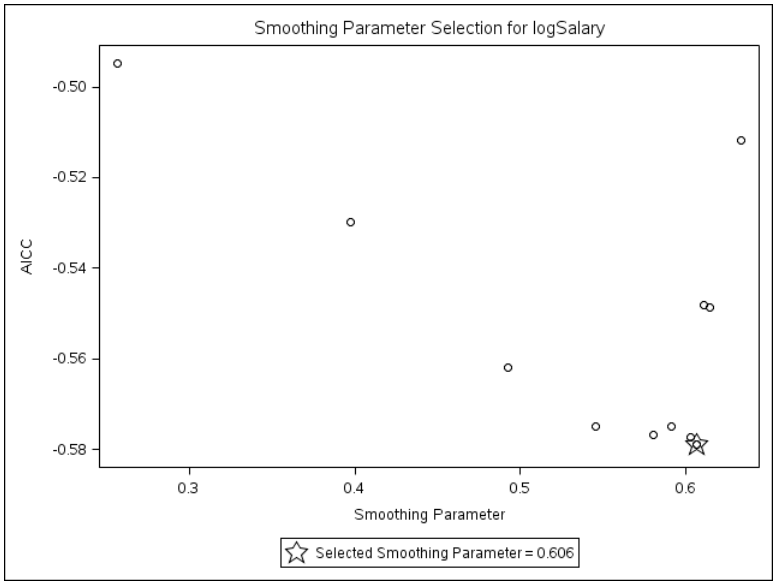
4.4.1- SAS: Nonparametric Regression Methods (LOESS, Regression Trees, and Random Forests)

Example: (Baseball, same as Handout #23 Ex. 2)

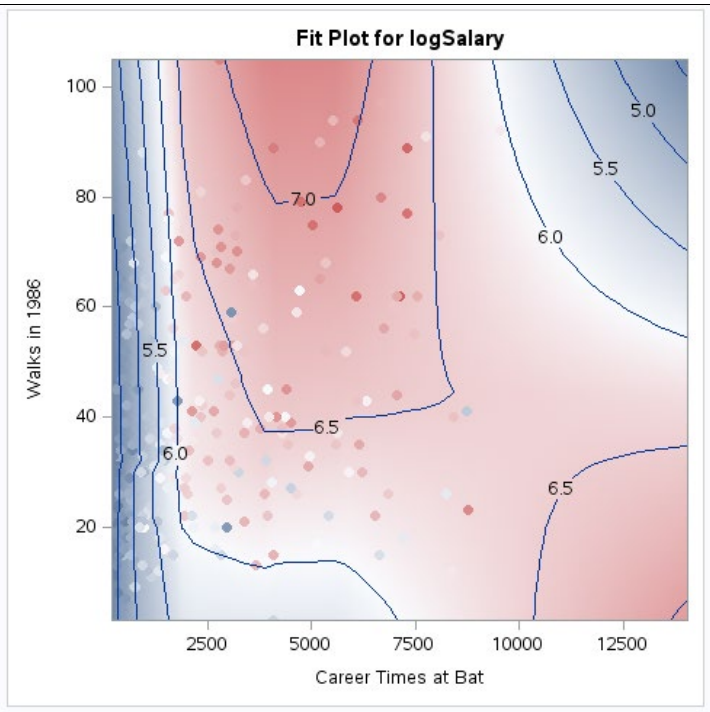
```
data baseball; set sashelp.baseball;
  AmerLg = (League="American");
  EastDv = (Division="East");
run;


/* loess */
proc loess data=baseball plots=(fitpanel fitplot contourfitpanel
contourfit);
 model logSalary =  crAtBat nBB
                  / degree=2 select=AICC scale=sd;
 output out=out1 p=predloess;
run;
```

