Micro Capstone

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Read in excel sheet with data from baseball reference from 1969 to 2021 with about 162 games (excluding 1981, 1994, 1995, and 2020)

```
baseball = read.table("BaseballCapstoneData.csv", header = TRUE, sep=",")
baseball$X = NULL
baseball$X.1 = NULL
baseball$X.2 = NULL
baseball$X.3 = NULL
baseball$X.4 = NULL
baseball$X.5 = NULL
```

Run the full model looking at response variable y with all the variables

```
startmodel = lm(W ~ BatAge + RG + R + H + SB + TB + HR + RBI + SB + CS + BB + SO + BA + OBP + SLG + OPS

summary(startmodel)
```

```
##
## Call:
## lm(formula = W ~ BatAge + RG + R + H + SB + TB + HR + RBI + SB +
##     CS + BB + SO + BA + OBP + SLG + OPS + PAge + RAG + ERA +
##     CG + tSho + cSho + SV + HA + RA + ER + HRA + BBA + SOA +
##     FIP + WHIP, data = baseball)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -9.7991 -2.1342 -0.0171  2.0923 10.9872
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  4.052e+00  6.279e+00   0.645  0.51878
## BatAge       1.337e-01  8.149e-02   1.641  0.10101
## RG          -2.925e+01  1.441e+01  -2.030  0.04260 *
## R            2.612e-01  8.988e-02   2.905  0.00373 **
## H           -1.005e-01  1.543e-02  -6.509 1.07e-10 ***
## SB          -3.276e-02  2.437e-02  -1.344  0.17911
## TB          -6.653e-02  5.033e-02  -1.322  0.18640
## HR          -8.210e-02  7.255e-02  -1.132  0.25800
## RBI          3.800e-03  1.285e-02   0.296  0.76743
## CS          -4.009e-02  7.225e-03  -5.548 3.48e-08 ***
## BB          -1.416e-02  6.424e-03  -2.204  0.02771 *
## SO           2.640e-03  1.027e-03   2.570  0.01028 *
## BA           5.011e+02  2.091e+02   2.396  0.01669 *
```

```
## OBP         -1.977e+02  1.425e+02  -1.387  0.16565
## SLG         -1.267e+02  1.694e+02  -0.748  0.45478
## OPS          2.852e+02  1.335e+02   2.136  0.03287 *
## PAge         4.387e-02  7.077e-02   0.620  0.53543
## RAG          2.301e+01  1.459e+01   1.577  0.11495
## ERA         -5.224e+00  1.131e+01  -0.462  0.64434
## CG           1.342e-01  1.438e-02   9.336  < 2e-16 ***
## tSho         1.639e-01  3.646e-02   4.494 7.59e-06 ***
## cSho         2.465e-02  5.250e-02   0.470  0.63872
## SV           3.274e-01  1.494e-02  21.922  < 2e-16 ***
## HA           9.418e-02  2.310e-02   4.078 4.82e-05 ***
## RA          -2.012e-01  9.026e-02  -2.229  0.02598 *
## ER           3.997e-02  7.093e-02   0.564  0.57313
## HRA         -2.117e-03  1.090e-02  -0.194  0.84601
## BBA          9.643e-02  2.329e-02   4.140 3.69e-05 ***
## SOA          5.395e-04  1.462e-03   0.369  0.71213
## FIP         -8.661e-01  1.015e+00  -0.853  0.39359
## WHIP        -1.463e+02  3.330e+01  -4.395 1.20e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.107 on 1325 degrees of freedom
## Multiple R-squared:  0.9291, Adjusted R-squared:  0.9275
## F-statistic: 578.6 on 30 and 1325 DF,  p-value: < 2.2e-16
```

