0.24118762  0.02329422
## N         0.14752012  0.06119671  0.01714642  0.19688890
## Fe        0.21097383  0.06511098  0.38090784 -0.06702428
```

```

## K -0.08752664 0.51653216 -0.04407730 0.52077621
## Mn 0.26602320 0.14635054 -0.14778498 0.40918234
## N 1.00000000 -0.00179316 -0.27418722 -0.20298667
## P -0.00179316 1.00000000 0.19943103 0.44412039
## Zn -0.27418722 0.19943103 1.00000000 -0.01573664
## waterperc -0.20298667 0.44412039 -0.01573664 1.00000000
## Arabinose 0.50437095 0.15178920 -0.03326204 -0.13363171
## Galactose -0.05886260 0.23588945 -0.09546717 0.39630166
## Mannose 0.19603140 -0.29217825 -0.18492797 -0.61853204
## perc.Total.lignin 0.00661144 -0.04916041 -0.25312787 0.23972388
## Rhamnose -0.08463428 0.25274418 0.16278547 -0.17236076
## Arabinose Galactose Mannose perc.Total.lignin
## Ca -0.15339938 0.15086712 -0.29756338 -0.30258675
## Fe 0.41450144 -0.38587935 0.19005214 0.19999598
## K 0.15968397 0.22407822 -0.09955850 -0.35056354
## Mn 0.13151941 0.18391483 -0.48356548 0.21712559
## N 0.50437095 -0.05886260 0.19603140 0.00661144
## P 0.15178920 0.23588945 -0.29217825 -0.04916041
## Zn -0.03326204 -0.09546717 -0.18492797 -0.25312787
## waterperc -0.13363171 0.39630166 -0.61853204 0.23972388
## Arabinose 1.00000000 -0.18170967 0.34426991 0.04729579
## Galactose -0.18170967 1.00000000 -0.31391893 0.13170023
## Mannose 0.34426991 -0.31391893 1.00000000 -0.03272294
## perc.Total.lignin 0.04729579 0.13170023 -0.03272294 1.00000000
## Rhamnose 0.25958594 0.09683404 0.06321777 -0.47548640
## Rhamnose
## Ca 0.33675261
## Fe -0.21781332
## K 0.24118762
## Mn 0.02329422
## N -0.08463428
## P 0.25274418
## Zn 0.16278547
## waterperc -0.17236076
## Arabinose 0.25958594
## Galactose 0.09683404
## Mannose 0.06321777
## perc.Total.lignin -0.47548640
## Rhamnose 1.00000000

```

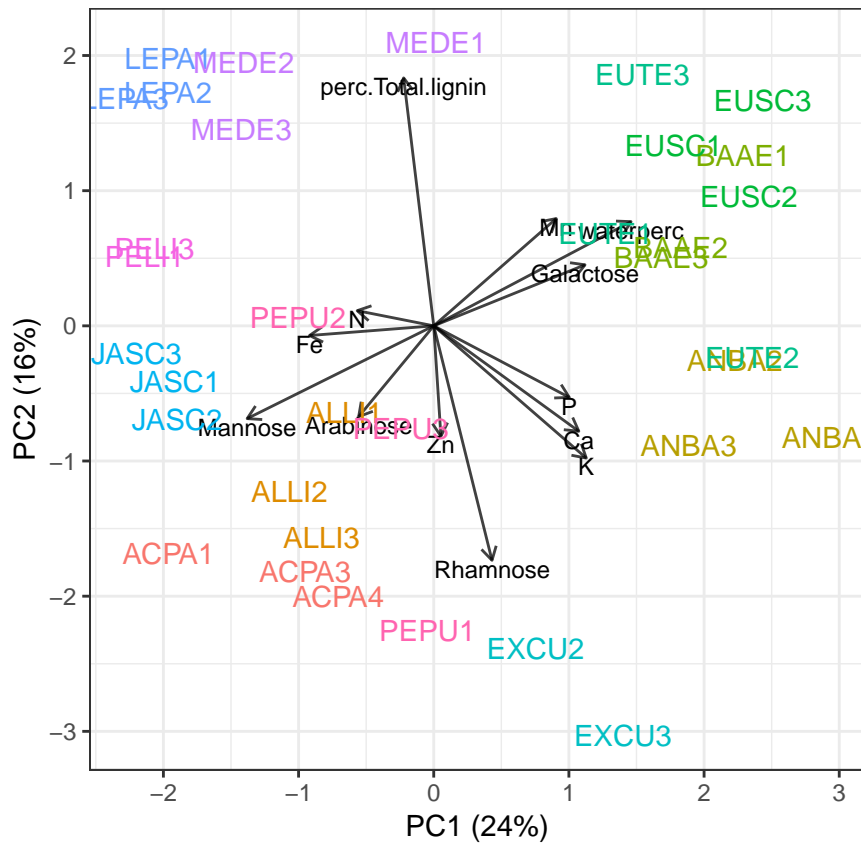
Note that waterperc and Mannose are negatively correlated (-0.62), but I'm leaving them in there.

Visualize the codeStems in trait space

```

## Importance of components:
## PC1 PC2 PC3 PC4 PC5 PC6 PC7
## Standard deviation 1.7546 1.4515 1.3829 1.2759 1.03964 0.92683 0.81385
## Proportion of Variance 0.2368 0.1621 0.1471 0.1252 0.08314 0.06608 0.05095
## Cumulative Proportion 0.2368 0.3989 0.5460 0.6712 0.75436 0.82044 0.87139
## PC8 PC9 PC10 PC11 PC12 PC13
## Standard deviation 0.75862 0.64073 0.54823 0.43129 0.35571 0.2699
## Proportion of Variance 0.04427 0.03158 0.02312 0.01431 0.00973 0.0056
## Cumulative Proportion 0.91566 0.94724 0.97035 0.98466 0.99440 1.0000

```



How do wood C fractions contribute to explaining decay?

(1) by codeStem

Merge trait matrix with the percent mass loss data

Remember there are 34 codeStems/observations.

Set up models

(a) Original traits: “Ca”, “Fe”, “K”, “Mn”, “N”, “P”, “Zn”, “waterperc” predict percent mass remaining (PMR) at each time point

```
## Start: AIC=-210.31
## time7 ~ Ca + Fe + K + Mn + N + P + Zn + waterperc
##
##           Df Sum of Sq    RSS    AIC
## - Mn       1 0.00007942 0.041301 -212.25
## - K        1 0.00013811 0.041360 -212.20
## - P        1 0.00027871 0.041501 -212.09
## - Zn       1 0.00148174 0.042704 -211.11
## - Ca       1 0.00150901 0.042731 -211.09
## - Fe       1 0.00154263 0.042765 -211.07
## - N        1 0.00194486 0.043167 -210.75
## <none>          0.041222 -210.31
## - waterperc 1 0.00294589 0.044168 -209.97
##
## Step: AIC=-212.25
## time7 ~ Ca + Fe + K + N + P + Zn + waterperc
##
```

```

##           Df Sum of Sq      RSS      AIC
## - K         1 0.0002215 0.041523 -214.07
## - P         1 0.0002710 0.041572 -214.03
## - Zn        1 0.0014199 0.042721 -213.10
## - Fe        1 0.0015007 0.042802 -213.04
## - Ca        1 0.0016524 0.042954 -212.92
## - N         1 0.0021013 0.043403 -212.56
## <none>                0.041301 -212.25
## - waterperc  1 0.0035163 0.044818 -211.47
##
## Step:  AIC=-214.07
## time7 ~ Ca + Fe + N + P + Zn + waterperc
##
##           Df Sum of Sq      RSS      AIC
## - P         1 0.0006473 0.042170 -215.54
## - Zn        1 0.0012561 0.042779 -215.05
## - Fe        1 0.0013916 0.042914 -214.95
## - Ca        1 0.0014314 0.042954 -214.91
## - N         1 0.0020219 0.043545 -214.45
## <none>                0.041523 -214.07
## - waterperc  1 0.0044594 0.045982 -212.60
##
## Step:  AIC=-215.54
## time7 ~ Ca + Fe + N + Zn + waterperc
##
##           Df Sum of Sq      RSS      AIC
## - Ca        1 0.0015016 0.043672 -216.35
## - Fe        1 0.0015023 0.043672 -216.35
## - Zn        1 0.0019085 0.044079 -216.04
## - N         1 0.0025480 0.044718 -215.55
## <none>                0.042170 -215.54
## - waterperc  1 0.0080989 0.050269 -211.57
##
## Step:  AIC=-216.35
## time7 ~ Fe + N + Zn + waterperc
##
##           Df Sum of Sq      RSS      AIC
## - Fe        1 0.0007030 0.044375 -217.81
## - Zn        1 0.0014223 0.045094 -217.26
## - N         1 0.0024567 0.046129 -216.49
## <none>                0.043672 -216.35
## - waterperc  1 0.0070938 0.050766 -213.23
##
## Step:  AIC=-217.81
## time7 ~ N + Zn + waterperc
##
##           Df Sum of Sq      RSS      AIC
## - Zn        1 0.0008212 0.045196 -219.19
## - N         1 0.0018500 0.046225 -218.42
## <none>                0.044375 -217.81
## - waterperc  1 0.0070437 0.051418 -214.80
##
## Step:  AIC=-219.19
## time7 ~ N + waterperc

```

```

##
##           Df Sum of Sq      RSS      AIC
## - N           1 0.0013238 0.046520 -220.20
## <none>                0.045196 -219.19
## - waterperc   1 0.0067224 0.051918 -216.47
##
## Step: AIC=-220.2
## time7 ~ waterperc
##
##           Df Sum of Sq      RSS      AIC
## <none>                0.046520 -220.20
## - waterperc   1 0.005805 0.052325 -218.21
## Start: AIC=-196.54
## time13 ~ Ca + Fe + K + Mn + N + P + Zn + waterperc
##
##           Df Sum of Sq      RSS      AIC
## - Mn           1 0.0004815 0.050039 -198.22
## - K             1 0.0006905 0.050248 -198.08
## - Ca           1 0.0020723 0.051630 -197.19
## - P             1 0.0023504 0.051908 -197.01
## - Fe           1 0.0024378 0.051995 -196.95
## <none>                0.049557 -196.54
## - N             1 0.0098775 0.059435 -192.54
## - Zn            1 0.0127073 0.062265 -191.00
## - waterperc   1 0.0168131 0.066370 -188.90
##
## Step: AIC=-198.22
## time13 ~ Ca + Fe + K + N + P + Zn + waterperc
##
##           Df Sum of Sq      RSS      AIC
## - K             1 0.0014218 0.051461 -199.29
## - Fe            1 0.0019613 0.052000 -198.95
## - Ca            1 0.0027461 0.052785 -198.46
## - P             1 0.0028803 0.052919 -198.37
## <none>                0.050039 -198.22
## - N             1 0.0103427 0.060381 -194.02
## - Zn            1 0.0124098 0.062449 -192.91
## - waterperc   1 0.0200980 0.070137 -189.08
##
## Step: AIC=-199.29
## time13 ~ Ca + Fe + N + P + Zn + waterperc
##
##           Df Sum of Sq      RSS      AIC
## - P             1 0.0015046 0.052965 -200.34
## - Ca            1 0.0015283 0.052989 -200.33
## - Fe            1 0.0017881 0.053249 -200.17
## <none>                0.051461 -199.29
## - N             1 0.0095620 0.061022 -195.67
## - Zn            1 0.0110750 0.062536 -194.86
## - waterperc   1 0.0237516 0.075212 -188.77
##
## Step: AIC=-200.34
## time13 ~ Ca + Fe + N + Zn + waterperc
##

```



```

##           Df Sum of Sq      RSS      AIC
## - Ca       1  0.0013201 0.054285 -201.53
## - Fe       1  0.0017786 0.054744 -201.25
## <none>                0.052965 -200.34
## - N       1  0.0084463 0.061411 -197.46
## - Zn       1  0.0097032 0.062668 -196.79
## - waterperc 1  0.0244570 0.077422 -189.81
##
## Step: AIC=-201.53
## time13 ~ Fe + N + Zn + waterperc
##
##           Df Sum of Sq      RSS      AIC
## - Fe       1  0.0009961 0.055281 -202.93
## <none>                0.054285 -201.53
## - N       1  0.0082902 0.062575 -198.84
## - Zn       1  0.0088083 0.063094 -198.57
## - waterperc 1  0.0231859 0.077471 -191.79
##
## Step: AIC=-202.93
## time13 ~ N + Zn + waterperc
##
##           Df Sum of Sq      RSS      AIC
## <none>                0.055281 -202.93
## - N       1  0.0072942 0.062576 -200.84
## - Zn       1  0.0080148 0.063296 -200.46
## - waterperc 1  0.0230865 0.078368 -193.41
## Start: AIC=-155.13
## time25 ~ Ca + Fe + K + Mn + N + P + Zn + waterperc
##
##           Df Sum of Sq      RSS      AIC
## - Mn       1  0.000347 0.14342 -157.05
## - Fe       1  0.001166 0.14424 -156.87
## - N       1  0.002266 0.14533 -156.62
## - Ca       1  0.009007 0.15208 -155.17
## <none>                0.14307 -155.12
## - K       1  0.015972 0.15904 -153.74
## - Zn       1  0.017677 0.16075 -153.40
## - P       1  0.076119 0.21919 -143.47
## - waterperc 1  0.109328 0.25240 -138.96
##
## Step: AIC=-157.05
## time25 ~ Ca + Fe + K + N + P + Zn + waterperc
##
##           Df Sum of Sq      RSS      AIC
## - Fe       1  0.000830 0.14425 -158.86
## - N       1  0.005070 0.14849 -157.94
## - Ca       1  0.008827 0.15224 -157.14
## <none>                0.14342 -157.05
## - K       1  0.016018 0.15943 -155.66
## - Zn       1  0.019390 0.16281 -154.99
## - P       1  0.077040 0.22046 -145.29
## - waterperc 1  0.188897 0.33231 -132.16
##
## Step: AIC=-158.86

```

