

## Multiple Linear Regression (with Cross Validation)

```
# knitr::opts_chunk$set(warning = FALSE, message = FALSE)
custom <- trainControl(method = "repeatedcv", number = 10, repeats = 5, verboseIter = F)
lm <- train(log(SalePrice)~. , train_house, method = 'lm', trControl = custom)
```

```
summary(lm)
```

```
##
## Call:
## lm(formula = .outcome ~ ., data = dat)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.69490 -0.04682  0.00038  0.05358  0.68404
##
## Coefficients: (3 not defined because of singularities)
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    3.029e+00  8.684e-01   3.488 0.000504 ***
## MSSubClass     -3.085e-04  3.651e-04  -0.845 0.398322
## MSZoningFV      4.608e-01  5.376e-02  8.572 < 2e-16 ***
## MSZoningRH      4.550e-01  5.369e-02  8.475 < 2e-16 ***
## MSZoningRL      4.445e-01  4.521e-02  9.832 < 2e-16 ***
## MSZoningRM      3.989e-01  4.216e-02  9.460 < 2e-16 ***
## LotArea         2.345e-06  4.743e-07  4.944 8.67e-07 ***
## LotShapeIR2     3.464e-02  1.912e-02  1.812 0.070252 .
## LotShapeIR3     1.841e-02  3.933e-02  0.468 0.639904
## LotShapeReg      6.351e-03  7.365e-03  0.862 0.388687
## LandContourHLS   3.522e-02  2.335e-02  1.509 0.131668
## LandContourLow  -1.112e-02  2.886e-02  -0.385 0.699971
## LandContourLvl   2.695e-02  1.674e-02  1.610 0.107641
## LotConfigCulDSac 2.992e-02  1.508e-02  1.984 0.047471 *
## LotConfigFR2     -3.058e-02  1.849e-02  -1.654 0.098365 .
## LotConfigFR3     -9.097e-02  5.782e-02  -1.573 0.115904
## LotConfigInside  -1.042e-02  8.165e-03  -1.276 0.202238
## LandSlopeMod     2.894e-02  1.813e-02  1.597 0.110589
## LandSlopeSev     -1.382e-01  4.892e-02  -2.826 0.004788 **
## NeighborhoodBlueste -4.533e-02  8.736e-02  -0.519 0.603902
## NeighborhoodBrDale -4.274e-02  5.012e-02  -0.853 0.394013
## NeighborhoodBrkSide 1.997e-02  4.257e-02  0.469 0.639077
## NeighborhoodClearCr 2.191e-02  4.221e-02  0.519 0.603804
## NeighborhoodCollgCr -1.871e-02  3.301e-02  -0.567 0.571002
## NeighborhoodCrawfor 1.088e-01  3.905e-02  2.786 0.005418 **
## NeighborhoodEdwards -7.051e-02  3.643e-02  -1.936 0.053142 .
## NeighborhoodGilbert -4.867e-03  3.516e-02  -0.138 0.889921
## NeighborhoodIDOTRR -3.161e-02  4.836e-02  -0.654 0.513454
## NeighborhoodMeadowV -1.642e-01  5.146e-02  -3.191 0.001452 **
## NeighborhoodMitchel -4.566e-02  3.712e-02  -1.230 0.218842
## NeighborhoodNames  -3.313e-02  3.554e-02  -0.932 0.351517
## NeighborhoodNoRidge 3.008e-02  3.852e-02  0.781 0.435067
```