The LOESS Procedure

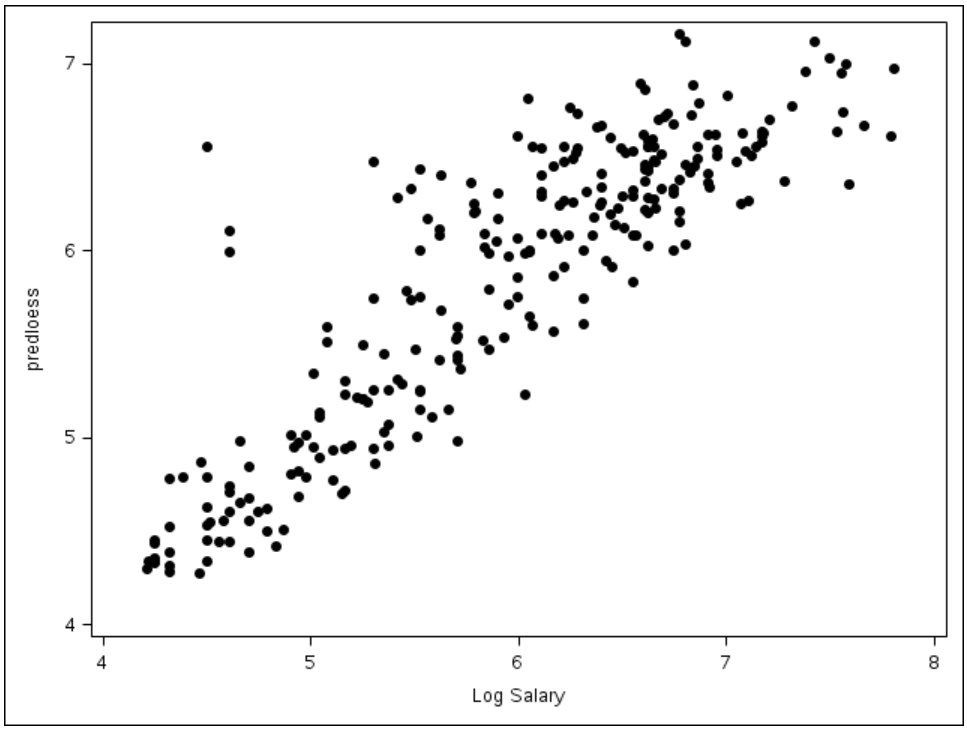


Optimal Smoothing Criterion

AICC	*Smoothing Parameter*
-0.57876	0.60646

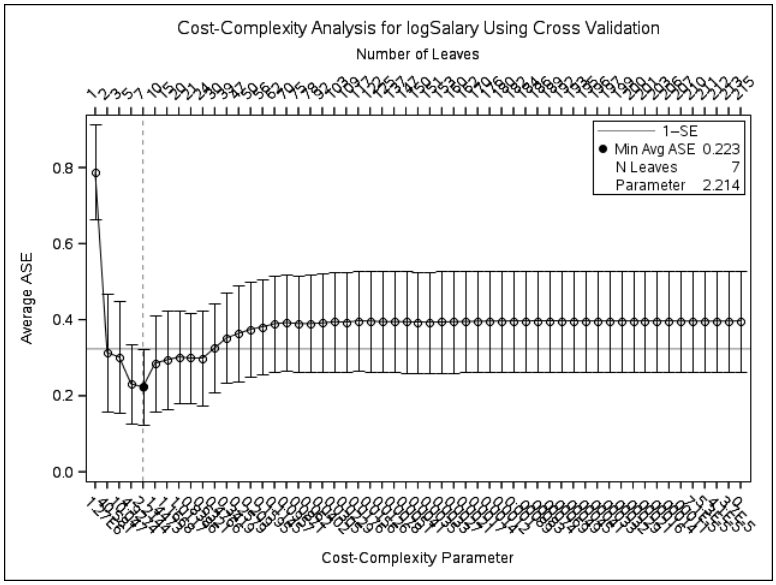


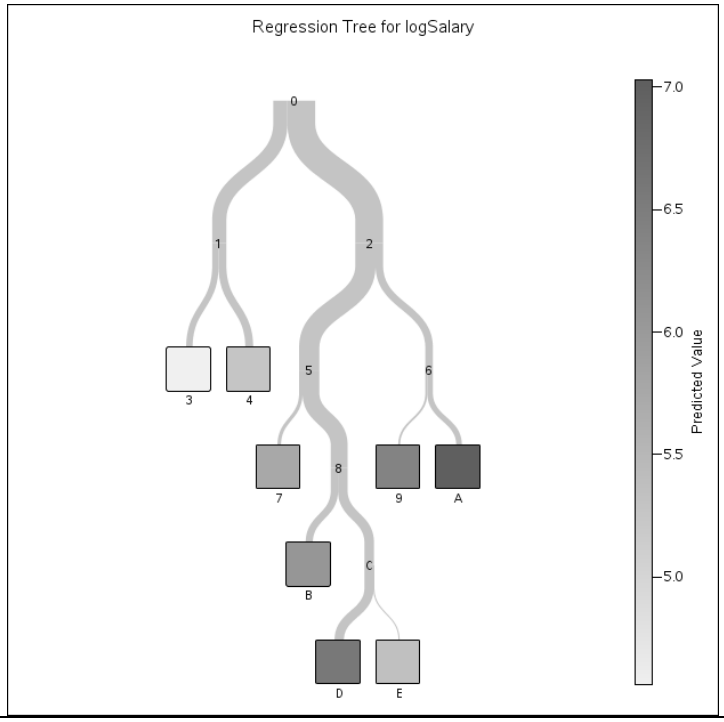

```
proc sgplot data=out1;
  scatter x=logSalary y=predloess /
markerattrs=(symbol=circlefilled size=6pt);
run;
```

