

# Applying Bayesian Methods for GPA Prediction

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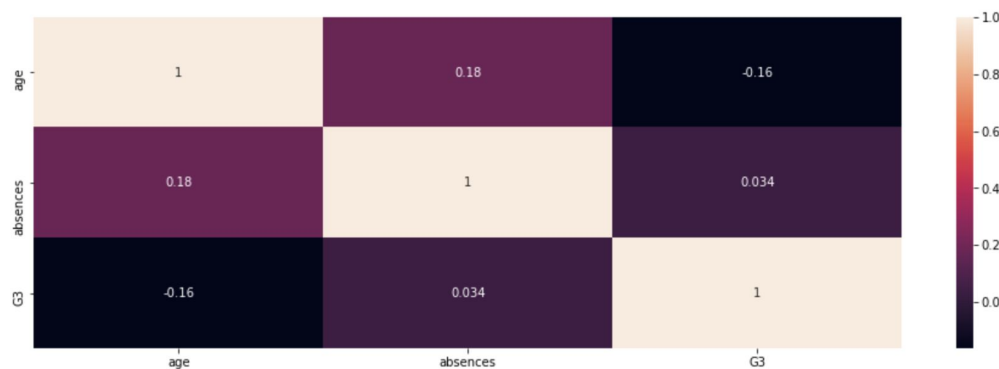
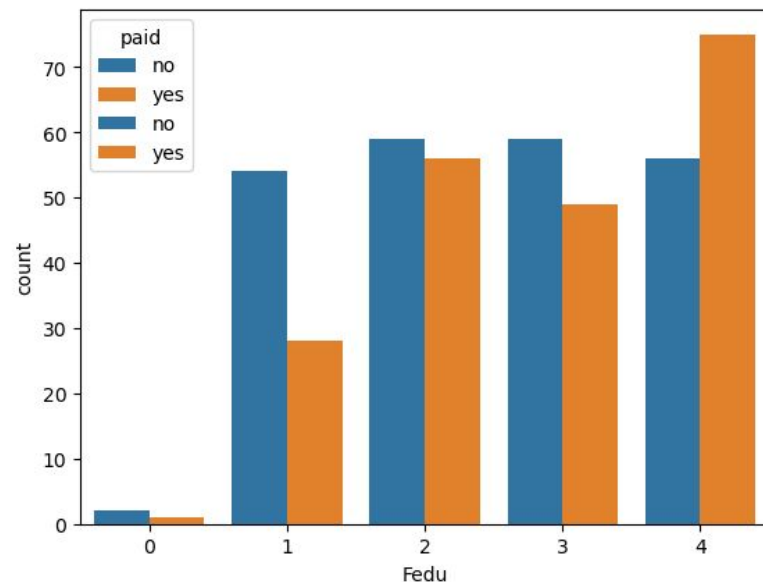
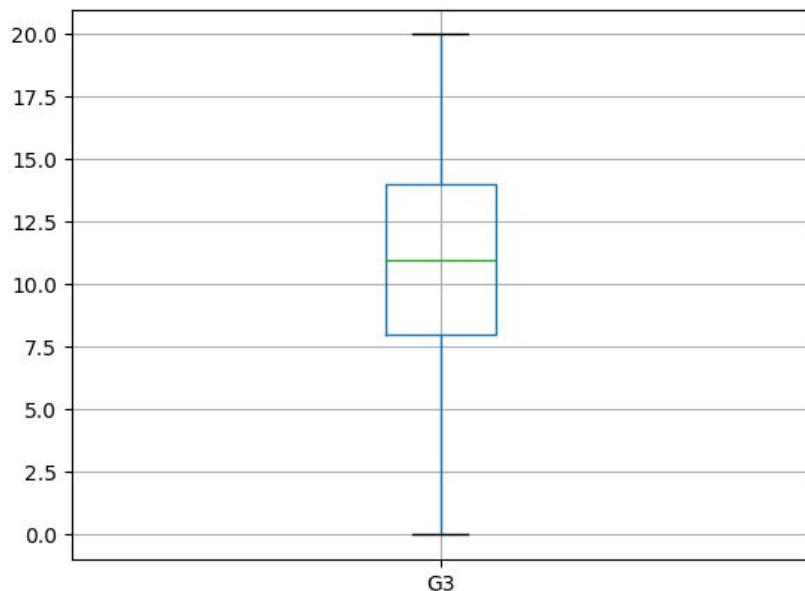


