

Data-driven Sales Leads Prediction

for Everything-as-a-Service in the Cloud

Data Scientists @ IBM Cloud | **Chul Sung, Bo Zhang, Chunhui Higgins**

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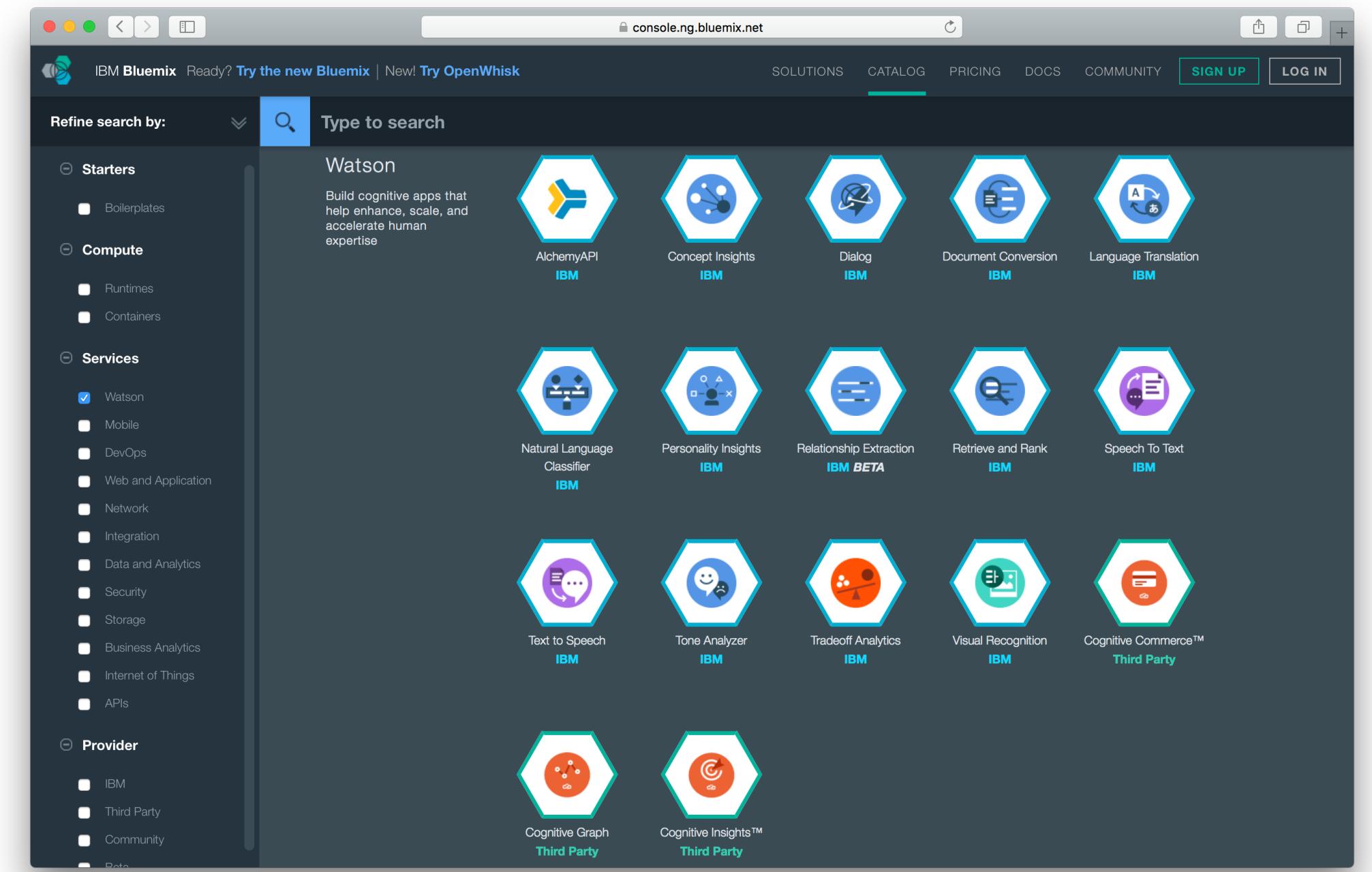
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October 19, 2016 at IEEE DSAA 2016