Run stepwise to find best model

```
require(MASS)
```

```
## Loading required package: MASS
```

```
min_model = lm(W ~ 1, data = baseball)
max_model = formula(W ~ BatAge + RG + R + H + SB + TB + HR + RBI + SB + CS + BB + SO + BA + OBP + SLG +
best_model = step(min_model, direction = "both", scope = max_model)
```

```
## Start:  AIC=6633.56
## W ~ 1
##
##          Df Sum of Sq    RSS    AIC
## + WHIP    1     65134 115247 6028.1
## + RAG     1     58997 121384 6098.4
## + RA      1     57263 123118 6117.7
## + RG      1     52723 127658 6166.8
## + R       1     52385 127995 6170.4
## + ERA     1     51985 128396 6174.6
## + OBP     1     50440 129941 6190.8
## + SV      1     49823 130558 6197.2
## + RBI     1     49805 130576 6197.4
## + ER      1     48400 131981 6211.9
## + OPS     1     43557 136824 6260.8
## + HA      1     36560 143821 6328.4
## + tSho    1     36162 144219 6332.2
```

```
## + BBA     1     34699 145682 6345.9
## + SLG     1     32998 147383 6361.6
## + BA      1     30265 150116 6386.5
## + BB      1     29342 151038 6394.8
## + FIP     1     28120 152261 6405.8
## + H       1     25698 154682 6427.1
## + PAge    1     19945 160436 6476.7
## + HR      1     18277 162104 6490.7
## + BatAge  1     16343 164038 6506.8
## + SB      1      9107 171273 6565.3
## + HRA     1      8611 171770 6569.2
## + cSho    1      6139 174242 6588.6
## + SOA     1      5825 174556 6591.1
## + CG      1      1039 179342 6627.7
## + SO      1       680 179701 6630.4
## + CS      1       572 179808 6631.2
## + TB      1       279 180102 6633.5
## <none>                180381 6633.6
##
## Step:  AIC=6028.09
## W ~ WHIP
##
##          Df Sum of Sq    RSS    AIC
## + R       1     75733  39514 4578.6
## + RG      1     75643  39604 4581.7
## + RBI     1     72692  42555 4679.1
## + OBP     1     72220  43027 4694.1
## + OPS     1     67498  47749 4835.3
## + BA      1     56063  59184 5126.4
## + H       1     53381  61866 5186.5
## + SLG     1     53151  62096 5191.5
## + BB      1     29470  85777 5629.6
## + HR      1     25969  89278 5683.9
## + SV      1     25078  90169 5697.3
## + SB      1     20259  94988 5767.9
## + BatAge  1     12225 103022 5878.0
## + PAge    1     10793 104454 5896.8
## + HA      1      2494 112754 6000.4
## + FIP     1      1093 114154 6017.2
## + RAG     1      1040 114207 6017.8
## + SO      1      1034 114213 6017.9
## + tSho    1      1010 114238 6018.2
## + RA      1       643 114605 6022.5
## + TB      1       447 114800 6024.8
## + CS      1       422 114825 6025.1
## + ERA     1       262 114985 6027.0
## + HRA     1       214 115034 6027.6
## <none>                115247 6028.1
## + SOA     1       150 115097 6028.3
## + CG      1       141 115106 6028.4
## + BBA     1        74 115173 6029.2
## + cSho    1        11 115237 6030.0
## + ER      1         2 115245 6030.1
## - WHIP    1     65134 180381 6633.6
```

```
##
## Step:  AIC=4578.59
## W ~ WHIP + R
##
##          Df Sum of Sq    RSS    AIC
## + RAG     1     17553  21961 3784.1
## + RA      1     17230  22284 3803.9
## + ERA     1     15572  23942 3901.2
## + ER      1     14846  24667 3941.7
## + HRA     1     10479  29035 4162.7
## + FIP     1      7779  31735 4283.3
## + SO      1      4959  34555 4398.8
## + OBP     1      4109  35405 4431.7
## + SV      1      4046  35468 4434.1
## + cSho    1      3813  35701 4443.0
## + SOA     1      3660  35854 4448.8
## + tSho    1      3525  35989 4453.9
## + CG      1      3101  36413 4469.8
## + HR      1      2488  37026 4492.4
## + BA      1      2145  37369 4504.9
## + SB      1      2000  37514 4510.2
## + SLG     1      1618  37896 4523.9
## + RBI     1      1528  37986 4527.1
## + CS      1      1481  38032 4528.8
## + BBA     1      1169  38345 4539.9
## + BB      1      1096  38418 4542.4
## + H       1      1053  38461 4544.0
## + TB      1       577  38937 4560.6
## + BatAge  1       249  39265 4572.0
## + HA      1       171  39343 4574.7
## <none>                  39514 4578.6
## + OPS     1        37  39477 4579.3
## + RG      1        10  39504 4580.3
## + PAge    1         5  39509 4580.4
## - R       1     75733 115247 6028.1
## - WHIP    1     88482 127995 6170.4
##
## Step:  AIC=3784.08
## W ~ WHIP + R + RAG
##
##          Df Sum of Sq    RSS    AIC
## + SV      1      3798  18163 3528.6
## + tSho    1       337  21624 3765.1
## + BatAge  1       174  21786 3775.3
## + OBP     1       168  21793 3775.7
## + OPS     1       168  21793 3775.7
## + HA      1       122  21839 3778.5
## + SB      1        96  21864 3780.1
## + FIP     1        65  21896 3782.1
## + PAge    1        62  21899 3782.2
## + ERA     1        50  21910 3783.0
## + HRA     1        43  21918 3783.4
## + SLG     1        36  21924 3783.8
## + BB      1        36  21925 3783.9
```

```
## <none>                21961 3784.1
## + BA      1        32  21929 3784.1
## + HR      1        29  21932 3784.3
## + CS      1        26  21935 3784.5
## + SO      1        23  21938 3784.7
## + cSho    1        22  21939 3784.7
## + RG      1        22  21939 3784.7
## + RA      1        21  21940 3784.8
## + TB      1        18  21943 3785.0
## + RBI     1        12  21949 3785.3
## + BBA     1         3  21958 3785.9
## + ER      1         2  21959 3786.0
## + H       1         1  21960 3786.0
## + SOA     1         1  21960 3786.0
## + CG      1         0  21961 3786.1
## - WHIP    1       133  22094 3790.3
## - RAG     1     17553  39514 4578.6
## - R       1     92246 114207 6017.8
##
## Step:  AIC=3528.62
## W ~ WHIP + R + RAG + SV
##
##          Df Sum of Sq   RSS    AIC
## + CG      1      2624 15539 3319.1
## + cSho    1      1910 16253 3379.9
## + tSho    1       694 17469 3477.8
## + SB      1       596 17567 3485.3
## + SO      1       483 17680 3494.1
## + FIP     1       429 17734 3498.2
## + ERA     1       428 17735 3498.3
## + OBP     1       344 17819 3504.7
## + SOA     1       313 17850 3507.0
## + HRA     1       280 17883 3509.6
## + ER      1       222 17941 3513.9
## + BB      1       147 18016 3519.6
## + RBI     1        98 18065 3523.3
## + CS      1        85 18078 3524.3
## + BA      1        73 18090 3525.2
## + HA      1        60 18103 3526.1
## + SLG     1        56 18107 3526.4
## - WHIP    1         5 18168 3527.0
## <none>                18163 3528.6
## + BatAge  1        21 18142 3529.1
## + HR      1        21 18142 3529.1
## + H       1        11 18152 3529.8
## + RA      1         9 18154 3530.0
## + RG      1         8 18155 3530.0
## + TB      1         8 18155 3530.0
## + OPS     1         6 18157 3530.1
## + PAge    1         2 18161 3530.5
## + BBA     1         0 18163 3530.6
## - SV      1      3798 21961 3784.1
## - RAG     1     17305 35468 4434.1
## - R       1     69545 87708 5661.8
```

```
##
## Step:  AIC=3319.06
## W ~ WHIP + R + RAG + SV + CG
##
##          Df Sum of Sq   RSS    AIC
## + tSho    1       500 15039 3276.7
## + SOA     1       300 15240 3294.7
## + cSho    1       129 15410 3309.7
## + OPS     1       120 15420 3310.6
## + BatAge  1       115 15425 3311.0
## + SO      1        98 15441 3312.5
## + OBP     1        80 15459 3314.1
## + TB      1        74 15466 3314.6
## + CS      1        63 15477 3315.6
## + HR      1        61 15478 3315.7
## + RBI     1        56 15484 3316.2
## + BB      1        52 15487 3316.5
## + ER      1        45 15494 3317.1
## + BBA     1        42 15498 3317.4
## + SLG     1        41 15498 3317.5
## + FIP     1        34 15505 3318.1
## <none>                15539 3319.1
## + RG      1        22 15518 3319.2
## + PAge    1        19 15520 3319.4
## + RA      1        16 15524 3319.7
## + H       1        11 15528 3320.1
## + BA      1         2 15538 3320.9
## + HA      1         1 15539 3321.0
## + SB      1         1 15539 3321.0
## + HRA     1         0 15539 3321.0
## + ERA     1         0 15539 3321.1
## - WHIP    1       325 15865 3345.1
## - CG      1      2624 18163 3528.6
## - SV      1      6421 21961 3786.1
## - RAG     1      7321 22861 3840.5
## - R       1     63533 79073 5523.3
##
## Step:  AIC=3276.68
## W ~ WHIP + R + RAG + SV + CG + tSho
##
##          Df Sum of Sq   RSS    AIC
## + SOA     1       210 14829 3259.6
## + BatAge  1        96 14943 3270.0
## + OPS     1        92 14947 3270.4
## + OBP     1        72 14967 3272.1
## + TB      1        70 14969 3272.4
## + BB      1        63 14976 3273.0
## + SO      1        62 14977 3273.0
## + HR      1        55 14984 3273.7
## + RBI     1        35 15004 3275.5
## + ER      1        34 15005 3275.6
## + BBA     1        34 15005 3275.6
## + CS      1        27 15012 3276.2
## + SLG     1        26 15013 3276.3
```

```
## + RG      1        26 15013 3276.3
## + FIP     1        25 15014 3276.4
## <none>                15039 3276.7
## + PAge    1        19 15020 3276.9
## + RA      1        18 15021 3277.0
## + H       1        13 15026 3277.5
## + SB      1         6 15033 3278.2
## + HA      1         4 15035 3278.4
## + BA      1         3 15036 3278.4
## + ERA     1         2 15037 3278.5
## + cSho    1         1 15038 3278.6
## + HRA     1         0 15039 3278.7
## - WHIP    1       230 15269 3295.2
## - tSho    1       500 15539 3319.1
## - CG      1      2430 17469 3477.8
## - RAG     1      6029 21068 3731.8
## - SV      1      6579 21618 3766.7
## - R       1     62930 77969 5506.2
##
## Step:  AIC=3259.58
## W ~ WHIP + R + RAG + SV + CG + tSho + SOA
##
##          Df Sum of Sq   RSS    AIC
## + OBP     1       115 14714 3251.0
## + BatAge  1       101 14728 3252.3
## + HA      1        58 14770 3256.2
## + OPS     1        58 14771 3256.3
## + BB      1        54 14775 3256.6
## + PAge    1        31 14798 3258.8
## + TB      1        31 14798 3258.8
## + HRA     1        25 14804 3259.3
## + RG      1        23 14806 3259.5
## <none>                14829 3259.6
## + RA      1        15 14813 3260.2
## + ER      1        14 14815 3260.3
## + RBI     1        13 14815 3260.4
## + ERA     1        13 14816 3260.4
## + FIP     1         8 14821 3260.9
## + SB      1         7 14822 3261.0
## + BA      1         5 14824 3261.2
## + HR      1         5 14824 3261.2
## + cSho    1         4 14825 3261.2
## + SLG     1         3 14825 3261.3
## + CS      1         0 14828 3261.5
## + BBA     1         0 14828 3261.6
## + H       1         0 14828 3261.6
## + SO      1         0 14829 3261.6
## - WHIP    1        63 14892 3263.3
## - SOA     1       210 15039 3276.7
## - tSho    1       411 15240 3294.7
## - CG      1      2273 17101 3450.9
## - RAG     1      6239 21068 3733.8
## - SV      1      6777 21606 3768.0
## - R       1     60808 75637 5467.0
```

```
##
## Step:  AIC=3251.02
## W ~ WHIP + R + RAG + SV + CG + tSho + SOA + OBP
##
##          Df Sum of Sq   RSS    AIC
## + BatAge  1      70.7 14643 3246.5
## + HA      1      54.7 14659 3248.0
## + HR      1      53.9 14660 3248.0
## + RG      1      31.5 14682 3250.1
## + TB      1      27.9 14686 3250.4
## + RA      1      23.4 14690 3250.9
## <none>                14714 3251.0
## + PAge    1      21.4 14692 3251.0
## + RBI     1      18.3 14695 3251.3
## + H       1      17.9 14696 3251.4
## + ER      1      17.5 14696 3251.4
## + SB      1      15.0 14699 3251.6
## + OPS     1      14.7 14699 3251.7
## + SLG     1      12.1 14702 3251.9
## + SO      1      11.9 14702 3251.9
## + ERA     1      11.1 14702 3252.0
## + HRA     1      10.2 14703 3252.1
## + BA      1       9.3 14704 3252.2
## + CS      1       3.4 14710 3252.7
## + BB      1       3.3 14710 3252.7
## + cSho    1       2.8 14711 3252.8
## + FIP     1       1.7 14712 3252.9
## + BBA     1       0.7 14713 3253.0
## - WHIP    1     102.9 14816 3258.5
## - OBP     1     115.0 14829 3259.6
## - SOA     1     253.1 14967 3272.1
## - tSho    1     393.5 15107 3284.8
## - CG      1    2202.5 16916 3438.2
## - RAG     1    5557.5 20271 3683.5
## - SV      1    6736.4 21450 3760.2
## - R       1   12593.3 27307 4087.5
##
## Step:  AIC=3246.49
## W ~ WHIP + R + RAG + SV + CG + tSho + SOA + OBP + BatAge
##
##          Df Sum of Sq   RSS    AIC
## + HA      1      43.4 14599 3244.5
## + HR      1      41.1 14602 3244.7
## + SO      1      30.2 14613 3245.7
## + RG      1      30.0 14613 3245.7
## + RA      1      22.0 14621 3246.4
## <none>                14643 3246.5
## + ERA     1      20.8 14622 3246.6
## + H       1      18.2 14625 3246.8
## + SB      1      13.8 14629 3247.2
## + TB      1      12.8 14630 3247.3
## + OPS     1      11.5 14631 3247.4
## + HRA     1      11.2 14632 3247.5
## + RBI     1       9.8 14633 3247.6
```

```
## + BA      1       9.5 14633 3247.6
## + SLG     1       9.4 14634 3247.6
## + ER      1       8.7 14634 3247.7
## + BBA     1       3.1 14640 3248.2
## + BB      1       3.1 14640 3248.2
## + cSho    1       2.7 14640 3248.2
## + FIP     1       2.1 14641 3248.3
## + PAge    1       1.2 14642 3248.4
## + CS      1       0.6 14642 3248.4
## - BatAge  1      70.7 14714 3251.0
## - OBP     1      84.9 14728 3252.3
## - WHIP    1      98.9 14742 3253.6
## - SOA     1     251.1 14894 3267.5
## - tSho    1     380.8 15024 3279.3
## - CG      1    2264.9 16908 3439.5
## - RAG     1    5525.9 20169 3678.7
## - SV      1    6690.9 21334 3754.8
## - R       1   12577.2 27220 4085.2
##
## Step:  AIC=3244.46
## W ~ WHIP + R + RAG + SV + CG + tSho + SOA + OBP + BatAge + HA
##
##          Df Sum of Sq   RSS    AIC
## + BBA     1     251.7 14348 3222.9
## + HR      1      50.3 14549 3241.8
## + H       1      40.4 14559 3242.7
## + SO      1      29.1 14570 3243.8
## + SB      1      26.3 14573 3244.0
## <none>                 14599 3244.5
## + ERA     1      20.3 14579 3244.6
## + BA      1      19.6 14580 3244.6
## + RG      1      16.6 14583 3244.9
## + TB      1      15.5 14584 3245.0
## + RA      1      10.2 14589 3245.5
## + OPS     1       9.6 14590 3245.6
## + HRA     1       8.2 14591 3245.7
## + SLG     1       7.6 14592 3245.8
## + BB      1       7.6 14592 3245.8
## + RBI     1       7.3 14592 3245.8
## + ER      1       3.8 14596 3246.1
## + cSho    1       3.5 14596 3246.1
## + FIP     1       0.7 14599 3246.4
## + PAge    1       0.3 14599 3246.4
## + CS      1       0.2 14599 3246.4
## - HA      1      43.4 14643 3246.5
## - BatAge  1      59.4 14659 3248.0
## - OBP     1      84.3 14684 3250.3
## - WHIP    1     130.9 14730 3254.6
## - SOA     1     294.3 14894 3269.5
## - tSho    1     381.6 14981 3277.5
## - CG      1    2306.7 16906 3441.4
## - RAG     1    5346.2 19946 3665.6
## - SV      1    6629.4 21229 3750.1
## - R       1   12425.5 27025 4077.5
```

```
##
## Step:  AIC=3222.88
## W ~ WHIP + R + RAG + SV + CG + tSho + SOA + OBP + BatAge + HA +
##     BBA
##
##           Df Sum of Sq   RSS    AIC
## + HR       1      88.8 14259 3216.5
## + H        1      87.5 14260 3216.6
## + OPS      1      53.8 14294 3219.8
## + SLG      1      48.6 14299 3220.3
## + SO       1      38.2 14310 3221.3
## + RA       1      36.7 14311 3221.4
## + TB       1      29.4 14318 3222.1
## + RG       1      25.1 14323 3222.5
## + SB       1      23.8 14324 3222.6
## + RBI      1      23.6 14324 3222.6
## <none>                 14348 3222.9
## + CS       1      16.1 14332 3223.4
## + BA       1      10.4 14337 3223.9
## + cSho     1       3.2 14344 3224.6
## + ERA      1       2.3 14345 3224.7
## + ER       1       1.5 14346 3224.7
## + PAge     1       1.2 14346 3224.8
## + HRA      1       0.6 14347 3224.8
## + BB       1       0.3 14348 3224.9
## + FIP      1       0.2 14348 3224.9
## - BatAge   1      70.3 14418 3227.5
## - OBP      1      98.0 14446 3230.1
## - SOA      1     227.6 14575 3242.2
## - BBA      1     251.7 14599 3244.5
## - HA       1     292.0 14640 3248.2
## - WHIP     1     366.1 14714 3255.0
## - tSho     1     406.9 14755 3258.8
## - CG       1    2184.8 16533 3413.1
## - RAG      1    4457.0 18805 3587.7
## - SV       1    6466.3 20814 3725.4
## - R        1   11841.8 26190 4036.9
##
## Step:  AIC=3216.46
## W ~ WHIP + R + RAG + SV + CG + tSho + SOA + OBP + BatAge + HA +
##     BBA + HR
##
##           Df Sum of Sq   RSS    AIC
## + H        1      44.0 14215 3214.3
## + RA       1      31.7 14227 3215.4
## <none>                 14259 3216.5
## + RG       1      20.6 14238 3216.5
## + BB       1      11.1 14248 3217.4
## + HRA      1      10.3 14249 3217.5
## + SB       1       9.9 14249 3217.5
## + SO       1       9.3 14250 3217.6
## + cSho     1       3.5 14256 3218.1
## + CS       1       3.5 14256 3218.1
## + TB       1       2.7 14256 3218.2
```

```
## + RBI     1       2.6 14256 3218.2
## + OPS     1       2.2 14257 3218.3
## + FIP     1       1.6 14257 3218.3
## + ERA     1       1.3 14258 3218.3
## + SLG     1       0.9 14258 3218.4
## + ER      1       0.7 14258 3218.4
## + PAge    1       0.4 14259 3218.4
## + BA      1       0.0 14259 3218.5
## - BatAge  1      51.6 14311 3219.4
## - HR      1      88.8 14348 3222.9
## - SOA     1     128.7 14388 3226.7
## - OBP     1     170.2 14429 3230.5
## - BBA     1     290.2 14549 3241.8
## - HA      1     340.1 14599 3246.4
## - WHIP    1     405.7 14665 3252.5
## - tSho    1     417.6 14677 3253.6
## - CG      1    2091.3 16350 3400.0
## - RAG     1    4542.4 18801 3589.5
## - R       1    5565.3 19824 3661.3
## - SV      1    6289.5 20548 3709.9
##
## Step:  AIC=3214.27
## W ~ WHIP + R + RAG + SV + CG + tSho + SOA + OBP + BatAge + HA +
##     BBA + HR + H
##
##           Df Sum of Sq   RSS    AIC
## + BA       1     875.4 13340 3130.1
## + BB       1     565.6 13649 3161.2
## + OPS      1     102.7 14112 3206.4
## + SLG      1      89.7 14125 3207.7
## + RA       1      29.7 14185 3213.4
## <none>                 14215 3214.3
## + RG       1      18.6 14196 3214.5
## + HRA      1      11.6 14203 3215.2
## + RBI      1       8.0 14207 3215.5
## + CS       1       6.4 14209 3215.7
## + ERA      1       3.3 14212 3216.0
## + ER       1       2.2 14213 3216.1
## + cSho     1       2.1 14213 3216.1
## + SB       1       1.4 14214 3216.1
## + FIP      1       1.4 14214 3216.1
## + TB       1       0.4 14215 3216.2
## + SO       1       0.4 14215 3216.2
## + PAge     1       0.2 14215 3216.3
## - H        1      44.0 14259 3216.5
## - HR       1      45.3 14260 3216.6
## - BatAge   1      53.9 14269 3217.4
## - SOA      1     129.0 14344 3224.5
## - OBP      1     199.9 14415 3231.2
## - BBA      1     316.8 14532 3242.2
## - HA       1     380.6 14596 3248.1
## - tSho     1     426.7 14642 3252.4
## - WHIP     1     436.0 14651 3253.2
## - CG       1    2077.7 16293 3397.3
```

```
## - RAG     1    4553.8 18769 3589.1
## - R       1    4992.8 19208 3620.5
## - SV      1    6288.1 20503 3708.9
##
## Step:  AIC=3130.08
## W ~ WHIP + R + RAG + SV + CG + tSho + SOA + OBP + BatAge + HA +
##     BBA + HR + H + BA
##
##          Df Sum of Sq   RSS    AIC
## + CS      1     306.9 13033 3100.5
## + SO      1      56.0 13284 3126.4
## + BB      1      49.3 13290 3127.1
## - OBP     1       1.1 13341 3128.2
## <none>                13340 3130.1
## + RBI     1      14.7 13325 3130.6
## + RA      1      13.2 13326 3130.7
## + HRA     1      10.0 13330 3131.1
## + TB      1       6.7 13333 3131.4
## + RG      1       5.0 13335 3131.6
## + ER      1       4.8 13335 3131.6
## + ERA     1       4.7 13335 3131.6
## + FIP     1       3.7 13336 3131.7
## + PAge    1       1.8 13338 3131.9
## + SLG     1       1.0 13339 3132.0
## + SB      1       0.2 13339 3132.1
## + OPS     1       0.1 13340 3132.1
## + cSho    1       0.1 13340 3132.1
## - BatAge  1      49.1 13389 3133.1
## - HR      1     105.0 13445 3138.7
## - SOA     1     211.7 13551 3149.4
## - tSho    1     425.9 13766 3170.7
## - BA      1     875.4 14215 3214.3
## - H       1     919.4 14259 3218.5
## - BBA     1    1167.8 14507 3241.9
## - HA      1    1245.7 14585 3249.1
## - WHIP    1    1299.5 14639 3254.1
## - CG      1    1642.7 14982 3285.6
## - RAG     1    3666.8 17006 3457.4
## - SV      1    4944.4 18284 3555.6
## - R       1    5309.0 18649 3582.4
##
## Step:  AIC=3100.52
## W ~ WHIP + R + RAG + SV + CG + tSho + SOA + OBP + BatAge + HA +
##     BBA + HR + H + BA + CS
##
##          Df Sum of Sq   RSS    AIC
## + SO      1      55.8 12977 3096.7
## + BB      1      36.1 12997 3098.8
## - OBP     1      16.6 13049 3100.3
## <none>                13033 3100.5
## + HRA     1      17.0 13016 3100.8
## - BatAge  1      26.3 13059 3101.3
## + FIP     1      10.0 13023 3101.5
## + RA      1       9.0 13024 3101.6
```

```
## + PAge    1       3.0 13030 3102.2
## + SB      1       2.8 13030 3102.2
## + cSho    1       2.8 13030 3102.2
## + SLG     1       2.4 13030 3102.3
## + RG      1       1.8 13031 3102.3
## - HR      1      37.1 13070 3102.4
## + TB      1       0.7 13032 3102.5
## + OPS     1       0.6 13032 3102.5
## + ER      1       0.6 13032 3102.5
## + ERA     1       0.5 13032 3102.5
## + RBI     1       0.2 13032 3102.5
## - SOA     1      98.8 13132 3108.8
## - CS      1     306.9 13340 3130.1
## - tSho    1     356.8 13390 3135.2
## - BA      1    1175.9 14209 3215.7
## - H       1    1222.8 14256 3220.1
## - BBA     1    1474.4 14507 3243.9
## - HA      1    1552.5 14585 3251.1
## - WHIP    1    1604.6 14637 3256.0
## - CG      1    1632.1 14665 3258.5
## - RAG     1    3121.9 16155 3389.7
## - SV      1    4952.8 17986 3535.3
## - R       1    5524.9 18558 3577.8
##
## Step:  AIC=3096.7
## W ~ WHIP + R + RAG + SV + CG + tSho + SOA + OBP + BatAge + HA +
##     BBA + HR + H + BA + CS + SO
##
##          Df Sum of Sq   RSS    AIC
## + BB      1      26.6 12950 3095.9
## + FIP     1      22.4 12954 3096.4
## + HRA     1      21.4 12956 3096.5
## - HR      1      18.6 12996 3096.7
## <none>                 12977 3096.7
## - OBP     1      21.0 12998 3096.9
## + RA      1      10.2 12967 3097.6
## - SOA     1      29.2 13006 3097.8
## + SLG     1       7.9 12969 3097.9
## + SB      1       5.5 12971 3098.1
## + OPS     1       4.3 12973 3098.3
## + TB      1       4.2 12973 3098.3
## + cSho    1       3.3 12974 3098.4
## + PAge    1       2.9 12974 3098.4
## + RG      1       1.8 12975 3098.5
## + ERA     1       0.0 12977 3098.7
## + ER      1       0.0 12977 3098.7
## + RBI     1       0.0 12977 3098.7
## - BatAge  1      50.7 13028 3100.0
## - SO      1      55.8 13033 3100.5
## - CS      1     306.7 13284 3126.4
## - tSho    1     332.9 13310 3129.1
## - BA      1    1231.6 14208 3217.6
## - H       1    1268.1 14245 3221.1
## - BBA     1    1523.0 14500 3245.2
```

```
## - HA      1    1592.7 14570 3251.7
## - CG      1    1644.9 14622 3256.5
## - WHIP    1    1648.9 14626 3256.9
## - RAG     1    3137.4 16114 3388.3
## - SV      1    5001.4 17978 3536.8
## - R       1    5425.4 18402 3568.4
##
## Step:  AIC=3095.92
## W ~ WHIP + R + RAG + SV + CG + tSho + SOA + OBP + BatAge + HA +
##     BBA + HR + H + BA + CS + SO + BB
##
##          Df Sum of Sq   RSS    AIC
## + FIP     1      35.6 12915 3094.2
## + HRA     1      28.4 12922 3094.9
## - OBP     1      11.9 12962 3095.2
## - HR      1      13.9 12964 3095.4
## <none>                 12950 3095.9
## - SOA     1      23.0 12973 3096.3
## - BB      1      26.6 12977 3096.7
## + SLG     1      11.2 12939 3096.8
## + RA      1      11.0 12939 3096.8
## + SB      1       9.2 12941 3097.0
## + OPS     1       6.5 12944 3097.2
## + cSho    1       4.7 12946 3097.4
## + PAge    1       3.9 12946 3097.5
## + TB      1       3.3 12947 3097.6
## + RG      1       1.8 12948 3097.7
## + ERA     1       0.4 12950 3097.9
## + ER      1       0.3 12950 3097.9
## + RBI     1       0.0 12950 3097.9
## - SO      1      46.3 12997 3098.8
## - BatAge  1      53.2 13004 3099.5
## - CS      1     295.1 13246 3124.5
## - tSho    1     319.7 13270 3127.0
## - BA      1     629.1 13579 3158.2
## - H       1    1188.5 14139 3213.0
## - BBA     1    1548.9 14499 3247.1
## - HA      1    1618.7 14569 3253.6
## - CG      1    1670.3 14621 3258.4
## - WHIP    1    1673.8 14624 3258.7
## - RAG     1    3158.8 16109 3389.9
## - SV      1    4997.8 17948 3536.5
## - R       1    5450.7 18401 3570.3
##
## Step:  AIC=3094.19
## W ~ WHIP + R + RAG + SV + CG + tSho + SOA + OBP + BatAge + HA +
##     BBA + HR + H + BA + CS + SO + BB + FIP
##
##          Df Sum of Sq   RSS    AIC
## - SOA     1       3.7 12918 3092.6
## - HR      1      18.4 12933 3094.1
## <none>                 12915 3094.2
## - OBP     1      19.7 12934 3094.3
## + SLG     1      10.6 12904 3095.1
```

```
## + SB      1       6.8 12908 3095.5
## + OPS     1       5.9 12909 3095.6
## + RA      1       5.7 12909 3095.6
## + TB      1       5.3 12909 3095.6
## + ER      1       4.5 12910 3095.7
## + PAge    1       4.1 12911 3095.8
## + ERA     1       4.0 12911 3095.8
## - FIP     1      35.6 12950 3095.9
## + cSho    1       2.0 12913 3096.0
## + RBI     1       0.2 12914 3096.2
## + RG      1       0.2 12914 3096.2
## + HRA     1       0.1 12915 3096.2
## - BB      1      39.8 12954 3096.4
## - SO      1      60.2 12975 3098.5
## - BatAge  1      61.4 12976 3098.6
## - CS      1     306.4 13221 3124.0
## - tSho    1     309.1 13224 3124.3
## - BA      1     611.9 13527 3155.0
## - H       1    1204.7 14119 3213.1
## - CG      1    1388.9 14304 3230.7
## - BBA     1    1583.8 14498 3249.0
## - HA      1    1628.5 14543 3253.2
## - WHIP    1    1704.2 14619 3260.3
## - RAG     1    2010.4 14925 3288.4
## - SV      1    4920.0 17835 3529.9
## - R       1    5484.0 18399 3572.1
##
## Step:  AIC=3092.58
## W ~ WHIP + R + RAG + SV + CG + tSho + OBP + BatAge + HA + BBA +
##     HR + H + BA + CS + SO + BB + FIP
##
##          Df Sum of Sq   RSS    AIC
## <none>                12918 3092.6
## - HR      1      20.4 12939 3092.7
## - OBP     1      23.3 12942 3093.0
## + SLG     1      10.5 12908 3093.5
## + ER      1       6.4 12912 3093.9
## + TB      1       6.3 12912 3093.9
## + OPS     1       5.9 12912 3094.0
## + SB      1       5.9 12912 3094.0
## + ERA     1       5.8 12913 3094.0
## + RA      1       4.8 12914 3094.1
## + PAge    1       3.8 12914 3094.2
## + SOA     1       3.7 12915 3094.2
## + HRA     1       1.2 12917 3094.4
## + cSho    1       1.2 12917 3094.4
## + RBI     1       0.3 12918 3094.5
## + RG      1       0.1 12918 3094.6
## - BB      1      46.1 12964 3095.4
## - FIP     1      54.9 12973 3096.3
## - BatAge  1      67.6 12986 3097.7
## - SO      1      95.8 13014 3100.6
## - tSho    1     310.9 13229 3122.8
## - CS      1     335.6 13254 3125.4
```

```
## - BA      1     611.1 13530 3153.3
## - H       1    1218.4 14137 3212.8
## - CG      1    1554.6 14473 3244.7
## - HA      1    1651.5 14570 3253.7
## - BBA     1    1692.3 14611 3257.5
## - WHIP    1    1825.7 14744 3269.8
## - RAG     1    2228.6 15147 3306.4
## - SV      1    4971.8 17890 3532.1
## - R       1    5480.5 18399 3570.1
```

