Student Alcohol Consumption

Do students who consume alcohol score less in exams?

It contains a lot of interesting social (family background, alcohol consumption), gender and study information about students. You can use it for some EDA or try to predict students final grade.

In [4]:
```
%matplotlib inline
import os
import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)
import seaborn as sns # visualize
import matplotlib.pyplot as plt
import matplotlib.pyplot as plt
import scipy.stats as st
from statsmodels.formula.api import ols
if int(os.environ.get("MODERN_PANDAS_EPUB", 0)):
    import prep
```

In [6]:
```
#Merging the the files into final
pd.options.display.max_rows = 10
sns.set(style='ticks', context='talk')

d1=pd.read_csv("/Users/ruchi/data/student-mat.csv")
d2=pd.read_csv("/Users/ruchi/data/student-por.csv")

final = pd.merge(d1, d2, how='outer',on=["school","sex","age","address",
"famsize","Pstatus",
                            "Medu","Fedu","Mjob","Fjob","reason","nurser
y","internet",
                            "guardian","guardian","traveltime","studytim
e","failures",
                            "schoolsup","famsup","activities","higher",
"romantic",
                            "famrel","freetime","goout","Dalc","Walc","h
ealth","absences"])
final.to_csv('final.csv', index=False)
```

In [7]:
```
#Merging both the csv to get students who took both Maths and Portuguese
dinner = pd.merge(d1, d2, how='inner',on=["school","sex","age","address"
,"famsize","Pstatus",
                              "Medu","Fedu","Mjob","Fjob","reason","nurser
y","internet",
                              "guardian","guardian","traveltime","studytim
e","failures",
                              "schoolsup","famsup","activities","higher",
"romantic",
                              "famrel","freetime","goout","Dalc","Walc","h
ealth","absences"])
dinner.to_csv('inner.csv', index=False)
dinner.shape


#Merging both the csv to get students who took either Maths or Portugues
e
douter = pd.merge(d1, d2, how='outer',on=["school","sex","age","address"
,"famsize","Pstatus",
                              "Medu","Fedu","Mjob","Fjob","reason","nurser
y","internet",
                              "guardian","guardian","traveltime","studytim
e","failures",
                              "schoolsup","famsup","activities","higher",
"romantic",
                              "famrel","freetime","goout","Dalc","Walc","h
ealth","absences"])
douter.to_csv('outer.csv', index=False)

print(douter)
```

```
    school sex  age address famsize Pstatus  Medu  Fedu      Mjob      
Fjob  \
0       GP   F   18       U     GT3       A     4     4   at_home   tea
cher
1       GP   F   17       U     GT3       T     1     1   at_home     o
ther
2       GP   F   15       U     LE3       T     1     1   at_home     o
ther
3       GP   F   15       U     GT3       T     4     2    health  serv
ices
4       GP   F   16       U     GT3       T     3     3     other     o
ther
..     ...  ..  ...     ...     ...     ...   ...   ...       ...      
...
954     MS   F   19       R     GT3       T     2     3  services     o
ther
955     MS   F   18       U     LE3       T     3     1   teacher  serv
ices
956     MS   F   18       U     GT3       T     1     1     other     o
ther
957     MS   M   17       U     LE3       T     3     1  services  serv
ices
958     MS   M   18       R     LE3       T     3     2  services     o
ther

     ...  Walc health  absences  G1_x  G2_x  G3_x paid_y  G1_y  G2_y  G
3_y
0    ...     1      3         6   5.0   6.0   6.0    NaN   NaN   NaN   
NaN
1    ...     1      3         4   5.0   5.0   6.0    NaN   NaN   NaN   
NaN
2    ...     3      3        10   7.0   8.0  10.0    NaN   NaN   NaN   
NaN
3    ...     1      5         2  15.0  14.0  15.0    NaN   NaN   NaN   
NaN
4    ...     2      5         4   6.0  10.0  10.0    NaN   NaN   NaN   
NaN
..   ...   ...    ...       ...   ...   ...   ...    ...   ...   ...   
...
954  ...     2      5         4   NaN   NaN   NaN     no  10.0  11.0  1
0.0
955  ...     1      1         4   NaN   NaN   NaN     no  15.0  15.0  1
6.0
956  ...     1      5         6   NaN   NaN   NaN     no  11.0  12.0   
9.0
957  ...     4      2         6   NaN   NaN   NaN     no  10.0  10.0  1
0.0
958  ...     4      5         4   NaN   NaN   NaN     no  10.0  11.0  1
1.0

[959 rows x 37 columns]
```

In [51]:

```
#Calculating the average of the grades scored by students
d2['AvgGrade']= d2[['G1', 'G2', 'G3']].mean(axis=1)
d1['AvgGrade']= d1[['G1', 'G2', 'G3']].mean(axis=1)
```

In [52]:

```
#Pivot on Maths table
df = d1
pivot = pd.pivot_table(df,
             values = ['AvgGrade', 'G1', 'G2', 'G3'''],
             index = ['school',
                      'sex',
                     'famsize',
                      'paid',
                     'guardian'],
                       columns= ['Mjob'],
                       aggfunc=[np.mean],
                       margins=True).fillna('')
pivot
```

Out[52]:

					mean					
					AvgGrade					
				Mjob	**at_home**	**health**	**other**	**services**	**teacher**	**All**
school	**sex**	**famsize**	**paid**	**guardian**						
GP	**F**	**GT3**	**no**	**father**	8.11111	6.33333	9.11111	10.3333		9.187
				mother	7.76923	12.1667	9.74074	11.9048	14.5	9.939
				other	11.5556		6.5			9.533
			yes	**father**	9	16.1667	11.6667	12.8333		12.26
				mother	10.6667	14.5	9.01852	10.4444	10.3333	10.29
...	**...**	**...**	**...**	**...**	...	...	...	...	...	...
MS	**M**	**LE3**	**no**	**mother**	10			13.1667		11.58
			yes	**father**	12.6667					12.66
				mother					13	13.00
				other				9		9.000
All					9.76271	12.2353	10.0591	11.2071	11.2701	10.67

43 rows × 24 columns

In [53]:
```
# Pivot on Portuguese table
df = d2
pivot = pd.pivot_table(df,
            values = ['AvgGrade', 'G1', 'G2', 'G3'''],
            index = ['school',
                     'sex',
                    'famsize',
                     'paid',
                    'guardian'],
                      columns= ['Mjob'],
                      aggfunc=[np.mean],
                      margins=True).fillna('')
pivot
```