IBM Bluemix

- A **hybrid cloud development platform** to access a catalog of services and APIs, on which customers can build and run their apps
- It is a **compelling** platform:
 - **Widest selection** of compute choices for scalable, enterprise production apps such as bare metal, virtual servers, cloud foundry, and containers
 - **Big data and analytics for insights** beyond all needs
 - **Watson** for instant cognitive capabilities into apps and services
 - Over **one million** visiting customers



Cognitive Era with IBM Bluemix

- **IBM Bluemix** helps to run scalable analytics solutions like Streaming Analytics or AlchemyData News to get results in seconds.
- You can improve decisions and outcomes with Retrieve and Rank.



Streaming
Analytics



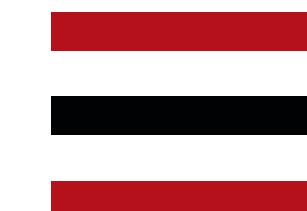
Retrieve and
Rank



AlchemyData



Geospatial
Analytics



Challenge

IBM Bluemix is **growing rapidly** in popularity, but ...

- A key challenge is how to **engage with a huge number of customers** while optimizing sales and marketing performance.
- It is nearly impossible to understand behaviors of the customers without **an inter-team collaboration** among various stakeholders.

On top of these challenges ...

DDBA Challenge

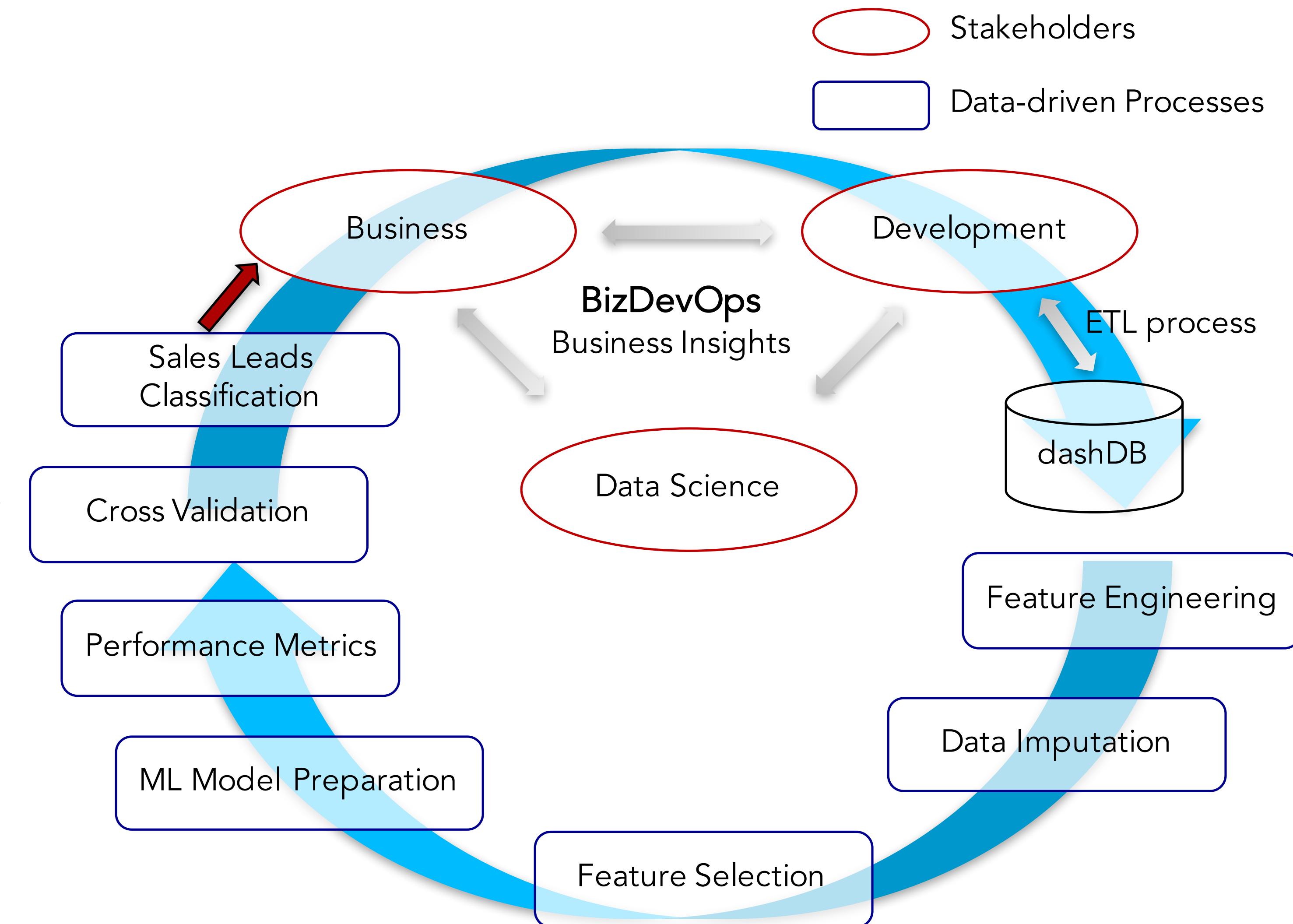
Additional challenges to **recognize high profile customers** in Data-driven Business Analysis (DDBA):