run new stepwise model

```
stepwiseModel = lm(W ~ WHIP + R + RAG + SV + CG + tSho + OBP + BatAge + HA + BBA +
    HR + H + BA + CS + SO + BB + FIP, data = baseball)

summary(stepwiseModel)
```

```
##
## Call:
## lm(formula = W ~ WHIP + R + RAG + SV + CG + tSho + OBP + BatAge +
##     HA + BBA + HR + H + BA + CS + SO + BB + FIP, data = baseball)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -9.8808 -2.1016 -0.0087  2.0919 10.8046
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  5.126e+00  5.811e+00   0.882  0.37784
## WHIP        -1.579e+02  1.148e+01 -13.751  < 2e-16 ***
## R            8.257e-02  3.466e-03  23.825  < 2e-16 ***
## RAG         -8.544e+00  5.624e-01 -15.193  < 2e-16 ***
## SV           3.288e-01  1.449e-02  22.693  < 2e-16 ***
## CG           1.348e-01  1.062e-02  12.689  < 2e-16 ***
## tSho         1.677e-01  2.955e-02   5.675 1.70e-08 ***
## OBP          8.544e+01  5.501e+01   1.553  0.12062
## BatAge       1.899e-01  7.173e-02   2.647  0.00822 **
## HA           1.017e-01  7.777e-03  13.079  < 2e-16 ***
## BBA          1.046e-01  7.899e-03  13.239  < 2e-16 ***
## HR           6.523e-03  4.491e-03   1.452  0.14663
## H           -1.147e-01  1.021e-02 -11.233  < 2e-16 ***
## BA           7.370e+02  9.263e+01   7.956 3.76e-15 ***
## CS          -4.022e-02  6.822e-03  -5.896 4.71e-09 ***
## SO           2.737e-03  8.690e-04   3.150  0.00167 **
## BB          -1.337e-02  6.121e-03  -2.185  0.02907 *
## FIP         -9.949e-01  4.173e-01  -2.384  0.01725 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.107 on 1338 degrees of freedom
## Multiple R-squared:  0.9284, Adjusted R-squared:  0.9275
## F-statistic:  1020 on 17 and 1338 DF,  p-value: < 2.2e-16
```