```

## time25 ~ Ca + K + N + P + Zn + waterperc
##
##           Df Sum of Sq    RSS    AIC
## - N         1  0.008265 0.15251 -159.08
## <none>                0.14425 -158.86
## - Ca         1  0.013157 0.15740 -158.07
## - K          1  0.017223 0.16147 -157.25
## - Zn         1  0.032724 0.17697 -154.32
## - P          1  0.081255 0.22550 -146.56
## - waterperc  1  0.193091 0.33734 -133.68
##
## Step:  AIC=-159.08
## time25 ~ Ca + K + P + Zn + waterperc
##
##           Df Sum of Sq    RSS    AIC
## <none>                0.15251 -159.08
## - Ca         1  0.015076 0.16759 -158.06
## - K          1  0.016354 0.16886 -157.82
## - Zn         1  0.025716 0.17823 -156.09
## - P          1  0.074337 0.22685 -148.38
## - waterperc  1  0.185050 0.33756 -135.66
## Start:  AIC=-125.39
## time37 ~ Ca + Fe + K + Mn + N + P + Zn + waterperc
##
##           Df Sum of Sq    RSS    AIC
## - Fe         1  0.00029 0.36262 -127.36
## - Zn         1  0.01106 0.37338 -126.43
## - P          1  0.01245 0.37477 -126.31
## - Ca         1  0.01336 0.37568 -126.23
## - N          1  0.01627 0.37859 -125.98
## - K          1  0.01824 0.38056 -125.82
## - Mn         1  0.02308 0.38540 -125.42
## <none>                0.36232 -125.39
## - waterperc  1  0.32090 0.68323 -107.09
##
## Step:  AIC=-127.36
## time37 ~ Ca + K + Mn + N + P + Zn + waterperc
##
##           Df Sum of Sq    RSS    AIC
## - P          1  0.01221 0.37482 -128.31
## - Zn         1  0.01254 0.37515 -128.28
## - Ca         1  0.01328 0.37589 -128.21
## - K          1  0.01823 0.38084 -127.80
## - N          1  0.01825 0.38087 -127.79
## <none>                0.36262 -127.36
## - Mn         1  0.02447 0.38708 -127.28
## - waterperc  1  0.33853 0.70115 -108.27
##
## Step:  AIC=-128.31
## time37 ~ Ca + K + Mn + N + Zn + waterperc
##
##           Df Sum of Sq    RSS    AIC
## - Zn         1  0.00640 0.38122 -129.76
## - K          1  0.01016 0.38498 -129.45

```

```

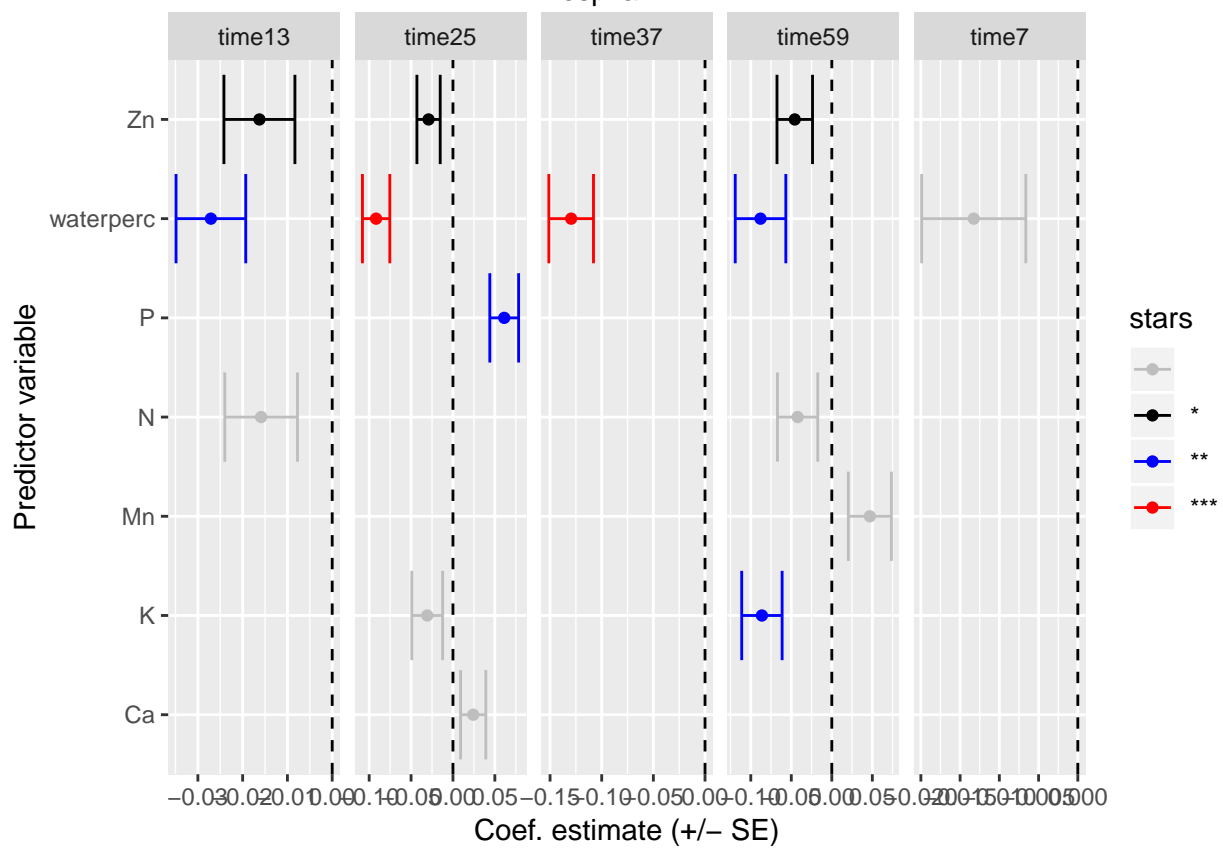
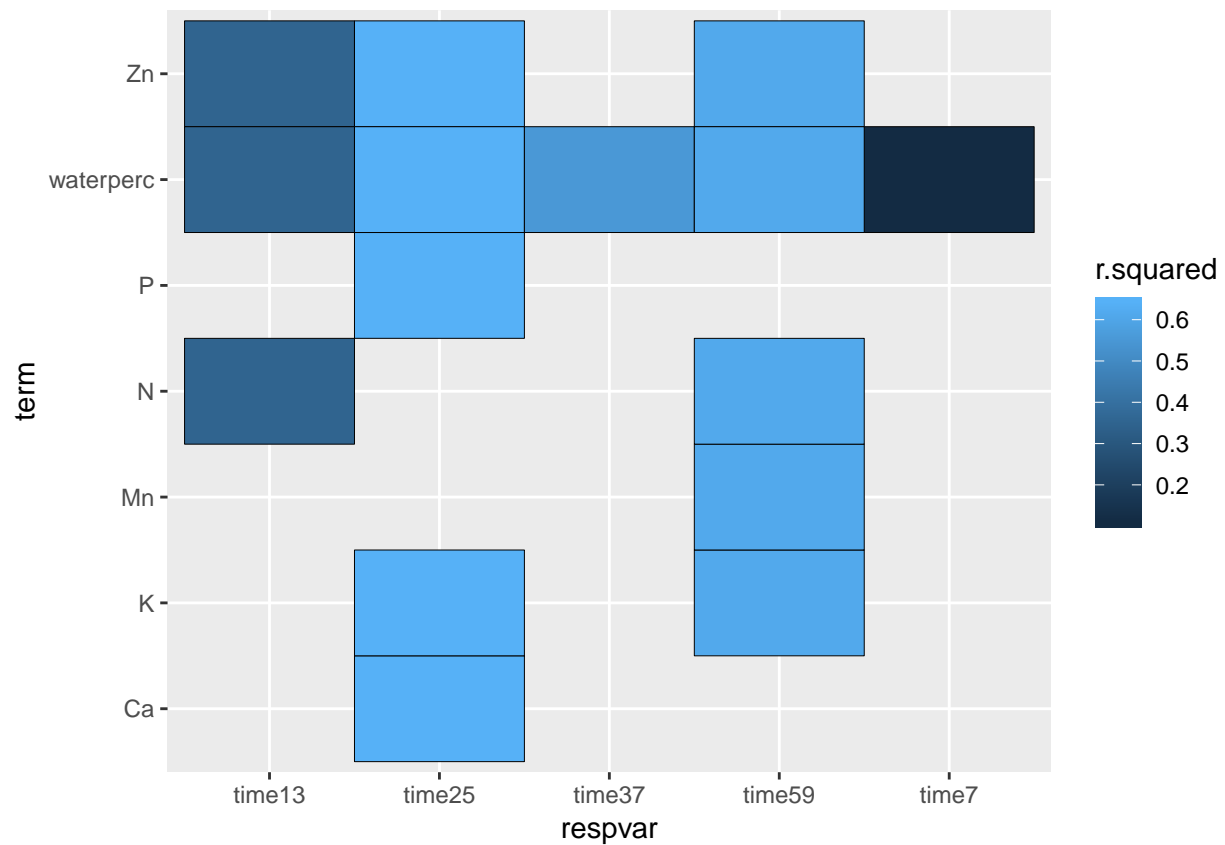
## - Ca      1  0.01119 0.38601 -129.36
## - N      1  0.01419 0.38901 -129.12
## <none>           0.37482 -128.31
## - Mn      1  0.02563 0.40045 -128.19
## - waterperc 1  0.32633 0.70115 -110.27
##
## Step: AIC=-129.76
## time37 ~ Ca + K + Mn + N + waterperc
##
##           Df Sum of Sq    RSS    AIC
## - K      1  0.00936 0.39057 -130.99
## - N      1  0.01052 0.39174 -130.89
## - Ca      1  0.01082 0.39204 -130.87
## <none>           0.38122 -129.76
## - Mn      1  0.02584 0.40706 -129.66
## - waterperc 1  0.32516 0.70638 -112.03
##
## Step: AIC=-130.99
## time37 ~ Ca + Mn + N + waterperc
##
##           Df Sum of Sq    RSS    AIC
## - Ca      1  0.00435 0.39493 -132.63
## - N      1  0.01409 0.40466 -131.85
## <none>           0.39057 -130.99
## - Mn      1  0.03238 0.42295 -130.44
## - waterperc 1  0.48864 0.87922 -107.02
##
## Step: AIC=-132.63
## time37 ~ Mn + N + waterperc
##
##           Df Sum of Sq    RSS    AIC
## - N      1  0.01586 0.41079 -133.37
## <none>           0.39493 -132.63
## - Mn      1  0.03239 0.42732 -132.11
## - waterperc 1  0.49044 0.88537 -108.80
##
## Step: AIC=-133.37
## time37 ~ Mn + waterperc
##
##           Df Sum of Sq    RSS    AIC
## - Mn      1  0.01827 0.42906 -133.98
## <none>           0.41079 -133.37
## - waterperc 1  0.50136 0.91215 -109.85
##
## Step: AIC=-133.98
## time37 ~ waterperc
##
##           Df Sum of Sq    RSS    AIC
## <none>           0.42906 -133.98
## - waterperc 1  0.51435 0.94341 -110.77
## Start: AIC=-132.25
## time59 ~ Ca + Fe + K + Mn + N + P + Zn + waterperc
##
##           Df Sum of Sq    RSS    AIC

```

```

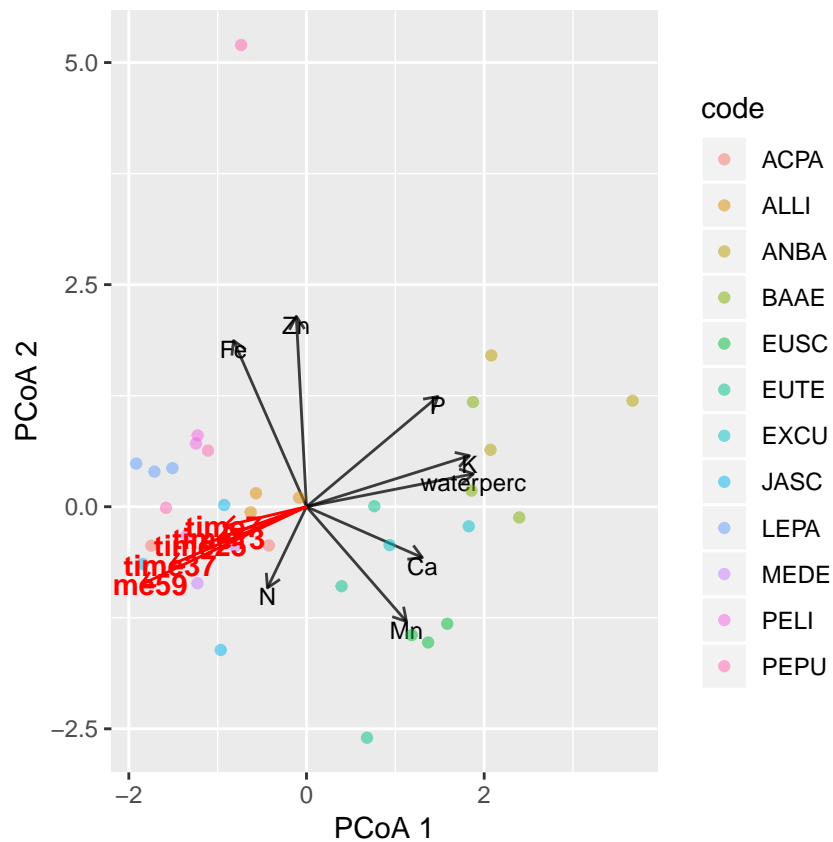
## - P          1  0.008776 0.35639 -133.43
## - Ca          1  0.011030 0.35865 -133.22
## <none>                0.34762 -132.25
## - Fe          1  0.029133 0.37675 -131.60
## - Mn          1  0.040351 0.38797 -130.63
## - N           1  0.053054 0.40067 -129.57
## - Zn          1  0.095643 0.44326 -126.23
## - waterperc   1  0.099306 0.44692 -125.96
## - K           1  0.151274 0.49889 -122.33
##
## Step:  AIC=-133.43
## time59 ~ Ca + Fe + K + Mn + N + Zn + waterperc
##
##           Df Sum of Sq    RSS    AIC
## - Ca       1  0.007935 0.36433 -134.71
## <none>                0.35639 -133.43
## - Fe       1  0.026392 0.38279 -133.07
## - Mn       1  0.042067 0.39846 -131.75
## - N        1  0.048210 0.40460 -131.25
## - Zn       1  0.086884 0.44328 -128.23
## - waterperc 1  0.092028 0.44842 -127.85
## - K        1  0.148738 0.50513 -123.92
##
## Step:  AIC=-134.7
## time59 ~ Fe + K + Mn + N + Zn + waterperc
##
##           Df Sum of Sq    RSS    AIC
## - Fe       1  0.018627 0.38296 -135.06
## <none>                0.36433 -134.71
## - N        1  0.058322 0.42265 -131.81
## - Mn       1  0.060622 0.42495 -131.63
## - Zn       1  0.080282 0.44461 -130.13
## - waterperc 1  0.126019 0.49035 -126.90
## - K        1  0.146370 0.51070 -125.56
##
## Step:  AIC=-135.06
## time59 ~ K + Mn + N + Zn + waterperc
##
##           Df Sum of Sq    RSS    AIC
## <none>                0.38296 -135.06
## - N        1  0.040801 0.42376 -133.72
## - Mn       1  0.044222 0.42718 -133.45
## - Zn       1  0.061679 0.44464 -132.13
## - waterperc 1  0.112656 0.49561 -128.55
## - K        1  0.169830 0.55279 -124.95

```



Visualize codeStems in trait space, add pmr vectors

```
## Importance of components:
##               PC1    PC2    PC3    PC4    PC5    PC6    PC7
## Standard deviation 1.5225 1.2785 1.1575 0.9315 0.89350 0.7510 0.52787
## Proportion of Variance 0.2898 0.2043 0.1675 0.1085 0.09979 0.0705 0.03483
## Cumulative Proportion 0.2898 0.4941 0.6616 0.7700 0.86983 0.9403 0.97516
##               PC8
## Standard deviation 0.44576
## Proportion of Variance 0.02484
## Cumulative Proportion 1.00000
```



(b) Original traits plus C fractions...