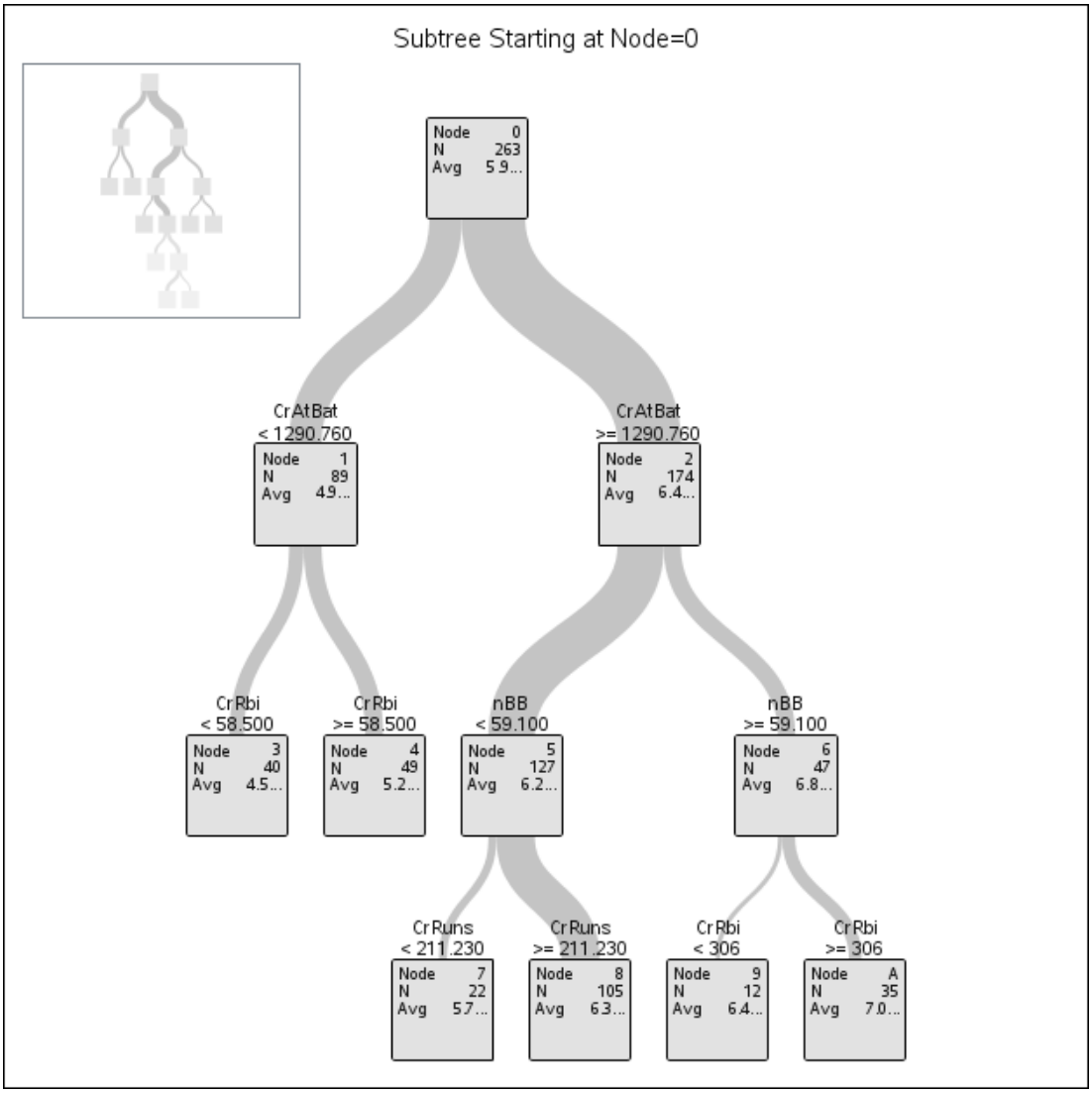


```
/* regression tree */
proc hpsplit data=baseball seed=123 maxdepth=15 maxbranch=2;
 class league division;
 model logSalary = nAtBat nHits nHome nRuns nRBI nBB
                   yrMajor crAtBat crHits crHome crRuns crRbi
                   crBB league division nOuts nAssts nError;
 output out=out2;
run;
```

