New version External Report

Carla Schaerer

External Step

Logistic Regression for approval

```
Call:
glm(formula = IsApproved ~ . + Gender:Division + Gender:PercentFemale +
    Gender:ApplicantTrack + InstType:Division, family = "binomial",
    data = data)

Deviance Residuals:
    Min       1Q    Median      3Q       Max
-2.4435  -0.8248   0.3475   0.7641    2.3987

Coefficients:
                           Estimate Std. Error z value Pr(>|z|)
(Intercept)               -2.825251   1.710909  -1.651 0.098674 .
ApplicantTrack4            1.068437   0.640934   1.667 0.095514 .
ApplicantTrack5            1.569166   0.643813   2.437 0.014797 *
ApplicantTrack6            2.240959   0.669648   3.346 0.000818 ***
ScientificRelevance4       0.973704   0.392782   2.479 0.013175 *
ScientificRelevance5       1.619786   0.407403   3.976 7.01e-05 ***
ScientificRelevance6       1.743556   0.465394   3.746 0.000179 ***
Suitability4               0.660676   0.216996   3.045 0.002330 **
Suitability5               1.785305   0.251556   7.097 1.27e-12 ***
Suitability6               1.959409   0.391975   4.999 5.77e-07 ***
PercentFemale             -0.482505   0.323079  -1.493 0.135317
NumberExternalReviewers   -0.074361   0.062292  -1.194 0.232580
Age                       -0.003454   0.008290  -0.417 0.676955
Genderf                    0.093744   1.004496   0.093 0.925646
DivisionDiv 2             -0.493560   0.440134  -1.121 0.262123
DivisionDiv 3              0.369348   0.554063   0.667 0.505017
IsContinuation1            0.740935   0.162477   4.560 5.11e-06 ***
PreviousRequest1          -0.050188   0.185346  -0.271 0.786561
InstTypeOther             -0.105453   0.621404  -0.170 0.865245
InstTypeUAS/UTE           -0.141240   0.469157  -0.301 0.763375
InstTypeUni               -0.418471   0.425878  -0.983 0.325801
SemesterOktober            0.201023   0.129692   1.550 0.121140
logAmount                 -0.008541   0.119088  -0.072 0.942823
Genderf:DivisionDiv 2      0.150768   0.389586   0.387 0.698759
Genderf:DivisionDiv 3      0.188020   0.348181   0.540 0.589193
PercentFemale:Genderf      0.340882   0.558943   0.610 0.541948
ApplicantTrack4:Genderf   -0.194354   1.001970  -0.194 0.846198
ApplicantTrack5:Genderf   -0.443824   0.993699  -0.447 0.655136
ApplicantTrack6:Genderf   -0.766600   1.042735  -0.735 0.462229
DivisionDiv 2:InstTypeOther    0.234177   0.813566   0.288 0.773469
DivisionDiv 3:InstTypeOther   -0.796655   0.844377  -0.943 0.345434
DivisionDiv 2:InstTypeUAS/UTE -1.470105   0.820285  -1.792 0.073103 .
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```
DivisionDiv 3:InstTypeUAS/UTE -0.195563    0.996166   -0.196 0.844363
DivisionDiv 2:InstTypeUni       0.450810    0.483178    0.933 0.350814
DivisionDiv 3:InstTypeUni      -0.333450    0.571995   -0.583 0.559920
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1


(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 2243.9  on 1622  degrees of freedom
Residual deviance: 1626.4  on 1588  degrees of freedom
AIC: 1696.4

Number of Fisher Scoring iterations: 5
```
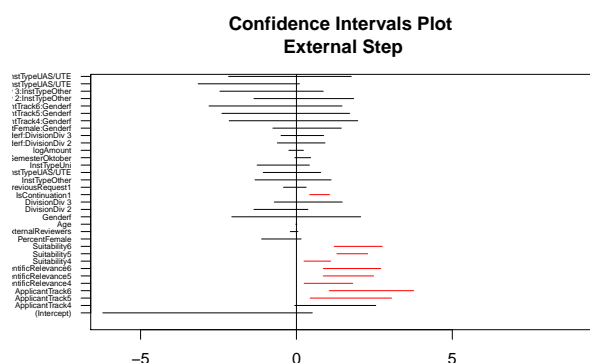