run test for collinearity

```
require(regclass)
```

```
## Loading required package: regclass

## Loading required package: bestglm

## Loading required package: leaps

## Loading required package: VGAM

## Loading required package: stats4

## Loading required package: splines

## Loading required package: rpart

## Loading required package: randomForest

## randomForest 4.7-1

## Type rfNews() to see new features/changes/bug fixes.

## Important regclass change from 1.3:
## All functions that had a . in the name now have an _
## all.correlations -> all_correlations, cor.demo -> cor_demo, etc.
```

```
stepwiseModel = lm(W ~ WHIP + R + RAG + SV + CG + tSho + OBP + BatAge + HA + BBA +
    HR + H + BA + CS + SO + BB + FIP, data = baseball)
VIF(stepwiseModel)
```

```
##       WHIP          R        RAG         SV         CG       tSho        OBP
## 157.956450  13.144543  13.928407   2.342199   4.182153   2.081504  85.882095
##     BatAge         HA        BBA         HR          H         BA         CS
##   1.370887  73.997832  38.774936   5.031586 112.132710 186.191068   1.983313
##         SO         BB        FIP
##   4.289048  25.542655   5.579742
```

make small data frame for correlation matrix

```
baseballNew <- baseball[, colnames(baseball)[c(3,7,9,10,13,16,17,18,19,20,24,26,27,29,30,34,36,37)]]
```

run correlation matrix

```
round(cor(baseballNew),3)
```

```
##             W BatAge      R      H     HR     CS     BB     SO     BA    OBP
## W       1.000  0.301  0.539  0.377  0.318 -0.056  0.403 -0.061  0.410  0.529
## BatAge  0.301  1.000  0.331  0.265  0.279 -0.194  0.235 -0.015  0.270  0.340
## R       0.539  0.331  1.000  0.770  0.716 -0.206  0.514  0.131  0.757  0.860
## H       0.377  0.265  0.770  1.000  0.313 -0.028  0.180 -0.227  0.979  0.802
## HR      0.318  0.279  0.716  0.313  1.000 -0.473  0.291  0.543  0.274  0.417
## CS     -0.056 -0.194 -0.206 -0.028 -0.473  1.000 -0.007 -0.491  0.027 -0.035
## BB      0.403  0.235  0.514  0.180  0.291 -0.007  1.000  0.001  0.201  0.688
## SO     -0.061 -0.015  0.131 -0.227  0.543 -0.491  0.001  1.000 -0.295 -0.143
## BA      0.410  0.270  0.757  0.979  0.274  0.027  0.201 -0.295  1.000  0.835
## OBP     0.529  0.340  0.860  0.802  0.417 -0.035  0.688 -0.143  0.835  1.000
## RAG    -0.572 -0.017  0.297  0.271  0.315 -0.124  0.006  0.207  0.225  0.185
## CG      0.076 -0.209 -0.261 -0.092 -0.455  0.388  0.047 -0.677 -0.037 -0.064
## tSho    0.448  0.031 -0.183 -0.169 -0.196  0.012 -0.005 -0.118 -0.134 -0.104
## SV      0.526  0.258  0.294  0.166  0.304 -0.130  0.108  0.252  0.167  0.213
## HA     -0.450  0.022  0.259  0.388  0.124  0.013  0.003 -0.056  0.342  0.239
## BBA    -0.439 -0.144  0.010  0.022  0.014  0.061  0.063  0.006 -0.006  0.023
## FIP    -0.395  0.064  0.395  0.284  0.452 -0.199  0.037  0.325  0.242  0.235
## WHIP   -0.601 -0.069  0.166  0.249  0.099  0.013  0.001 -0.024  0.223  0.160
##            RAG     CG   tSho     SV     HA    BBA    FIP   WHIP
## W      -0.572  0.076  0.448  0.526 -0.450 -0.439 -0.395 -0.601
## BatAge -0.017 -0.209  0.031  0.258  0.022 -0.144  0.064 -0.069
## R       0.297 -0.261 -0.183  0.294  0.259  0.010  0.395  0.166
## H       0.271 -0.092 -0.169  0.166  0.388  0.022  0.284  0.249
## HR      0.315 -0.455 -0.196  0.304  0.124  0.014  0.452  0.099
## CS     -0.124  0.388  0.012 -0.130  0.013  0.061 -0.199  0.013
## BB      0.006  0.047 -0.005  0.108  0.003  0.063  0.037  0.001
## SO      0.207 -0.677 -0.118  0.252 -0.056  0.006  0.325 -0.024
## BA      0.225 -0.037 -0.134  0.167  0.342 -0.006  0.242  0.223
## OBP     0.185 -0.064 -0.104  0.213  0.239  0.023  0.235  0.160
## RAG     1.000 -0.357 -0.694 -0.203  0.819  0.537  0.865  0.895
## CG     -0.357  1.000  0.313 -0.524 -0.181 -0.067 -0.489 -0.172
## tSho   -0.694  0.313  1.000  0.077 -0.600 -0.395 -0.623 -0.651
## SV     -0.203 -0.524  0.077  1.000 -0.174 -0.248 -0.032 -0.279
## HA      0.819 -0.181 -0.600 -0.174  1.000  0.267  0.638  0.852
## BBA     0.537 -0.067 -0.395 -0.248  0.267  1.000  0.501  0.706
## FIP     0.865 -0.489 -0.623 -0.032  0.638  0.501  1.000  0.744
## WHIP    0.895 -0.172 -0.651 -0.279  0.852  0.706  0.744  1.000
```

Model after removing collinerarity

```
require(regclass)
modelfinal = lm(W ~ WHIP + SV + tSho + OBP + BatAge +
    HR + CS + SO + BB + FIP, data = baseball)
VIF(modelfinal)
```

```
##     WHIP       SV     tSho      OBP   BatAge       HR       CS       SO
## 3.553551 1.391125 1.916321 3.153331 1.271202 2.648083 1.518892 2.473281
##       BB      FIP
## 2.153899 3.963699
```

```
summary(modelfinal)
```

```
##
## Call:
## lm(formula = W ~ WHIP + SV + tSho + OBP + BatAge + HR + CS +
##     SO + BB + FIP, data = baseball)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -13.7278  -2.9637  -0.0434   3.0229  16.4988
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  25.711585   5.391586   4.769 2.05e-06 ***
## WHIP        -51.694825   2.452699 -21.077  < 2e-16 ***
## SV            0.316476   0.015909  19.893  < 2e-16 ***
## tSho          0.366377   0.040388   9.071  < 2e-16 ***
## OBP         400.913979  15.016133  26.699  < 2e-16 ***
## BatAge       -0.164544   0.098400  -1.672   0.0947 .
## HR            0.079719   0.004641  17.176  < 2e-16 ***
## CS            0.018947   0.008504   2.228   0.0260 *
## SO           -0.007316   0.000940  -7.783 1.41e-14 ***
## BB           -0.005647   0.002532  -2.230   0.0259 *
## FIP          -4.733624   0.500983  -9.449  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 4.426 on 1345 degrees of freedom
## Multiple R-squared:  0.8539, Adjusted R-squared:  0.8528
## F-statistic: 786.1 on 10 and 1345 DF,  p-value: < 2.2e-16
```

remove batters age since not significant

```
modelfinal = lm(W ~ WHIP + SV + tSho + OBP +
    HR + CS + SO + BB + FIP, data = baseball)
summary(modelfinal)
```

```
##
## Call:
## lm(formula = W ~ WHIP + SV + tSho + OBP + HR + CS + SO + BB +
##     FIP, data = baseball)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -13.708  -2.999  -0.073   3.036  16.567
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  2.155e+01  4.785e+00   4.503 7.28e-06 ***
## WHIP        -5.134e+01  2.445e+00 -20.997  < 2e-16 ***
## SV           3.120e-01  1.569e-02  19.880  < 2e-16 ***
## tSho         3.651e-01  4.041e-02   9.036  < 2e-16 ***
## OBP          3.987e+02  1.497e+01  26.639  < 2e-16 ***
## HR           7.887e-02  4.616e-03  17.085  < 2e-16 ***
## CS           2.145e-02  8.377e-03   2.561   0.0106 *
```