The HPSPLIT Procedure







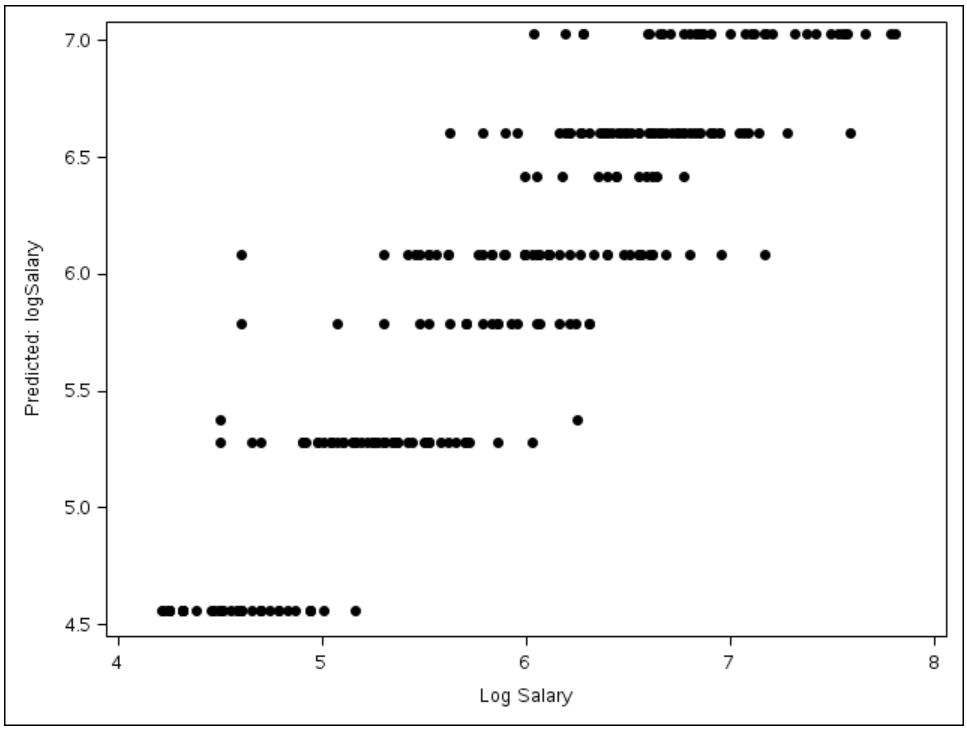
Model-Based Fit Statistics for Selected Tree

N Leaves	*ASE*	*RSS*
8	0.1443	37.9587

Variable Importance

Variable	*Variable Label*	*Training Relative*	*Training Importance*	*Training Count*
CrAtBat	Career Times at Bat	1.0000	11.2539	1
nBB	Walks in 1986	0.3546	3.9905	2
CrRbi	Career RBIs	0.3414	3.8415	2
nAtBat	Times at Bat in 1986	0.2168	2.4397	1
CrRuns	Career Runs	0.2161	2.4316	1

```
proc sgplot data=out2;
  scatter x=logSalary y=p_logSalary /
markerattrs=(symbol=circlefilled size=6pt);
run;
```



Question: What is going on in this plot? Do these patterns in the prediction make sense? If yes, why do they make sense?

Question: Recalling Output in Handout #23, what do the "important" variables have in common?

```
/* random forest */
proc hpforest data=baseball seed=134 scoreprole=oob;
 input nAtBat nHits nHome nRuns nRBI nBB
                  yrMajor crAtBat crHits crHome crRuns crRbi
                  crBB league division nOuts nAssts nError;
 target Salary;
 ods output FitStatistics=fitstats
   VariableImportance=varimp;
run;
```

The HPFOREST Procedure

Model Information

Parameter	Value	
Variables to Try	4	(Default)
Maximum Trees	100	(Default)
Missing Value Handling	.	Valid value