## NeighborhoodNPkVill	-1.597e-03	6.403e-02	-0.025	0.980105	
## NeighborhoodNridgHt	9.786e-02	3.374e-02	2.901	0.003790	**
## NeighborhoodNWAmes	-3.856e-02	3.659e-02	-1.054	0.292261	
## NeighborhoodOldTown	-3.881e-02	4.355e-02	-0.891	0.372977	
## NeighborhoodSawyer	-1.897e-02	3.709e-02	-0.512	0.609082	
## NeighborhoodSawyerW	-6.974e-03	3.559e-02	-0.196	0.844695	
## NeighborhoodSomerst	3.296e-02	4.103e-02	0.803	0.421940	
## NeighborhoodStoneBr	1.378e-01	3.792e-02	3.635	0.000290	***
## NeighborhoodSWISU	2.548e-03	4.411e-02	0.058	0.953948	
## NeighborhoodTimber	2.522e-03	3.713e-02	0.068	0.945863	
## NeighborhoodVeenker	5.514e-02	4.781e-02	1.153	0.248989	
## Condition1Feedr	2.700e-02	2.236e-02	1.207	0.227558	
## Condition1Norm	7.980e-02	1.855e-02	4.301	1.83e-05	***
## Condition1PosA	3.544e-02	4.557e-02	0.778	0.436956	
## Condition1PosN	7.780e-02	3.360e-02	2.315	0.020761	*
## Condition1RR Ae	-4.044e-02	3.972e-02	-1.018	0.308784	
## Condition1RRAn	4.051e-02	3.112e-02	1.302	0.193223	
## Condition1RRNe	1.747e-02	8.077e-02	0.216	0.828796	
## Condition1RRNn	6.394e-02	5.762e-02	1.110	0.267405	
## Condition2Feedr	1.408e-01	1.050e-01	1.341	0.180096	
## Condition2Norm	7.899e-02	9.042e-02	0.874	0.382516	
## Condition2PosA	2.700e-01	1.506e-01	1.792	0.073356	.
## Condition2PosN	-7.843e-01	1.247e-01	-6.287	4.46e-10	***
## Condition2RR Ae	-4.015e-01	2.096e-01	-1.915	0.055669	.
## Condition2RRAn	1.918e-02	1.423e-01	0.135	0.892799	
## Condition2RRNn	7.326e-02	1.225e-01	0.598	0.549917	
## BldgType2fmCon	3.580e-02	5.482e-02	0.653	0.513852	
## BldgTypeDuplex	-1.517e-02	3.292e-02	-0.461	0.644901	
## BldgTypeTwnhs	-5.635e-02	4.451e-02	-1.266	0.205777	
## BldgTypeTwnhsE	-1.327e-02	3.980e-02	-0.333	0.738944	
## HouseStyle1.5Unf	1.577e-02	3.438e-02	0.459	0.646519	
## HouseStyle1Story	-2.087e-02	1.944e-02	-1.073	0.283413	
## HouseStyle2.5Fin	-7.129e-02	5.528e-02	-1.290	0.197435	
## HouseStyle2.5Unf	4.954e-02	4.157e-02	1.192	0.233601	
## HouseStyle2Story	-1.744e-02	1.573e-02	-1.108	0.267878	
## HouseStyleSFoyer	-1.438e-02	2.809e-02	-0.512	0.608611	
## HouseStyleSLvl	1.657e-03	2.471e-02	0.067	0.946528	
## OverallQual	4.349e-02	4.591e-03	9.474	< 2e-16	***
## OverallCond	3.447e-02	3.878e-03	8.891	< 2e-16	***
## YearBuilt	1.484e-03	3.469e-04	4.279	2.02e-05	***
## YearRemodAdd	7.106e-04	2.487e-04	2.857	0.004341	**
## RoofStyleGable	-1.912e-02	8.481e-02	-0.225	0.821663	
## RoofStyleGambrel	-1.611e-02	9.221e-02	-0.175	0.861328	
## RoofStyleHip	-1.140e-02	8.502e-02	-0.134	0.893350	
## RoofStyleMansard	3.998e-02	9.864e-02	0.405	0.685319	
## RoofStyleShed	3.741e-01	1.583e-01	2.363	0.018256	*
## RoofMatlCompShg	2.646e+00	1.530e-01	17.298	< 2e-16	***
## RoofMatlMembran	3.017e+00	2.185e-01	13.806	< 2e-16	***
## RoofMatlMetal	2.856e+00	2.135e-01	13.377	< 2e-16	***
## RoofMatlRoll	2.657e+00	1.916e-01	13.871	< 2e-16	***
## `RoofMatlTar&Grv`	2.661e+00	1.746e-01	15.239	< 2e-16	***
## RoofMatlWdShake	2.569e+00	1.690e-01	15.198	< 2e-16	***
## RoofMatlWdShngl	2.749e+00	1.585e-01	17.343	< 2e-16	***
## Exterior1stAsphShn	-2.200e-02	1.505e-01	-0.146	0.883852	