Confidence Intervals Plot
**External Step**

The confidence intervals which do not include zero are those for the variables: IsContinuation, Suitability (all levels from 4 to 6), ScientificRelevance (all levels from 4 to 6), and ApplicantTrack(for levels 5 and 6)

```
       ApplicantTrack5      ApplicantTrack6 ScientificRelevance4
              4.802641             9.402340             2.647732
   ScientificRelevance5 ScientificRelevance6          Suitability4
              5.052007             5.717641             1.936100
            Suitability5          Suitability6       IsContinuation1
              5.961400             7.095133             2.097896
```

The interpretation of the coefficients is the following:

- If the Applicant Track grade is 5, the proposal is 4.8 times more likely to be approved than a 4 or lower
- If the Applicant Track grade is 6, the proposal is 9.4 times more likely to be approved than a 3 or lower
- If ScientificRelevance grade is 4, the proposal is 2.65 times more likely to be approved than a 3 or lower
- If ScientificRelevance grade is 5, the proposal is 5.05 times more likely to be approved than a 4 or lower
- If ScientificRelevance grade is 6, the proposal is 5.72 times more likely to be approved than a 5 or lower
- If the Suitability has grade 4, the proposal is 1.94 times more likely to be approved than a 3 or lower
- If the Suitability has grade 5, the proposal is 5.96 times more likely to be approved than a 4 or lower
- If the Suitability has grade 6, the proposal is 7.1 times more likely to be approved than a 5 or lower
- If the project is a continuation, it is 2.0978959 times more likely to be approved than if it's not

Notice that the coefficient for gender is not significant, since its confidence interval (-2.074,2.059) contains zero. The point estimate for gender is 0.094 and this means that a woman is 2.99 times more likely to be approved than a man.
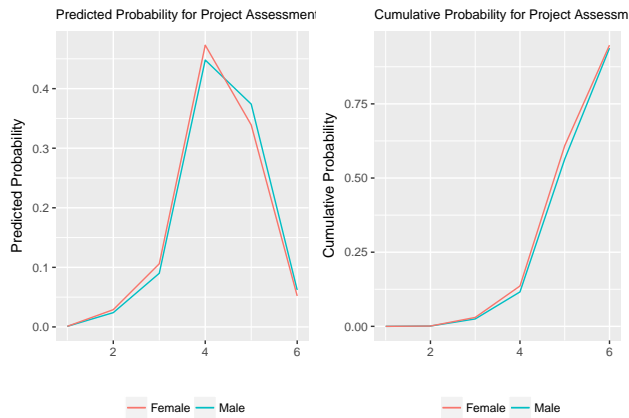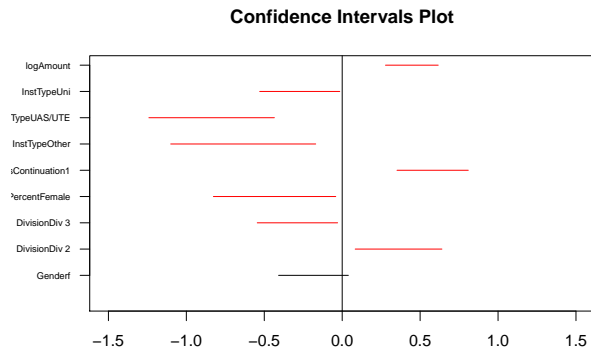
Gender effect plot