Out[53]:

					mean					
					AvgGrade					
				Mjob	**at_home**	**health**	**other**	**services**	**teacher**	**All**
school	**sex**	**famsize**	**paid**	**guardian**						
GP	**F**	**GT3**	**no**	**father**	13.125	14.8333	12.9091	12.9394		13.19
				mother	12.1884	15.1111	12.3203	12.2222	13.5385	12.59
				other	10	13.3333	11.3333		10	11.26
			yes	**mother**	10.8889		12	15.6667	11.3333	11.94
				other			11.3333	13		12.16
...	**...**	**...**	**...**	**...**	...	...	...	...	...	...
MS	**M**	**GT3**	**yes**	**father**			9			9.000
				mother	11		8.66667	10.5		10.33
		LE3	**no**	**father**	10.4444	10.5	12.3333		11.6667	11.42
				mother	9.45833		12.5	11.4444	15.6667	11.05
All					10.7358	12.7014	11.4574	11.826	12.7963	11.62

36 rows × 24 columns

In [54]:
```
# The merged table with data of students of both the school
final.describe()
```

Out[54]:

	age	Medu	Fedu	traveltime	studytime	failures	fam
count	959.000000	959.000000	959.000000	959.000000	959.000000	959.000000	959.0000
mean	16.755996	2.586027	2.364964	1.538060	1.958290	0.279458	3.914494
std	1.242473	1.116704	1.100514	0.739831	0.832741	0.672379	0.950216
min	15.000000	0.000000	0.000000	1.000000	1.000000	0.000000	1.000000
25%	16.000000	2.000000	1.000000	1.000000	1.000000	0.000000	4.000000
50%	17.000000	3.000000	2.000000	1.000000	2.000000	0.000000	4.000000
75%	18.000000	4.000000	3.000000	2.000000	2.000000	0.000000	5.000000
max	22.000000	4.000000	4.000000	4.000000	4.000000	3.000000	5.000000

In [55]:
```
# Categorical Data present in the table
categorical_features = (final.select_dtypes(include=['object']).columns.
values)
categorical_features
```

Out[55]:
```
array(['school', 'sex', 'address', 'famsize', 'Pstatus', 'Mjob', 'Fjo
b',
       'reason', 'guardian', 'schoolsup', 'famsup', 'paid_x', 'activiti
es',
       'nursery', 'higher', 'internet', 'romantic', 'paid_y'], dtype=ob
ject)
```

In [56]:
```
# Numerical / Non categorical data present in the table
numerical_features = final.select_dtypes(include = ['float64', 'int64'])
.columns.values
numerical_features
```

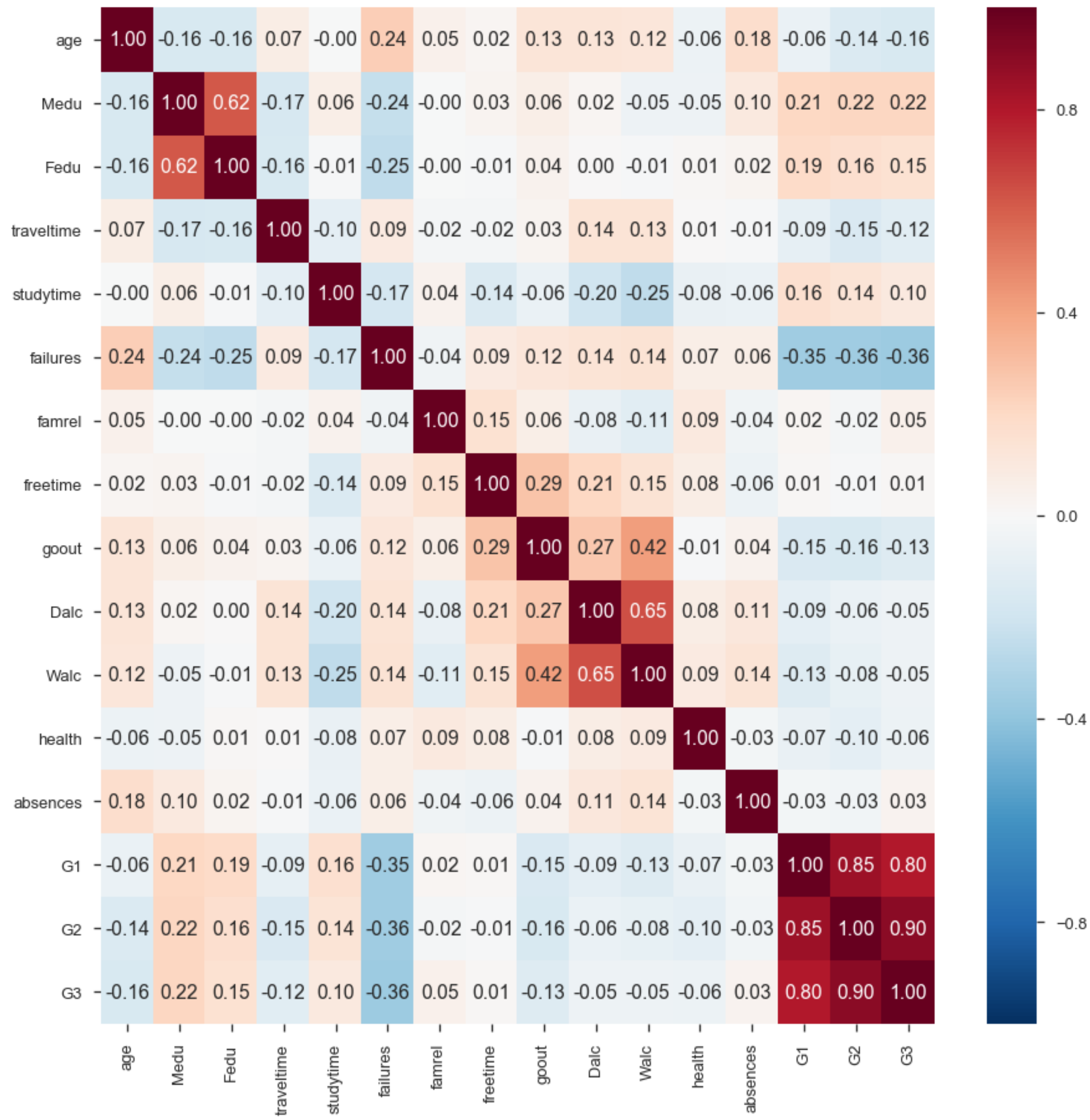
Out[56]:
```
array(['age', 'Medu', 'Fedu', 'traveltime', 'studytime', 'failures',
       'famrel', 'freetime', 'goout', 'Dalc', 'Walc', 'health', 'absenc
es',
       'G1_x', 'G2_x', 'G3_x', 'G1_y', 'G2_y', 'G3_y'], dtype=object)
```

Correlation between features

For broad perspective lets look at first correlation of features.