- **heavy customer traffic flows**
- conversion to **meaningful and consumable** features
- handling **missing values** of some customer behaviors
- **class imbalance problem** – the actual paying customer class represented by only a few tuples
- constantly **changing environment** – business models (providing services) and user behaviors

Iterative Prediction Framework

BizDevOps – fills in the gap between the actual business goals and DevOps deliverables.

Iterative – to adapt to a continuously changing environment.

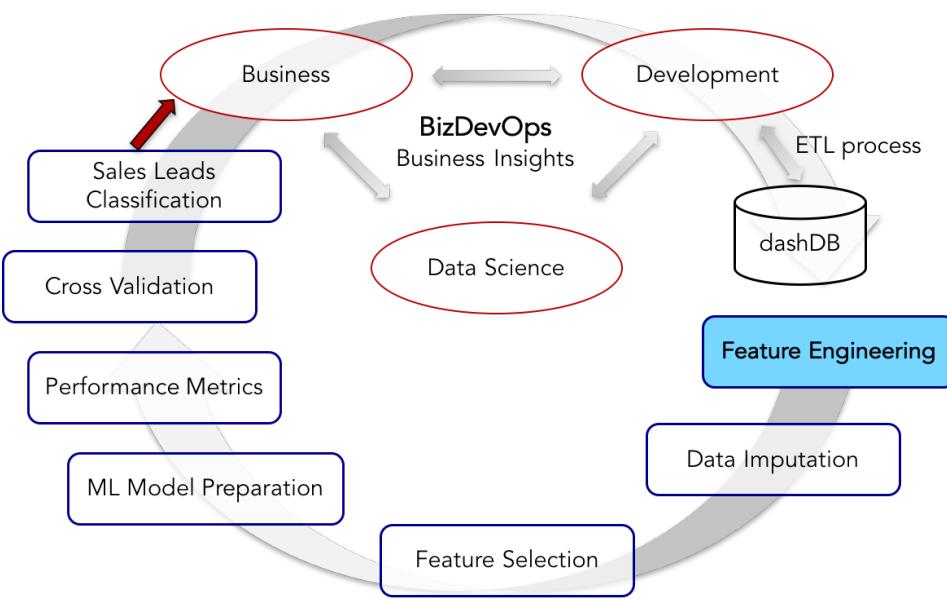
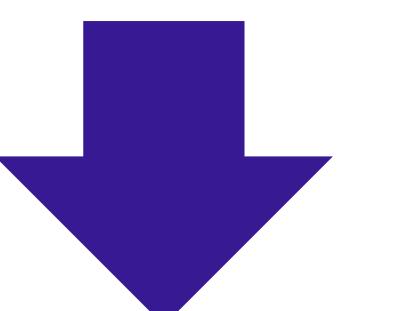


Feature Engineering (1)

- application creation
- application update
- service creation
- service binding creation
- service binding deletion
- service usage
- runtime usage