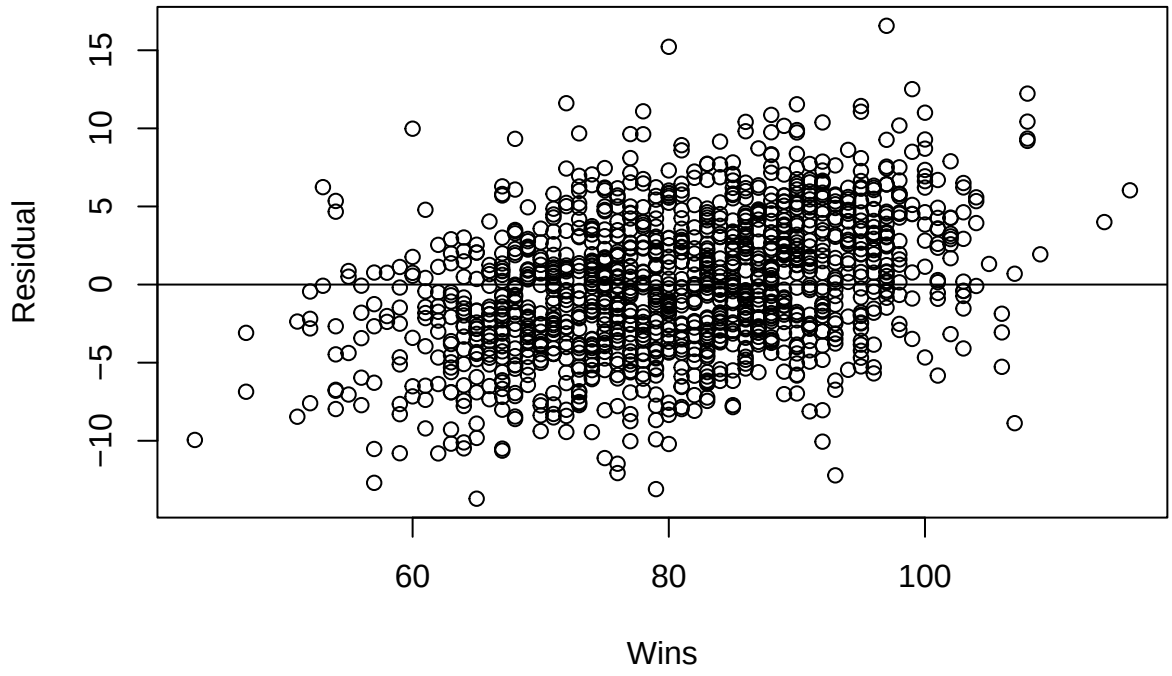
```
## SO          -7.020e-03  9.239e-04  -7.599 5.58e-14 ***
## BB          -5.864e-03  2.530e-03  -2.317   0.0206 *
## FIP         -4.795e+00  5.000e-01  -9.591  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 4.429 on 1346 degrees of freedom
## Multiple R-squared:  0.8536, Adjusted R-squared:  0.8526
## F-statistic:   872 on 9 and 1346 DF,  p-value: < 2.2e-16
```

predict wins with formula

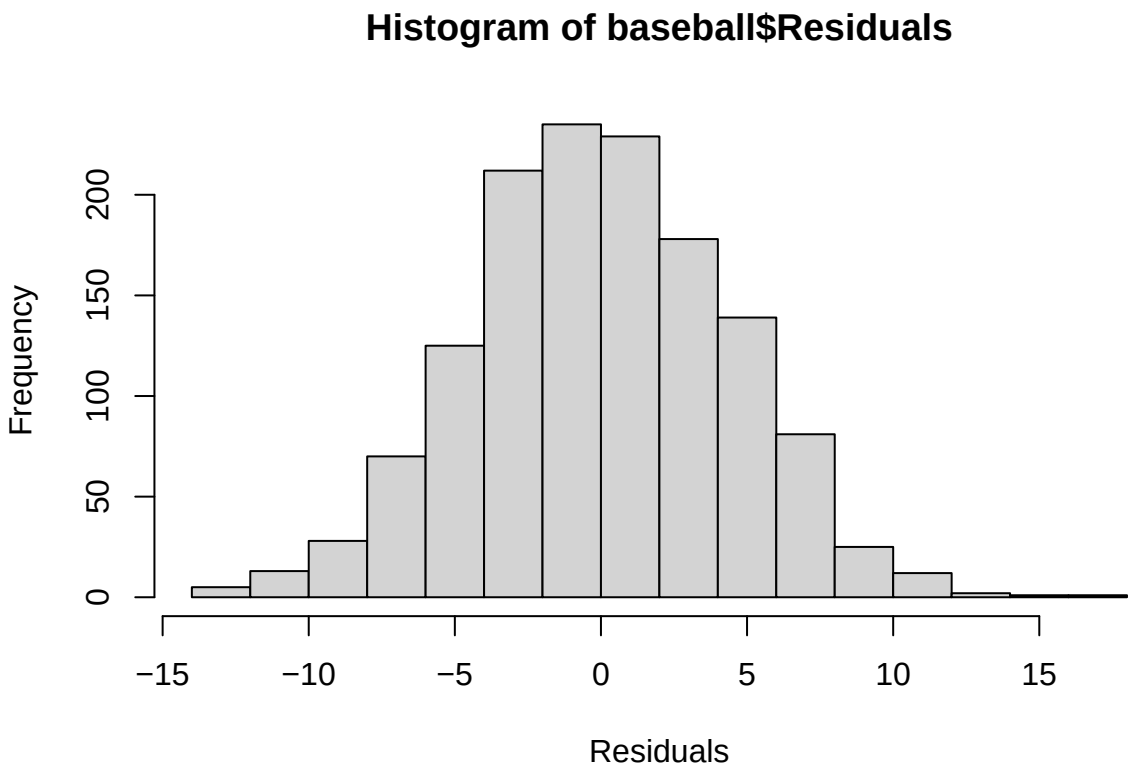
```
baseball$Pred = predict(modelfinal, baseball)
```

calculate residuals and plot

```
baseball$Residuals = residuals(modelfinal)
plot(baseball$W, baseball$Residuals, xlab = "Wins", ylab = "Residual")
abline(a=0, b=0)
```




```
hist(baseball$Residuals, xlab = "Residuals")
```



Start over using 2011-2021 exluding 2020 and see if there is any difference

Run the full model looking at response variable y with all the variables

```
##
## Call:
## lm(formula = W ~ BatAge + RG + R + H + SB + TB + HR + RBI + SB +
##     CS + BB + SO + BA + OBP + SLG + OPS + PAge + RAG + ERA +
##     CG + tSho + cSho + SV + HA + RA + ER + HRA + BBA + SOA +
##     FIP + WHIP, data = baseball10years)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -7.8226 -1.8424  0.1842  1.8985  8.8683
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  6.105e+00  1.872e+01   0.326 0.744584
## BatAge       1.043e-01  1.956e-01   0.533 0.594203
## RG           2.745e+01  4.519e+01   0.607 0.544082
## R           -2.040e-02  2.812e-01  -0.073 0.942218
## H           -1.295e-01  3.905e-02  -3.317 0.001035 **
## SB          -3.828e-02  5.549e-02  -0.690 0.490880
## TB          -9.270e-02  1.143e-01  -0.811 0.418172
## HR          -1.240e-01  1.655e-01  -0.749 0.454326
## RBI         -5.394e-02  3.076e-02  -1.753 0.080680 .
## CS          -9.528e-02  2.463e-02  -3.868 0.000138 ***
```

```
## BB          -2.289e-02  1.362e-02  -1.681 0.093938 .
## SO           1.717e-03  2.368e-03   0.725 0.468971
## BA           6.063e+02  4.888e+02   1.240 0.215955
## OBP         -6.145e+02  3.792e+02  -1.620 0.106360
## SLG         -4.084e+02  4.289e+02  -0.952 0.341774
## OPS          6.409e+02  3.695e+02   1.735 0.083931 .
## PAge         9.886e-02  1.945e-01   0.508 0.611609
## RAG         -2.486e+01  4.538e+01  -0.548 0.584189
## ERA          9.682e+01  3.822e+01   2.533 0.011863 *
## CG           4.150e-01  1.198e-01   3.465 0.000616 ***
## tSho         1.840e-01  6.611e-02   2.783 0.005767 **
## cSho        -1.885e-01  2.227e-01  -0.846 0.398248
## SV           3.887e-01  3.568e-02  10.894  < 2e-16 ***
## HA           3.470e-01  8.832e-02   3.929 0.000109 ***
## RA           1.104e-01  2.807e-01   0.393 0.694438
## ER          -5.951e-01  2.393e-01  -2.487 0.013502 *
## HRA         -2.573e-02  4.381e-02  -0.587 0.557470
## BBA          3.576e-01  8.876e-02   4.029 7.29e-05 ***
## SOA          6.549e-04  5.849e-03   0.112 0.910927
## FIP         -2.668e-01  4.499e+00  -0.059 0.952754
## WHIP        -5.192e+02  1.280e+02  -4.056 6.54e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.992 on 269 degrees of freedom
## Multiple R-squared:  0.9464, Adjusted R-squared:  0.9405
## F-statistic: 158.4 on 30 and 269 DF,  p-value: < 2.2e-16
```