In [22]:
```python
plt.figure(figsize=(15,15))
sns.heatmap(d1.corr(),annot = True,fmt = ".2f",cbar = True)
plt.xticks(rotation=90)
plt.yticks(rotation = 0)
```

Out[22]:
```
(array([  0.5,   1.5,   2.5,   3.5,   4.5,   5.5,   6.5,   7.5,   8.5,
          9.5,  10.5,  11.5,  12.5,  13.5,  14.5,  15.5]),
 <a list of 16 Text yticklabel objects>)
```

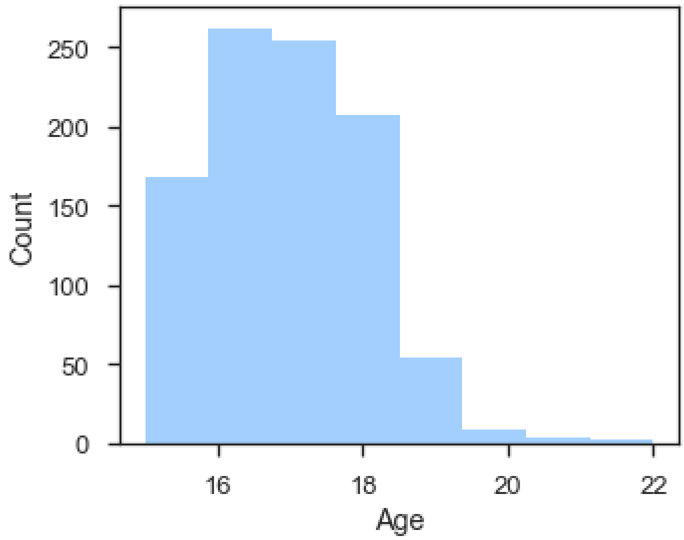


As it can be seen from correlation map the education of parents, alcohol consumption of students and exam scores are highly correlated with each other.

EDA

1. At what age students consumes more alcohol?

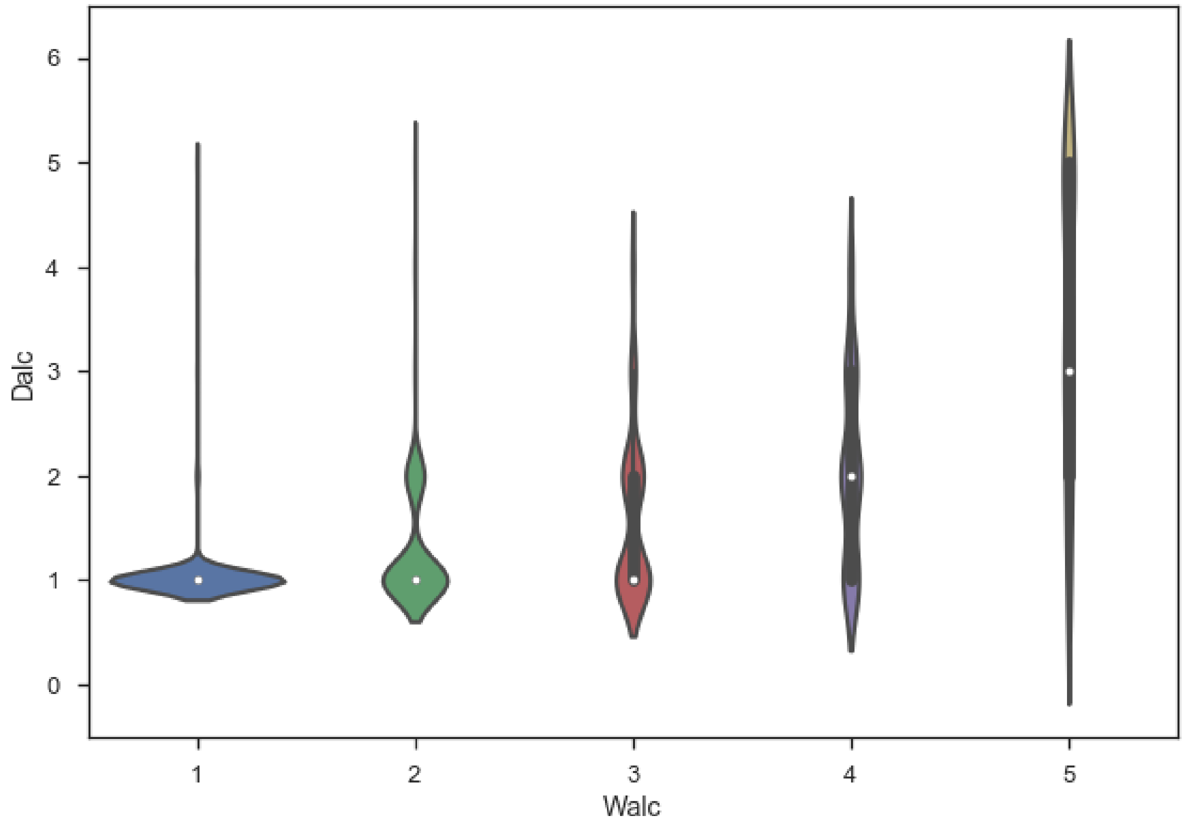
In [26]:
```
fig, ax = plt.subplots(figsize=(5, 4))
sns.distplot(final['age'],
             hist_kws={"alpha": 1, "color": "#a2cffe"},
             kde=False, bins=8)
ax = ax.set(ylabel="Count", xlabel="Age")
```