# Problem Description

- Analyzing extrinsic factors affecting student performance
  - Implement bayesian modeling techniques to measure uncertainty surrounding academic success
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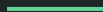
# The Data

- Survey data - Secondary School students in Porto, Portugal
- 400 entries, 33 features
- Mostly categorical



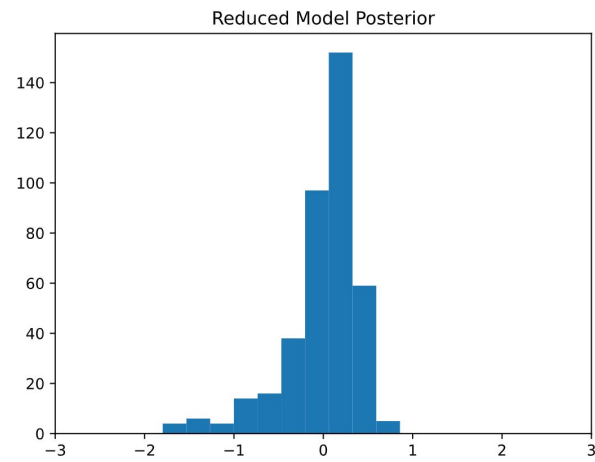
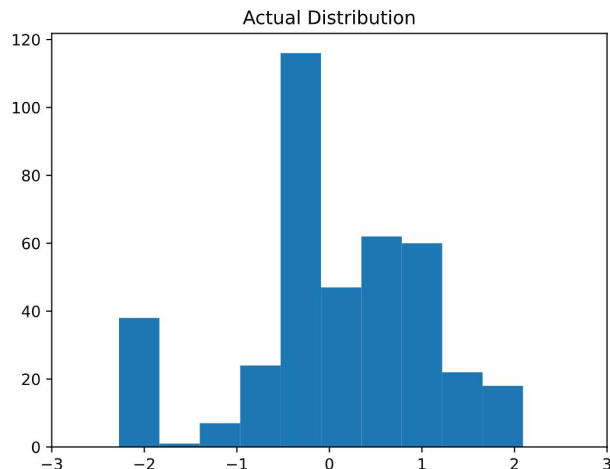
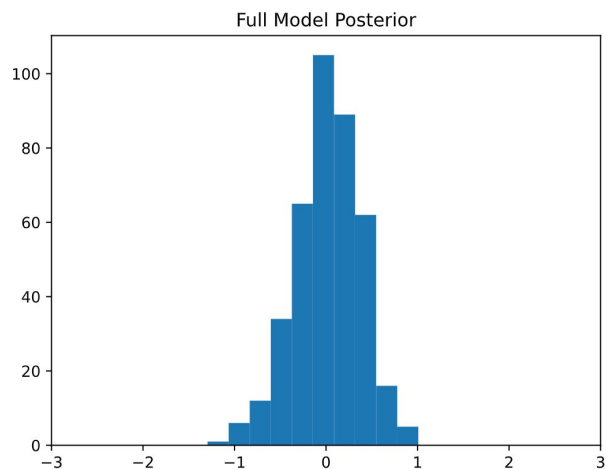
# Our Approach

- Bayesian Regression
- Bayesian Additive Regression Trees (BART)



# Bayesian Regression

- Full model and Reduced model
- Predictors for Reduced model
  - Rid one of predictors with high correlation
  - “Common sense”



