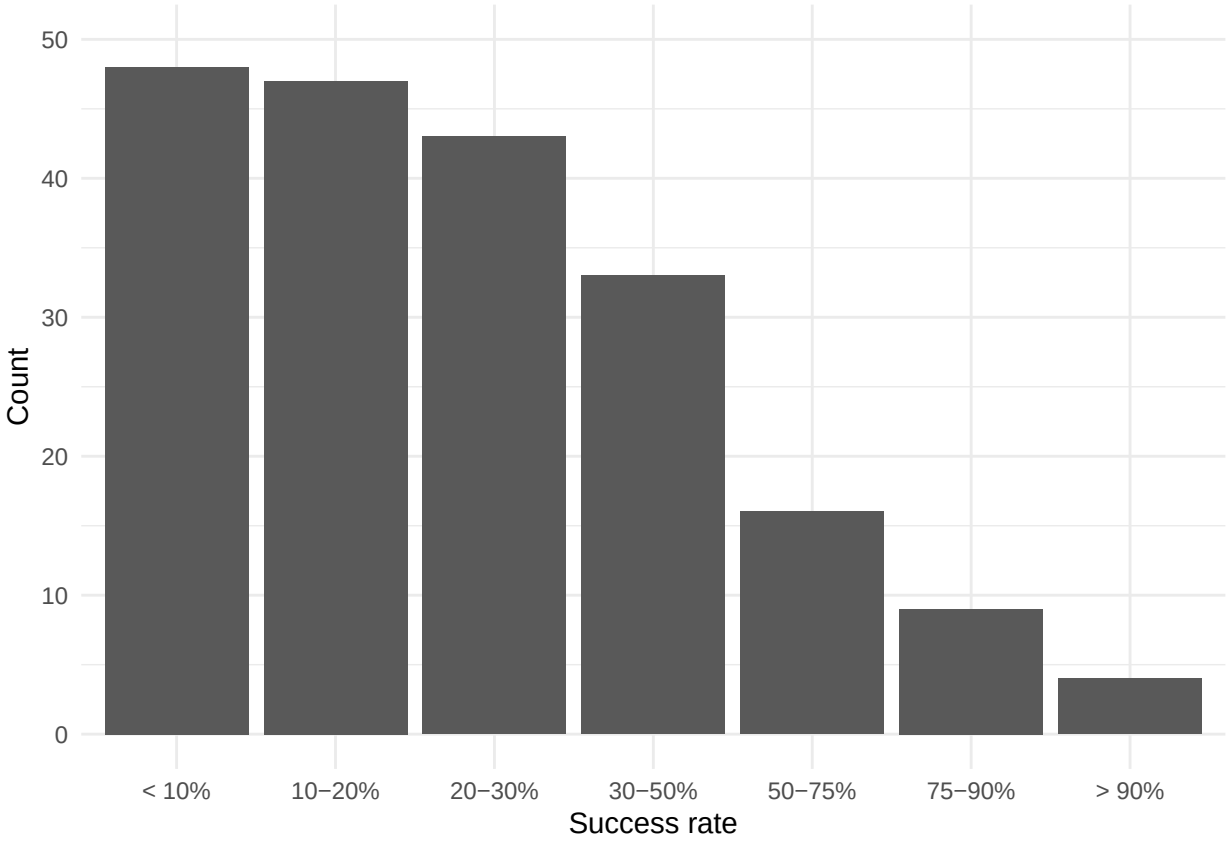
# Ordinal Logistic Regression or Proportional Odds Logistic Regression


50
40
30
20
10
0
Count
< 10%
10−20%
20−30%
30−50%
50−75%
75−90%
> 90%
Success rate