## Exterior1stBrkComm	-2.633e-01	1.260e-01	-2.089	0.036904	*
## Exterior1stBrkFace	6.998e-02	5.656e-02	1.237	0.216206	
## Exterior1stCBlock	-7.686e-02	1.172e-01	-0.656	0.512007	
## Exterior1stCemntBd	-7.970e-02	8.597e-02	-0.927	0.354019	
## Exterior1stHdBoard	-2.359e-02	5.706e-02	-0.413	0.679368	
## Exterior1stImStucc	-2.915e-02	1.258e-01	-0.232	0.816747	
## Exterior1stMetalSd	2.357e-02	6.534e-02	0.361	0.718318	
## Exterior1stPlywood	-2.127e-02	5.614e-02	-0.379	0.704868	
## Exterior1stStone	5.459e-02	1.105e-01	0.494	0.621265	
## Exterior1stStucco	8.764e-03	6.261e-02	0.140	0.888701	
## Exterior1stVinylSd	-1.452e-02	5.932e-02	-0.245	0.806679	
## `Exterior1stWd Sdng`	-5.225e-02	5.453e-02	-0.958	0.338175	
## Exterior1stWdShng	-1.246e-02	5.873e-02	-0.212	0.832056	
## Exterior2ndAsphShn	5.423e-02	1.014e-01	0.535	0.592922	
## `Exterior2ndBrk Cmn`	5.759e-02	9.138e-02	0.630	0.528676	
## Exterior2ndBrkFace	-2.263e-02	5.960e-02	-0.380	0.704289	
## Exterior2ndCBlock	NA	NA	NA	NA	
## Exterior2ndCmentBd	1.312e-01	8.525e-02	1.539	0.123941	
## Exterior2ndHdBoard	2.109e-02	5.544e-02	0.380	0.703709	
## Exterior2ndImStucc	4.993e-02	6.403e-02	0.780	0.435631	
## Exterior2ndMetalSd	1.033e-02	6.430e-02	0.161	0.872350	
## Exterior2ndOther	-6.998e-02	1.247e-01	-0.561	0.574725	
## Exterior2ndPlywood	2.993e-02	5.372e-02	0.557	0.577505	
## Exterior2ndStone	-3.169e-02	7.779e-02	-0.407	0.683759	
## Exterior2ndStucco	1.349e-02	6.123e-02	0.220	0.825632	
## Exterior2ndVinylSd	4.247e-02	5.784e-02	0.734	0.462859	
## `Exterior2ndWd Sdng`	6.341e-02	5.347e-02	1.186	0.235927	
## `Exterior2ndWd Shng`	1.737e-02	5.569e-02	0.312	0.755152	
## ExterQual	-5.363e-03	9.470e-03	-0.566	0.571279	
## ExterCond	2.443e-02	2.534e-02	0.964	0.335054	
## FoundationCBlock	1.869e-02	1.436e-02	1.302	0.193308	
## FoundationPConc	3.457e-02	1.556e-02	2.221	0.026504	*
## FoundationSlab	-1.378e-02	4.550e-02	-0.303	0.762075	
## FoundationStone	1.082e-01	4.799e-02	2.254	0.024349	*
## FoundationWood	-1.237e-01	6.776e-02	-1.825	0.068259	.
## BsmtQual	1.370e-02	8.230e-03	1.664	0.096296	.
## BsmtCond	2.942e-03	7.903e-03	0.372	0.709748	
## BsmtExposure	1.142e-02	3.863e-03	2.957	0.003165	**
## BsmtFinType1BLQ	-6.488e-03	1.265e-02	-0.513	0.608046	
## BsmtFinType1GLQ	9.250e-03	1.145e-02	0.808	0.419170	
## BsmtFinType1LwQ	-2.625e-02	1.713e-02	-1.532	0.125731	
## BsmtFinType1No_Bsmt	2.110e-01	1.274e-01	1.656	0.098063	.
## BsmtFinType1Rec	-1.129e-02	1.363e-02	-0.828	0.407963	
## BsmtFinType1Unf	-9.051e-03	1.321e-02	-0.685	0.493191	
## BsmtFinSF1	1.587e-04	2.389e-05	6.644	4.55e-11	***
## BsmtFinType2BLQ	-6.939e-02	3.442e-02	-2.016	0.043979	*
## BsmtFinType2GLQ	3.212e-03	4.256e-02	0.075	0.939860	
## BsmtFinType2LwQ	-3.308e-02	3.368e-02	-0.982	0.326180	
## BsmtFinType2No_Bsmt	-1.712e-01	1.153e-01	-1.485	0.137914	
## BsmtFinType2Rec	-3.071e-02	3.237e-02	-0.949	0.342953	
## BsmtFinType2Unf	-1.652e-02	3.433e-02	-0.481	0.630501	
## BsmtFinSF2	1.383e-04	4.124e-05	3.354	0.000821	***
## BsmtUnfSF	9.601e-05	2.189e-05	4.386	1.25e-05	***
## TotalBsmtSF	NA	NA	NA	NA	