RFD Analysis

*R*ecency + *F*requency + *D*uration

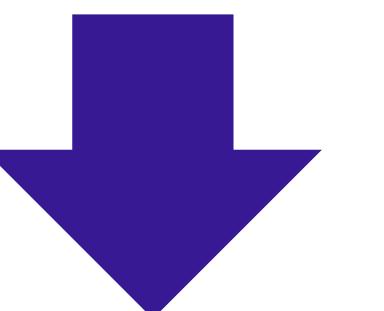


Feature Engineering (2)

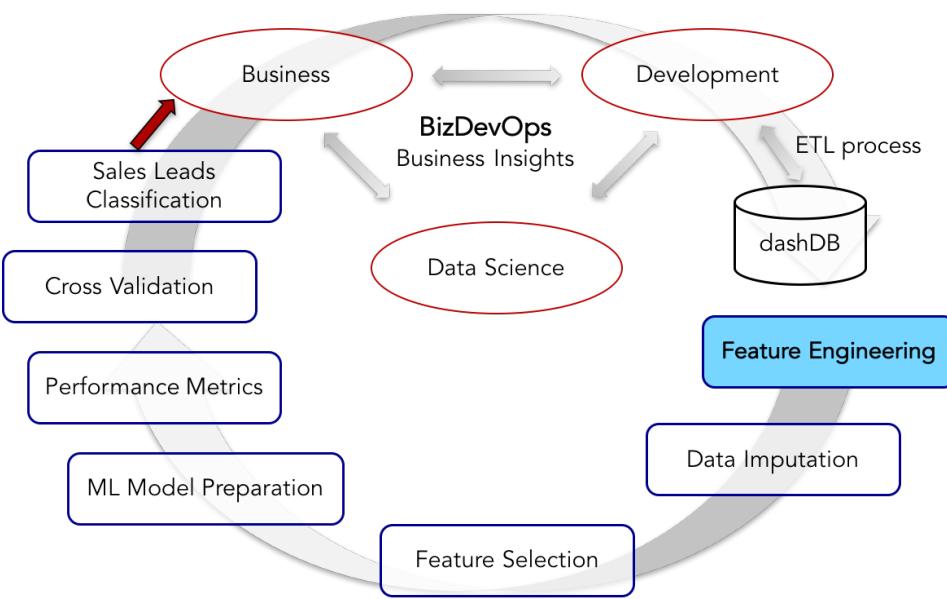
- customer account
 - applications
 - services