We conclude that teenagers drink more alcohol compared to adults

2. Students consume more alcohol on weekend or weekday?

In [16]:
```
sns.violinplot(x="Walc", y="Dalc", data=final);
```

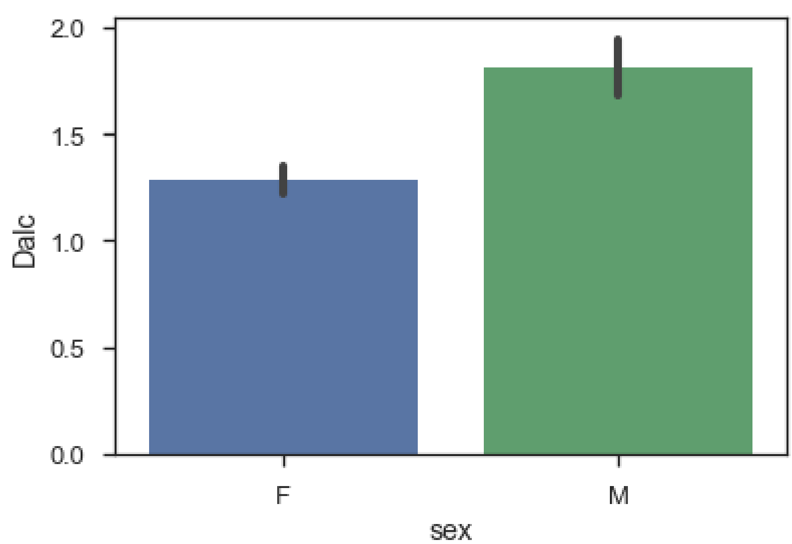


Students drink more alcohol on Weekend

3. Which gender consumes more alcohol on daily basis?

In [20]:
```
sns.barplot(x = "sex", y = "Dalc",data = d2)
```

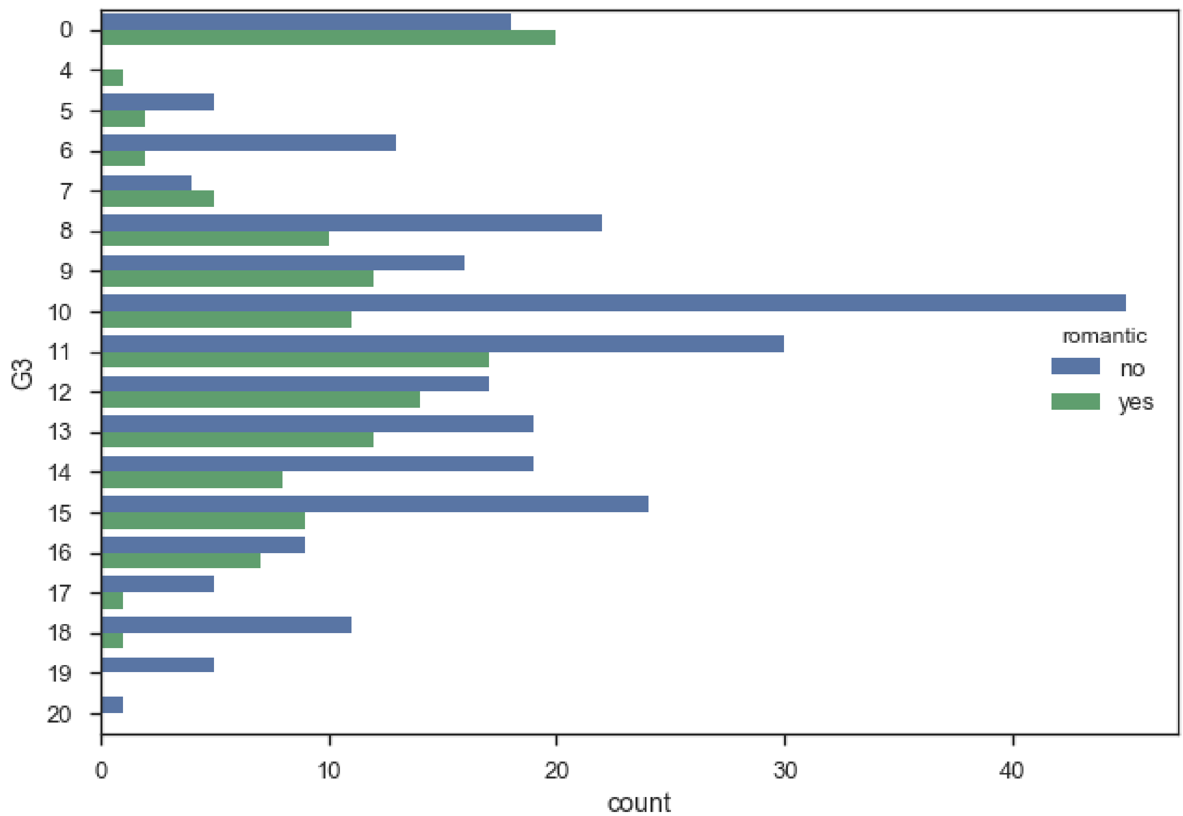
Out[20]: <matplotlib.axes._subplots.AxesSubplot at 0x112c2b128>



So, we see that males consume more alcohol as compared to females on daily basis

4. How do students in romantic relationship score?

In [27]:
```
sns.countplot(hue="romantic", y="G3", data=d1);
```



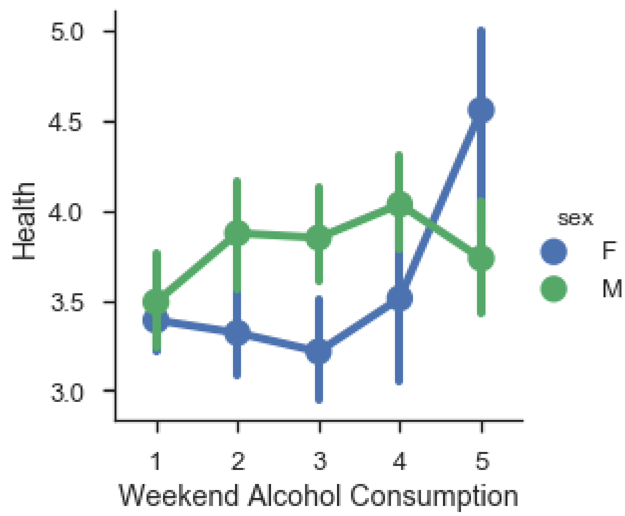
As we see students who are in a romantic relationship score less

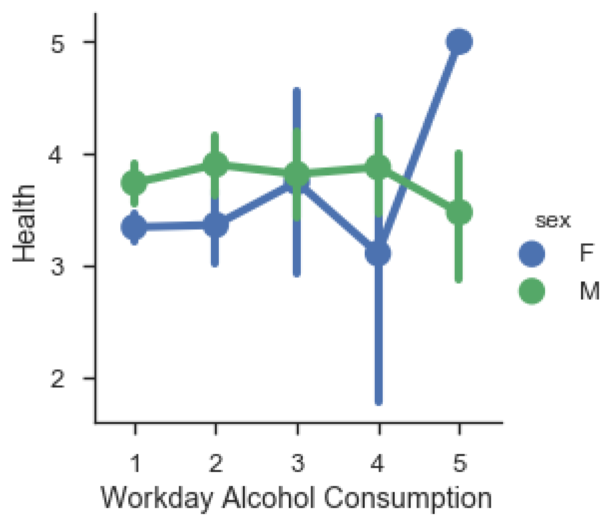
5. The health of which gender is most affected by alcohol consumption?

