Risk and Protective Factors of Student Alcohol Consumption

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Introduction

- Data: UCI ML data on Student Alcohol Consumption
    - Portuguese secondary school
    - Size: 423 students
    - Age: 15-18+
    - 30 original features

- Included several demographic and behavioral variables

- Response variable: Weekend alcohol consumption (Walc)

Relevant Variables

`goout`

Going out with friends?
(Likert, 1-5)

`famrel`

Quality of family relationships?
(Likert, 1-5)

`female`

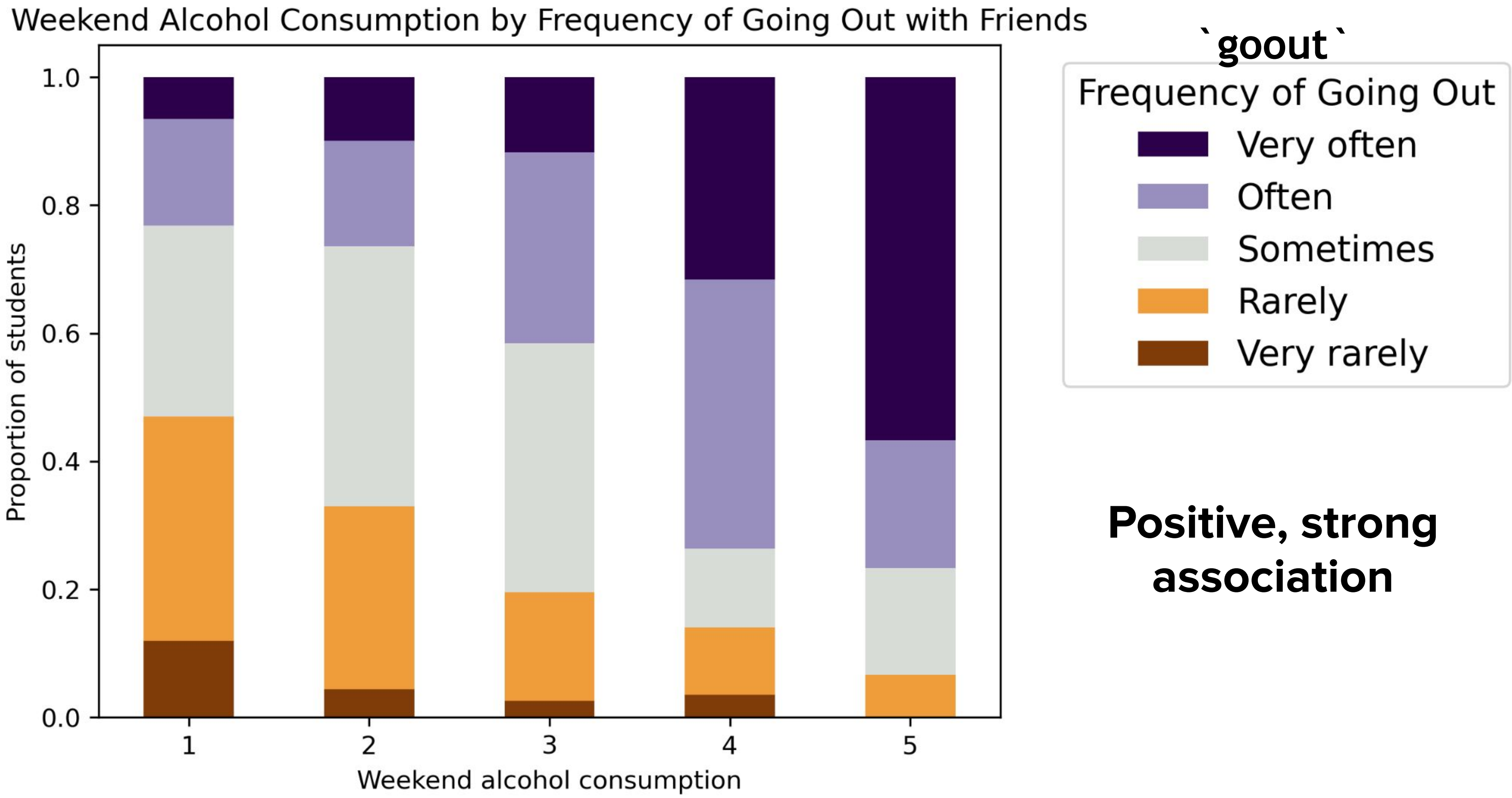
Female?
(binary, 1/0)