```
## Start: AIC=-218.59
## time7 ~ Ca + Fe + K + Mn + N + P + Zn + waterperc + Arabinose +
## Galactose + Mannose + perc.Total.lignin + Rhamnose
##
##               Df Sum of Sq    RSS    AIC
## - Galactose    1 0.0000192 0.024100 -220.56
## - P            1 0.0001202 0.024201 -220.42
## - perc.Total.lignin 1 0.0001257 0.024206 -220.41
## - Ca          1 0.0001884 0.024269 -220.33
## - Mn          1 0.0004035 0.024484 -220.03
## - Rhamnose     1 0.0007978 0.024878 -219.48
## - N           1 0.0008172 0.024898 -219.46
## - K           1 0.0009978 0.025078 -219.21
## <none>                0.024081 -218.59
## - Arabinose     1 0.0028721 0.026953 -216.76
## - Zn           1 0.0032804 0.027361 -216.25
```

```

## - Fe          1 0.0038790 0.027960 -215.51
## - Mannose     1 0.0044478 0.028528 -214.83
## - waterperc   1 0.0100517 0.034132 -208.73
##
## Step: AIC=-220.57
## time7 ~ Ca + Fe + K + Mn + N + P + Zn + waterperc + Arabinose +
##      Mannose + perc.Total.lignin + Rhamnose
##
##           Df Sum of Sq      RSS      AIC
## - perc.Total.lignin 1 0.0001067 0.024206 -222.41
## - P                  1 0.0001328 0.024233 -222.38
## - Ca                 1 0.0001755 0.024275 -222.32
## - Mn                 1 0.0003893 0.024489 -222.02
## - Rhamnose           1 0.0007912 0.024891 -221.47
## - N                  1 0.0008514 0.024951 -221.38
## - K                  1 0.0011244 0.025224 -221.01
## <none>                0.024100 -220.56
## - Arabinose          1 0.0029647 0.027064 -218.62
## - Zn                 1 0.0034067 0.027506 -218.07
## - Fe                 1 0.0046690 0.028769 -216.54
## - Mannose            1 0.0047466 0.028846 -216.45
## - waterperc          1 0.0101324 0.034232 -210.63
##
## Step: AIC=-222.41
## time7 ~ Ca + Fe + K + Mn + N + P + Zn + waterperc + Arabinose +
##      Mannose + Rhamnose
##
##           Df Sum of Sq      RSS      AIC
## - Ca                1 0.0001447 0.024351 -224.21
## - P                  1 0.0002534 0.024460 -224.06
## - Mn                 1 0.0003066 0.024513 -223.99
## - Rhamnose           1 0.0006852 0.024892 -223.47
## - N                  1 0.0007484 0.024955 -223.38
## <none>                0.024206 -222.41
## - K                  1 0.0027613 0.026968 -220.74
## - Arabinose          1 0.0033415 0.027548 -220.02
## - Zn                 1 0.0036213 0.027828 -219.68
## - Fe                 1 0.0046567 0.028863 -218.43
## - Mannose            1 0.0059713 0.030178 -216.92
## - waterperc          1 0.0137189 0.037925 -209.15
##
## Step: AIC=-224.21
## time7 ~ Fe + K + Mn + N + P + Zn + waterperc + Arabinose + Mannose +
##      Rhamnose
##
##           Df Sum of Sq      RSS      AIC
## - Mn                1 0.0003439 0.024695 -225.74
## - P                  1 0.0004124 0.024763 -225.64
## - Rhamnose           1 0.0005649 0.024916 -225.43
## - N                  1 0.0007164 0.025067 -225.23
## <none>                0.024351 -224.21
## - Zn                 1 0.0035580 0.027909 -221.58
## - Arabinose          1 0.0036166 0.027968 -221.50
## - K                  1 0.0040267 0.028378 -221.01

```

```

## - Fe          1 0.0045563 0.028907 -220.38
## - Mannose     1 0.0068473 0.031198 -217.79
## - waterperc   1 0.0141200 0.038471 -210.66
##
## Step: AIC=-225.74
## time7 ~ Fe + K + N + P + Zn + waterperc + Arabinose + Mannose +
## Rhamnose
##
##           Df Sum of Sq      RSS      AIC
## - N         1 0.0004670 0.025162 -227.10
## - P         1 0.0004879 0.025183 -227.07
## - Rhamnose   1 0.0005466 0.025242 -226.99
## <none>                0.024695 -225.74
## - Arabinose  1 0.0032819 0.027977 -223.49
## - Zn         1 0.0034207 0.028116 -223.32
## - K         1 0.0036991 0.028394 -222.99
## - Fe         1 0.0043273 0.029022 -222.25
## - Mannose    1 0.0089448 0.033640 -217.23
## - waterperc  1 0.0143009 0.038996 -212.20
##
## Step: AIC=-227.1
## time7 ~ Fe + K + P + Zn + waterperc + Arabinose + Mannose + Rhamnose
##
##           Df Sum of Sq      RSS      AIC
## - Rhamnose   1 0.0003605 0.025522 -228.62
## - P          1 0.0006522 0.025814 -228.23
## <none>                0.025162 -227.10
## - Zn         1 0.0029646 0.028127 -225.31
## - K          1 0.0037936 0.028955 -224.32
## - Fe         1 0.0041762 0.029338 -223.88
## - Arabinose  1 0.0058796 0.031042 -221.96
## - Mannose    1 0.0084872 0.033649 -219.22
## - waterperc  1 0.0139333 0.039095 -214.12
##
## Step: AIC=-228.61
## time7 ~ Fe + K + P + Zn + waterperc + Arabinose + Mannose
##
##           Df Sum of Sq      RSS      AIC
## - P          1 0.0008848 0.026407 -229.46
## <none>                0.025522 -228.62
## - K          1 0.0034449 0.028967 -226.31
## - Zn         1 0.0041046 0.029627 -225.54
## - Fe         1 0.0067524 0.032275 -222.63
## - Arabinose  1 0.0082212 0.033744 -221.12
## - Mannose    1 0.0082308 0.033753 -221.11
## - waterperc  1 0.0140658 0.039588 -215.69
##
## Step: AIC=-229.46
## time7 ~ Fe + K + Zn + waterperc + Arabinose + Mannose
##
##           Df Sum of Sq      RSS      AIC
## <none>                0.026407 -229.46
## - K          1 0.0026388 0.029046 -228.22
## - Zn         1 0.0051316 0.031539 -225.42

```



```

## - Fe          1 0.0067680 0.033175 -223.70
## - Mannose     1 0.0075878 0.033995 -222.87
## - Arabinose   1 0.0095934 0.036001 -220.92
## - waterperc   1 0.0150638 0.041471 -216.11
## Start:  AIC=-194.52
## time13 ~ Ca + Fe + K + Mn + N + P + Zn + waterperc + Arabinose +
##      Galactose + Mannose + perc.Total.lignin + Rhamnose
##
##              Df Sum of Sq      RSS      AIC
## - Ca          1 0.0001016 0.039006 -196.44
## - P           1 0.0001032 0.039007 -196.44
## - Galactose    1 0.0001297 0.039034 -196.41
## - Mn          1 0.0002421 0.039146 -196.32
## - Rhamnose     1 0.0008335 0.039738 -195.82
## - N           1 0.0010333 0.039937 -195.66
## - Fe          1 0.0015537 0.040458 -195.23
## - Mannose     1 0.0021422 0.041046 -194.76
## - K           1 0.0021660 0.041070 -194.74
## <none>                0.038904 -194.52
## - Zn          1 0.0035273 0.042431 -193.66
## - perc.Total.lignin 1 0.0042720 0.043176 -193.09
## - Arabinose   1 0.0051821 0.044086 -192.40
## - waterperc   1 0.0218332 0.060737 -181.82
##
## Step:  AIC=-196.44
## time13 ~ Fe + K + Mn + N + P + Zn + waterperc + Arabinose + Galactose +
##      Mannose + perc.Total.lignin + Rhamnose
##
##              Df Sum of Sq      RSS      AIC
## - P           1 0.0000332 0.039039 -198.41
## - Mn          1 0.0002603 0.039266 -198.22
## - Galactose    1 0.0002688 0.039275 -198.21
## - N           1 0.0009356 0.039941 -197.66
## - Rhamnose     1 0.0011167 0.040122 -197.51
## - Fe          1 0.0014524 0.040458 -197.23
## <none>                0.039006 -196.44
## - Mannose     1 0.0026481 0.041654 -196.27
## - Zn          1 0.0034986 0.042504 -195.60
## - K           1 0.0041574 0.043163 -195.10
## - perc.Total.lignin 1 0.0052493 0.044255 -194.27
## - Arabinose   1 0.0058955 0.044901 -193.79
## - waterperc   1 0.0228626 0.061868 -183.22
##
## Step:  AIC=-198.41
## time13 ~ Fe + K + Mn + N + Zn + waterperc + Arabinose + Galactose +
##      Mannose + perc.Total.lignin + Rhamnose
##
##              Df Sum of Sq      RSS      AIC
## - Mn          1 0.0002457 0.039285 -200.20
## - Galactose    1 0.0003787 0.039418 -200.09
## - N           1 0.0009256 0.039965 -199.64
## - Rhamnose     1 0.0012256 0.040265 -199.39
## - Fe          1 0.0014194 0.040458 -199.23
## <none>                0.039039 -198.41

```

```

## - Mannose          1 0.0027999 0.041839 -198.12
## - Zn               1 0.0038963 0.042935 -197.27
## - Arabinose        1 0.0059888 0.045028 -195.70
## - perc.Total.lignin 1 0.0067368 0.045776 -195.16
## - K                1 0.0069303 0.045969 -195.02
## - waterperc        1 0.0228321 0.061871 -185.21
##
## Step: AIC=-200.2
## time13 ~ Fe + K + N + Zn + waterperc + Arabinose + Galactose +
##      Mannose + perc.Total.lignin + Rhamnose
##
##              Df Sum of Sq      RSS      AIC
## - Galactose    1 0.0005246 0.039809 -201.76
## - N            1 0.0006837 0.039968 -201.63
## - Fe           1 0.0011914 0.040476 -201.22
## - Rhamnose     1 0.0014871 0.040772 -200.98
## <none>         0.039285 -200.20
## - Zn          1 0.0036708 0.042955 -199.25
## - Mannose     1 0.0043325 0.043617 -198.75
## - Arabinose   1 0.0057571 0.045042 -197.69
## - K           1 0.0068033 0.046088 -196.93
## - perc.Total.lignin 1 0.0084775 0.047762 -195.75
## - waterperc   1 0.0228530 0.062138 -187.07
##
## Step: AIC=-201.77
## time13 ~ Fe + K + N + Zn + waterperc + Arabinose + Mannose +
##      perc.Total.lignin + Rhamnose
##
##              Df Sum of Sq      RSS      AIC
## - N            1 0.0011767 0.040986 -202.80
## - Rhamnose     1 0.0014085 0.041218 -202.62
## - Fe           1 0.0022800 0.042089 -201.93
## <none>         0.039809 -201.76
## - Mannose     1 0.0044274 0.044237 -200.28
## - Zn          1 0.0047966 0.044606 -200.01
## - Arabinose   1 0.0053402 0.045150 -199.61
## - K           1 0.0062896 0.046099 -198.93
## - perc.Total.lignin 1 0.0080845 0.047894 -197.66
## - waterperc   1 0.0234866 0.063296 -188.46
##
## Step: AIC=-202.8
## time13 ~ Fe + K + Zn + waterperc + Arabinose + Mannose + perc.Total.lignin +
##      Rhamnose
##
##              Df Sum of Sq      RSS      AIC
## - Fe           1 0.0019387 0.042925 -203.28
## - Rhamnose     1 0.0022580 0.043244 -203.03
## <none>         0.040986 -202.80
## - Zn          1 0.0037109 0.044697 -201.94
## - Mannose     1 0.0038813 0.044867 -201.82
## - K           1 0.0074061 0.048392 -199.32
## - perc.Total.lignin 1 0.0107486 0.051735 -197.12
## - Arabinose   1 0.0114005 0.052386 -196.71
## - waterperc   1 0.0230560 0.064042 -190.08

```

```

##
## Step: AIC=-203.28
## time13 ~ K + Zn + waterperc + Arabinose + Mannose + perc.Total.lignin +
## Rhamnose
##
##      Df Sum of Sq      RSS      AIC
## - Rhamnose      1 0.0011003 0.044025 -204.44
## - Zn            1 0.0018920 0.044817 -203.86
## <none>                      0.042925 -203.28
## - Mannose      1 0.0032725 0.046197 -202.85
## - K            1 0.0077206 0.050645 -199.82
## - Arabinose    1 0.0095688 0.052493 -198.64
## - perc.Total.lignin 1 0.0125048 0.055429 -196.84
## - waterperc    1 0.0234717 0.066396 -190.88
##
## Step: AIC=-204.44
## time13 ~ K + Zn + waterperc + Arabinose + Mannose + perc.Total.lignin
##
##      Df Sum of Sq      RSS      AIC
## - Zn            1 0.0016354 0.045660 -205.24
## <none>                      0.044025 -204.44
## - Mannose      1 0.0036312 0.047656 -203.83
## - Arabinose    1 0.0084900 0.052515 -200.62
## - K            1 0.0093074 0.053332 -200.12
## - perc.Total.lignin 1 0.0114241 0.055449 -198.83
## - waterperc    1 0.0259546 0.069979 -191.15
##
## Step: AIC=-205.24
## time13 ~ K + waterperc + Arabinose + Mannose + perc.Total.lignin
##
##      Df Sum of Sq      RSS      AIC
## <none>                      0.045660 -205.24
## - Mannose      1 0.0030363 0.048697 -205.12
## - Arabinose    1 0.0094360 0.055096 -201.04
## - K            1 0.0111867 0.056847 -200.01
## - perc.Total.lignin 1 0.0153639 0.061024 -197.67
## - waterperc    1 0.0269610 0.072621 -191.93
## Start: AIC=-148.36
## time25 ~ Ca + Fe + K + Mn + N + P + Zn + waterperc + Arabinose +
## Galactose + Mannose + perc.Total.lignin + Rhamnose
##
##      Df Sum of Sq      RSS      AIC
## - Rhamnose      1 0.000008 0.12930 -150.36
## - perc.Total.lignin 1 0.001036 0.13033 -150.11
## - Mannose      1 0.001101 0.13040 -150.09
## - N            1 0.001235 0.13053 -150.06
## - Mn           1 0.002730 0.13203 -149.70
## - Arabinose    1 0.003812 0.13311 -149.44
## - Zn           1 0.004275 0.13357 -149.32
## - Galactose    1 0.004549 0.13385 -149.26
## - Fe           1 0.008258 0.13756 -148.38
## <none>                      0.12930 -148.36
## - K            1 0.010320 0.13962 -147.91
## - Ca           1 0.010406 0.13970 -147.89

```