IsApproved vs Gender
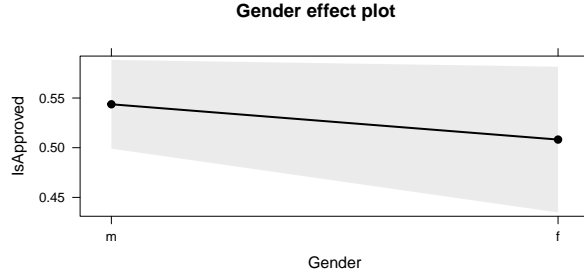
Ordinal regression for Project Assessment

- **Project Assessment**: After fitting a full model with ProposalCombined as a response variable and different interactions, and then selecting from this model the significant variables with the AIC criteria and the help of the drop1() function in R, we end up with a model with the following predictors: Gender, Division, PercentFemale, IsContinuation, InstType and log(AmountRequested). If we fit the same model without Gender and compare it with the anova() function to the one with gender, we get a p.value of 0.1064133, meaning that for the grades given to the project, gender is not important. This is to be expected, as the project is being evaluated and not the applicant.

	Male	Female	Difference
poor	0.001	0.001	0.000
average	0.024	0.029	-0.005
good	0.090	0.106	-0.015
very good	0.448	0.473	-0.024
excellent	0.374	0.339	0.035
outstanding	0.062	0.052	0.010

Overall the average difference is really small: 0.01483. This seems to suggest that there is no evidence of gender influencing the probability of achiving a certain grade. We also represented in the plots below the probabilty and cumulative probability curves of getting each grade for male and female: they follow more or less the same trend and the only difference, as we've seen from the table above, is that women are slightly more likely to get a "very good" rather than an "excellent".

Predicted Probability for Project Assessment

Cumulative Probability for Project Assessm

Confidence Intervals Plot

From the plot above we can see that gender seems to be significant, even if the confidence interval upper bound is really close zero. The other significant predictors are Division, the percentage of female reviewers, if the project is a continuation, the Institution type and the log(AmountRequested).

Ordinal regression for Applicant Track

- **Applicant Track assessment**: The final model we used has ApplicantTrack as a response variable, and the following predictors: Gender, Division, PercentFemale, IsContinuation, InstType, log(AmountRequested) and the interaction between Gender and PercentFemale. Again we fitted the same model without Gender and compare it with the anova() function to the one with gender, we get a p.value of 0.0014, meaning that for the grades given to the main applicant, gender needs to be considered in the model. In the next table we present part of the summary for this model, to see the full summary refer to the Appendix.

We computed the difference in probability of getting a specific grade for both male and female.

	Male	Female	Difference
poor	0.001	0.001	0.000
average	0.008	0.011	-0.003
good	0.040	0.053	-0.013
very good	0.303	0.356	-0.053
excellent	0.468	0.438	0.030
outstanding	0.180	0.141	0.039

In the table above, we see the probabilty of getting each grade for both male and female and the difference between the two. The average difference of the cumulative probability is here 0.023, very close to zero. From the plot below we see that there is almost no difference between women and men probabilities. This seems to suggest that the small p-value from the likelihood ratio test is not really reliable to establish whether there is gender bias.
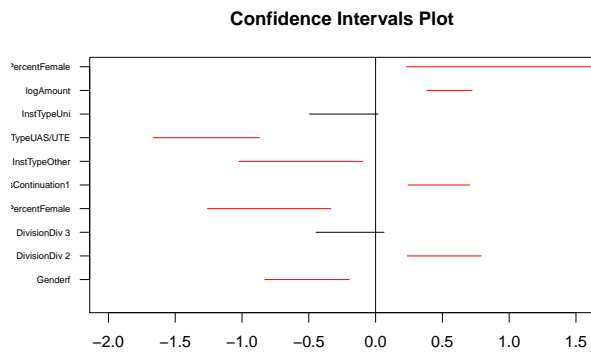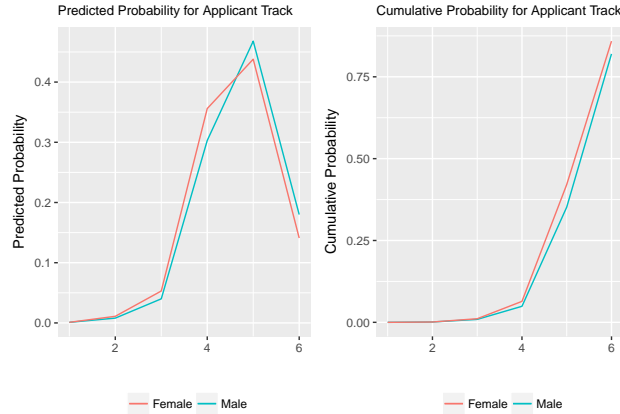
Notice that the confidence interval referring to gender includes zero and so the corresponding coefficient is not significant. In this case the significant variables to determine the Track record score are: the division, the percentage of female referees, the Institution type, the log(AmountRequested) and the interaction between the division and the percentage of female referees.