## HeatingGasA	1.510e-01	1.182e-01	1.278	0.201364	
## HeatingGasW	2.250e-01	1.216e-01	1.851	0.064368	.
## HeatingGrav	1.690e-02	1.258e-01	0.134	0.893152	
## HeatingOthW	1.317e-01	1.440e-01	0.914	0.360668	
## HeatingWall	2.360e-01	1.365e-01	1.729	0.084051	.
## HeatingQC	2.606e-02	7.996e-03	3.259	0.001149	**
## CentralAirY	6.818e-02	1.699e-02	4.014	6.33e-05	***
## X1stFlrSF	2.238e-04	2.546e-05	8.790	< 2e-16	***
## X2ndFlrSF	2.219e-04	2.508e-05	8.848	< 2e-16	***
## LowQualFinSF	2.243e-04	8.287e-05	2.707	0.006881	**
## GrLivArea	NA	NA	NA	NA	
## BsmtFullBath	2.205e-02	9.044e-03	2.438	0.014909	*
## BsmtHalfBath	2.238e-03	1.370e-02	0.163	0.870241	
## FullBath	1.669e-02	9.943e-03	1.679	0.093437	.
## HalfBath	2.729e-02	9.532e-03	2.863	0.004261	**
## BedroomAbvGr	3.009e-03	6.191e-03	0.486	0.627049	
## KitchenAbvGr	-3.449e-02	2.510e-02	-1.374	0.169721	
## KitchenQual	1.775e-02	7.443e-03	2.385	0.017217	*
## TotRmsAbvGrd	6.427e-03	4.270e-03	1.505	0.132543	
## FunctionalMaj2	-2.655e-01	6.534e-02	-4.063	5.14e-05	***
## FunctionalMin1	2.050e-02	3.840e-02	0.534	0.593479	
## FunctionalMin2	6.533e-03	3.807e-02	0.172	0.863754	
## FunctionalMod	-8.944e-02	4.553e-02	-1.964	0.049724	*
## FunctionalSev	-3.106e-01	1.330e-01	-2.335	0.019680	*
## FunctionalTyp	4.369e-02	3.298e-02	1.325	0.185443	
## Fireplaces	2.221e-02	6.104e-03	3.638	0.000286	***
## GarageTypeAttchd	1.125e-01	4.946e-02	2.275	0.023064	*
## GarageTypeBasment	9.935e-02	5.716e-02	1.738	0.082439	.
## GarageTypeBuiltIn	9.824e-02	5.155e-02	1.906	0.056927	.
## GarageTypeCarPort	1.251e-01	6.594e-02	1.898	0.057928	.
## GarageTypeDetchd	1.101e-01	4.939e-02	2.229	0.025985	*
## GarageTypeNo_Grg	2.080e-01	7.494e-02	2.776	0.005584	**
## GarageFinish	7.316e-03	5.485e-03	1.334	0.182498	
## GarageCars	1.967e-02	1.026e-02	1.917	0.055478	.
## GarageArea	1.203e-04	3.561e-05	3.377	0.000756	***
## GarageQual	3.452e-02	1.713e-02	2.015	0.044145	*
## GarageCond	3.860e-03	2.342e-02	0.165	0.869141	
## PavedDriveP	3.271e-03	2.488e-02	0.132	0.895400	
## PavedDriveY	1.865e-02	1.552e-02	1.202	0.229770	
## WoodDeckSF	8.590e-05	2.671e-05	3.216	0.001333	**
## OpenPorchSF	5.687e-05	5.195e-05	1.095	0.273849	
## EnclosedPorch	1.157e-04	5.632e-05	2.055	0.040084	*
## X3SsnPorch	1.778e-04	1.027e-04	1.730	0.083792	.