```

## - waterperc          1  0.030822 0.16012 -143.52
## - P                  1  0.061259 0.19056 -137.95
##
## Step:  AIC=-150.36
## time25 ~ Ca + Fe + K + Mn + N + P + Zn + waterperc + Arabinose +
##      Galactose + Mannose + perc.Total.lignin
##
##              Df Sum of Sq      RSS      AIC
## - Mannose      1  0.001106 0.13041 -152.09
## - N            1  0.001252 0.13056 -152.05
## - perc.Total.lignin 1  0.001363 0.13067 -152.03
## - Mn           1  0.002786 0.13209 -151.68
## - Zn           1  0.004291 0.13359 -151.32
## - Arabinose    1  0.004307 0.13361 -151.31
## - Galactose    1  0.004976 0.13428 -151.15
## <none>         0.12930 -150.36
## - Fe           1  0.008379 0.13768 -150.35
## - K            1  0.010712 0.14002 -149.81
## - Ca           1  0.011214 0.14052 -149.70
## - waterperc    1  0.030852 0.16016 -145.51
## - P            1  0.069264 0.19857 -138.64
##
## Step:  AIC=-152.09
## time25 ~ Ca + Fe + K + Mn + N + P + Zn + waterperc + Arabinose +
##      Galactose + perc.Total.lignin
##
##              Df Sum of Sq      RSS      AIC
## - N            1  0.001192 0.13160 -153.80
## - perc.Total.lignin 1  0.002431 0.13284 -153.50
## - Mn           1  0.004173 0.13458 -153.08
## - Zn           1  0.004661 0.13507 -152.97
## - Galactose    1  0.005409 0.13582 -152.79
## - Arabinose    1  0.005800 0.13621 -152.70
## <none>         0.13041 -152.09
## - Fe           1  0.008751 0.13916 -152.01
## - K            1  0.009958 0.14037 -151.74
## - Ca           1  0.010240 0.14065 -151.67
## - waterperc    1  0.059587 0.19000 -142.05
## - P            1  0.068750 0.19916 -140.54
##
## Step:  AIC=-153.8
## time25 ~ Ca + Fe + K + Mn + P + Zn + waterperc + Arabinose +
##      Galactose + perc.Total.lignin
##
##              Df Sum of Sq      RSS      AIC
## - Zn           1  0.003494 0.13509 -154.96
## - perc.Total.lignin 1  0.004579 0.13618 -154.70
## - Arabinose    1  0.004689 0.13629 -154.68
## - Galactose    1  0.007956 0.13956 -153.92
## <none>         0.13160 -153.80
## - K            1  0.008902 0.14050 -153.70
## - Mn           1  0.009304 0.14091 -153.61
## - Ca           1  0.009738 0.14134 -153.51
## - Fe           1  0.017630 0.14923 -151.78

```

```

## - waterperc          1  0.059585 0.19119 -143.85
## - P                  1  0.068347 0.19995 -142.41
##
## Step:  AIC=-154.96
## time25 ~ Ca + Fe + K + Mn + P + waterperc + Arabinose + Galactose +
##      perc.Total.lignin
##
##              Df Sum of Sq      RSS      AIC
## - K           1  0.006336 0.14143 -155.49
## - Arabinose    1  0.006695 0.14179 -155.41
## - Ca           1  0.008158 0.14325 -155.08
## <none>         0.13509 -154.96
## - Galactose    1  0.010189 0.14528 -154.63
## - Mn           1  0.010221 0.14532 -154.63
## - perc.Total.lignin 1  0.012100 0.14719 -154.22
## - Fe           1  0.036569 0.17166 -149.29
## - waterperc    1  0.062582 0.19768 -144.78
## - P           1  0.065230 0.20033 -144.35
##
## Step:  AIC=-155.49
## time25 ~ Ca + Fe + Mn + P + waterperc + Arabinose + Galactose +
##      perc.Total.lignin
##
##              Df Sum of Sq      RSS      AIC
## - Arabinose    1  0.002635 0.14407 -156.90
## - Ca           1  0.005223 0.14665 -156.33
## - Mn           1  0.006080 0.14751 -156.15
## <none>         0.14143 -155.49
## - Galactose    1  0.010155 0.15159 -155.28
## - perc.Total.lignin 1  0.026357 0.16779 -152.03
## - Fe           1  0.032376 0.17381 -150.90
## - P           1  0.058998 0.20043 -146.34
## - waterperc    1  0.146884 0.28831 -134.70
##
## Step:  AIC=-156.9
## time25 ~ Ca + Fe + Mn + P + waterperc + Galactose + perc.Total.lignin
##
##              Df Sum of Sq      RSS      AIC
## - Mn           1  0.003964 0.14803 -158.03
## - Ca           1  0.004997 0.14906 -157.81
## <none>         0.14407 -156.90
## - Galactose    1  0.009424 0.15349 -156.88
## - perc.Total.lignin 1  0.024808 0.16887 -153.82
## - Fe           1  0.030716 0.17478 -152.72
## - P           1  0.066686 0.21075 -146.73
## - waterperc    1  0.175653 0.31972 -133.39
##
## Step:  AIC=-158.03
## time25 ~ Ca + Fe + P + waterperc + Galactose + perc.Total.lignin
##
##              Df Sum of Sq      RSS      AIC
## - Ca           1  0.004489 0.15252 -159.08
## - Galactose    1  0.007743 0.15577 -158.40
## <none>         0.14803 -158.03

```

```

## - perc.Total.lignin 1 0.021217 0.16925 -155.75
## - Fe 1 0.026770 0.17480 -154.72
## - P 1 0.065942 0.21397 -148.25
## - waterperc 1 0.215721 0.36375 -131.26
##
## Step: AIC=-159.08
## time25 ~ Fe + P + waterperc + Galactose + perc.Total.lignin
##
##          Df Sum of Sq    RSS    AIC
## - Galactose 1 0.007985 0.16050 -159.44
## <none>          0.15252 -159.08
## - perc.Total.lignin 1 0.017382 0.16990 -157.62
## - Fe 1 0.036056 0.18858 -154.29
## - P 1 0.063049 0.21557 -150.01
## - waterperc 1 0.215685 0.36820 -132.88
##
## Step: AIC=-159.45
## time25 ~ Fe + P + waterperc + perc.Total.lignin
##
##          Df Sum of Sq    RSS    AIC
## <none>          0.16050 -159.44
## - perc.Total.lignin 1 0.013334 0.17384 -158.89
## - Fe 1 0.028172 0.18868 -156.27
## - P 1 0.057695 0.21820 -151.62
## - waterperc 1 0.253757 0.41426 -131.10
## Start: AIC=-144.31
## time37 ~ Ca + Fe + K + Mn + N + P + Zn + waterperc + Arabinose +
##          Galactose + Mannose + perc.Total.lignin + Rhamnose
##
##          Df Sum of Sq    RSS    AIC
## - P 1 0.00169 0.14846 -145.94
## - Rhamnose 1 0.00266 0.14944 -145.73
## - N 1 0.00624 0.15302 -144.97
## <none>          0.14678 -144.31
## - Mn 1 0.01291 0.15969 -143.61
## - Galactose 1 0.01560 0.16238 -143.07
## - Fe 1 0.02504 0.17182 -141.26
## - Arabinose 1 0.02686 0.17363 -140.93
## - Zn 1 0.02776 0.17454 -140.76
## - Mannose 1 0.02793 0.17471 -140.73
## - Ca 1 0.03324 0.18002 -139.77
## - K 1 0.05414 0.20092 -136.26
## - perc.Total.lignin 1 0.19202 0.33879 -119.54
## - waterperc 1 0.38570 0.53247 -105.07
##
## Step: AIC=-145.94
## time37 ~ Ca + Fe + K + Mn + N + Zn + waterperc + Arabinose +
##          Galactose + Mannose + perc.Total.lignin + Rhamnose
##
##          Df Sum of Sq    RSS    AIC
## - Rhamnose 1 0.00151 0.14998 -147.62
## - N 1 0.00473 0.15319 -146.94
## <none>          0.14846 -145.94
## - Galactose 1 0.01441 0.16287 -144.98

```

```

## - Mn                1    0.01497 0.16344 -144.87
## - Fe                1    0.02359 0.17206 -143.22
## - Arabinose         1    0.02559 0.17405 -142.85
## - Zn                1    0.02649 0.17496 -142.69
## - Mannose           1    0.02659 0.17505 -142.67
## - Ca                1    0.03750 0.18597 -140.73
## - K                 1    0.06002 0.20848 -137.08
## - perc.Total.lignin 1    0.20999 0.35845 -119.73
## - waterperc         1    0.38401 0.53247 -107.07
##
## Step:  AIC=-147.62
## time37 ~ Ca + Fe + K + Mn + N + Zn + waterperc + Arabinose +
##         Galactose + Mannose + perc.Total.lignin
##
##              Df Sum of Sq    RSS    AIC
## - N              1    0.00355 0.15353 -148.87
## <none>              0.14998 -147.62
## - Galactose       1    0.01304 0.16302 -146.95
## - Mn              1    0.01667 0.16665 -146.24
## - Arabinose       1    0.02515 0.17512 -144.66
## - Fe              1    0.02536 0.17534 -144.62
## - Mannose         1    0.02661 0.17659 -144.39
## - Zn              1    0.02776 0.17774 -144.18
## - Ca              1    0.04394 0.19392 -141.39
## - K               1    0.05987 0.20984 -138.87
## - perc.Total.lignin 1    0.21421 0.36419 -121.23
## - waterperc       1    0.40648 0.55646 -107.66
##
## Step:  AIC=-148.87
## time37 ~ Ca + Fe + K + Mn + Zn + waterperc + Arabinose + Galactose +
##         Mannose + perc.Total.lignin
##
##              Df Sum of Sq    RSS    AIC
## <none>              0.15353 -148.87
## - Galactose       1    0.01007 0.16361 -148.83
## - Arabinose       1    0.02203 0.17556 -146.58
## - Fe              1    0.02206 0.17559 -146.57
## - Mannose         1    0.02471 0.17824 -146.09
## - Zn              1    0.02496 0.17849 -146.05
## - Mn              1    0.02949 0.18302 -145.25
## - Ca              1    0.04207 0.19560 -143.12
## - K               1    0.05653 0.21006 -140.84
## - perc.Total.lignin 1    0.22337 0.37690 -122.13
## - waterperc       1    0.41167 0.56520 -109.16
## Start:  AIC=-134.1
## time59 ~ Ca + Fe + K + Mn + N + P + Zn + waterperc + Arabinose +
##         Galactose + Mannose + perc.Total.lignin + Rhamnose
##
##              Df Sum of Sq    RSS    AIC
## - Mannose         1    0.001135 0.24389 -135.95
## - Rhamnose        1    0.001632 0.24439 -135.88
## - P               1    0.002545 0.24530 -135.76
## - Ca              1    0.008247 0.25101 -135.00
## - N               1    0.013563 0.25632 -134.31

```

```

## - K          1  0.014590 0.25735 -134.18
## <none>              0.24276 -134.10
## - Galactose      1  0.016369 0.25913 -133.95
## - perc.Total.lignin 1  0.021770 0.26453 -133.27
## - Fe            1  0.031283 0.27404 -132.10
## - Zn            1  0.034075 0.27683 -131.77
## - Arabinose      1  0.040115 0.28287 -131.06
## - Mn            1  0.051459 0.29422 -129.76
## - waterperc      1  0.114560 0.35732 -123.35
##
## Step:  AIC=-135.95
## time59 ~ Ca + Fe + K + Mn + N + P + Zn + waterperc + Arabinose +
##         Galactose + perc.Total.lignin + Rhamnose
##
##              Df Sum of Sq    RSS    AIC
## - P          1  0.001787 0.24568 -137.71
## - Rhamnose    1  0.002006 0.24590 -137.68
## - Ca          1  0.007206 0.25110 -136.99
## - N          1  0.012656 0.25655 -136.28
## - K          1  0.014161 0.25805 -136.09
## <none>              0.24389 -135.95
## - Galactose   1  0.015312 0.25921 -135.94
## - Fe          1  0.030152 0.27405 -134.10
## - perc.Total.lignin 1  0.030602 0.27450 -134.05
## - Zn          1  0.033728 0.27762 -133.67
## - Arabinose   1  0.038981 0.28287 -133.06
## - Mn          1  0.053861 0.29775 -131.36
## - waterperc   1  0.164491 0.40838 -120.94
##
## Step:  AIC=-137.71
## time59 ~ Ca + Fe + K + Mn + N + Zn + waterperc + Arabinose +
##         Galactose + perc.Total.lignin + Rhamnose
##
##              Df Sum of Sq    RSS    AIC
## - Rhamnose    1  0.004054 0.24973 -139.17
## - Ca          1  0.005943 0.25162 -138.92
## - N          1  0.011054 0.25674 -138.25
## - K          1  0.012417 0.25810 -138.08
## - Galactose   1  0.014779 0.26046 -137.78
## <none>              0.24568 -137.71
## - Fe          1  0.029050 0.27473 -136.02
## - Zn          1  0.032302 0.27798 -135.63
## - perc.Total.lignin 1  0.037367 0.28305 -135.03
## - Arabinose   1  0.041820 0.28750 -134.52
## - Mn          1  0.052970 0.29865 -133.26
## - waterperc   1  0.163526 0.40921 -122.87
##
## Step:  AIC=-139.17
## time59 ~ Ca + Fe + K + Mn + N + Zn + waterperc + Arabinose +
##         Galactose + perc.Total.lignin
##
##              Df Sum of Sq    RSS    AIC
## - Ca          1  0.006937 0.25667 -140.26
## - K          1  0.012296 0.26203 -139.58

```