In [34]:
```
plot1 = sns.factorplot(x="Walc", y="health", hue="sex", data=final)
plot1.set(ylabel="Health", xlabel="Weekend Alcohol Consumption")

plot2 = sns.factorplot(x="Dalc", y="health", hue="sex", data=final)
plot2.set(ylabel="Health", xlabel="Workday Alcohol Consumption")
```

Out[34]: <seaborn.axisgrid.FacetGrid at 0x185ceed8da0>





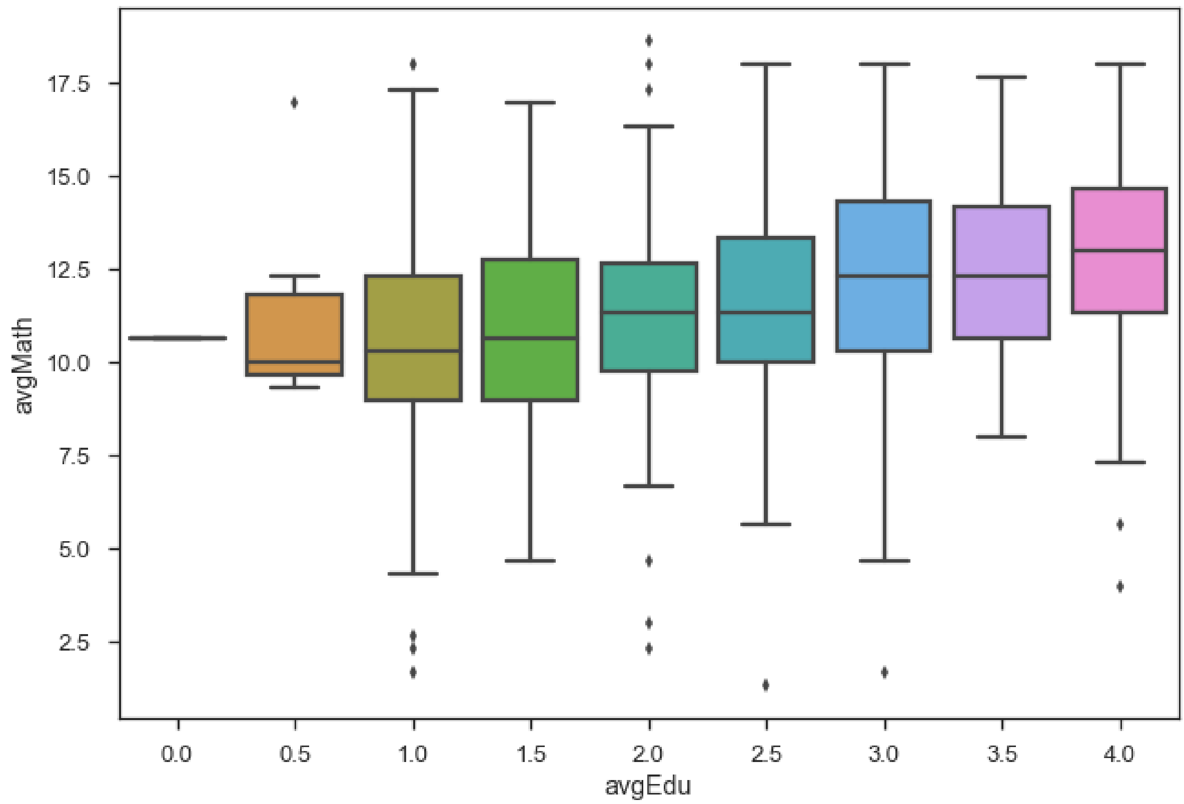
Females heath is more affected by consumption of alcohol

6. Do students whose parents have higher education score good grades?

In [24]:
```
d2['avgMath']= d2[['G1', 'G2', 'G3']].mean(axis=1)
d2['avgEdu']=d2[['Medu','Fedu']].mean(axis=1)

#Lets consider a plot between the student grades to how well educated an
y of the parent is!
sns.boxplot(x = "avgEdu", y = "avgMath", data = d2)
```

Out[24]: <matplotlib.axes._subplots.AxesSubplot at 0x11a4379b0>



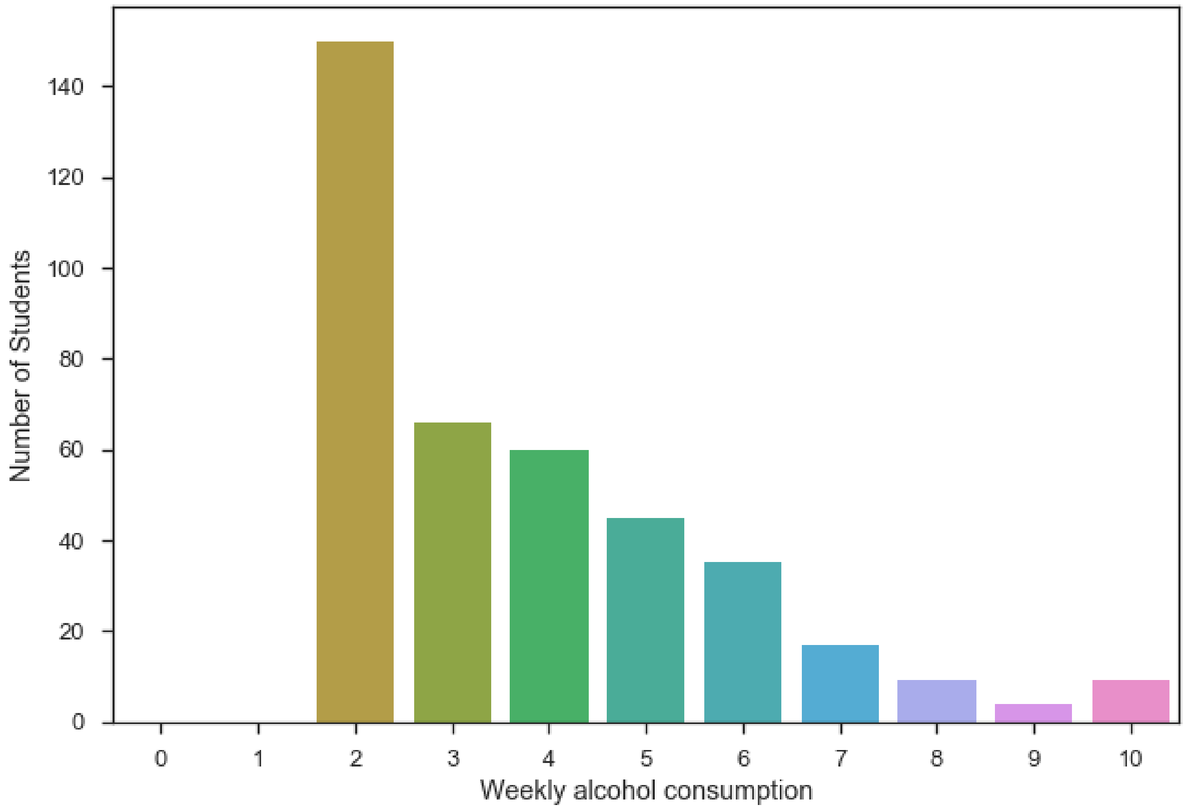
Students whose parents are more qualified tend to get higher grades

7. What is the weekly frequency of students to consume alcohol?

There is no student who does not consume alcohol. However, all students at least 2 times in a week consume alcohol.