Number of Observations

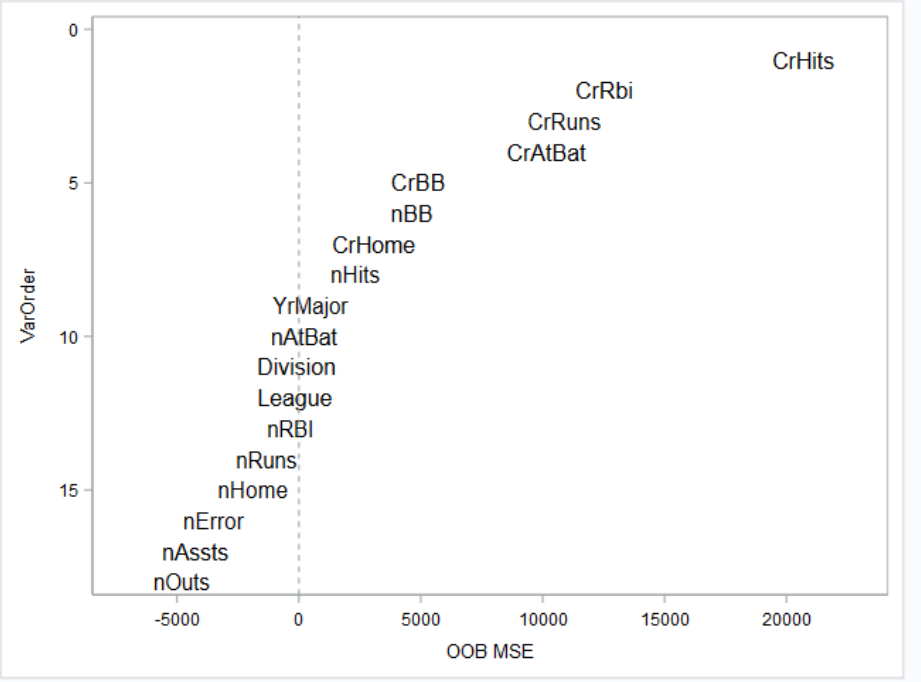
Type	N
Number of Observations Read	322
Number of Observations Used	263

Loss Reduction Variable Importance

Variable	Number of Rules	MSE	OOB MSE	Absolute Error	OOB Absolute Error
CrHits	907	27941.87	20687.57	48.803825	34.608172
CrRbi	1160	22995.54	12521.15	35.533126	19.290786
CrRuns	1072	23108.48	10892.41	39.211686	18.379497
CrAtBat	751	18859.52	10140.97	32.764124	20.230476
CrBB	1364	16893.90	4896.42	31.277359	11.410166
nBB	606	12942.85	4625.19	14.772798	3.751437
CrHome	804	13002.18	3062.38	18.501506	4.823677
nHits	439	10636.46	2314.45	14.907649	3.961956
YrMajor	455	5866.65	471.24	11.912504	2.927752
nAtBat	414	10120.05	199.98	14.692048	0.552953
Division	9	355.44	-102.12	0.373370	-0.103367
League	15	117.50	-174.16	0.244754	-0.153395
nRBI	572	11899.64	-352.58	15.151606	-0.354135
nRuns	497	8491.47	-1336.94	11.766502	-0.471976
nHome	423	5302.24	-1882.58	8.979994	-0.764283
nError	1755	4534.88	-3505.17	13.465747	-3.311704
nAssts	1582	3494.33	-4257.11	12.493737	-3.871985
nOuts	1802	9530.72	-4815.96	21.164897	-4.546558

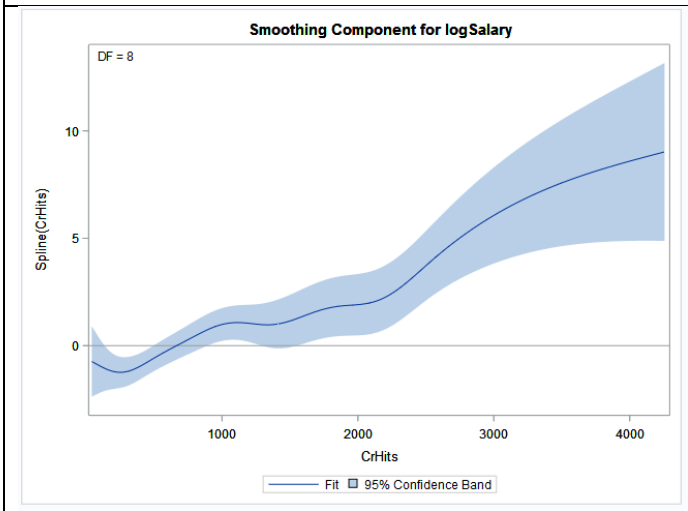
Question: What does it mean to have a negative out of bag mean square error? What does this provide evidence for?