```

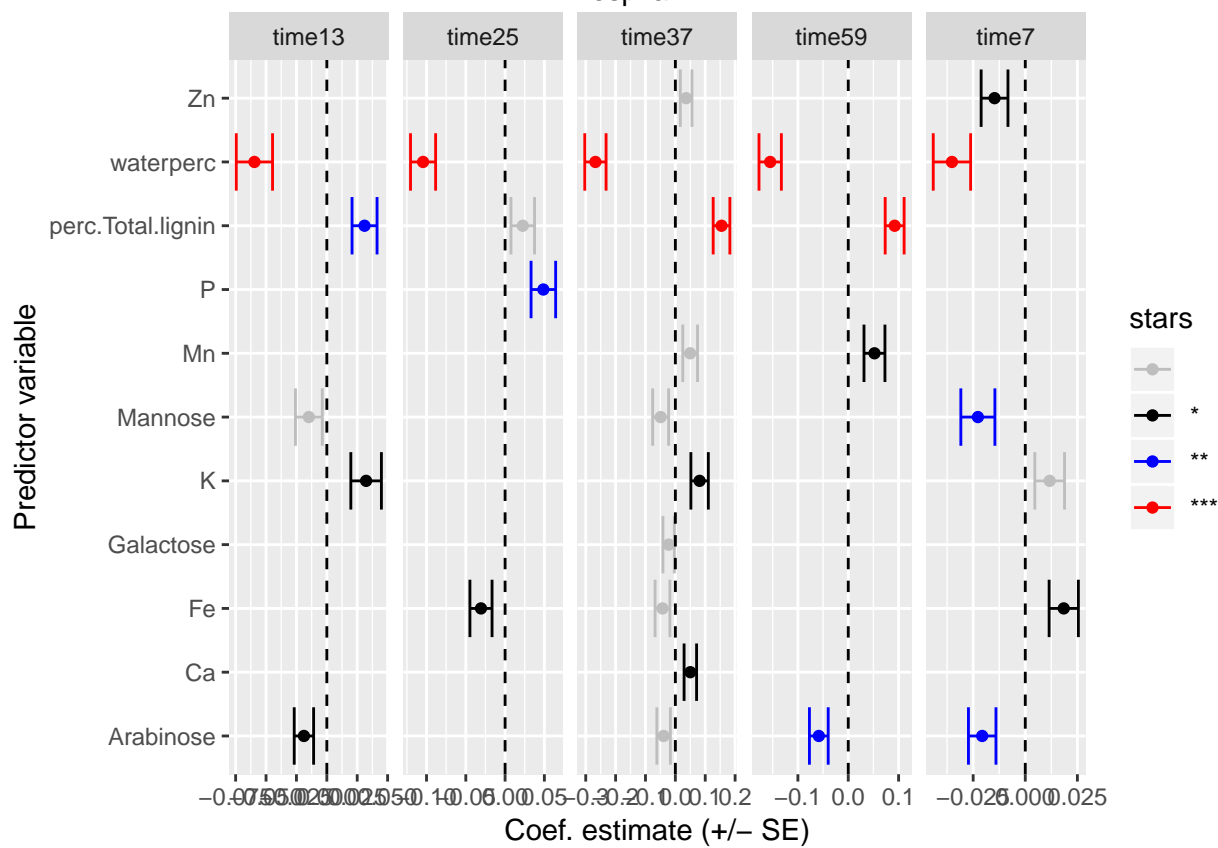
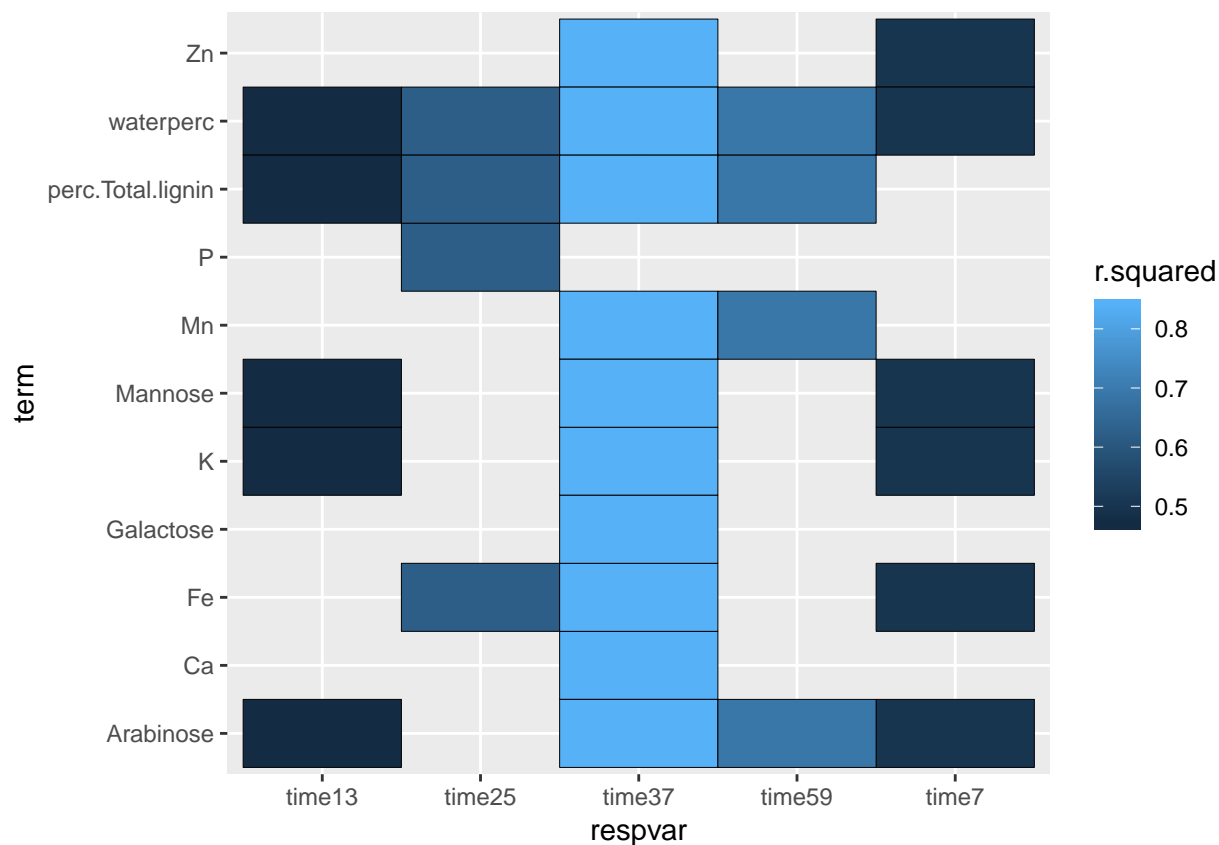
## <none>                                0.24973 -139.17
## - N                                1  0.018462 0.26820 -138.81
## - Galactose                        1  0.020295 0.27003 -138.59
## - Fe                               1  0.026201 0.27594 -137.88
## - Zn                               1  0.030422 0.28016 -137.37
## - perc.Total.lignin                1  0.033327 0.28306 -137.03
## - Arabinose                        1  0.039737 0.28947 -136.29
## - Mn                               1  0.059180 0.30891 -134.15
## - waterperc                        1  0.187835 0.43757 -122.66
##
## Step:  AIC=-140.26
## time59 ~ Fe + K + Mn + N + Zn + waterperc + Arabinose + Galactose +
##      perc.Total.lignin
##
##              Df Sum of Sq      RSS      AIC
## - K              1  0.007859 0.26453 -141.27
## <none>                                0.25667 -140.26
## - Galactose      1  0.019661 0.27633 -139.83
## - Fe              1  0.019957 0.27663 -139.79
## - N              1  0.022605 0.27928 -139.48
## - Zn              1  0.026545 0.28322 -139.02
## - perc.Total.lignin 1  0.034385 0.29106 -138.12
## - Arabinose      1  0.040583 0.29725 -137.42
## - Mn              1  0.078165 0.33484 -133.49
## - waterperc      1  0.229016 0.48569 -121.22
##
## Step:  AIC=-141.27
## time59 ~ Fe + Mn + N + Zn + waterperc + Arabinose + Galactose +
##      perc.Total.lignin
##
##              Df Sum of Sq      RSS      AIC
## - Galactose      1  0.01645 0.28098 -141.28
## <none>                                0.26453 -141.27
## - Fe              1  0.01839 0.28292 -141.05
## - N              1  0.01841 0.28294 -141.05
## - Zn              1  0.02047 0.28500 -140.81
## - Arabinose      1  0.07098 0.33551 -135.42
## - Mn              1  0.08766 0.35219 -133.82
## - perc.Total.lignin 1  0.09228 0.35681 -133.39
## - waterperc      1  0.47208 0.73661 -109.47
##
## Step:  AIC=-141.28
## time59 ~ Fe + Mn + N + Zn + waterperc + Arabinose + perc.Total.lignin
##
##              Df Sum of Sq      RSS      AIC
## - Fe              1  0.00719 0.28817 -142.44
## - N              1  0.01065 0.29163 -142.05
## - Zn              1  0.01260 0.29357 -141.83
## <none>                                0.28098 -141.28
## - Arabinose      1  0.06784 0.34882 -136.14
## - Mn              1  0.07339 0.35436 -135.62
## - perc.Total.lignin 1  0.12707 0.40805 -130.97
## - waterperc      1  0.48840 0.76938 -110.04
##

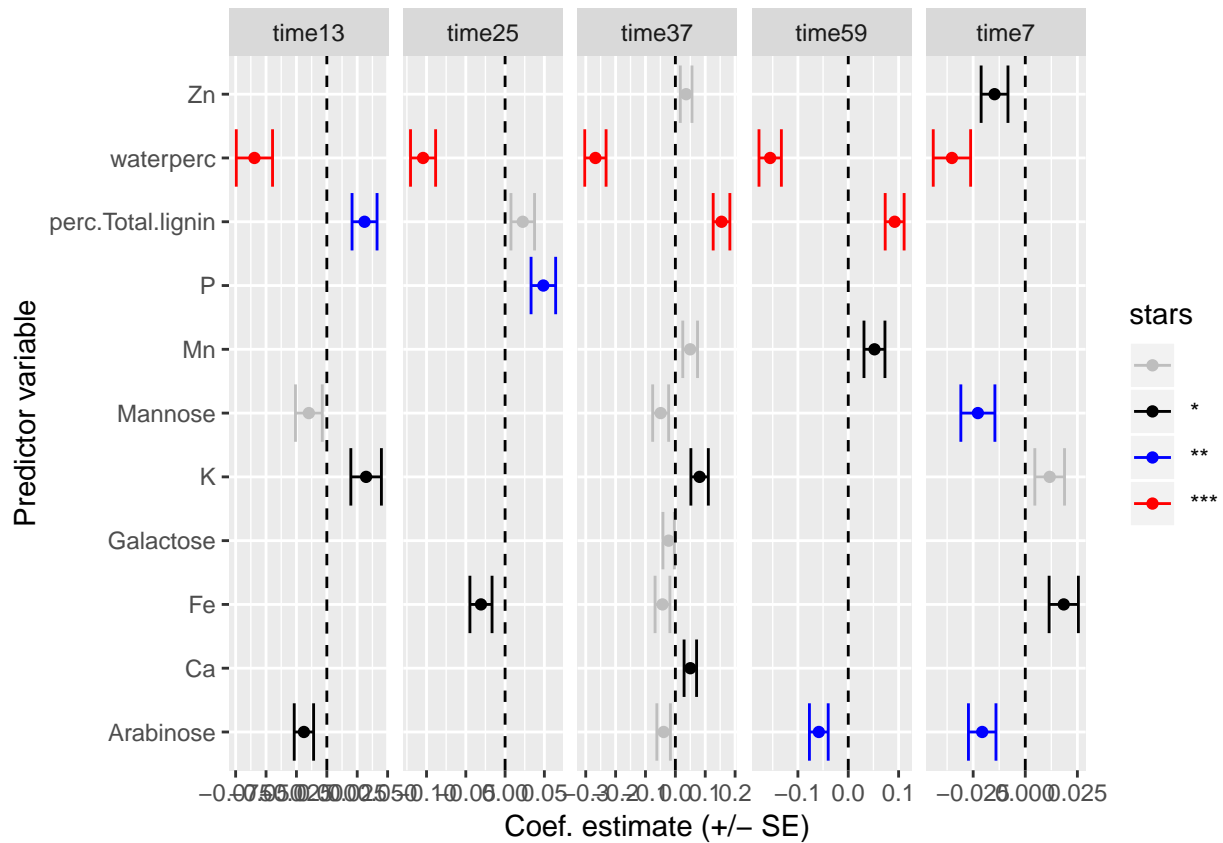
```

```

## Step: AIC=-142.44
## time59 ~ Mn + N + Zn + waterperc + Arabinose + perc.Total.lignin
##
##           Df Sum of Sq      RSS      AIC
## - Zn       1   0.00591 0.29408 -143.77
## - N        1   0.00648 0.29465 -143.71
## <none>                      0.28817 -142.44
## - Arabinose 1   0.06160 0.34977 -138.05
## - Mn        1   0.06861 0.35678 -137.40
## - perc.Total.lignin 1 0.22225 0.51042 -125.58
## - waterperc 1   0.48419 0.77236 -111.91
##
## Step: AIC=-143.77
## time59 ~ Mn + N + waterperc + Arabinose + perc.Total.lignin
##
##           Df Sum of Sq      RSS      AIC
## - N        1   0.00355 0.29763 -145.38
## <none>                      0.29408 -143.77
## - Mn        1   0.06784 0.36191 -138.92
## - Arabinose 1   0.06893 0.36301 -138.82
## - perc.Total.lignin 1 0.25563 0.54970 -125.13
## - waterperc 1   0.47982 0.77389 -113.84
##
## Step: AIC=-145.38
## time59 ~ Mn + waterperc + Arabinose + perc.Total.lignin
##
##           Df Sum of Sq      RSS      AIC
## <none>                      0.29763 -145.38
## - Mn        1   0.06634 0.36396 -140.74
## - Arabinose 1   0.10468 0.40231 -137.43
## - perc.Total.lignin 1 0.25530 0.55293 -126.94
## - waterperc 1   0.51767 0.81530 -114.12