Ordinal regression for OverallGrade

- **Overall Grade**: This last model has Ranking as a response and Gender, Division, PercentFemale, IsContinuation, InstType, PreviousRequest and logAmount as predictors. We are not considering here the grades given to the applicant track record and to the project, as we just want to see the influence of the demographic data and the project information in each grade. A comparison of this model with the same one without gender may suggest that gender is significant to the model: p.value of 0.11397.

	Male	Female	Difference
poor	0.001	0.001	0.000
average	0.020	0.027	-0.007
good	0.078	0.100	-0.022
very good	0.411	0.454	-0.043
excellent	0.398	0.347	0.051
outstanding	0.093	0.071	0.022

The predicted probabilities of achieving certain grade for male and female is shown in the next table. The average difference of the cumulative probability is here as well close to zero (0.02417). Notice that the only difference is that female applicants are mole likely to get a "good" grade rather than a "very good", compared to male applicants. From the cumulative probability plot below, we see that the trend is the same for both genders and that the difference is not relevant.

Predicted Probability for Ranking — Cumulative Probability for Ranking

Confidence Intervals Plot
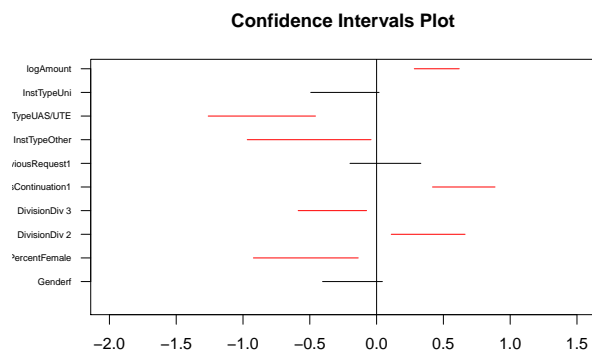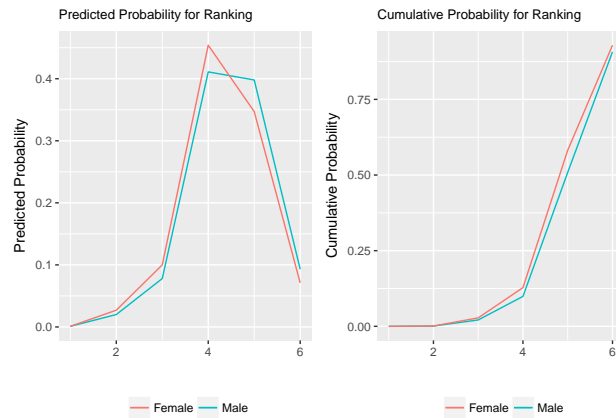
Here again gender seems to be not significant, since its confidence interval include zero. However the difference between the upper bound and zero is really small. The other significant variables in this model are the percentage of female referees, PreviousRequest, and the institution type.