**Minimum NP considered as reference**

### Model with NP1 as reference

```
## Call:
## polr(formula = SR ~ H + NP + AGR, data = lm_DF, Hess = TRUE)
##
## Coefficients:
##        Value Std. Error t value
## H    0.03031    0.01136   2.668
## NP2 -1.18770    0.30175  -3.936
## NP3 -2.17075    0.42733  -5.080
## NP4 -0.91961    0.48353  -1.902
## AGR  0.14120    0.07527   1.876
##
## Intercepts:
##     Value   Std. Error t value
## 1|2 -1.0619  0.6261    -1.6962
## 2|3  0.1405  0.6212     0.2261
## 3|4  1.1963  0.6226     1.9216
## 4|5  2.2741  0.6384     3.5622
## 5|6  3.2667  0.6794     4.8084
## 6|7  4.6059  0.8135     5.6621
##
## Residual Deviance: 651.4188
## AIC: 673.4188
```

```
##           Value Std. Error    t value p value
## H    0.03031046 0.01135996  2.6681833  0.0076
## NP2 -1.18770243 0.30175102 -3.9360345  0.0001
## NP3 -2.17074858 0.42733143 -5.0797775  0.0000
## NP4 -0.91961361 0.48352842 -1.9018812  0.0572
## AGR  0.14120116 0.07527353  1.8758409  0.0607
## 1|2 -1.06189135 0.62605975 -1.6961502  0.0899
## 2|3  0.14045822 0.62118839  0.2261121  0.8211
## 3|4  1.19632950 0.62256790  1.9216049  0.0547
## 4|5  2.27405314 0.63838658  3.5621882  0.0004
## 5|6  3.26665509 0.67936419  4.8084005  0.0000
## 6|7  4.60594272 0.81346226  5.6621468  0.0000
```

### Model with NP1 as reference and kfold cross validation

```
##
## Coefficients:
##        Value Std. Error t value
## H    0.12651    0.07764  1.6295
## AGR  0.05285    0.06687  0.7903
## NP2 -1.02568    0.29158 -3.5177
## NP3 -1.73176    0.39944 -4.3354
## NP4 -0.53065    0.43910 -1.2085
##
## Intercepts:
##     Value   Std. Error t value
## 1|2 -1.1972  0.6076    -1.9704
## 2|3 -0.0268  0.5844    -0.0459
## 3|4  0.9571  0.5814     1.6463
## 4|5  2.4001  0.7171     3.3467
## 5|6  5.5056  1.7074     3.2246
## 6|7 18.7849 10.7040     1.7549
##
## Residual Deviance: 654.8958
## AIC: 676.8958
```

```
##           Value  Std. Error     t value p value
## H    0.12651114  0.07763958  1.62946713  0.1032
## AGR  0.05284807  0.06687260  0.79027991  0.4294
## NP2 -1.02568069  0.29157572 -3.51771642  0.0004
## NP3 -1.73175837  0.39944443 -4.33541753  0.0000
## NP4 -0.53065443  0.43910132 -1.20850109  0.2269
## 1|2 -1.19717467  0.60759047 -1.97036446  0.0488
## 2|3 -0.02683368  0.58444856 -0.04591282  0.9634
## 3|4  0.95713605  0.58138908  1.64629176  0.0997
## 4|5  2.40006459  0.71713450  3.34674264  0.0008
## 5|6  5.50558423  1.70738604  3.22456908  0.0013
## 6|7 18.78489650 10.70403698  1.75493569  0.0793
```

### Cooccurrence matrix and misclassification rate

```
##
## pred  1  2  3  4  5  6  7
##    1 12 10  3  2  0  0  0
##    2 22 27 16 10  8  1  0
##    3  9  7 13 11  4  1  0
##    4  5  3 11 10  4  6  4
##    5  0  0  0  0  0  0  0
##    6  0  0  0  0  0  1  0
##    7  0  0  0  0  0  0  0
```

```
## [1] 0.685
```

### Model with NP4 as reference

```
## Call:
## polr(formula = SR ~ H + NP + AGR, data = lm_DF, Hess = TRUE)
##
## Coefficients:
##        Value Std. Error t value
## H    0.03031    0.01136  2.6683
## NP1  0.91949    0.48353  1.9016
## NP2 -0.26816    0.47102 -0.5693
## NP3 -1.25130    0.55775 -2.2435
## AGR  0.14121    0.07527  1.8759
##
## Intercepts:
##     Value   Std. Error t value
## 1|2 -0.1423  0.6877    -0.2069
## 2|3  1.0600  0.6882     1.5402
## 3|4  2.1159  0.6977     3.0326
## 4|5  3.1936  0.7182     4.4467
## 5|6  4.1862  0.7591     5.5147
## 6|7  5.5254  0.8839     6.2510
##
## Residual Deviance: 651.4188
## AIC: 673.4188
```

```
##           Value Std. Error    t value p value
## H    0.03031208 0.01136003  2.6683105  0.0076
## NP1  0.91949328 0.48352622  1.9016410  0.0572
## NP2 -0.26815833 0.47101691 -0.5693178  0.5691
## NP3 -1.25130129 0.55775296 -2.2434686  0.0249
## AGR  0.14120692 0.07527355  1.8759169  0.0607
## 1|2 -0.14227840 0.68773643 -0.2068793  0.8361
## 2|3  1.06002580 0.68824168  1.5401941  0.1235
## 3|4  2.11591325 0.69771587  3.0326288  0.0024
## 4|5  3.19362859 0.71819754  4.4467273  0.0000
## 5|6  4.18623334 0.75910215  5.5147168  0.0000
## 6|7  5.52541668 0.88391865  6.2510466  0.0000
```