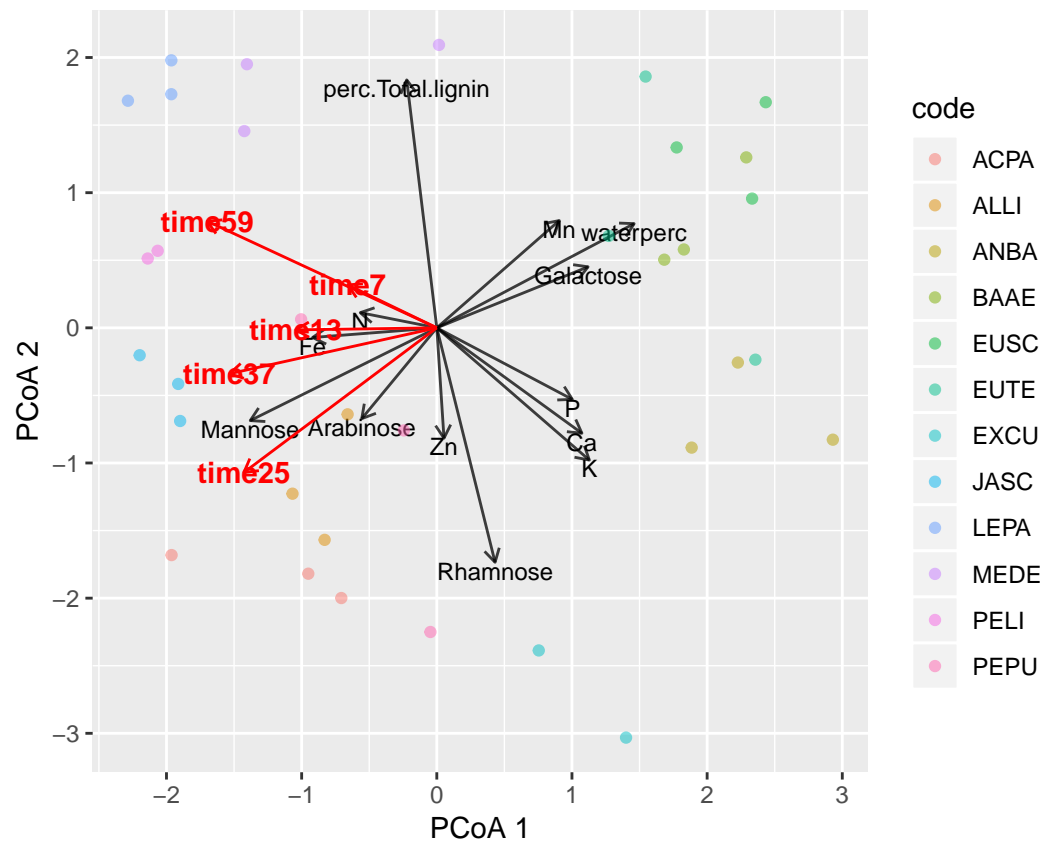
```





Visualize codeStems in trait space, add pmr vectors

```
## Importance of components:
##
##          PC1    PC2    PC3    PC4    PC5    PC6    PC7
## Standard deviation  1.7546 1.4515 1.3829 1.2759 1.03964 0.92683 0.81385
## Proportion of Variance 0.2368 0.1621 0.1471 0.1252 0.08314 0.06608 0.05095
## Cumulative Proportion 0.2368 0.3989 0.5460 0.6712 0.75436 0.82044 0.87139
##
##          PC8    PC9    PC10    PC11    PC12    PC13
## Standard deviation  0.75862 0.64073 0.54823 0.43129 0.35571 0.2699
## Proportion of Variance 0.04427 0.03158 0.02312 0.01431 0.00973 0.0056
## Cumulative Proportion 0.91566 0.94724 0.97035 0.98466 0.99440 1.0000
```



(2) by code

Merge trait matrix with the decay parameters estimated by code

```
## [1] 12 35
```

Remember there are 12 codes/observations

Set up models

(a) Original traits: “K”, “N”, “P”, “waterperc” predict code-level decay parameters

```
## Start: AIC=-34.24
## alpha ~ K + N + P + waterperc
##
##           Df Sum of Sq    RSS    AIC
## - N         1  0.008054 0.30868 -35.924
## - waterperc  1  0.040357 0.34098 -34.730
## <none>                 0.30062 -34.242
## - P         1  0.108278 0.40890 -32.550
## - K         1  0.217722 0.51834 -29.704
##
## Step: AIC=-35.92
## alpha ~ K + P + waterperc
##
##           Df Sum of Sq    RSS    AIC
## - waterperc  1  0.034441 0.34312 -36.655
## <none>                 0.30868 -35.924
## - P         1  0.101819 0.41050 -34.504
## - K         1  0.225072 0.53375 -31.353
```

```

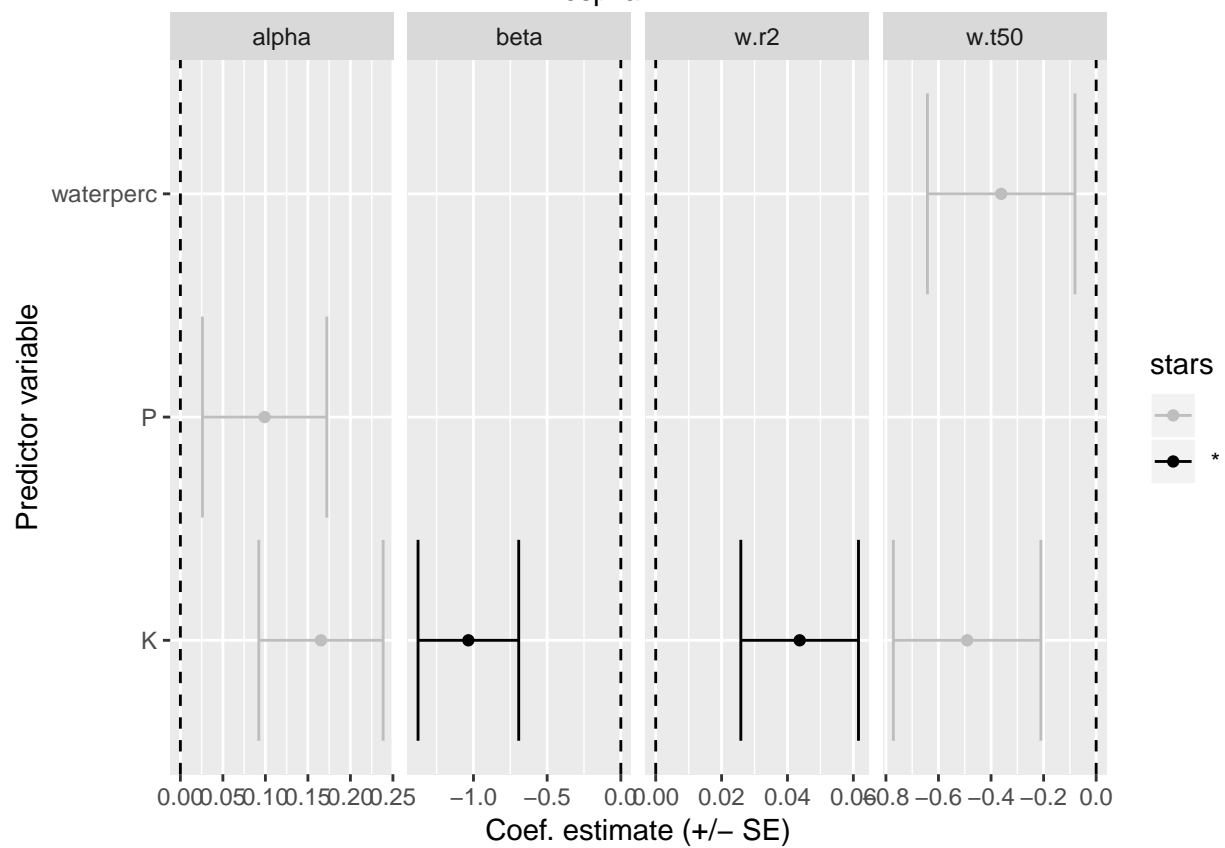
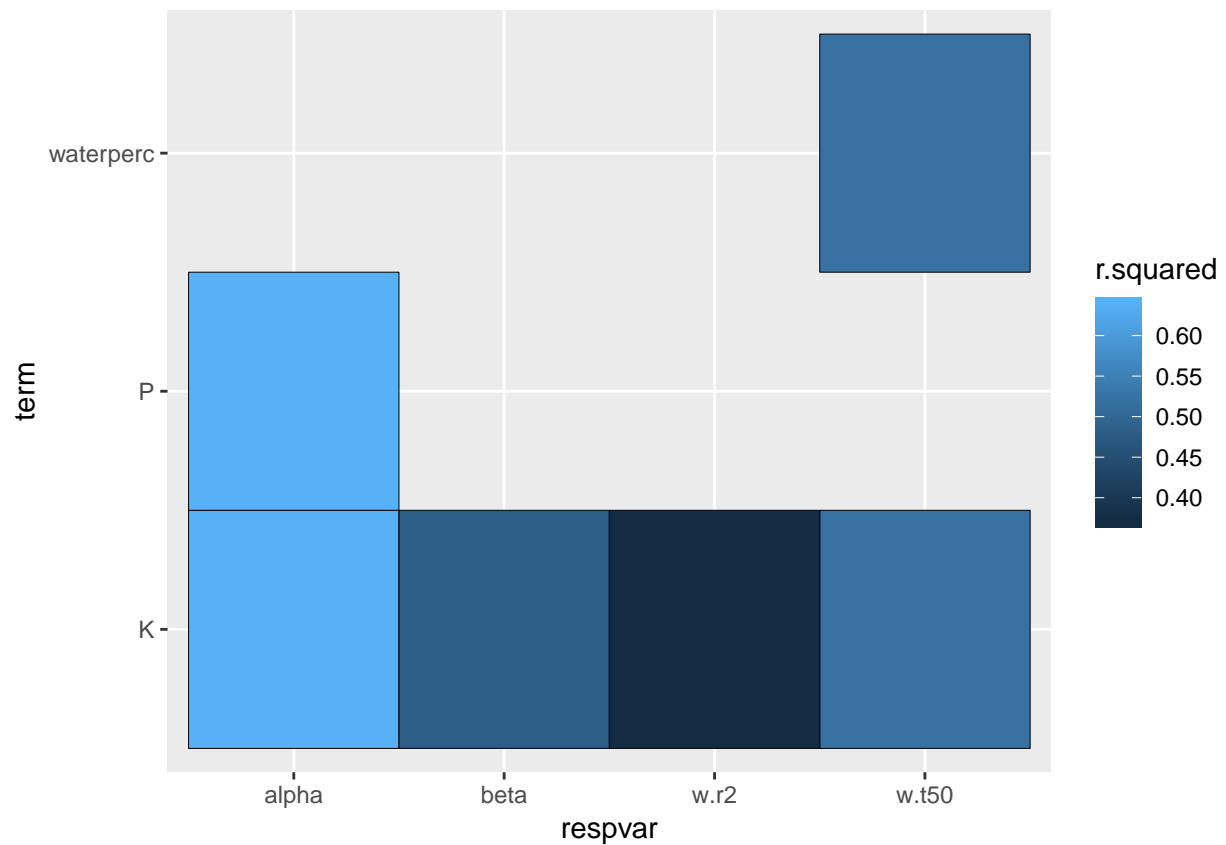
##
## Step:  AIC=-36.66
## alpha ~ K + P
##
##      Df Sum of Sq    RSS    AIC
## <none>                0.34312 -36.655
## - P      1    0.07003 0.41315 -36.426
## - K      1    0.19501 0.53812 -33.255
## Start:  AIC=9.47
## beta ~ K + N + P + waterperc
##
##      Df Sum of Sq    RSS    AIC
## - N      1    0.0054 11.491  7.4799
## - P      1    0.2224 11.708  7.7043
## - waterperc 1    1.3152 12.801  8.7752
## <none>                11.486  9.4742
## - K      1    5.5044 16.990 12.1726
##
## Step:  AIC=7.48
## beta ~ K + P + waterperc
##
##      Df Sum of Sq    RSS    AIC
## - P      1    0.2169 11.708  5.7043
## - waterperc 1    1.3444 12.835  6.8076
## <none>                11.491  7.4799
## - K      1    5.5086 17.000 10.1794
##
## Step:  AIC=5.7
## beta ~ K + waterperc
##
##      Df Sum of Sq    RSS    AIC
## - waterperc 1    1.1294 12.837  4.8094
## <none>                11.708  5.7043
## - K      1    5.5695 17.277  8.3740
##
## Step:  AIC=4.81
## beta ~ K
##
##      Df Sum of Sq    RSS    AIC
## <none>                12.837  4.8094
## - K      1    11.772 24.609 10.6186
## Start:  AIC=0.5
## w.t50 ~ K + N + P + waterperc
##
##      Df Sum of Sq    RSS    AIC
## - N      1    0.01261 5.4476 -1.47671
## - P      1    0.20718 5.6422 -1.05560
## <none>                5.4350  0.49548
## - waterperc 1    1.22747 6.6625  0.93903
## - K      1    2.10354 7.5386  2.42149
##
## Step:  AIC=-1.48
## w.t50 ~ K + P + waterperc
##

```