`Fjob_services`

Father in service industry?
(binary, 1/0)

`activities`

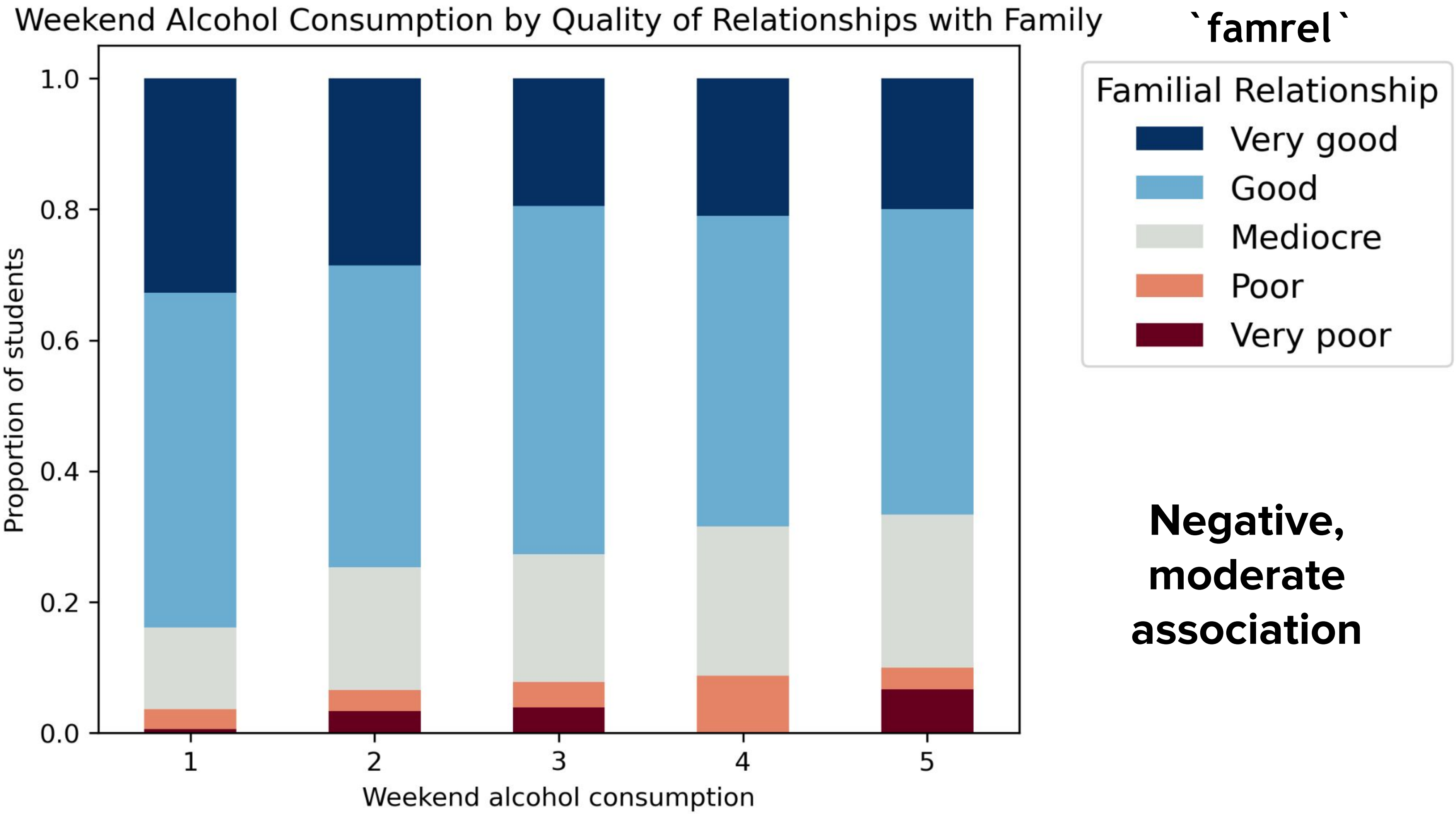
Extracurricular activities?
(binary, 1/0)