### Model with NP4 as reference and kfold cross validation

```
##
## Coefficients:
##        Value Std. Error t value
## H    0.12579    0.07715  1.6305
## AGR  0.05297    0.06687  0.7921
## NP1  0.52985    0.43918  1.2065
## NP2 -0.49567    0.42860 -1.1565
## NP3 -1.20202    0.50801 -2.3661
##
## Intercepts:
##     Value   Std. Error t value
## 1|2 -0.6689  0.6501    -1.0290
## 2|3  0.5015  0.6285     0.7979
## 3|4  1.4853  0.6484     2.2905
## 4|5  2.9276  0.7771     3.7673
## 5|6  6.0279  1.7209     3.5027
## 6|7 19.2123 10.6137     1.8101
##
## Residual Deviance: 654.8957
## AIC: 676.8957
```

```
##           Value  Std. Error    t value p value
## H    0.1257851  0.07714628  1.6304752  0.1030
## AGR  0.0529692  0.06686921  0.7921314  0.4283
## NP1  0.5298532  0.43918294  1.2064522  0.2276
## NP2 -0.4956678  0.42859628 -1.1564910  0.2475
## NP3 -1.2020228  0.50801176 -2.3661318  0.0180
## 1|2 -0.6689328  0.65006138 -1.0290302  0.3035
## 2|3  0.5014703  0.62849958  0.7978849  0.4249
## 3|4  1.4852822  0.64844332  2.2905351  0.0220
## 4|5  2.9275699  0.77709526  3.7673243  0.0002
## 5|6  6.0279243  1.72093338  3.5027064  0.0005
## 6|7 19.2123470 10.61374015  1.8101392  0.0703
```

### Model with all variables

```
## Call:
## polr(formula = SR ~ H + AGR + NP + DWH + T + DS, data = lm_DF,
##     Hess = TRUE)
##
## Coefficients:
##         Value Std. Error  t value
## H     0.03398    0.01176  2.89003
## AGR   0.14663    0.08027  1.82685
## NP1   0.90676    0.48787  1.85859
## NP2  -0.44977    0.47282 -0.95125
## NP3  -1.33379    0.56732 -2.35103
## DWH2  4.94143    1.90768  2.59028
## DWH3  3.00034    1.23398  2.43143
## DWH4  1.97839    1.14562  1.72691
## DWH5  1.33336    1.12390  1.18637
## T2    0.95483    0.77528  1.23159
## T3    0.30444    0.77046  0.39514
## T4    0.67078    0.76107  0.88136
## T5    0.49054    0.77787  0.63062
## DS2  -0.10287    1.33802 -0.07688
## DS3  -1.25692    1.17122 -1.07317
## DS4  -1.23791    1.14545 -1.08072
## DS5  -1.44120    1.17770 -1.22374
##
## Intercepts:
##     Value   Std. Error t value
## 1|2  0.7560  1.6072     0.4704
## 2|3  2.0580  1.6190     1.2712
## 3|4  3.2515  1.6262     1.9994
## 4|5  4.4745  1.6345     2.7376
## 5|6  5.5459  1.6517     3.3577
## 6|7  6.9766  1.7139     4.0706
##
## Residual Deviance: 620.1066
## AIC: 666.1066
```

```
##            Value Std. Error     t value p value
## H     0.03397504 0.01175595  2.89002872  0.0039
## AGR   0.14663236 0.08026525  1.82684726  0.0677
## NP1   0.90675729 0.48787412  1.85858864  0.0631
## NP2  -0.44976608 0.47281745 -0.95124679  0.3415
## NP3  -1.33379088 0.56732136 -2.35103234  0.0187
## DWH2  4.94142504 1.90767879  2.59028148  0.0096
## DWH3  3.00034434 1.23398397  2.43142894  0.0150
## DWH4  1.97838510 1.14562006  1.72691206  0.0842
## DWH5  1.33336270 1.12390265  1.18636850  0.2355
## T2    0.95483344 0.77528223  1.23159464  0.2181
## T3    0.30444407 0.77046446  0.39514357  0.6927
## T4    0.67077928 0.76107440  0.88135835  0.3781
## T5    0.49054262 0.77786984  0.63062301  0.5283
## DS2  -0.10286911 1.33802265 -0.07688144  0.9387
## DS3  -1.25692320 1.17122355 -1.07317105  0.2832
```

```
## DS4  -1.23790883 1.14545010 -1.08071825  0.2798
## DS5  -1.44119886 1.17769942 -1.22374083  0.2211
## 1|2   0.75597609 1.60719286  0.47037048  0.6381
## 2|3   2.05802556 1.61895205  1.27120847  0.2037
## 3|4   3.25148852 1.62621691  1.99941871  0.0456
## 4|5   4.47452162 1.63449252  2.73756017  0.0062
## 5|6   5.54591126 1.65171928  3.35765969  0.0008
## 6|7   6.97655589 1.71388506  4.07060896  0.0000
```