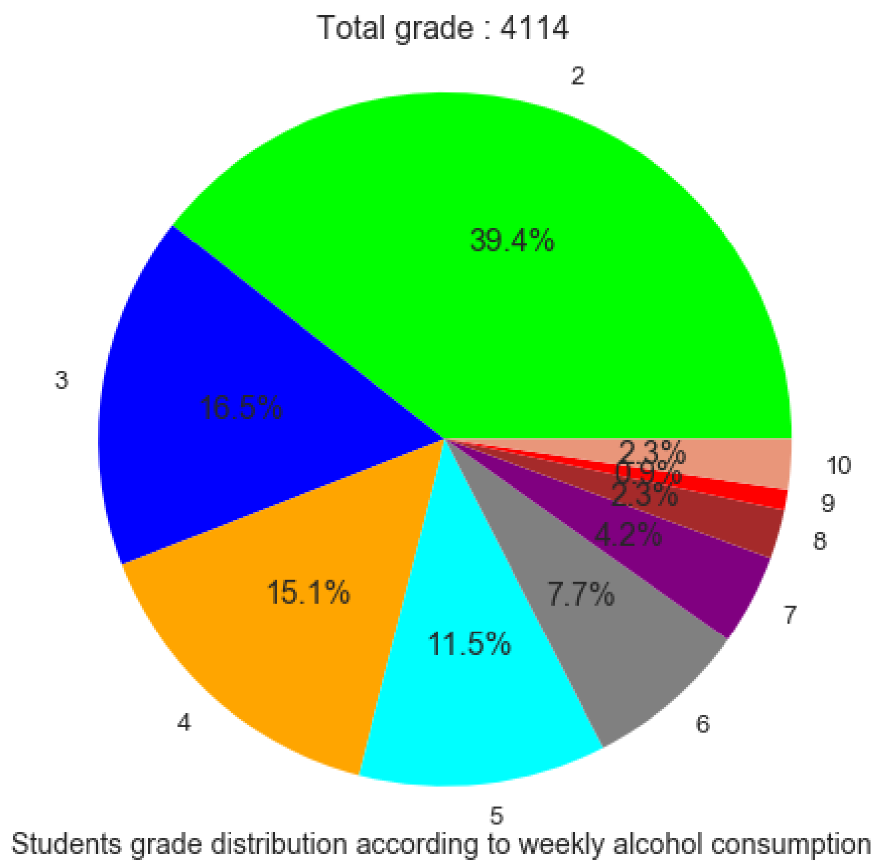
In [18]:
```
d1['Dalc'] = d1['Dalc'] + d1['Walc']
list = []
for i in range(11):
    list.append(len(d1[d1.Dalc == i]))
ax = sns.barplot(x = [0,1,2,3,4,5,6,7,8,9,10], y = list)
plt.ylabel('Number of Students')
plt.xlabel('Weekly alcohol consumption')
```

Out[18]: <matplotlib.text.Text at 0x119b1f278>



In [20]:
```
labels = ['2','3','4','5','6','7','8','9','10']
colors = ['lime','blue','orange','cyan','grey','purple','brown','red','d
arksalmon']
explode = [0,0,0,0,0,0,0,0,0]
sizes = []
for i in range(2,11):
    sizes.append(sum(d1[d1.Dalc == i].G3))
total_grade = sum(sizes)
average = total_grade/float(len(d1))
plt.pie(sizes,explode=explode,colors=colors,labels=labels,autopct = '%1.
1f%%')
plt.axis('equal')
plt.title('Total grade : '+str(total_grade))
plt.xlabel('Students grade distribution according to weekly alcohol cons
umption')
```

Out[20]: <matplotlib.text.Text at 0x119b27dd8>

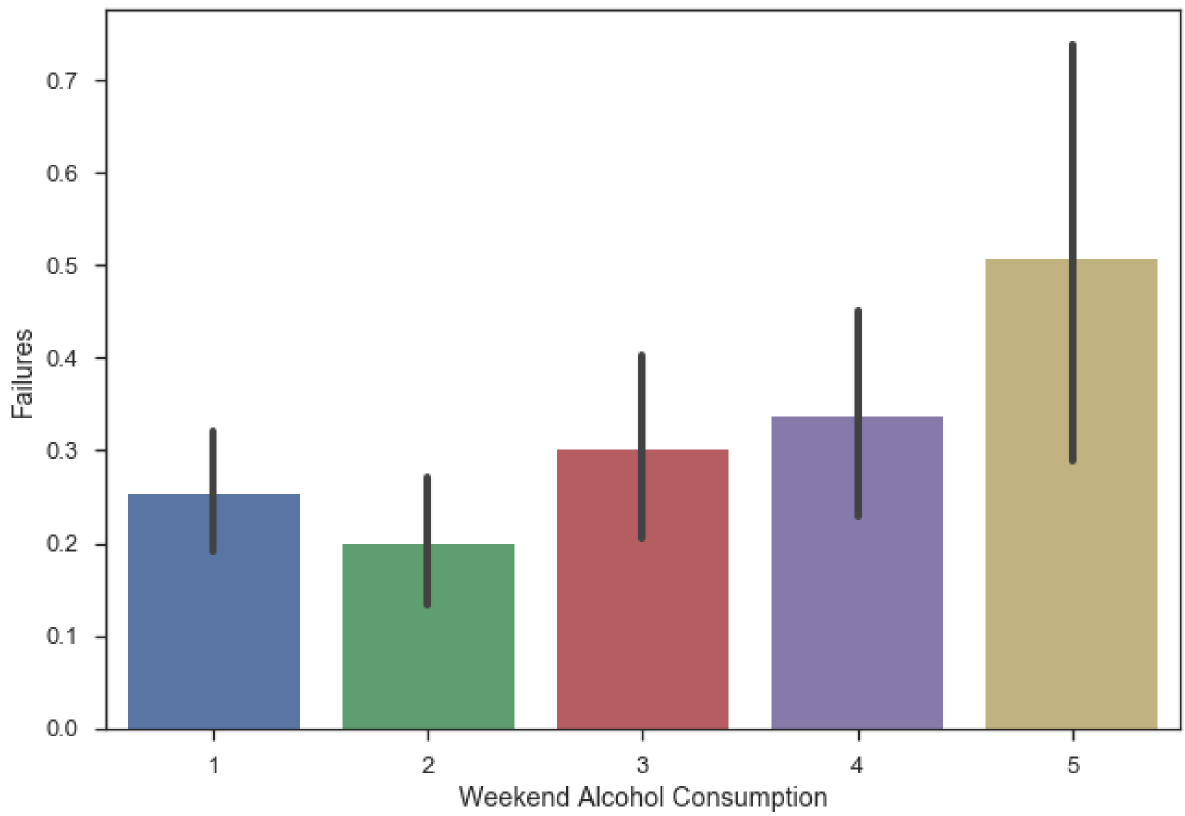


We see that students who drink alcohol less score better grades

8. What is failure rate of the students consuming alcohol on weekend?

In [39]:
```
plot1 = sns.barplot(x="Walc", y="failures", data=douter)
plot1.set(ylabel="Failures", xlabel="Weekend Alcohol Consumption")
```