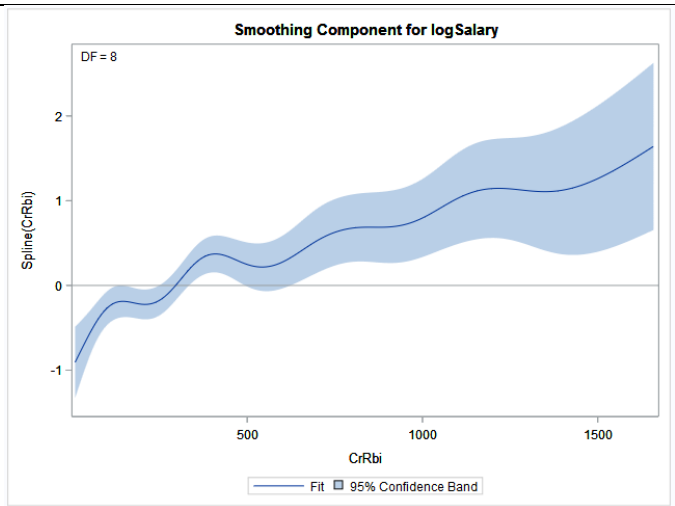
```
data varimp; set varimp;
 VarOrder=_n_;
proc sgplot data=varimp;
 scatter x=MSEOOB y=VarOrder / markerchar=Variable
markercharattrs=(size=12);
 yaxis reverse;
 refline 0 / axis = x LINEATTRS=(pattern=2);
run;
```

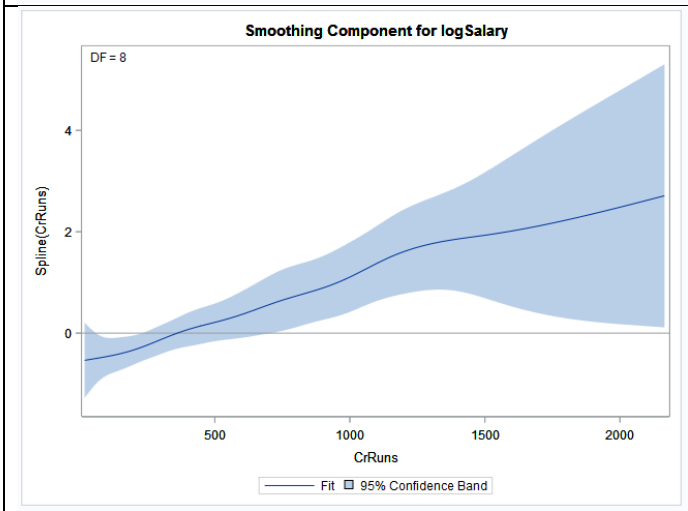


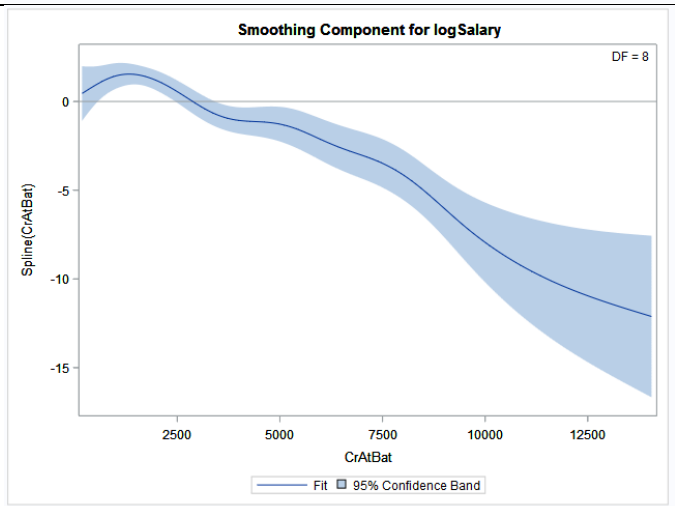
```
/* Visualize effects of top predictors using a generalized
additive model */
proc gampl data=baseball plots(unpack)=all;
  model logSalary = s(crHits) s(CrRbi) s(CrRuns) s(CrAtBat)
    / dist=norm;
run;
```

The GAMPL Procedure









```
/* Compare with simple scatter plot */
proc sgscatter data=baseball;
 matrix logSalary crHits crRBI
    crRuns crAtBat /
    markerattrs=(
       symbol=CIRCLEFILLED
       size=6pt);
run;
```