Run stepwise to find best model

```
require(MASS)
min_model = lm(W ~ 1, data = baseball10years)
max_model = formula(W ~ BatAge + RG + R + H + SB + TB + HR + RBI + SB + CS + BB + SO + BA + OBP + SLG +
best_model = step(min_model, direction = "both", scope = max_model)
```

```
## Start:  AIC=1504.82
## W ~ 1
##
##          Df Sum of Sq   RSS    AIC
## + WHIP    1   25769.5 19175 1251.3
## + RAG     1   24328.3 20617 1273.0
## + RA      1   24272.7 20672 1273.8
## + ERA     1   24027.3 20918 1277.4
## + ER      1   23542.8 21402 1284.2
## + HA      1   19494.7 25450 1336.2
## + SV      1   19224.5 25720 1339.4
## + FIP     1   17230.5 27714 1361.8
## + OBP     1   17203.6 27741 1362.1
## + R       1   15949.2 28996 1375.3
## + RG      1   15866.2 29079 1376.2
## + RBI     1   15730.4 29215 1377.6
## + OPS     1   14809.7 30135 1386.9
## + tSho    1   13896.9 31048 1395.8
```

```
## + SLG     1   11545.7 33399 1417.8
## + BB      1   11169.6 33775 1421.1
## + BBA     1    9712.8 35232 1433.8
## + SOA     1    9338.7 35606 1437.0
## + HR      1    7003.0 37942 1456.0
## + BA      1    6551.5 38393 1459.6
## + HRA     1    6079.5 38865 1463.2
## + PAge    1    5495.6 39449 1467.7
## + H       1    5235.9 39709 1469.7
## + SB      1    3941.2 41004 1479.3
## + BatAge  1    3251.3 41694 1484.3
## + CG      1    1703.7 43241 1495.2
## + cSho    1    1698.2 43247 1495.3
## + CS      1    1417.1 43528 1497.2
## + SO      1    1249.4 43696 1498.4
## + TB      1     685.8 44259 1502.2
## <none>                44945 1504.8
##
## Step:  AIC=1251.28
## W ~ WHIP
##
##          Df Sum of Sq   RSS    AIC
## + R       1   10147.6  9028 1027.3
## + RG      1   10122.7  9053 1028.1
## + OPS     1   10041.2  9134 1030.8
## + RBI     1   10009.2  9166 1031.8
## + SLG     1    9017.6 10158 1062.7
## + OBP     1    8799.0 10376 1069.0
## + BA      1    6791.8 12384 1122.1
## + H       1    6368.5 12807 1132.2
## + HR      1    4413.0 14762 1174.8
## + SB      1    3935.6 15240 1184.4
## + SV      1    3721.6 15454 1188.5
## + BB      1    2085.7 17090 1218.7
## + PAge    1    1106.7 18069 1235.5
## + RAG     1     769.5 18406 1241.0
## + RA      1     746.1 18429 1241.4
## + ERA     1     708.7 18467 1242.0
## + SOA     1     617.2 18558 1243.5
## + ER      1     518.9 18656 1245.0
## + BatAge  1     367.9 18807 1247.5
## + tSho    1     337.2 18838 1248.0
## + CS      1     266.4 18909 1249.1
## + BBA     1     254.7 18921 1249.3
## + SO      1     152.1 19023 1250.9
## <none>                19175 1251.3
## + FIP     1     113.2 19062 1251.5
## + cSho    1      23.6 19152 1252.9
## + CG      1      20.8 19155 1253.0
## + HA      1       4.7 19171 1253.2
## + HRA     1       0.7 19175 1253.3
## + TB      1       0.0 19175 1253.3
## - WHIP    1   25769.5 44945 1504.8
##
```

```
## Step:  AIC=1027.28
## W ~ WHIP + R
##
##          Df Sum of Sq     RSS     AIC
## + RAG     1    3924.9  5102.8  858.13
## + RA      1    3922.4  5105.4  858.28
## + SV      1    3809.6  5218.2  864.84
## + ERA     1    3745.4  5282.4  868.51
## + ER      1    3591.4  5436.4  877.13
## + HRA     1    2391.5  6636.3  936.96
## + FIP     1    1848.3  7179.5  960.56
## + tSho    1     765.4  8262.4 1002.70
## + BA      1     745.8  8281.9 1003.42
## + H       1     575.9  8451.9 1009.51
## + OBP     1     406.9  8620.9 1015.45
## + SO      1     398.1  8629.7 1015.75
## + SOA     1     297.5  8730.3 1019.23
## + OPS     1     242.3  8785.5 1021.12
## + HR      1     224.3  8803.5 1021.74
## + BatAge  1     210.0  8817.7 1022.22
## + BB      1     168.0  8859.7 1023.65
## + CS      1     101.2  8926.6 1025.90
## + CG      1      87.8  8939.9 1026.35
## + HA      1      72.5  8955.3 1026.86
## + cSho    1      71.6  8956.2 1026.89
## <none>                  9027.8 1027.28
## + RG      1      46.9  8980.9 1027.72
## + SB      1      40.0  8987.8 1027.95
## + PAge    1      23.5  9004.3 1028.50
## + SLG     1      22.7  9005.1 1028.53
## + TB      1      20.4  9007.4 1028.61
## + RBI     1      16.1  9011.7 1028.75
## + BBA     1      10.6  9017.2 1028.93
## - R       1   10147.6 19175.4 1251.28
## - WHIP    1   19968.0 28995.8 1375.34
##
## Step:  AIC=858.13
## W ~ WHIP + R + RAG
##
##          Df Sum of Sq     RSS     AIC
## + SV      1    1805.3  3297.5  729.14
## + tSho    1     126.9  4975.9  852.58
## + SLG     1      98.6  5004.3  854.28
## + HR      1      92.1  5010.7  854.67
## + BatAge  1      80.8  5022.0  855.34
## + OPS     1      62.0  5040.9  856.47
## - WHIP    1      10.9  5113.7  856.77
## + ERA     1      49.7  5053.1  857.19
## + TB      1      38.0  5064.8  857.89
## <none>                  5102.8  858.13
## + BB      1      31.6  5071.3  858.27
## + HA      1      26.1  5076.7  858.59
## + SB      1      19.5  5083.4  858.98
## + SO      1      12.8  5090.1  859.38
```

```
## + CS      1      11.2  5091.6  859.47
## + FIP     1       9.1  5093.8  859.60
## + HRA     1       4.6  5098.2  859.86
## + SOA     1       4.2  5098.7  859.89
## + ER      1       3.1  5099.7  859.95
## + PAge    1       2.7  5100.1  859.97
## + OBP     1       2.6  5100.2  859.98
## + CG      1       1.4  5101.5  860.05
## + RBI     1       0.6  5102.2  860.09
## + BA      1       0.4  5102.5  860.11
## + RG      1       0.2  5102.6  860.12
## + RA      1       0.2  5102.7  860.12
## + cSho    1       0.1  5102.7  860.12
## + H       1       0.1  5102.7  860.13
## + BBA     1       0.1  5102.8  860.13
## - RAG     1    3924.9  9027.8 1027.28
## - R       1   13303.0 18405.8 1240.99
##
## Step:  AIC=729.14
## W ~ WHIP + R + RAG + SV
##
##          Df Sum of Sq     RSS     AIC
## + tSho    1     137.6  3159.9  718.36
## + cSho    1     130.6  3166.9  719.01
## + CG      1     124.5  3173.0  719.60
## + BatAge  1      42.9  3254.6  727.22
## + HRA     1      33.5  3264.0  728.08
## <none>                3297.5  729.14
## + ERA     1      16.7  3280.8  729.62
## - WHIP    1      27.9  3325.4  729.67
## + BB      1      15.4  3282.1  729.73
## + RBI     1      14.8  3282.7  729.79
## + BBA     1      12.7  3284.8  729.98
## + FIP     1      11.3  3286.2  730.11
## + TB      1      11.3  3286.2  730.12
## + CS      1       7.6  3289.9  730.45
## + SO      1       7.4  3290.1  730.47
## + RA      1       6.7  3290.8  730.53
## + RG      1       4.7  3292.8  730.71
## + BA      1       4.1  3293.4  730.77
## + HR      1       4.0  3293.5  730.78
## + ER      1       2.2  3295.3  730.94
## + PAge    1       2.1  3295.4  730.95
## + SB      1       1.9  3295.6  730.97
## + SLG     1       1.8  3295.7  730.98
## + H       1       1.7  3295.8  730.99
## + OPS     1       1.4  3296.1  731.01
## + HA      1       0.3  3297.2  731.11
## + OBP     1       0.1  3297.4  731.13
## + SOA     1       0.1  3297.4  731.14
## - SV      1    1805.3  5102.8  858.13
## - RAG     1    1920.7  5218.2  864.84
## - R       1   12095.4 15392.9 1189.36
##
```

```
## Step:  AIC=718.36
## W ~ WHIP + R + RAG + SV + tSho
##
##          Df Sum of Sq     RSS     AIC
## + CG      1      89.2  3070.7  711.77
## + cSho    1      61.9  3098.0  714.42
## + BatAge  1      46.4  3113.5  715.92
## + HRA     1      29.4  3130.6  717.55
## - WHIP    1      14.4  3174.3  717.72
## + ERA     1      21.6  3138.3  718.30
## + BB      1      21.3  3138.6  718.33
## <none>                 3159.9  718.36
## + TB      1      16.8  3143.1  718.76
## + BBA     1      11.1  3148.8  719.30
## + FIP     1       9.6  3150.4  719.45
## + CS      1       8.7  3151.2  719.53
## + RBI     1       8.6  3151.3  719.53
## + RA      1       5.6  3154.3  719.82
## + SO      1       5.0  3154.9  719.88
## + PAge    1       4.4  3155.6  719.94
## + ER      1       4.0  3155.9  719.97
## + OBP     1       4.0  3155.9  719.97
## + RG      1       3.5  3156.4  720.03
## + SB      1       3.2  3156.7  720.05
## + OPS     1       3.1  3156.8  720.06
## + BA      1       1.8  3158.1  720.18
## + HR      1       1.5  3158.5  720.22
## + SLG     1       1.0  3158.9  720.26
## + H       1       0.8  3159.1  720.28
## + SOA     1       0.3  3159.7  720.33
## + HA      1       0.1  3159.8  720.35
## - tSho    1     137.6  3297.5  729.14
## - RAG     1    1549.4  4709.3  836.05
## - SV      1    1816.0  4975.9  852.58
## - R       1   12098.8 15258.7 1188.74
##
## Step:  AIC=711.77
## W ~ WHIP + R + RAG + SV + tSho + CG
##
##          Df Sum of Sq     RSS     AIC
## + BBA     1      52.0  3018.7  708.64
## + CS      1      23.6  3047.1  711.45
## + TB      1      23.6  3047.1  711.45
## - WHIP    1      18.3  3089.0  711.54
## + BatAge  1      22.4  3048.3  711.57
## <none>                 3070.7  711.77
## + BB      1      19.9  3050.8  711.82
## + OBP     1      18.1  3052.7  712.00
## + HRA     1      16.4  3054.3  712.16
## + ERA     1      14.9  3055.9  712.31
## + HA      1      14.4  3056.4  712.36
## + SOA     1      11.0  3059.7  712.69
## + RBI     1       9.7  3061.0  712.82
## + OPS     1       6.8  3063.9  713.10
```

```
## + FIP     1       4.1  3066.6  713.36
## + H       1       2.7  3068.0  713.50
## + SO      1       2.7  3068.1  713.51
## + ER      1       2.1  3068.7  713.57
## + RA      1       2.0  3068.8  713.58
## + PAge    1       1.9  3068.8  713.58
## + BA      1       1.7  3069.0  713.60
## + RG      1       1.7  3069.1  713.60
## + cSho    1       1.5  3069.2  713.62
## + HR      1       1.4  3069.3  713.63
## + SLG     1       0.4  3070.3  713.73
## + SB      1       0.1  3070.6  713.76
## - CG      1      89.2  3159.9  718.36
## - tSho    1     102.3  3173.0  719.60
## - RAG     1    1323.6  4394.3  817.29
## - SV      1    1896.7  4967.4  854.06
## - R       1   12173.5 15244.3 1190.45
##
## Step:  AIC=708.64
## W ~ WHIP + R + RAG + SV + tSho + CG + BBA
##
##          Df Sum of Sq     RSS     AIC
## + HA      1      33.9  2984.8  707.25
## + HRA     1      31.5  2987.2  707.49
## + CS      1      28.5  2990.2  707.79
## + BB      1      28.0  2990.7  707.84
## + BatAge  1      25.8  2992.9  708.06
## + FIP     1      24.5  2994.2  708.19
## <none>                3018.7  708.64
## + TB      1      19.9  2998.8  708.65
## + ERA     1      16.0  3002.6  709.04
## + OBP     1      13.4  3005.3  709.30
## + RBI     1      10.6  3008.1  709.59
## + cSho    1       5.0  3013.7  710.14
## + PAge    1       3.6  3015.1  710.28
## + OPS     1       3.3  3015.4  710.31
## + ER      1       2.4  3016.3  710.40
## + SB      1       1.9  3016.8  710.45
## + RA      1       1.6  3017.0  710.48
## + RG      1       1.3  3017.4  710.51
## + SOA     1       0.3  3018.4  710.61
## + HR      1       0.1  3018.5  710.62
## + BA      1       0.1  3018.6  710.63
## + SO      1       0.0  3018.7  710.64
## + SLG     1       0.0  3018.7  710.64
## + H       1       0.0  3018.7  710.64
## - WHIP    1      50.5  3069.1  711.61
## - BBA     1      52.0  3070.7  711.77
## - tSho    1      90.2  3108.9  715.48
## - CG      1     130.1  3148.8  719.30
## - RAG     1    1206.7  4225.4  807.52
## - SV      1    1946.4  4965.1  855.92
## - R       1   11725.2 14743.9 1182.44
##
```

```
## Step:  AIC=707.25
## W ~ WHIP + R + RAG + SV + tSho + CG + BBA + HA
##
##          Df Sum of Sq     RSS     AIC
## + CS      1      42.5  2942.3  704.95
## + BB      1      34.5  2950.3  705.76
## + BatAge  1      24.0  2960.8  706.83
## + TB      1      23.7  2961.1  706.86
## + HRA     1      21.0  2963.8  707.14
## <none>                 2984.8  707.25
## + OBP     1      13.8  2971.0  707.86
## + FIP     1      13.8  2971.0  707.86
## + RBI     1      10.3  2974.5  708.22
## - HA      1      33.9  3018.7  708.64
## + RA      1       6.0  2978.8  708.65
## + PAge    1       5.6  2979.2  708.69
## + RG      1       5.6  2979.2  708.69
## + cSho    1       4.4  2980.4  708.81
## + ER      1       3.2  2981.6  708.93
## + H       1       3.2  2981.6  708.93
## + ERA     1       1.8  2983.0  709.07
## + OPS     1       1.4  2983.4  709.11
## + HR      1       1.1  2983.7  709.15
## + SOA     1       0.7  2984.1  709.18
## + SLG     1       0.6  2984.2  709.19
## + SO      1       0.0  2984.8  709.25
## + SB      1       0.0  2984.8  709.25
## + BA      1       0.0  2984.8  709.25
## - WHIP    1      65.3  3050.1  711.75
## - BBA     1      71.5  3056.4  712.36
## - tSho    1      92.6  3077.4  714.41
## - CG      1     123.2  3108.0  717.38
## - RAG     1    1108.9  4093.7  800.02
## - SV      1    1845.6  4830.4  849.67
## - R       1   11541.6 14526.4 1179.98
##
## Step:  AIC=704.95
## W ~ WHIP + R + RAG + SV + tSho + CG + BBA + HA + CS
##
##          Df Sum of Sq     RSS     AIC
## + BB      1      38.3  2904.1  703.02
## + HRA     1      27.6  2914.7  704.12
## <none>                 2942.3  704.95
## + RBI     1      17.9  2924.5  705.12
## + BatAge  1      13.3  2929.1  705.60
## + FIP     1      11.6  2930.7  705.77
## + TB      1      10.4  2932.0  705.89
## + OBP     1       8.4  2933.9  706.09
## + cSho    1       6.2  2936.2  706.32
## + PAge    1       4.2  2938.1  706.52
## + RG      1       4.2  2938.1  706.53
## + RA      1       4.1  2938.2  706.53
## + ER      1       3.8  2938.6  706.57
## + ERA     1       2.3  2940.0  706.72
```

```
## + H       1       1.9  2940.5  706.76
## + SOA     1       0.8  2941.5  706.87
## + BA      1       0.7  2941.6  706.88
## + SLG     1       0.7  2941.6  706.88
## + OPS     1       0.4  2941.9  706.91
## + SO      1       0.1  2942.2  706.94
## + SB      1       0.0  2942.3  706.95
## + HR      1       0.0  2942.3  706.95
## - CS      1      42.5  2984.8  707.25
## - HA      1      47.8  2990.2  707.79
## - WHIP    1      75.9  3018.3  710.60
## - tSho    1      90.6  3032.9  712.05
## - BBA     1      91.3  3033.6  712.12
## - CG      1     147.9  3090.3  717.67
## - RAG     1    1143.6  4086.0  801.46
## - SV      1    1860.5  4802.9  849.96
## - R       1   10788.4 13730.7 1165.08
##
## Step:  AIC=703.02
## W ~ WHIP + R + RAG + SV + tSho + CG + BBA + HA + CS + BB
##
##          Df Sum of Sq     RSS     AIC
## + H       1      27.3  2876.7  702.19
## + HRA     1      26.4  2877.7  702.29
## <none>                 2904.1  703.02
## + RBI     1      19.1  2884.9  703.04
## + TB      1      14.9  2889.2  703.48
## + FIP     1      14.5  2889.6  703.53
## + BatAge  1      11.7  2892.4  703.82
## + ER      1       8.8  2895.3  704.11
## + ERA     1       6.4  2897.7  704.37
## + BA      1       5.5  2898.6  704.46
## + PAge    1       5.2  2898.9  704.49
## + cSho    1       5.1  2898.9  704.50
## + SO      1       3.3  2900.8  704.69
## + RA      1       2.7  2901.4  704.75
## + RG      1       2.7  2901.4  704.75
## + SLG     1       0.7  2903.4  704.95
## - BB      1      38.3  2942.3  704.95
## + OPS     1       0.6  2903.5  704.97
## + SB      1       0.5  2903.5  704.97
## + HR      1       0.2  2903.8  705.00
## + OBP     1       0.2  2903.9  705.00
## + SOA     1       0.0  2904.0  705.02
## - CS      1      46.2  2950.3  705.76
## - HA      1      56.5  2960.5  706.80
## - WHIP    1      95.5  2999.5  710.73
## - tSho    1      96.6  3000.7  710.84
## - BBA     1     106.8  3010.8  711.86
## - CG      1     152.1  3056.2  716.34
## - RAG     1    1072.4  3976.5  795.31
## - SV      1    1842.2  4746.2  848.40
## - R       1    8747.1 11651.2 1117.81
##
```

```
## Step:  AIC=702.19
## W ~ WHIP + R + RAG + SV + tSho + CG + BBA + HA + CS + BB + H
##
##          Df Sum of Sq    RSS    AIC
## + BA      1     267.6 2609.1 674.90
## + OBP     1     141.9 2734.8 689.01
## + HRA     1      42.3 2834.4 699.74
## + FIP     1      27.6 2849.2 701.30
## + RBI     1      19.9 2856.8 702.10
## <none>                2876.7 702.19
## + BatAge  1      14.2 2862.6 702.71
## - H       1      27.3 2904.1 703.02
## + ER      1       8.8 2868.0 703.27
## + TB      1       7.7 2869.1 703.39
## + HR      1       7.2 2869.6 703.44
## + OPS     1       6.7 2870.1 703.49
## + ERA     1       6.4 2870.4 703.52
## + PAge    1       5.6 2871.2 703.61
## + RA      1       4.9 2871.8 703.68
## + RG      1       4.5 2872.2 703.72
## + cSho    1       3.8 2872.9 703.79
## + SB      1       1.8 2874.9 704.00
## + SO      1       1.0 2875.7 704.08
## + SOA     1       0.1 2876.7 704.18
## + SLG     1       0.0 2876.7 704.19
## - CS      1      42.8 2919.5 704.62
## - BB      1      63.7 2940.5 706.76
## - HA      1      79.3 2956.0 708.34
## - tSho    1     102.1 2978.8 710.65
## - WHIP    1     111.7 2988.4 711.61
## - BBA     1     127.6 3004.3 713.21
## - CG      1     171.7 3048.4 717.58
## - RAG     1    1080.7 3957.5 795.87
## - SV      1    1798.3 4675.1 845.87
## - R       1    3705.1 6581.8 948.49
##
## Step:  AIC=674.9
## W ~ WHIP + R + RAG + SV + tSho + CG + BBA + HA + CS + BB + H +
##     BA
##
##          Df Sum of Sq    RSS    AIC
## + HRA     1      46.9 2562.3 671.46
## + RBI     1      35.3 2573.9 672.82
## + FIP     1      32.5 2576.6 673.14
## <none>                2609.1 674.90
## + SB      1       8.5 2600.6 675.92
## + HR      1       6.1 2603.1 676.20
## + PAge    1       4.7 2604.4 676.35
## + OBP     1       4.6 2604.5 676.37
## + SO      1       3.9 2605.2 676.45
## + SLG     1       2.6 2606.5 676.60
## + BatAge  1       1.9 2607.3 676.68
## + ER      1       1.8 2607.4 676.69
## + cSho    1       1.7 2607.5 676.71
```

```
## + OPS     1       0.9 2608.2 676.79
## + RG      1       0.8 2608.3 676.81
## + ERA     1       0.6 2608.5 676.83
## + RA      1       0.2 2608.9 676.88
## + TB      1       0.0 2609.1 676.90
## + SOA     1       0.0 2609.1 676.90
## - tSho    1      75.1 2684.2 681.41
## - BB      1     130.6 2739.8 687.55
## - CG      1     148.9 2758.1 689.55
## - CS      1     152.2 2761.3 689.90
## - BA      1     267.6 2876.7 702.19
## - H       1     289.4 2898.6 704.46
## - HA      1     345.9 2955.0 710.25
## - WHIP    1     379.2 2988.3 713.61
## - BBA     1     395.1 3004.2 715.20
## - RAG     1     612.6 3221.7 736.17
## - SV      1    1312.6 3921.7 795.15
## - R       1    3688.0 6297.2 937.22
##
## Step:  AIC=671.46
## W ~ WHIP + R + RAG + SV + tSho + CG + BBA + HA + CS + BB + H +
##     BA + HRA
##
##          Df Sum of Sq    RSS    AIC
## + RBI     1      30.2 2532.1 669.90
## <none>                2562.3 671.46
## + OBP     1       5.0 2557.3 672.88
## + PAge    1       4.5 2557.8 672.94
## + SB      1       4.2 2558.1 672.97
## + SO      1       2.9 2559.3 673.12
## + cSho    1       2.8 2559.5 673.13
## + ERA     1       2.4 2559.8 673.17
## + BatAge  1       2.3 2559.9 673.19
## + SOA     1       2.1 2560.1 673.21
## + ER      1       0.9 2561.3 673.35
## + RG      1       0.9 2561.4 673.35
## + TB      1       0.8 2561.4 673.36
## + HR      1       0.6 2561.6 673.39
## + FIP     1       0.6 2561.7 673.39
## + OPS     1       0.2 2562.1 673.44
## + RA      1       0.1 2562.2 673.45
## + SLG     1       0.1 2562.2 673.45
## - HRA     1      46.9 2609.1 674.90
## - tSho    1      72.5 2634.8 677.83
## - BB      1     145.8 2708.0 686.06
## - CG      1     149.1 2711.4 686.43
## - CS      1     166.7 2728.9 688.37
## - RAG     1     196.4 2758.7 691.62
## - BA      1     272.2 2834.4 699.74
## - H       1     302.7 2865.0 702.96
## - HA      1     339.2 2901.5 706.76
## - WHIP    1     398.5 2960.8 712.83
## - BBA     1     399.1 2961.4 712.89
## - SV      1    1345.8 3908.1 796.11
```

```
## - R       1    3572.2 6134.4 931.37
##
## Step:  AIC=669.9
## W ~ WHIP + R + RAG + SV + tSho + CG + BBA + HA + CS + BB + H +
##     BA + HRA + RBI
##
##          Df Sum of Sq    RSS    AIC
## <none>                2532.1 669.90
## + OBP     1      5.19 2526.9 671.29
## + cSho    1      4.83 2527.2 671.33
## + SO      1      4.59 2527.5 671.36
## + OPS     1      4.20 2527.9 671.40
## - RBI     1     30.19 2562.3 671.46
## + BatAge  1      3.23 2528.8 671.52
## + SB      1      3.05 2529.0 671.54
## + ERA     1      2.77 2529.3 671.57
## + SOA     1      2.52 2529.5 671.60
## + PAge    1      2.34 2529.7 671.62
## + TB      1      1.96 2530.1 671.67
## + SLG     1      1.84 2530.2 671.68
## + RG      1      1.76 2530.3 671.69
## + ER      1      1.19 2530.9 671.76
## + HR      1      0.94 2531.1 671.79
## + FIP     1      0.92 2531.1 671.79
## + RA      1      0.55 2531.5 671.84
## - HRA     1     41.82 2573.9 672.82
## - tSho    1     63.93 2596.0 675.38
## - BB      1    151.01 2683.1 685.28
## - CG      1    155.76 2687.8 685.81
## - CS      1    186.10 2718.2 689.18
## - RAG     1    192.13 2724.2 689.84
## - R       1    255.32 2787.4 696.72
## - BA      1    286.12 2818.2 700.02
## - H       1    317.13 2849.2 703.30
## - HA      1    355.12 2887.2 707.28
## - WHIP    1    415.83 2947.9 713.52
## - BBA     1    416.36 2948.4 713.57
## - SV      1   1369.55 3901.6 797.61
```