`goout`

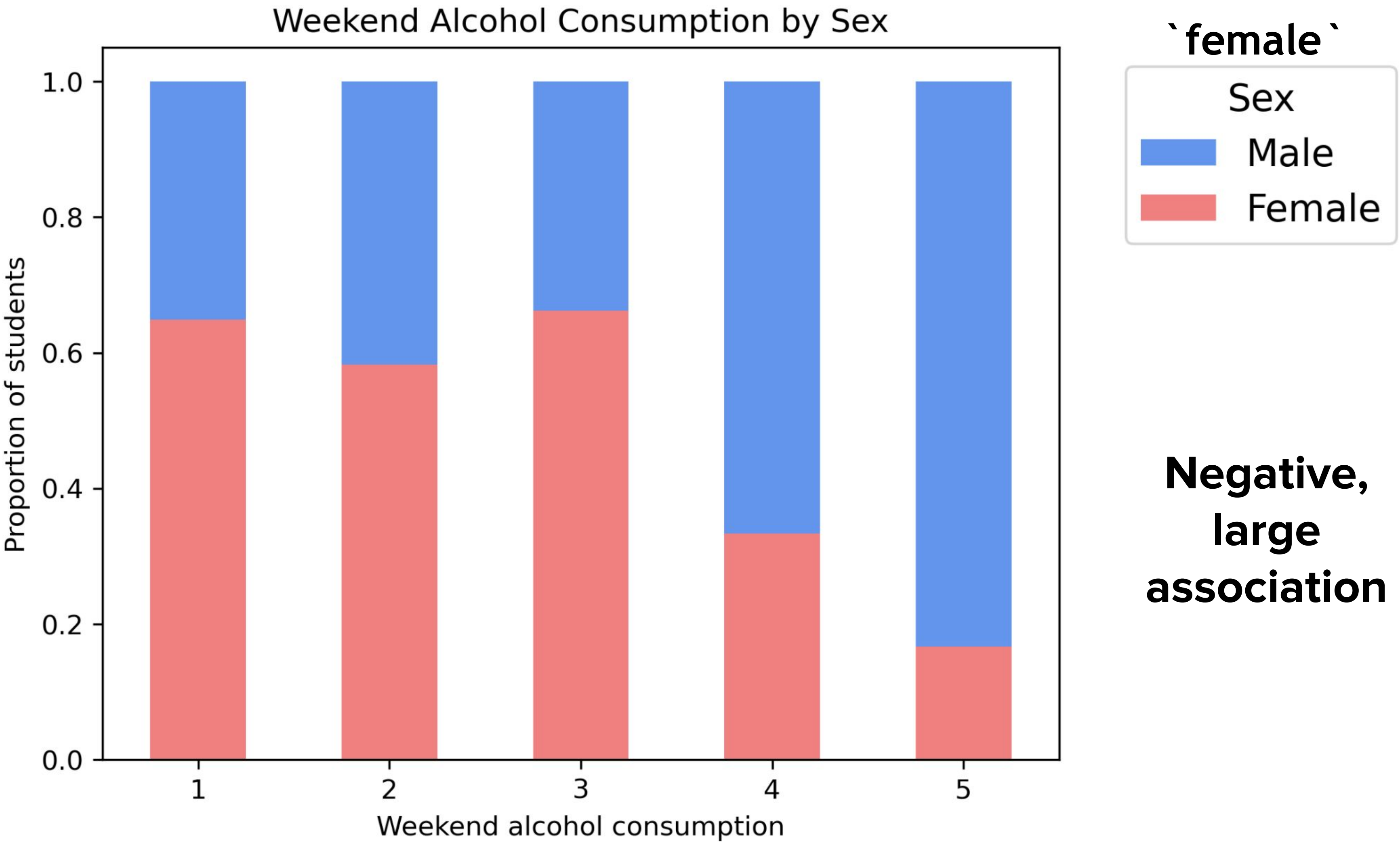
Positive, strong association

`famrel`



Negative, moderate association

`female`



Negative, large association

Feature	Hypothesized Importance	Hypothesized Effect	Calculated Importance	Calculated Effect
`goout`	Very high	Positive, large		
`famrel`	High	Negative, moderate		
`female`	Very high	Negative, large		

Data Format and Processing

- Binary variables reduced to 0, 1
- Parent job variables were one-hot encoded
- Likert scale responses and some categorical variables in ordinal form (1-5) but not linear
    - Ex: parent education and weekend alcohol consumption (Walc)

Feature Selection using Lasso

Lasso[5] regression uses L1 regularization, finding $\min_{\mathbf{w},b}\left(\frac{1}{N}\sum_{i=1}^{N}\left[f_{\mathbf{w},b}(\mathbf{x}_i)-y_i\right]^2+\alpha|\mathbf{w}|\right)$ where $\alpha \geq 0$.[6]

Lasso with α = 1:

```
array([ 0., -0.,  0.,  0., -0.,  0., -0., -0.,  0., -0., -0., -0.,  0.,
        0., -0.,  0.,  0.,  0.,  0., -0.,  0., -0., -0.,  0.])
```

Lasso with α = 0.01:

```
array([ 0.01209795, -0.01994296, -0.        ,  0.01600177, -0.09266678,
        0.        , -0.04173893, -0.        ,  0.        ,  0.        ,
       -0.00952809,  0.        ,  0.        ,  0.        , -0.0720974 ,
       -0.05019267,  0.14489994,  0.02028593,  0.0083867 , -0.25878453,
        0.        ,  0.        , -0.        ,  2.10094054])
```

Lasso regression requires linear data

- weekend alcohol consumption uses Likert scale
  - numeric: from 1 - very low to 5 - very high

Feature Selection only got us to ~45% Accuracy

- Train, test, split
- Permutation feature importance for logistic regression classifier and decision tree classifier
- The low accuracy score could be because the model had to predict 5 different scores instead of a binary yes or no

Top five features Logistic Regression Classifier:

	cols	importance
13	goout	0.104732
16	female	0.056782
18	famsize_GT3	0.030284
3	studytime	0.029022
11	famrel	0.027129

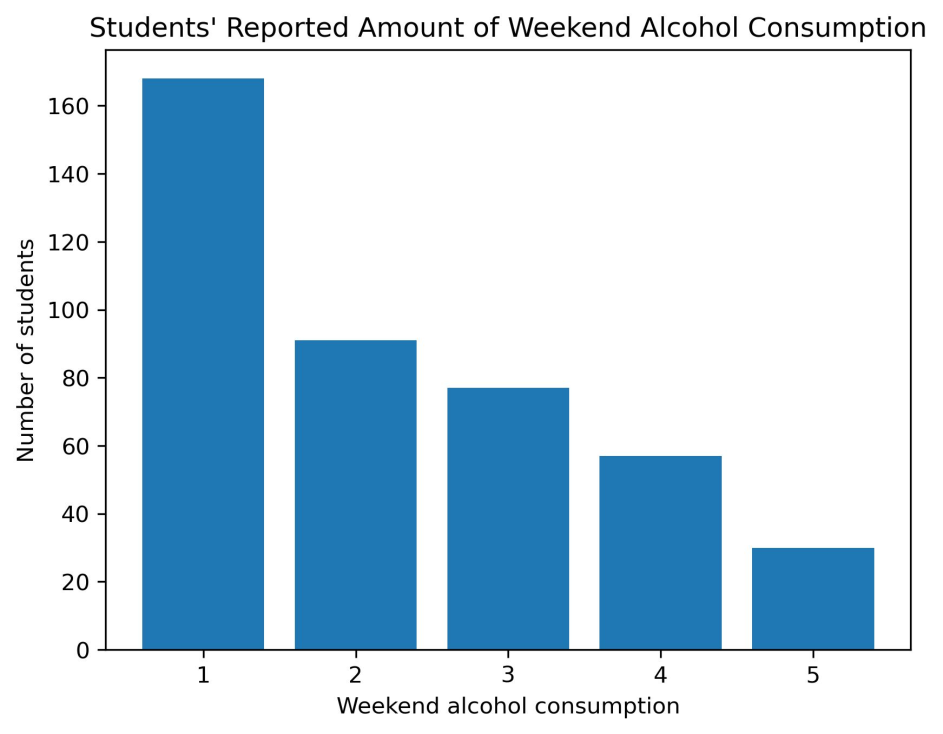
Top five features for the Decision Tree Classifier:

	cols	importance
13	goout	0.505994
11	famrel	0.252997
16	female	0.188013
20	age	0.174763
7	activities	0.146372

```
Logistic regression classifier with features ["goout", "female", "famsize_GT3"] earned an accuracy score of 0.453.
Decision tree classifier with features ["goout", "famrel", "age", "female"] earned an accuracy score of 0.425.
```

Binary classification may yield better predictions

- Compared low to average/high Walc
    - Binned 1-2 and 3-5
    - Yielded 60/40 split
- Data resampled to get 50/50 split



Five feature selection methods to identify key features:

By making the response variable binary, we were able to get the accuracy score up to around **72%**.

Feature Selection Methods*	Key Features Identified
KBest (threshold = 3)	failures, **goout**, absences
f_classif (threshold = 7)	**goout**, **female**, failures, Fjob_teacher, studytime, **famrel**, activities
mutual_info_classif (threshold = 5)	**goout**, higher, Fjob_other, **female**, Medu
VarianceThreshold (threshold = 0.3)	age, Medu, Fedu, traveltime, studytime, failures, **famrel**, freetime, **goout**, health, absences
permutation_importance (log reg)	**goout**, Fjob_services, **female**, Fjob_other, **famrel**
permutation_importance (decision tree)	**goout**, **female**, Medu, age, freetime

*Adapted from Halil Ertan's Medium article

Of six models, highest accuracy score was ~76.4%

Logistic Regression models:

```
permutation_importance model with features ["goout", "female", "famrel", "Fjob_services", "Fjob_other"] earned an accuracy score of 0.745.

f_classif model with features ["goout", "failures", "Fjob_teacher"] earned an accuracy score of 0.745.

educated_guesswork model with features ["goout", "female", "activities", "famrel", "Fjob_services"] earned an accuracy score of 0.764.
```

Decision Tree models:

```
permutation_importance model with features ["goout", "female", "Medu", "age", "health"] earned an accuracy score of 0.679.

f_classif model with features ["goout", "failures", "Fjob_teacher"] earned an accuracy score of 0.736.

educated_guesswork model with features ["goout", "female", "activities", "famrel", "Fjob_services"] earned an accuracy score of 0.632.
```

Feature	Hypothesized Importance	Hypothesized Effect	Calculated Importance	Calculated Coefficient
`goout`	Very high	Positive, large	0.146	0.860
`famrel`	High	Negative, moderate	0.027	–0.458
`female`	Very high	Negative, large	0.021	–0.847
`Fjob_services`	Medium	Positive, moderate	0.014	0.523
`activities`	None	Negligible, N/A	0.007	–0.475

Main takeaways

1. Response variable type matters → a small change can lead to a large accuracy boost
2. Utilize multiple different feature selection methods
3. Good to have some intuition when putting together a model

Questions?

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