```

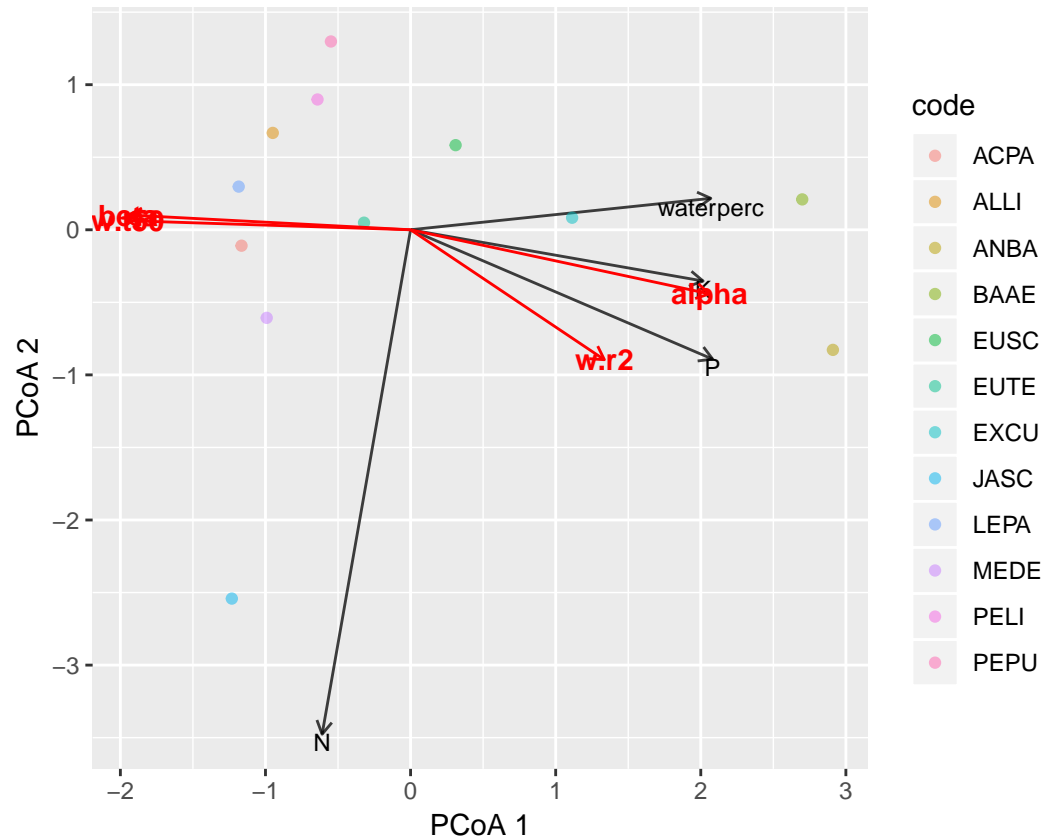
##           Df Sum of Sq    RSS    AIC
## - P           1   0.19644 5.6441 -3.05161
## <none>                5.4476 -1.47671
## - waterperc    1   1.23374 6.6814 -1.02699
## - K           1   2.09097 7.5386  0.42156
##
## Step:  AIC=-3.05
## w.t50 ~ K + waterperc
##
##           Df Sum of Sq    RSS    AIC
## <none>                5.6441 -3.0516
## - waterperc    1   1.0394 6.6835 -3.0232
## - K           1   1.9182 7.5623 -1.5408
## Start:  AIC=-60.64
## w.r2 ~ K + N + P + waterperc
##
##           Df Sum of Sq    RSS    AIC
## - waterperc    1 0.0002863 0.033612 -62.533
## - P           1 0.0003970 0.033723 -62.494
## - N           1 0.0009138 0.034240 -62.311
## <none>                0.033326 -60.636
## - K           1 0.0125083 0.045834 -58.812
##
## Step:  AIC=-62.53
## w.r2 ~ K + N + P
##
##           Df Sum of Sq    RSS    AIC
## - P           1 0.0001887 0.033801 -64.466
## - N           1 0.0012154 0.034828 -64.107
## <none>                0.033612 -62.533
## - K           1 0.0123107 0.045923 -60.788
##
## Step:  AIC=-64.47
## w.r2 ~ K + N
##
##           Df Sum of Sq    RSS    AIC
## - N           1 0.0012776 0.035079 -66.021
## <none>                0.033801 -64.466
## - K           1 0.0219578 0.055759 -60.460
##
## Step:  AIC=-66.02
## w.r2 ~ K
##
##           Df Sum of Sq    RSS    AIC
## <none>                0.035079 -66.021
## - K           1 0.021008 0.056087 -62.389

```



Visualize code in trait space, add decayfit vectors


```
## Importance of components:
##               PC1    PC2    PC3    PC4
## Standard deviation  1.4793 0.9974 0.6865 0.58779
## Proportion of Variance 0.5471 0.2487 0.1178 0.08637
## Cumulative Proportion 0.5471 0.7958 0.9136 1.00000
```



(b) Original traits plus C fractions...

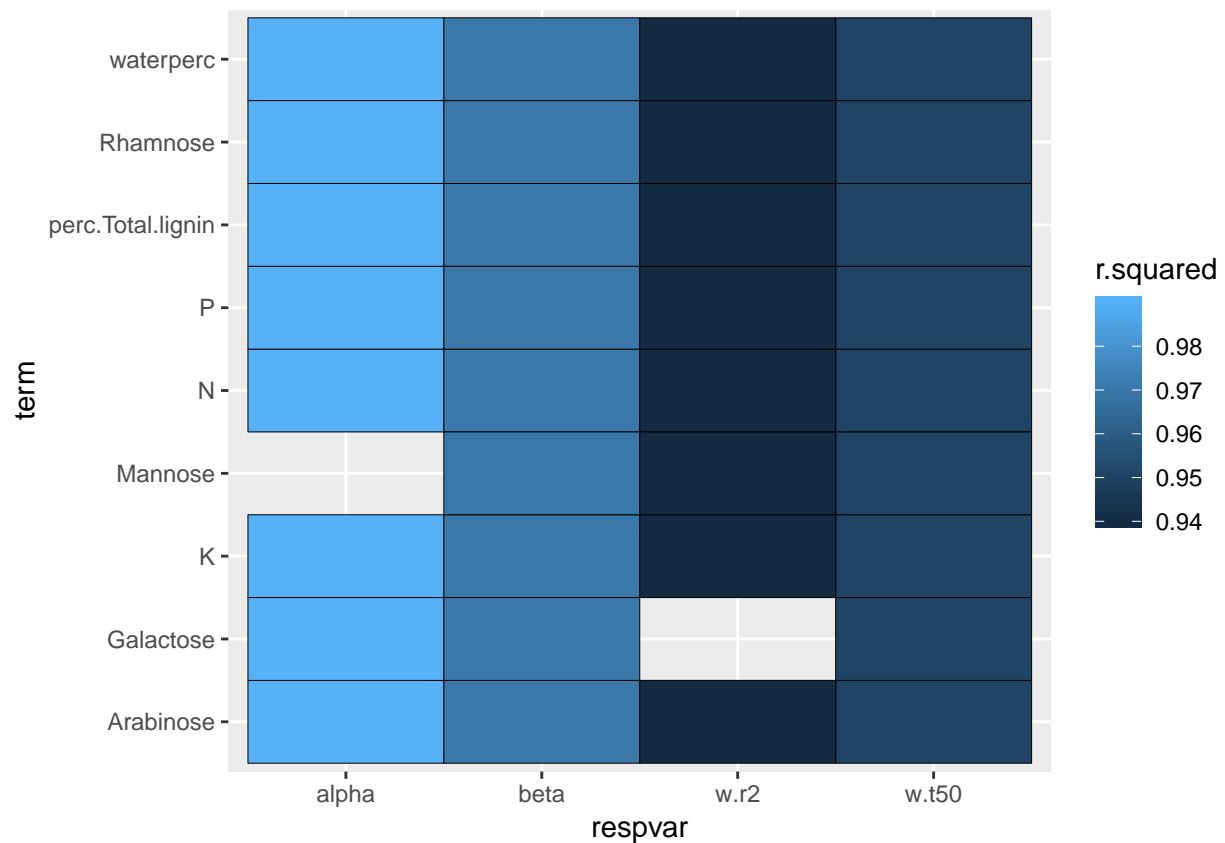
```
## Start:  AIC=-70.87
## alpha ~ K + N + P + waterperc + Arabinose + Galactose + Mannose +
##         perc.Total.lignin + Rhamnose
##
##               Df Sum of Sq    RSS    AIC
## - Mannose      1  0.000159 0.006329 -72.570
## <none>          0.006170 -70.875
## - Arabinose    1  0.003956 0.010126 -66.931
## - N            1  0.004083 0.010254 -66.780
## - waterperc    1  0.008103 0.014273 -62.811
## - perc.Total.lignin 1  0.009386 0.015557 -61.778
## - Galactose    1  0.012387 0.018557 -59.662
## - Rhamnose     1  0.032579 0.038749 -50.827
## - K            1  0.034643 0.040813 -50.204
## - P            1  0.107975 0.114146 -37.862
##
## Step:  AIC=-72.57
## alpha ~ K + N + P + waterperc + Arabinose + Galactose + perc.Total.lignin +
##         Rhamnose
##
```

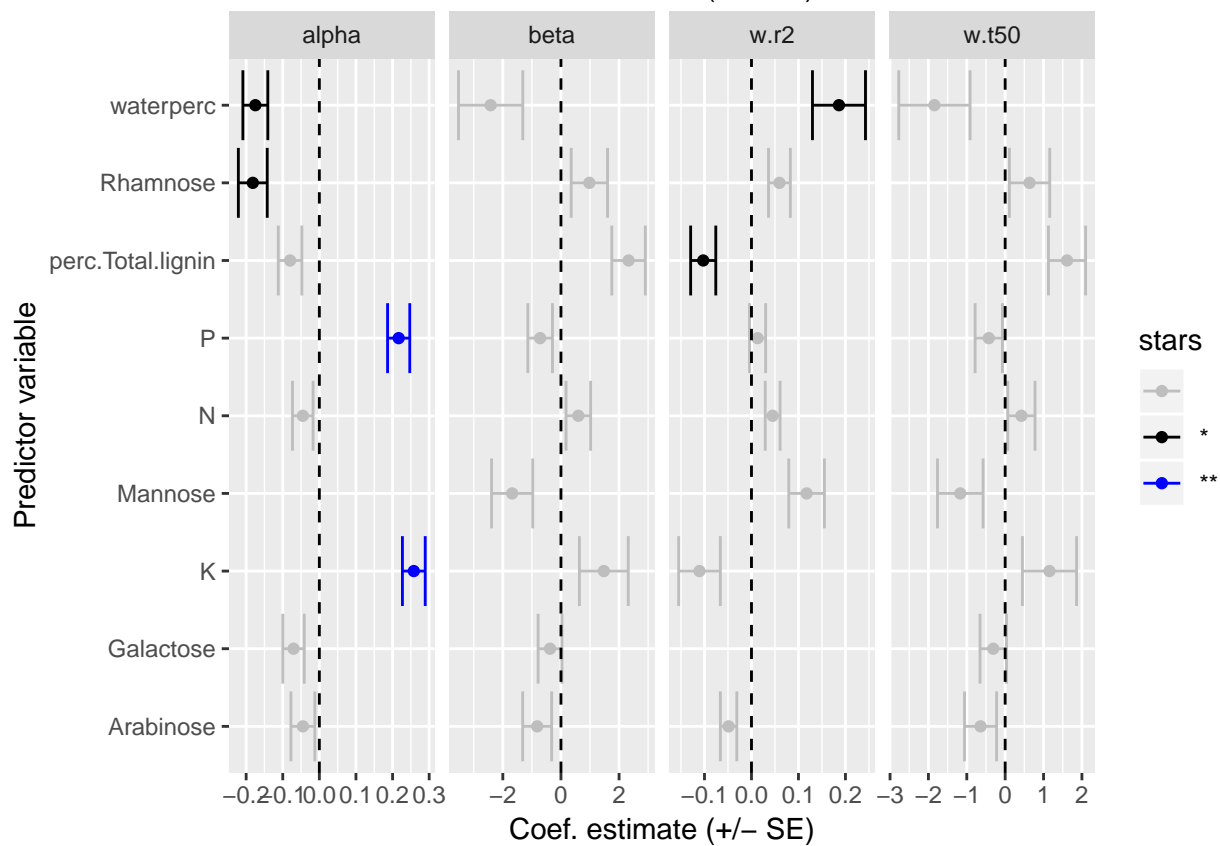
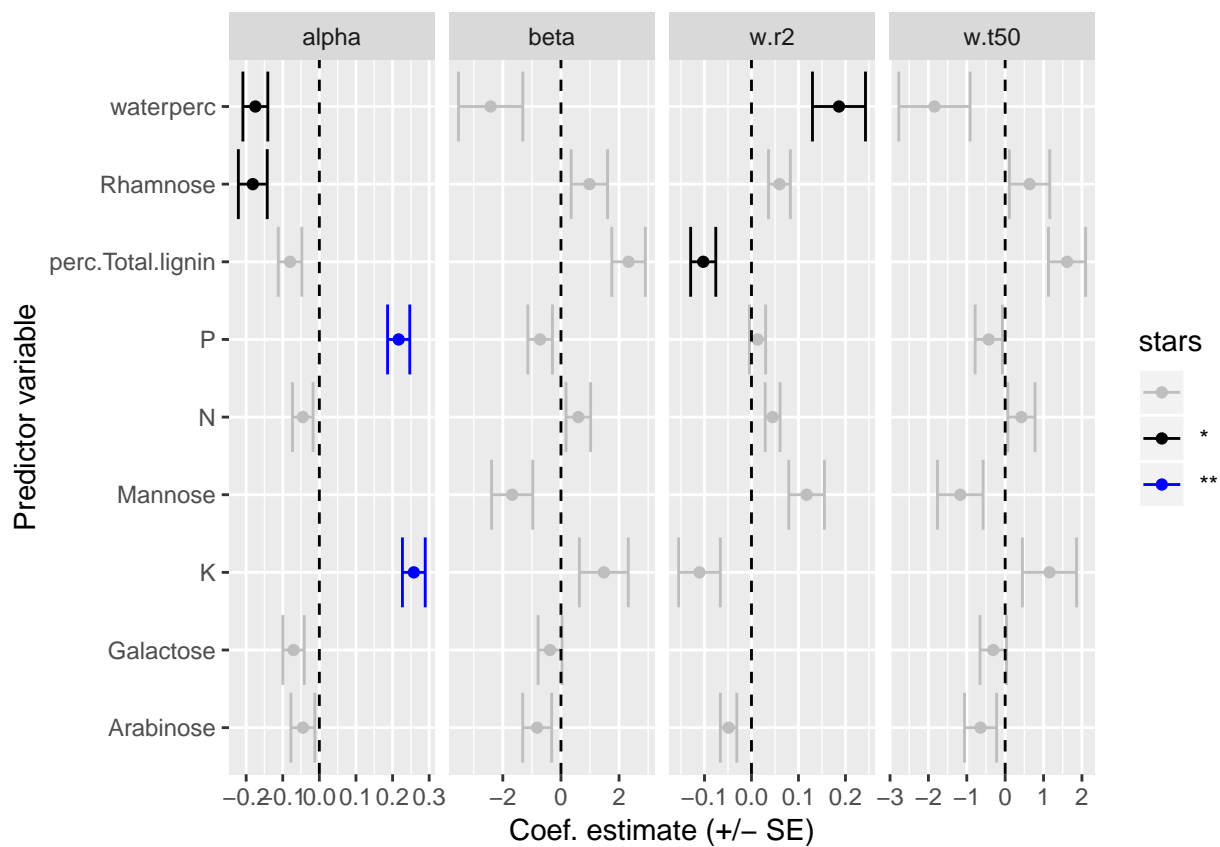
```