### Model with all variables and Kfold cross validation

```
##
## Coefficients:
##         Value Std. Error  t value
## H     0.03398    0.01176  2.89003
## AGR   0.14663    0.08027  1.82685
## NP1   0.90676    0.48787  1.85859
## NP2  -0.44977    0.47282 -0.95125
## NP3  -1.33379    0.56732 -2.35103
## DWH2  4.94143    1.90768  2.59028
## DWH3  3.00034    1.23398  2.43143
## DWH4  1.97839    1.14562  1.72691
## DWH5  1.33336    1.12390  1.18637
## T2    0.95483    0.77528  1.23159
## T3    0.30444    0.77046  0.39514
## T4    0.67078    0.76107  0.88136
## T5    0.49054    0.77787  0.63062
## DS2  -0.10287    1.33802 -0.07688
## DS3  -1.25692    1.17122 -1.07317
## DS4  -1.23791    1.14545 -1.08072
## DS5  -1.44120    1.17770 -1.22374
##
## Intercepts:
##     Value   Std. Error t value
## 1|2  0.7560  1.6072     0.4704
## 2|3  2.0580  1.6190     1.2712
## 3|4  3.2515  1.6262     1.9994
## 4|5  4.4745  1.6345     2.7376
## 5|6  5.5459  1.6517     3.3577
## 6|7  6.9766  1.7139     4.0706
##
## Residual Deviance: 620.1066
## AIC: 666.1066
```

```
##            Value Std. Error     t value p value
## H     0.03397504 0.01175595  2.89002872  0.0039
## AGR   0.14663236 0.08026525  1.82684726  0.0677
## NP1   0.90675729 0.48787412  1.85858864  0.0631
## NP2  -0.44976608 0.47281745 -0.95124679  0.3415
## NP3  -1.33379088 0.56732136 -2.35103234  0.0187
## DWH2  4.94142504 1.90767879  2.59028148  0.0096
## DWH3  3.00034434 1.23398397  2.43142894  0.0150
## DWH4  1.97838510 1.14562006  1.72691206  0.0842
## DWH5  1.33336270 1.12390265  1.18636850  0.2355
## T2    0.95483344 0.77528223  1.23159464  0.2181
## T3    0.30444407 0.77046446  0.39514357  0.6927
## T4    0.67077928 0.76107440  0.88135835  0.3781
## T5    0.49054262 0.77786984  0.63062301  0.5283
## DS2  -0.10286911 1.33802265 -0.07688144  0.9387
## DS3  -1.25692320 1.17122355 -1.07317105  0.2832
## DS4  -1.23790883 1.14545010 -1.08071825  0.2798
## DS5  -1.44119886 1.17769942 -1.22374083  0.2211
## 1|2   0.75597609 1.60719286  0.47037048  0.6381
```

```
## 2|3   2.05802556 1.61895205  1.27120847  0.2037
## 3|4   3.25148852 1.62621691  1.99941871  0.0456
## 4|5   4.47452162 1.63449252  2.73756017  0.0062
## 5|6   5.54591126 1.65171928  3.35765969  0.0008
## 6|7   6.97655589 1.71388506  4.07060896  0.0000
```

### Cooccurrence matrix and misclassification rate

```
##
## pred  1  2  3  4  5  6  7
##    1 23 20  8  5  2  0  0
##    2 14 16 10  2  5  0  0
##    3  7  7 19 13  2  1  0
##    4  4  4  6 12  6  7  2
##    5  0  0  0  1  1  0  1
##    6  0  0  0  0  0  0  1
##    7  0  0  0  0  0  1  0
```

```
## [1] 0.645
```