## ScreenPorch	2.494e-04	5.522e-05	4.516	6.89e-06	***
## PoolArea	1.210e-04	8.232e-05	1.470	0.141714	
## MiscVal	-1.546e-06	6.454e-06	-0.240	0.810714	
## SaleTypeCon	8.680e-02	8.089e-02	1.073	0.283393	
## SaleTypeConLD	1.236e-01	4.372e-02	2.827	0.004778	**
## SaleTypeConLI	-2.341e-02	5.269e-02	-0.444	0.656856	
## SaleTypeConLw	5.279e-03	5.503e-02	0.096	0.923601	
## SaleTypeCWD	6.275e-02	5.922e-02	1.060	0.289571	
## SaleTypeNew	8.705e-02	7.094e-02	1.227	0.220062	
## SaleTypeOth	7.954e-02	6.634e-02	1.199	0.230775	
## SaleTypeWD	-1.149e-02	1.907e-02	-0.602	0.547090	

```
## SaleConditionAdjLand 9.747e-02 6.405e-02 1.522 0.128346
## SaleConditionAlloca 6.068e-02 3.913e-02 1.550 0.121291
## SaleConditionFamily 9.634e-03 2.798e-02 0.344 0.730688
## SaleConditionNormal 6.551e-02 1.318e-02 4.968 7.68e-07 ***
## SaleConditionPartial 1.704e-02 6.847e-02 0.249 0.803562
## MasVnrTypeBrkFace 3.161e-02 3.122e-02 1.013 0.311455
## MasVnrTypeNone 2.633e-02 3.144e-02 0.837 0.402533
## MasVnrTypeStone 4.214e-02 3.298e-02 1.278 0.201496
## ElectricalMix 1.705e-01 1.303e-01 1.308 0.190981
## ElectricalSBrkr -1.808e-02 1.249e-02 -1.448 0.147939
## LotFrontage 3.633e-04 1.977e-04 1.838 0.066329 .
## MasVnrArea 1.881e-05 2.589e-05 0.726 0.467810
## GarageYrBlt -2.420e-04 2.791e-04 -0.867 0.386144
## ---
```

```
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
##
## Residual standard error: 0.1053 on 1256 degrees of freedom
## Multiple R-squared: 0.9402, Adjusted R-squared: 0.9306
## F-statistic: 97.31 on 203 and 1256 DF, p-value: < 2.2e-16
```

```
lm$results
```

```
## intercept RMSE Rsquared MAE RMSESD RsquaredSD MAESD
## 1 TRUE 0.180902 0.8061907 0.09280052 0.07196069 0.1241297 0.01314951
```

```
lm
```

```
## Linear Regression
```

```
##
```

```
## 1460 samples
```

```
## 70 predictor
```

```
##
```

```
## No pre-processing
```

```
## Resampling: Cross-Validated (10 fold, repeated 5 times)
```

```
## Summary of sample sizes: 1313, 1314, 1314, 1313, 1315, 1314, ...
```

```
## Resampling results:
```

```
##
```

```
## RMSE Rsquared MAE
## 0.180902 0.8061907 0.09280052
```

```
##
```

```
## Tuning parameter 'intercept' was held constant at a value of TRUE
```