# Bayesian Regression

- Comparison
  - Reduced model significantly better
  - Attempted Bayesian Model Averaging; Reduced model was 100% weighted

	rank	waic	p_waic	d_waic	weight	se	dse	warning	waic_scale
<b>reduced_model</b>	0	-537.823060	15.453466	0.000000	1.0	15.371176	0.000000	True	log
<b>full_model</b>	1	-2907.968088	18.825506	2370.145028	0.0	15.842441	21.576382	True	log

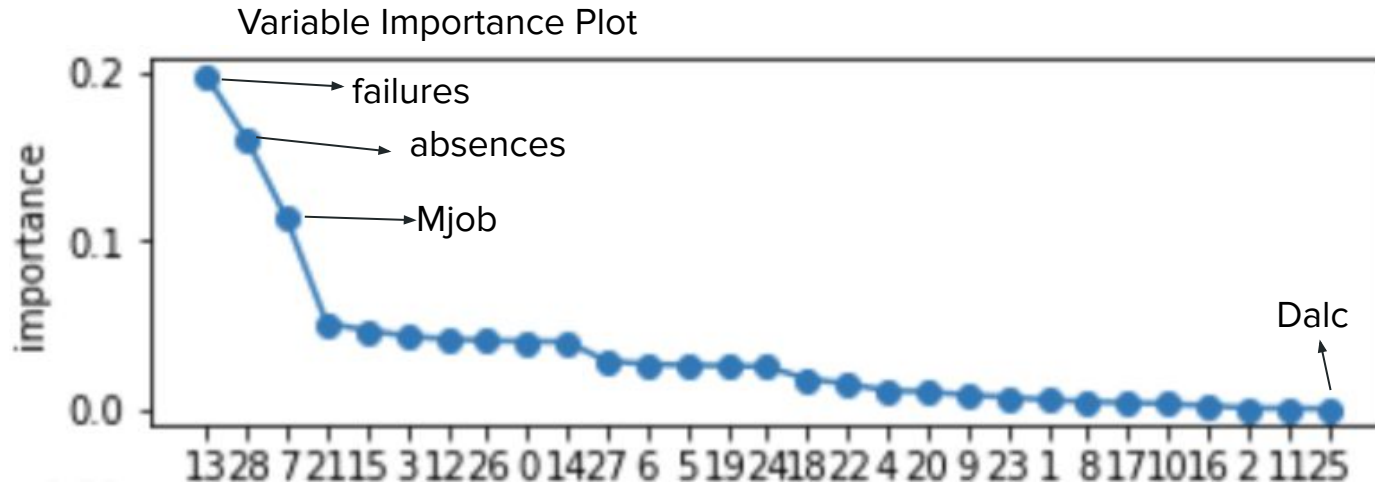
	rank	loo	p_loo	d_loo	weight	se	dse	warning	loo_scale
<b>reduced_model</b>	0	-537.913650	15.544056	0.000000	1.0	15.073266	0.000000	False	log
<b>full_model</b>	1	-2908.112402	18.969821	2370.198752	0.0	15.495354	21.588761	False	log

# BART

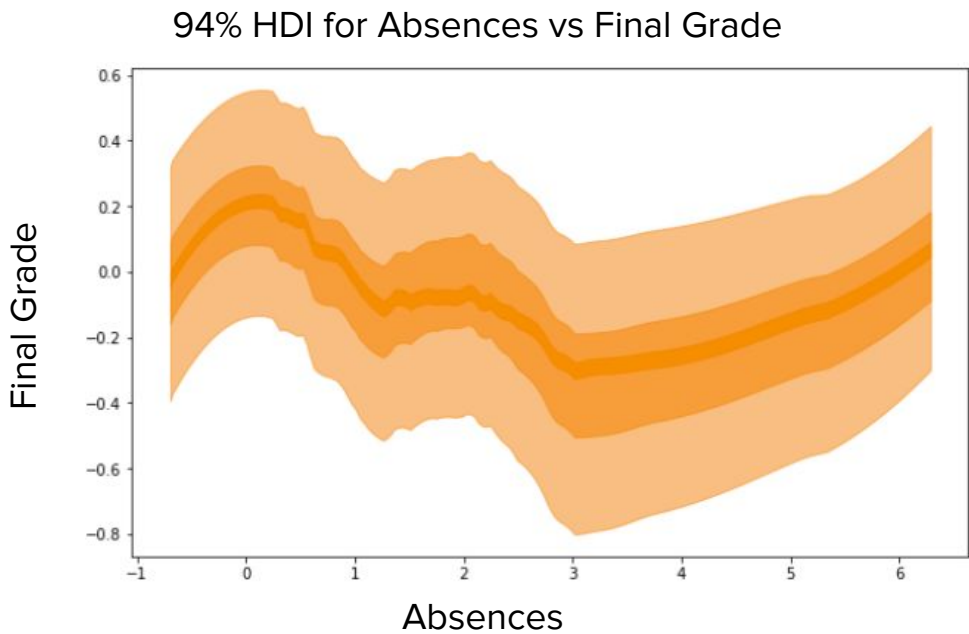
- ❖ Needed to explore ideal combination of predictors following poor performance of the full and reduced models