run new stepwise model and check for collinerarity

```
require(regclass)
stepwiseModel = lm(W ~ WHIP + R + RAG + SV + tSho + CG + BBA + HA + CS + BB + H +
    BA + HRA + RBI, data = baseball10years)

summary(stepwiseModel)
```

```
##
## Call:
## lm(formula = W ~ WHIP + R + RAG + SV + tSho + CG + BBA + HA +
##     CS + BB + H + BA + HRA + RBI, data = baseball10years)
##
## Residuals:
```

```
##     Min      1Q  Median      3Q     Max
## -7.6382 -1.9468  0.0922  2.0890  9.7663
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  2.362e+01  9.614e+00   2.457  0.01460 *
## WHIP        -1.934e+02  2.827e+01  -6.841 4.79e-11 ***
## R            1.504e-01  2.806e-02   5.361 1.71e-07 ***
## RAG         -6.181e+00  1.329e+00  -4.650 5.08e-06 ***
## SV           4.151e-01  3.343e-02  12.416  < 2e-16 ***
## tSho         1.605e-01  5.982e-02   2.682  0.00774 **
## CG           3.386e-01  8.087e-02   4.187 3.77e-05 ***
## BBA          1.341e-01  1.958e-02   6.846 4.67e-11 ***
## HA           1.207e-01  1.910e-02   6.322 9.92e-10 ***
## CS          -1.003e-01  2.191e-02  -4.577 7.06e-06 ***
## BB          -1.834e-02  4.448e-03  -4.123 4.91e-05 ***
## H           -1.383e-01  2.315e-02  -5.975 6.87e-09 ***
## BA           8.730e+02  1.538e+02   5.675 3.41e-08 ***
## HRA         -2.302e-02  1.061e-02  -2.170  0.03087 *
## RBI         -5.241e-02  2.843e-02  -1.844  0.06629 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.981 on 285 degrees of freedom
## Multiple R-squared:  0.9437, Adjusted R-squared:  0.9409
## F-statistic:   341 on 14 and 285 DF,  p-value: < 2.2e-16
```

```
VIF(stepwiseModel)
```

```
##       WHIP          R        RAG         SV       tSho         CG        BBA
## 200.709177 158.086345  17.202079   2.062542   1.972563   1.586756  40.056851
##         HA         CS         BB          H         BA        HRA        RBI
##  99.271989   1.508850   2.589122 105.846748  98.086851   4.489701 156.159505
```