L Analysis

Lifetime

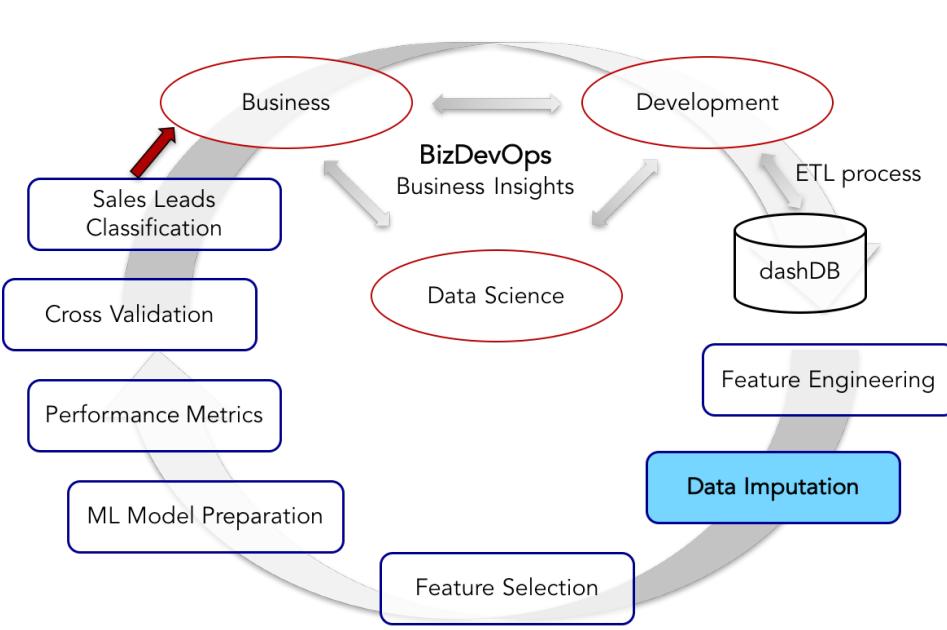


total **24** features



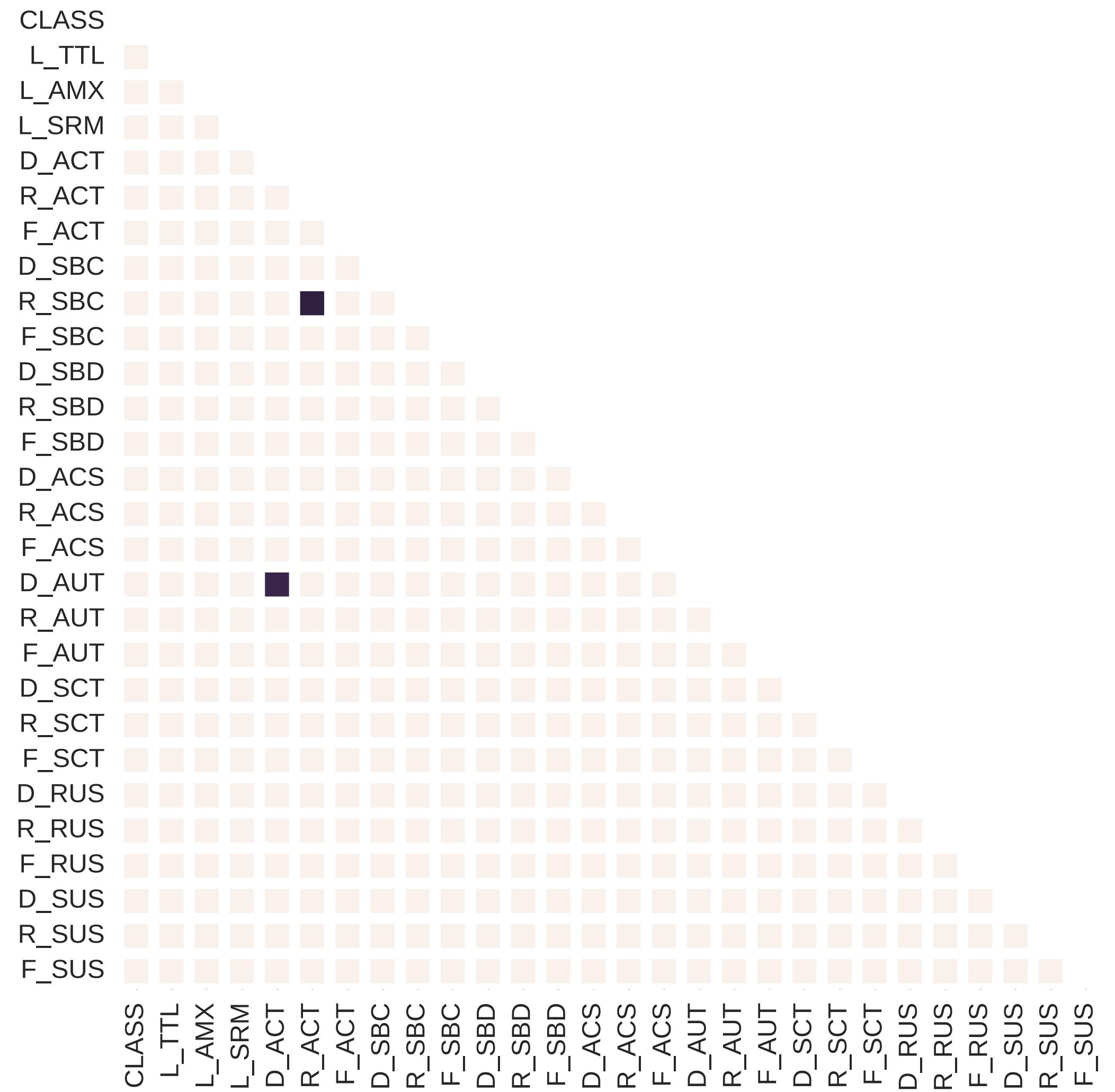
Data Completion

- Ignoring instances having null values
- null values to the mean of close group
- **null values to max or min of values** – in the way which least affects the data
 - less Recency/Duration values more informative, so **max** of values for the attributes
 - bigger Frequency/Lifetime values more informative, so **min** of values for the attributes