##              Df Sum of Sq      RSS      AIC
## <none>                0.006329 -72.570
## - Arabinose          1  0.003985 0.010314 -68.710
## - N                  1  0.005465 0.011794 -67.101
## - Galactose          1  0.012235 0.018564 -61.657
## - perc.Total.lignin  1  0.013030 0.019359 -61.154
## - Rhamnose          1  0.044848 0.051177 -49.488
## - waterperc         1  0.055583 0.061911 -47.203
## - P                  1  0.107900 0.114229 -39.854
## - K                  1  0.144790 0.151119 -36.495
## Start:  AIC=-12.16
## beta ~ K + N + P + waterperc + Arabinose + Galactose + Mannose +
##      perc.Total.lignin + Rhamnose
##
##              Df Sum of Sq      RSS      AIC
## <none>                0.8230 -12.1565
## - Galactose          1  0.3438 1.1668 -9.9681
## - N                  1  0.8221 1.6451 -5.8450
## - Rhamnose          1  1.0055 1.8285 -4.5772
## - Arabinose          1  1.1099 1.9329 -3.9109
## - P                  1  1.1714 1.9944 -3.5349
## - K                  1  1.2691 2.0921 -2.9609
## - waterperc         1  1.9677 2.7907  0.4968
## - Mannose           1  2.3129 3.1359  1.8962
## - perc.Total.lignin  1  6.7004 7.5234 12.3973
## Start:  AIC=-16.36
## w.t50 ~ K + N + P + waterperc + Arabinose + Galactose + Mannose +
##      perc.Total.lignin + Rhamnose
##
##              Df Sum of Sq      RSS      AIC
## <none>                0.5800 -16.3550
## - Galactose          1  0.2353 0.8153 -14.2694
## - N                  1  0.4098 0.9898 -11.9422
## - P                  1  0.4175 0.9976 -11.8481
## - Rhamnose          1  0.4247 1.0047 -11.7627
## - Arabinose          1  0.6819 1.2619 -9.0271
## - K                  1  0.7761 1.3561 -8.1634
## - Mannose           1  1.1213 1.7013 -5.4420
## - waterperc         1  1.1429 1.7230 -5.2904
## - perc.Total.lignin  1  3.2141 3.7941  4.1826
## Start:  AIC=-77.87
## w.r2 ~ K + N + P + waterperc + Arabinose + Galactose + Mannose +
##      perc.Total.lignin + Rhamnose
##
##              Df Sum of Sq      RSS      AIC
## - Galactose          1 0.0001163 0.0035619 -79.468
## - P                  1 0.0001571 0.0036027 -79.332
## <none>                0.0034456 -77.867
## - Rhamnose          1 0.0047332 0.0081788 -69.493
## - Arabinose          1 0.0050140 0.0084596 -69.088
## - N                  1 0.0057771 0.0092227 -68.052
## - K                  1 0.0067892 0.0102348 -66.802
## - Mannose           1 0.0114882 0.0149338 -62.268
## - perc.Total.lignin  1 0.0118361 0.0152817 -61.992

```

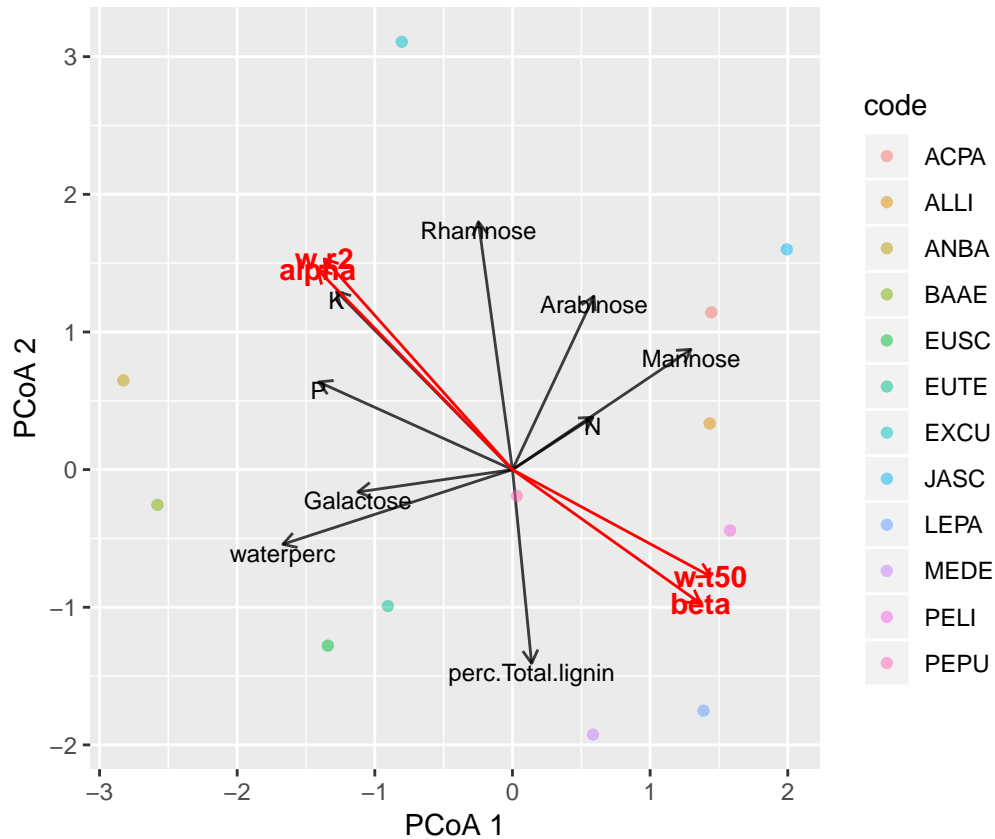
```
## - waterperc          1 0.0123976 0.0158432 -61.559
##
## Step: AIC=-79.47
## w.r2 ~ K + N + P + waterperc + Arabinose + Mannose + perc.Total.lignin +
##      Rhamnose
##
##              Df Sum of Sq      RSS      AIC
## <none>                0.0035619 -79.468
## - P                  1 0.0006753 0.0042372 -79.385
## - K                  1 0.0073940 0.0109559 -67.985
## - Rhamnose           1 0.0077836 0.0113455 -67.566
## - Arabinose          1 0.0091881 0.0127500 -66.166
## - N                  1 0.0096365 0.0131984 -65.751
## - Mannose            1 0.0113732 0.0149351 -64.267
## - waterperc          1 0.0129296 0.0164915 -63.078
## - perc.Total.lignin  1 0.0174957 0.0210576 -60.145
```





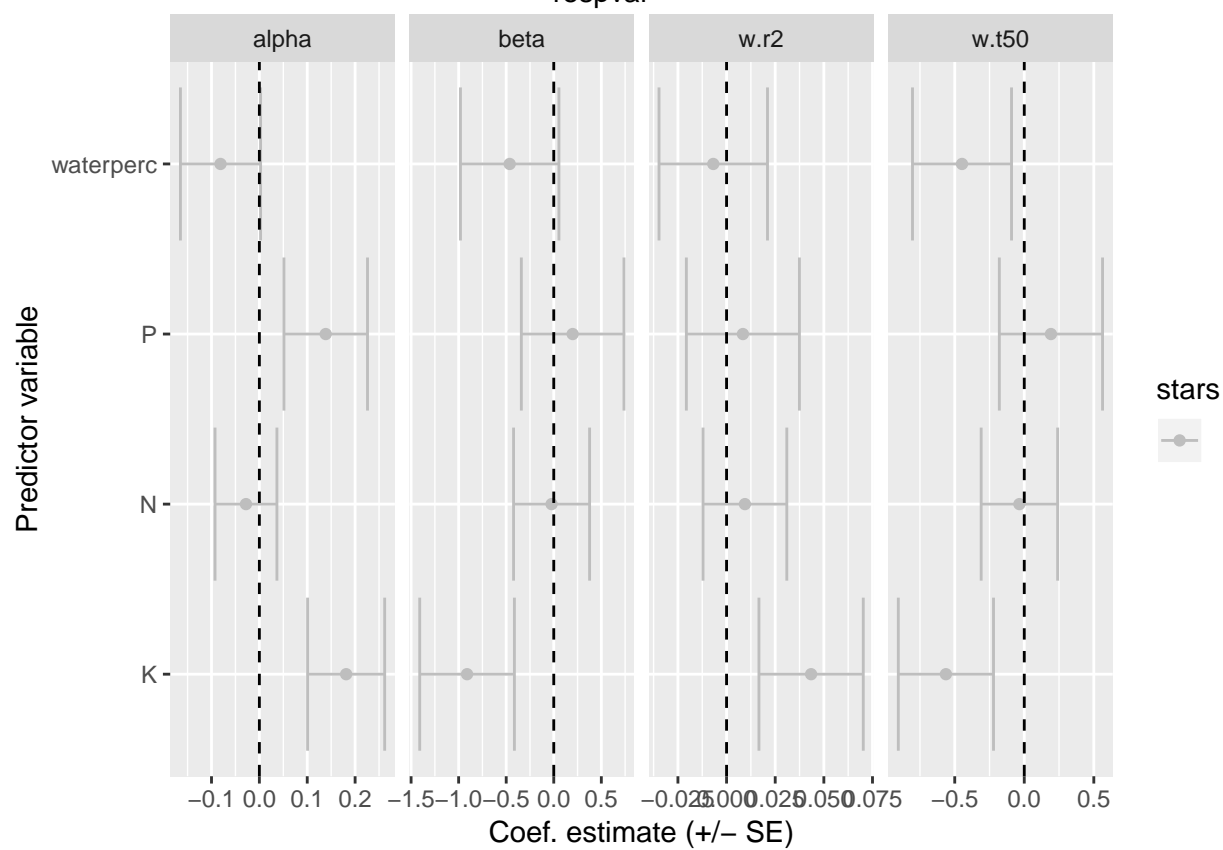
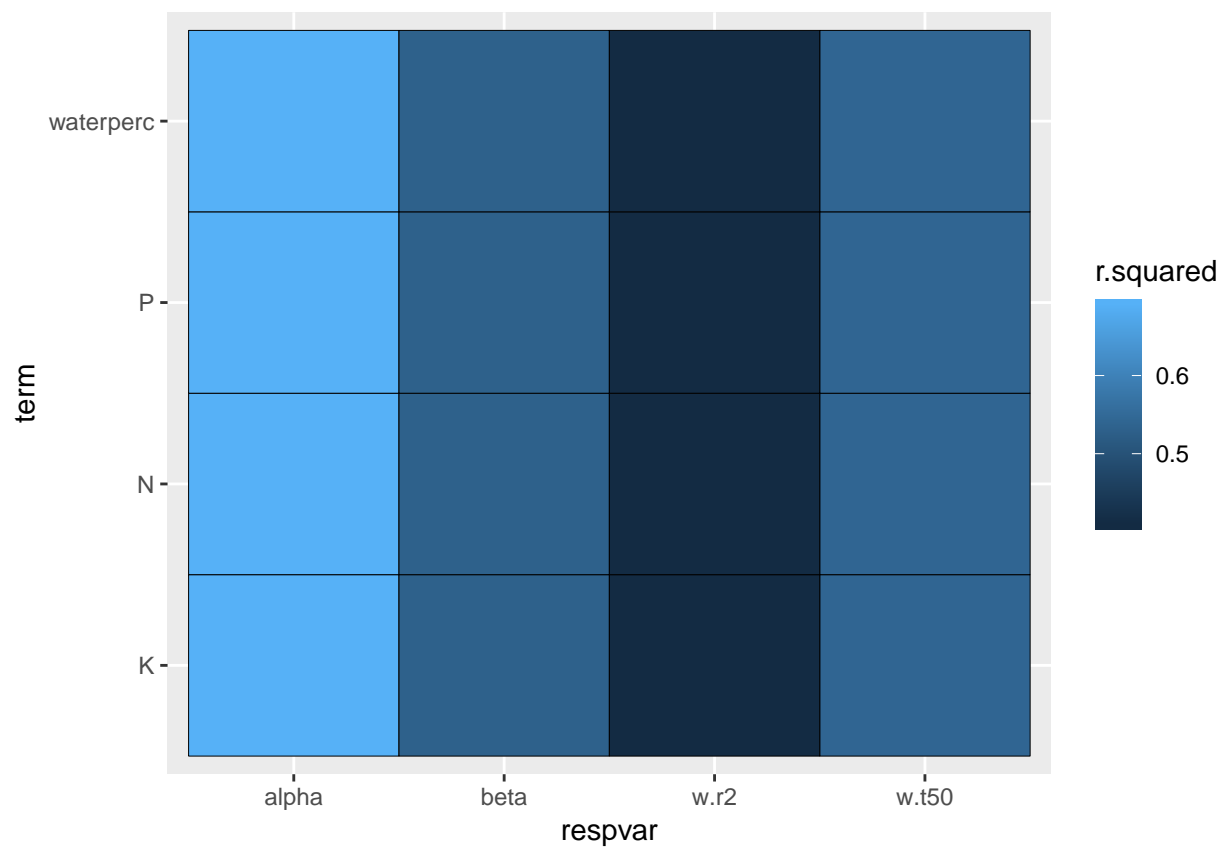
Visualize code in trait space, add decayfit vectors

```
## Importance of components:
##              PC1      PC2      PC3      PC4      PC5      PC6      PC7
## Standard deviation  1.673  1.4692  1.1874  0.94083  0.92773  0.7287  0.55212
## Proportion of Variance 0.311 0.2399 0.1567 0.09835 0.09563 0.0590 0.03387
## Cumulative Proportion 0.311 0.5509 0.7075 0.80588 0.90151 0.9605 0.99438
##              PC8      PC9
## Standard deviation  0.18958 0.12099
## Proportion of Variance 0.00399 0.00163
## Cumulative Proportion 0.99837 1.00000
```



(a-forward) Original traits but using forward selection instead of backward

```
## Start: AIC=-34.24
## alpha ~ K + N + P + waterperc
##
## Start: AIC=9.47
## beta ~ K + N + P + waterperc
##
## Start: AIC=0.5
## w.t50 ~ K + N + P + waterperc
##
## Start: AIC=-60.64
## w.r2 ~ K + N + P + waterperc
```



(b-forward) Original traits plus C fractions...

```
## Start: AIC=-70.87
## alpha ~ K + N + P + waterperc + Arabinose + Galactose + Mannose +
##      perc.Total.lignin + Rhamnose
##
## Start: AIC=-12.16
## beta ~ K + N + P + waterperc + Arabinose + Galactose + Mannose +
##      perc.Total.lignin + Rhamnose
##
## Start: AIC=-16.36
## w.t50 ~ K + N + P + waterperc + Arabinose + Galactose + Mannose +
##      perc.Total.lignin + Rhamnose
##
## Start: AIC=-77.87
## w.r2 ~ K + N + P + waterperc + Arabinose + Galactose + Mannose +
##      perc.Total.lignin + Rhamnose
```