make small data frame for correlation matrix

```
baseball10New <- baseball10years[, colnames(baseball10years)[c(3,9,10,14,16,17,19,24,26,27,29,30,33,34,3
```

run correlation matrix

```
round(cor(baseball10New),3)
```

```
##           W      R      H    RBI     CS     BB     BA    RAG     CG   tSho
## W     1.000  0.596  0.341  0.592 -0.178  0.499  0.382 -0.736  0.195  0.556
## R     0.596  1.000  0.585  0.997 -0.275  0.573  0.591 -0.011 -0.082  0.040
## H     0.341  0.585  1.000  0.580  0.014  0.014  0.979 -0.006  0.138  0.011
## RBI   0.592  0.997  0.580  1.000 -0.286  0.570  0.586 -0.008 -0.085  0.034
## CS   -0.178 -0.275  0.014 -0.286  1.000 -0.219  0.027 -0.003  0.194 -0.016
## BB    0.499  0.573  0.014  0.570 -0.219  1.000  0.027 -0.245  0.034  0.235
## BA    0.382  0.591  0.979  0.586  0.027  0.027  1.000 -0.052  0.162  0.052
## RAG  -0.736 -0.011 -0.006 -0.008 -0.003 -0.245 -0.052  1.000 -0.341 -0.675
## CG    0.195 -0.082  0.138 -0.085  0.194  0.034  0.162 -0.341  1.000  0.330
```

```
## tSho  0.556  0.040  0.011  0.034 -0.016  0.235  0.052 -0.675  0.330  1.000
## SV    0.654  0.086  0.040  0.090 -0.022  0.164  0.073 -0.613 -0.003  0.407
## HA   -0.659 -0.198  0.155 -0.196  0.175 -0.397  0.089  0.753 -0.101 -0.558
## HRA  -0.368  0.291 -0.057  0.298 -0.223  0.066 -0.081  0.738 -0.364 -0.472
## BBA  -0.465 -0.025 -0.054 -0.024  0.071 -0.168 -0.078  0.609 -0.411 -0.431
## WHIP -0.757 -0.168  0.046 -0.167  0.134 -0.397  0.009  0.894 -0.284 -0.647
##          SV     HA    HRA    BBA   WHIP
## W     0.654 -0.659 -0.368 -0.465 -0.757
## R     0.086 -0.198  0.291 -0.025 -0.168
## H     0.040  0.155 -0.057 -0.054  0.046
## RBI   0.090 -0.196  0.298 -0.024 -0.167
## CS   -0.022  0.175 -0.223  0.071  0.134
## BB    0.164 -0.397  0.066 -0.168 -0.397
## BA    0.073  0.089 -0.081 -0.078  0.009
## RAG  -0.613  0.753  0.738  0.609  0.894
## CG   -0.003 -0.101 -0.364 -0.411 -0.284
## tSho  0.407 -0.558 -0.472 -0.431 -0.647
## SV    1.000 -0.410 -0.406 -0.414 -0.545
## HA   -0.410  1.000  0.306  0.261  0.863
## HRA  -0.406  0.306  1.000  0.426  0.481
## BBA  -0.414  0.261  0.426  1.000  0.686
## WHIP -0.545  0.863  0.481  0.686  1.000
```

Model after removing collinerarity

```
require(regclass)
modelfinal10 = lm(W ~ WHIP + SV + tSho + CG + BBA + CS +
    BA + HRA + RBI, data = baseball10years)
VIF(modelfinal10)
```

```
##     WHIP       SV     tSho       CG      BBA       CS       BA      HRA
## 3.873704 1.657548 1.910820 1.542377 2.258060 1.235664 2.289115 2.333414
##      RBI
## 2.876127
```

```
summary(modelfinal10)
```

```
##
## Call:
## lm(formula = W ~ WHIP + SV + tSho + CG + BBA + CS + BA + HRA +
##     RBI, data = baseball10years)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -8.2639 -2.4317  0.0435  2.3483  8.8124
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  64.978354   6.913419   9.399  < 2e-16 ***
## WHIP        -55.911443   4.568532 -12.238  < 2e-16 ***
## SV            0.532142   0.034857  15.267  < 2e-16 ***
## tSho          0.240657   0.068481   3.514 0.000512 ***
## CG            0.354137   0.092728   3.819 0.000164 ***
```

```
## BBA           0.022540   0.005408   4.168 4.06e-05 ***
## CS           -0.035278   0.023058  -1.530 0.127108
## BA           25.242414  27.333135   0.924 0.356509
## HRA          -0.067818   0.008897  -7.622 3.57e-13 ***
## RBI           0.087158   0.004487  19.423  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.467 on 290 degrees of freedom
## Multiple R-squared:  0.9225, Adjusted R-squared:   0.92
## F-statistic: 383.3 on 9 and 290 DF,  p-value: < 2.2e-16
```

remove CS and BA since not significant

```
modelfinal10 = lm(W ~ WHIP + SV + tSho + CG + BBA + HRA + RBI, data = baseball10years)
summary(modelfinal10)
```

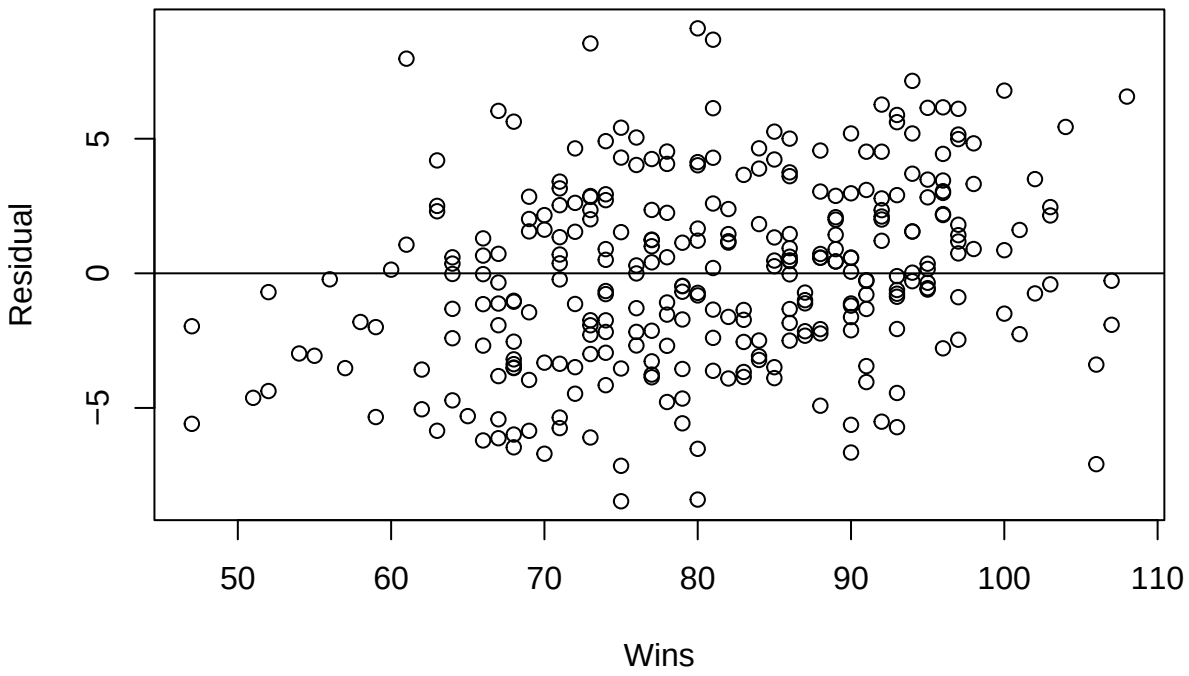
```
##
## Call:
## lm(formula = W ~ WHIP + SV + tSho + CG + BBA + HRA + RBI, data = baseball10years)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -8.4650 -2.4005  0.0105  2.3523  9.0989
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  67.470780   6.216757  10.853  < 2e-16 ***
## WHIP        -54.982403   4.131133 -13.309  < 2e-16 ***
## SV            0.530086   0.034784  15.239  < 2e-16 ***
## tSho          0.246410   0.068467   3.599 0.000375 ***
## CG            0.342424   0.089804   3.813 0.000168 ***
## BBA           0.020982   0.005315   3.948 9.90e-05 ***
## HRA          -0.068951   0.008023  -8.594 5.16e-16 ***
## RBI           0.090888   0.003011  30.186  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.472 on 292 degrees of freedom
## Multiple R-squared:  0.9217, Adjusted R-squared:  0.9198
## F-statistic: 490.9 on 7 and 292 DF,  p-value: < 2.2e-16
```

predict wins with formula

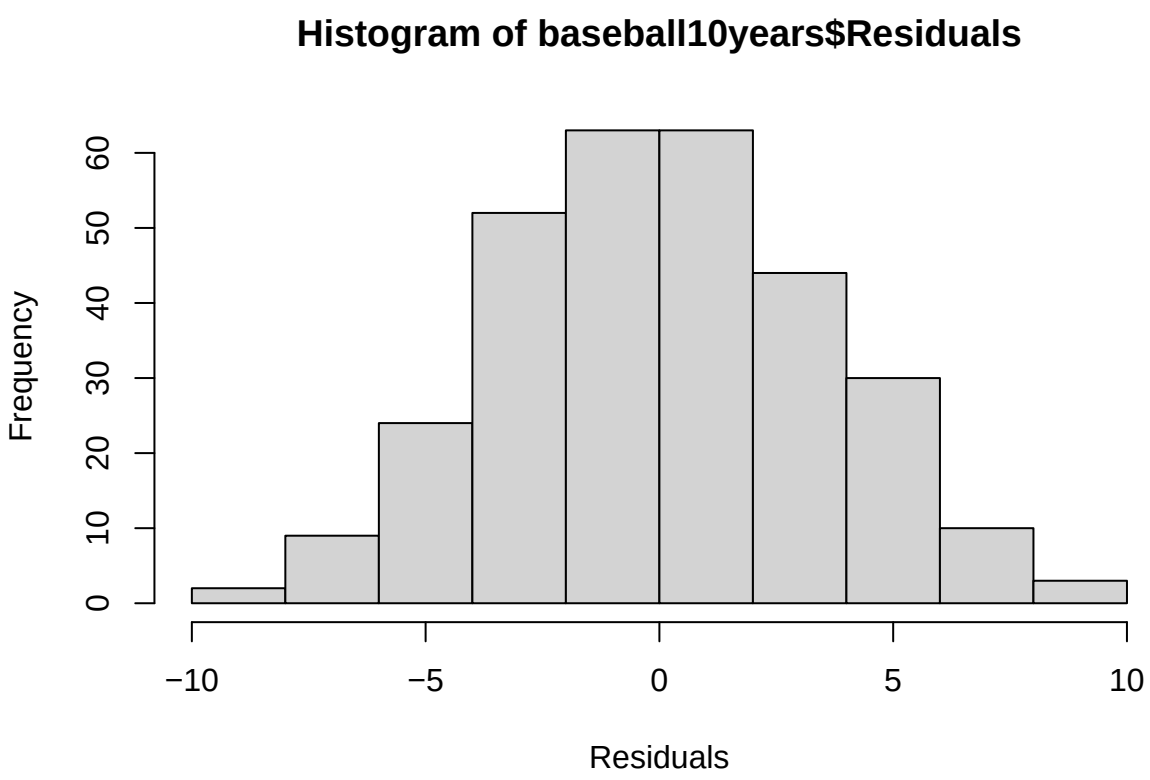
```
baseball10years$Pred = predict(modelfinal10, baseball10years)
```

calculate residuals and plot

```
baseball10years$Residuals = residuals(modelfinal10)
plot(baseball10years$W, baseball10years$Residuals, xlab = "Wins", ylab = "Residual")
abline(a=0, b=0)
```




```
hist(baseball10years$Residuals, xlab = "Residuals")
```


Histogram of baseball10years$Residuals
Frequency
0
10
20
30
40
50
60
−10
−5
0
5
10
Residuals