Advantages:

- ❖ Inherently includes regularization
- ❖ Detects nonlinear relationships
- ❖ Flexible functional form between predictors and response



# BART Results



	mean	sd	hdi_3%	hdi_97%	mcse_mean	mcse_sd	ess_bulk	ess_tail	r_hat
$\mu[131]$	-0.246	0.236	-0.688	0.167	0.023	0.016	108.0	374.0	1.0
$\mu[145]$	0.387	0.173	0.049	0.697	0.015	0.011	128.0	286.0	1.0
$\mu[92]$	0.172	0.162	-0.121	0.489	0.012	0.009	174.0	480.0	1.0
$\mu[177]$	0.592	0.197	0.230	0.941	0.016	0.012	147.0	413.0	1.0
$\mu[148]$	0.660	0.183	0.300	1.001	0.016	0.011	139.0	303.0	1.0
$\mu[218]$	0.205	0.189	-0.167	0.534	0.014	0.010	184.0	376.0	1.0
$\mu[36]$	0.118	0.185	-0.241	0.460	0.015	0.010	166.0	302.0	1.0
$\mu[150]$	-0.736	0.251	-1.228	-0.297	0.022	0.015	136.0	458.0	1.0
$\mu[213]$	0.611	0.201	0.257	1.018	0.017	0.012	142.0	273.0	1.0
$\mu[87]$	-0.743	0.234	-1.190	-0.317	0.019	0.013	156.0	371.0	1.0
$\mu[231]$	-0.198	0.184	-0.551	0.129	0.017	0.012	121.0	292.0	1.0
$\mu[210]$	0.285	0.215	-0.106	0.706	0.019	0.013	136.0	358.0	1.0
$\mu[202]$	-0.809	0.243	-1.266	-0.364	0.019	0.014	161.0	260.0	1.0



# BART and the other Linear Regression Models

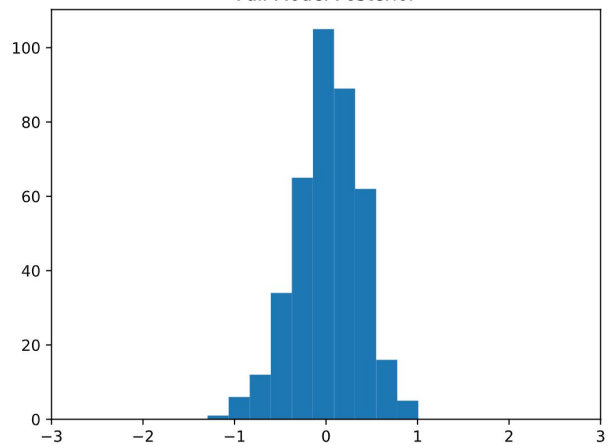
WAIC:

	rank	waic	p_waic	d_waic	weight	se	dse	warning	waic_scale
<b>BART_model</b>	0	-516.519476	64.287705	0.000000	0.999776	15.078966	0.000000	True	log
<b>reduced_model</b>	1	-537.823060	15.453466	21.303584	0.000224	15.617628	6.073060	True	log
<b>full_model</b>	2	-2907.968088	18.825506	2391.448612	0.000000	14.945587	21.012322	True	log