Out[39]:
```
[<matplotlib.text.Text at 0x185cf2f6908>,
 <matplotlib.text.Text at 0x185d0e07fd0>]
```



We see that students who consume more alcohol on weekends tend to have higher failure rate

Machine Learning

In [66]:
```
from sklearn.model_selection import train_test_split
from sklearn import linear_model
from sklearn.preprocessing import LabelEncoder
from sklearn.model_selection import cross_val_predict
import matplotlib.pyplot as plt
```

1. Logistic Regression

In [67]:
```
#Machine Learning models - Logistic
X=d2[['traveltime','studytime','G3','Dalc','Walc']] #Predictors
y=d2['sex'] #Response Variable
```

In [116]:
```
# 40% Test Data, 60% Training Data
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.4,
 random_state=59)
```

from sklearn.linear_model import LogisticRegression

In [91]:
```
log=LogisticRegression()
```

In [92]:
```
log.fit(X_train,y_train)
```

Out[92]:
```
LogisticRegression(C=1.0, class_weight=None, dual=False, fit_intercept=
True,
          intercept_scaling=1, max_iter=100, multi_class='ovr', n_jobs=
1,
          penalty='l2', random_state=None, solver='liblinear', tol=0.00
01,
          verbose=0, warm_start=False)
```

In [93]:
```
predicts=log.predict(X_test)
```

In [94]:
```
from sklearn.metrics import classification_report,confusion_matrix
```

In [95]:
```
print(classification_report(y_test,predicts))
print('\n')
print(confusion_matrix(y_test,predicts))
```

```
             precision    recall  f1-score   support

          F       0.75      0.81      0.78       163
          M       0.63      0.55      0.59        97

avg / total       0.71      0.71      0.71       260



[[132  31]
 [ 44  53]]
```

2. Linear Regression

In [40]:
```
import statsmodels.api as sm
from sklearn import linear_model
#Linear Regression
X=d2[['age','Medu','Fedu','absences','G1','G2']]
y=d2['G3']
```

```
/Users/ruchi/anaconda/lib/python3.6/site-packages/statsmodels/compat/pa
ndas.py:56: FutureWarning: The pandas.core.datetools module is deprecat
ed and will be removed in a future version. Please use the pandas.tseri
es module instead.
  from pandas.core import datetools
```

In [41]:
```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.4,
 random_state=59)
```

regr = linear_model.LinearRegression() regr.fit(X_train, y_train)# Now we can just create a data frame to store this values of coefficients in a data frame

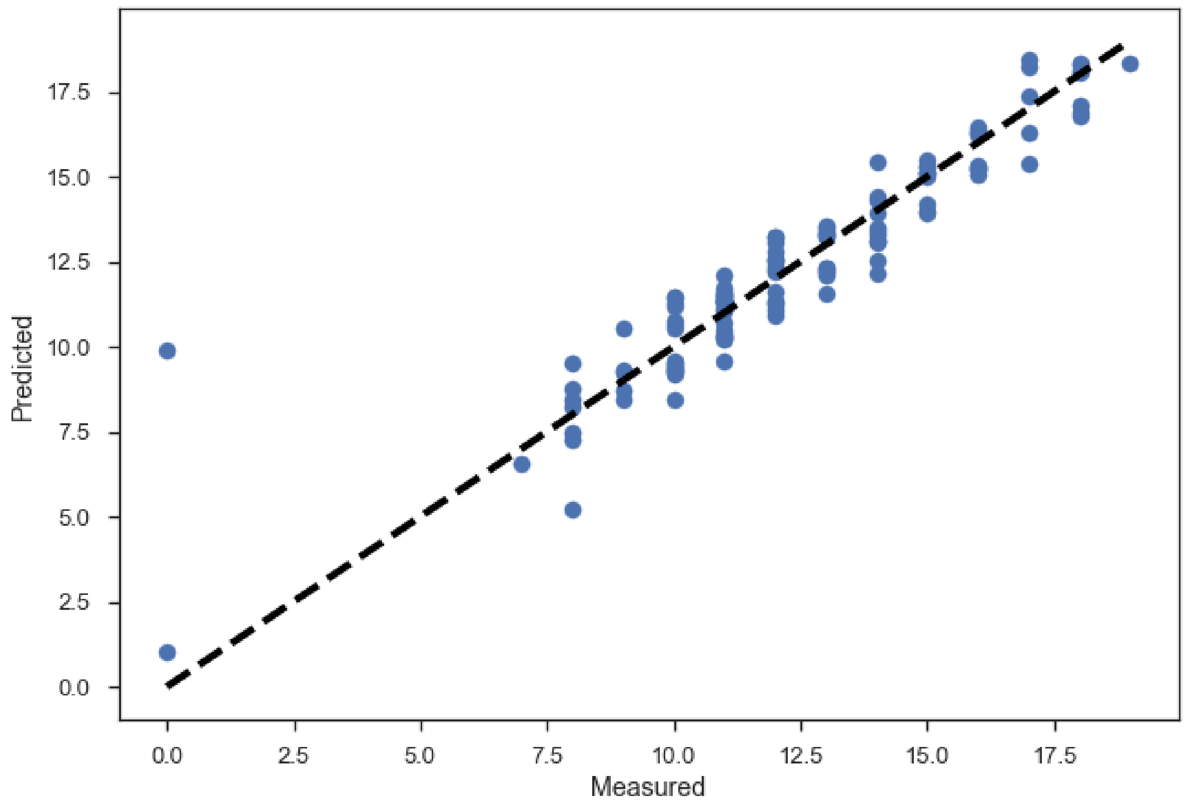
cdf=pd.DataFrame(lm.coef_,X_train.columns,columns= ['Coefficient'])

In [43]:
```
# Now we can just create a data frame to store this values of coefficien
ts in a data frame
cdf=pd.DataFrame(regr.coef_,X_train.columns,columns=['Coefficient'])
cdf
```

Out[43]:

	Coefficient
age	0.035736
Medu	0.017232
Fedu	0.026441
absences	0.030022
G1	0.173771
G2	0.847473

In [100]:
```
#10 samples
predicted = cross_val_predict(regr, X_test, y_test, cv=10)
fig, ax = plt.subplots()
ax.scatter(y_test, predicted)
ax.plot([y.min(), y.max()], [y.min(), y.max()], 'k--', lw=4)
ax.set_xlabel('Measured')
ax.set_ylabel('Predicted')
plt.show()
```



As we can see that it is a perfect linear fit. So the predictors Age, Medu, Fedu, Absences, G1 and G2 are strongly related to the response variable G3

In [45]:
```
model = sm.OLS(y, X)
results=model.fit()
results.summary()
```

Out[45]:

OLS Regression Results

Dep. Variable:	G3	**R-squared:**	0.990
Model:	OLS	**Adj. R-squared:**	0.990
Method:	Least Squares	**F-statistic:**	1.023e+04
Date:	Mon, 11 Dec 2017	**Prob (F-statistic):**	0.00
Time:	00:58:21	**Log-Likelihood:**	-1068.7
No. Observations:	649	**AIC:**	2149.
Df Residuals:	643	**BIC:**	2176.
Df Model:	6		
Covariance Type:	nonrobust		

	coef	**std err**	**t**	**P>|t|**	**[0.025**	**0.975]**
age	-0.0152	0.013	-1.196	0.232	-0.040	0.010
Medu	-0.0387	0.058	-0.667	0.505	-0.153	0.075
Fedu	0.0231	0.059	0.391	0.696	-0.093	0.139
absences	0.0202	0.011	1.854	0.064	-0.001	0.042
G1	0.1523	0.036	4.283	0.000	0.082	0.222
G2	0.8985	0.034	26.316	0.000	0.831	0.966

Omnibus:	463.984	**Durbin-Watson:**	1.855
Prob(Omnibus):	0.000	**Jarque-Bera (JB):**	10445.450
Skew:	-2.887	**Prob(JB):**	0.00
Kurtosis:	21.787	**Cond. No.**	36.3

R-squared which is goodness of fit is 99%, so it is a very good fit

In [108]:
```
from sklearn.model_selection import train_test_split
X=d2[['age','Medu','Fedu','absences','G1','G2']]
y=d2['G3']
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.20
, random_state=42)
```

3. Decision Tree Classifier

In [106]:
```
from sklearn import tree
from sklearn import metrics
clf = tree.DecisionTreeClassifier()
clf = clf.fit(X_train, y_train)
clf.score(X_train, y_train)
```

Out[106]: 0.98714652956298199

4. Matrix Accuracy

In [114]:
```
y_pred = clf.predict(X_test)
acc_test = metrics.accuracy_score(y_test,y_pred)
acc_test
```

Out[114]: 0.76923076923076927

5. Random Forest Classifier

In [115]:
```
from sklearn.ensemble import RandomForestClassifier
forest = RandomForestClassifier(n_estimators = 100)
forest = forest.fit(X_train, y_train)
forest.score(X_train, y_train)
y_pred = forest.predict(X_test)
acc_test = metrics.accuracy_score(y_test,y_pred)
acc_test
```

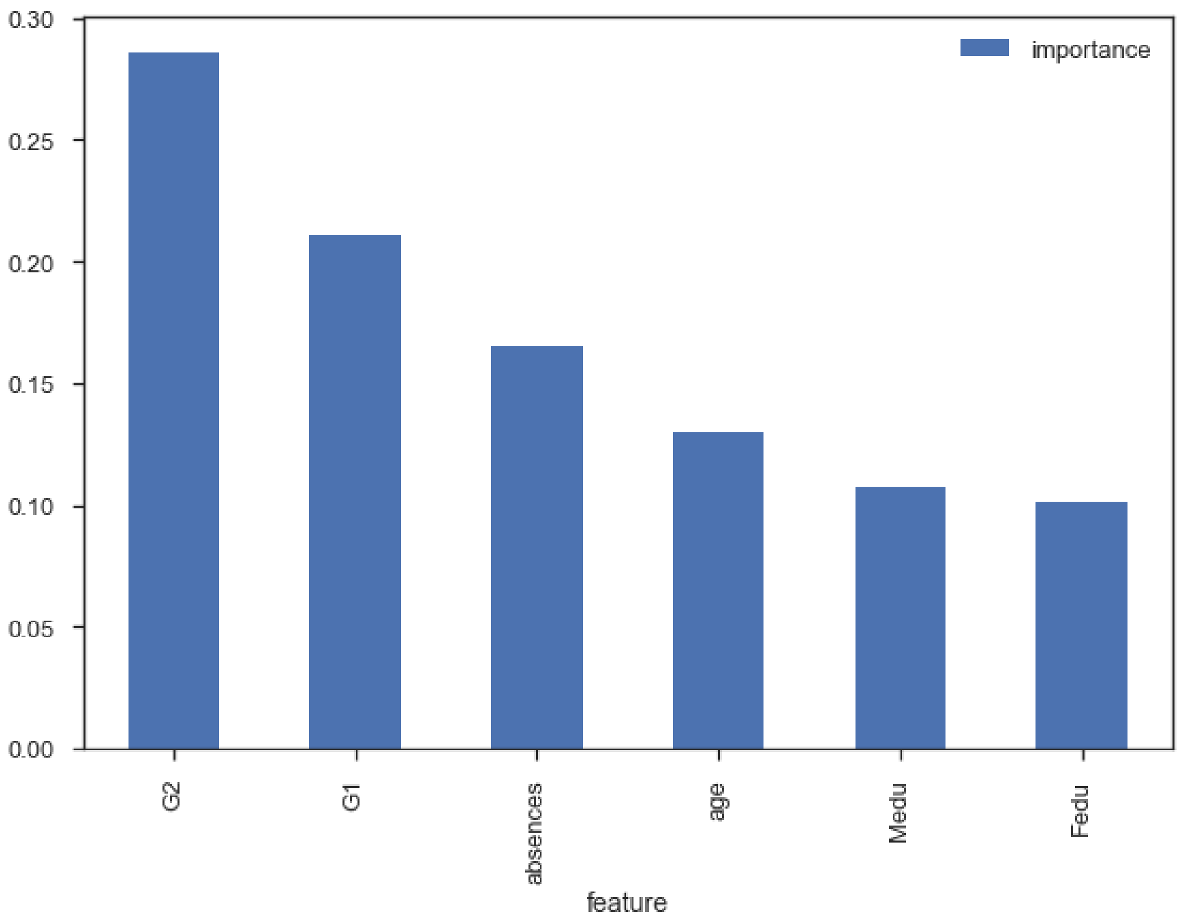
Out[115]: 0.43846153846153846

Important Features

In [111]:
```
importances = pd.DataFrame({'feature':X_train.columns,'importance':np.ro
und(forest.feature_importances_,3)})
importances = importances.sort_values('importance',ascending=False).set_
index('feature')
print (importances)
importances.plot.bar()
```

```
          importance
feature
G2             0.286
G1             0.211
absences       0.165
age            0.130
Medu           0.107
Fedu           0.101
```

Out[111]: `<matplotlib.axes._subplots.AxesSubplot at 0x11a722668>`



Grades G1 and G2 are most important feature for predicting final grade G3

Conclusion:

- The failure rate of students who consume alcohol frequently is more.
- Students whose parents are more qualified tend to get higher grades

References:

- https://www.kaggle.com/calcifer/alcohol-consumption-and-average-grades/data (https://www.kaggle.com/calcifer/alcohol-consumption-and-average-grades/data)
- https://seaborn.pydata.org/tutorial/categorical.html (https://seaborn.pydata.org/tutorial/categorical.html)

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