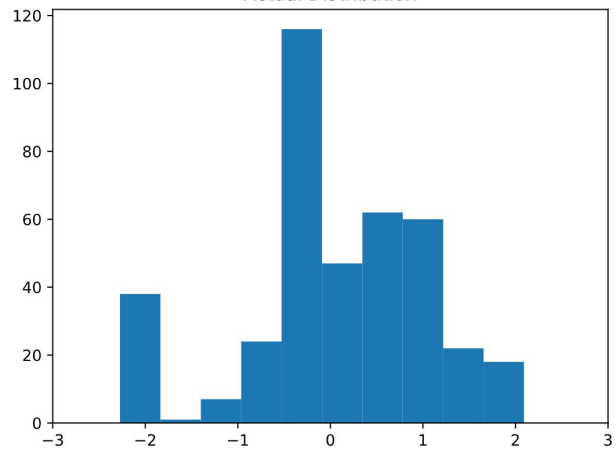
LOO:

	rank	loo	p_loo	d_loo	weight	se	dse	warning	loo_scale
<b>BART_model</b>	0	-518.825772	66.594001	0.000000	0.998476	15.258798	0.000000	True	log
<b>reduced_model</b>	1	-537.913650	15.544056	19.087878	0.001524	15.304307	6.100669	False	log
<b>full_model</b>	2	-2908.112402	18.969821	2389.286630	0.000000	14.607212	21.117330	False	log

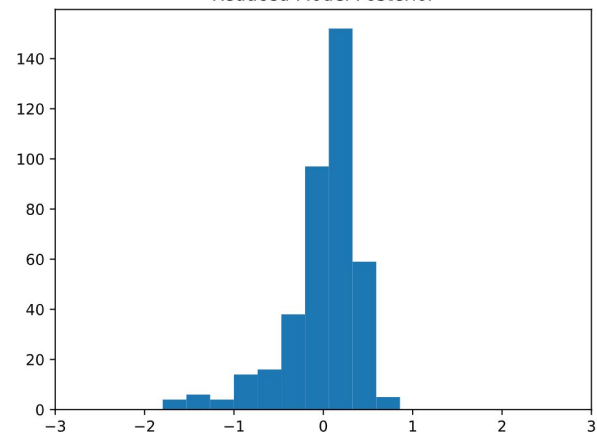
Full Model Posterior



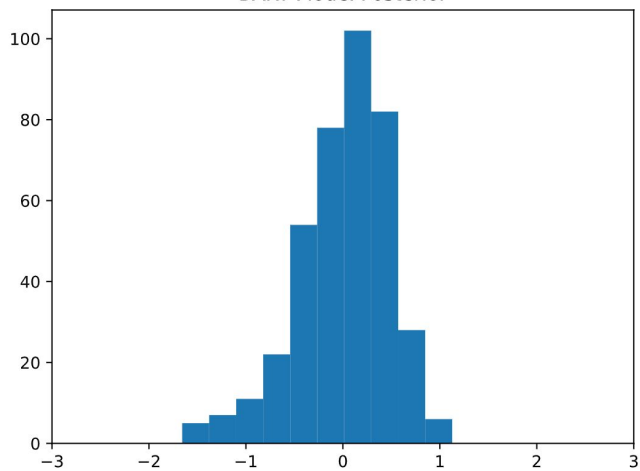
Actual Distribution



Reduced Model Posterior



BART Model Posterior



# Conclusions

- Did we achieve our goal?
- Limitations of our work



# Did we achieve our goal?

We were able to measure uncertainty surrounding the influence of the predictor variables; however, our model does a poor job predicting final grades.

└→ Bayesian Model Averaging

## Limitations:

- Don't have data about location of where these students are from - could indicate whether a student has barriers to outside support resources such as tutoring etc.
- Have not accounted to what extent intrinsic factors play a role here
- Skewness in some variables

Thank you!

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