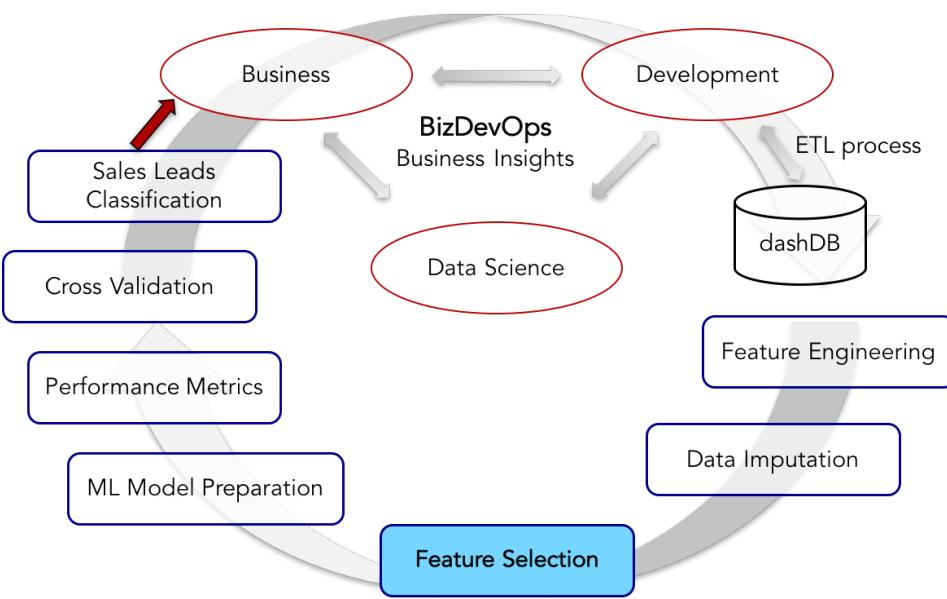


Feature Selection - C_95

Using **Pearson's correlation**, eliminate highly correlated features:
(R_SBC, R_ACT*) and
(D_ACT, D_AUT*)
over THR. |0.95|



* We dropped the red ones.



Feature Selection - C_90

Using **Pearson's correlation**,
eliminate highly correlated
features:

(R_SBC, R_SBD, R_ACT*),

(D_ACT, D_AUT*),

(F_SBC, F_ACT*),

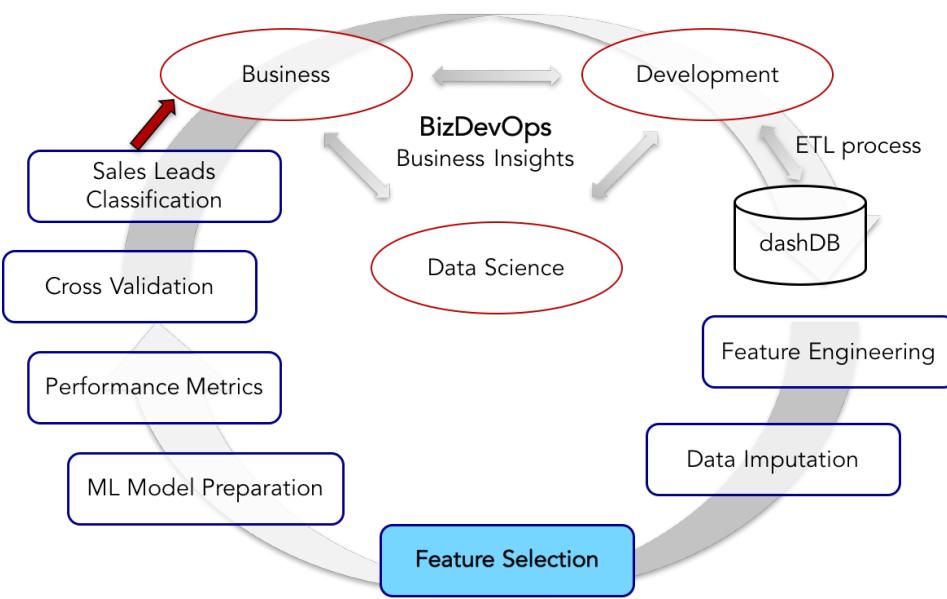
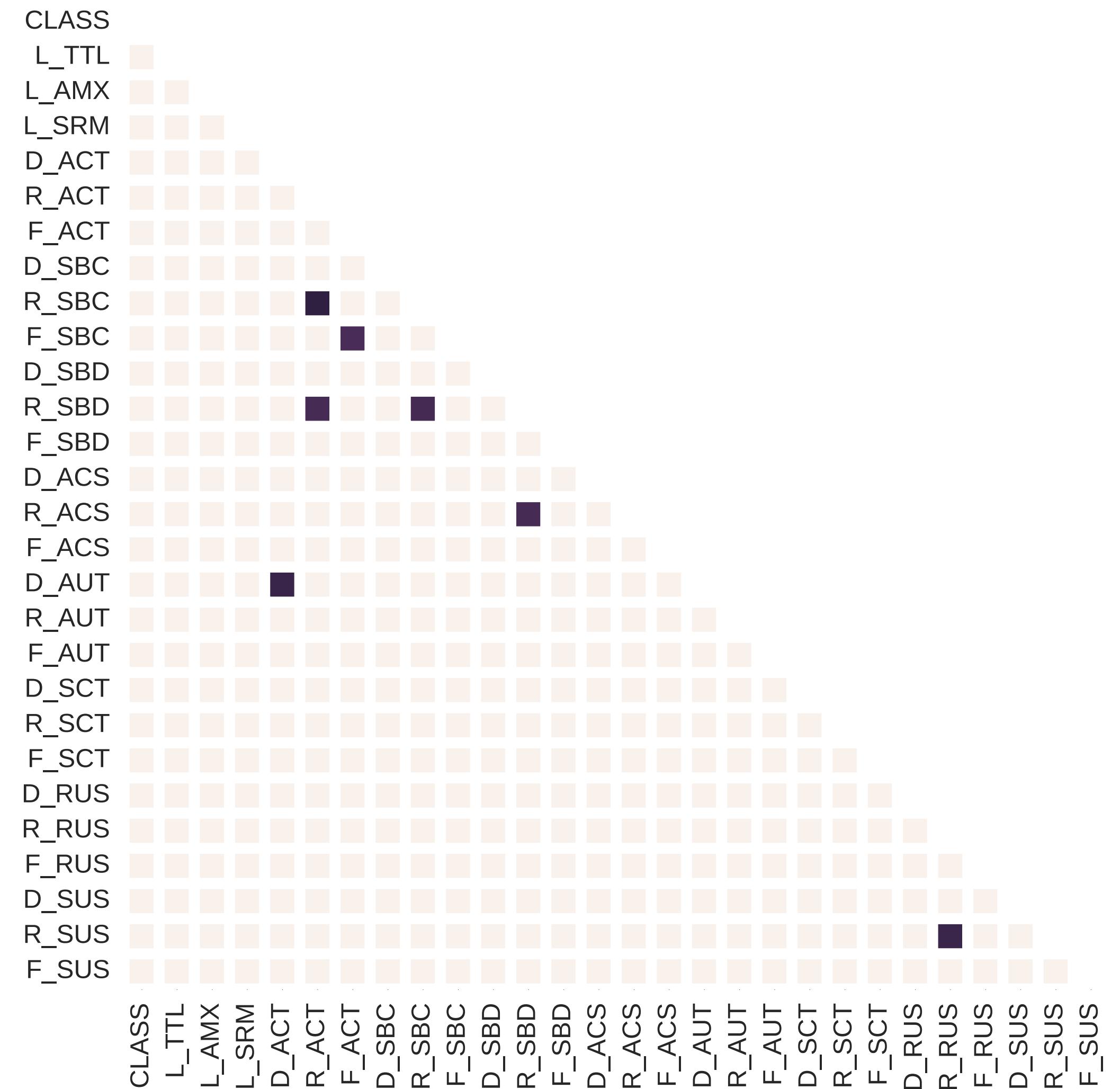
(R_ACS*, R_SBD),

(D_AUT, D_ACT*), and

(R_SUS*, R_RUS)

over THR. |0.90|

* We dropped the red ones.



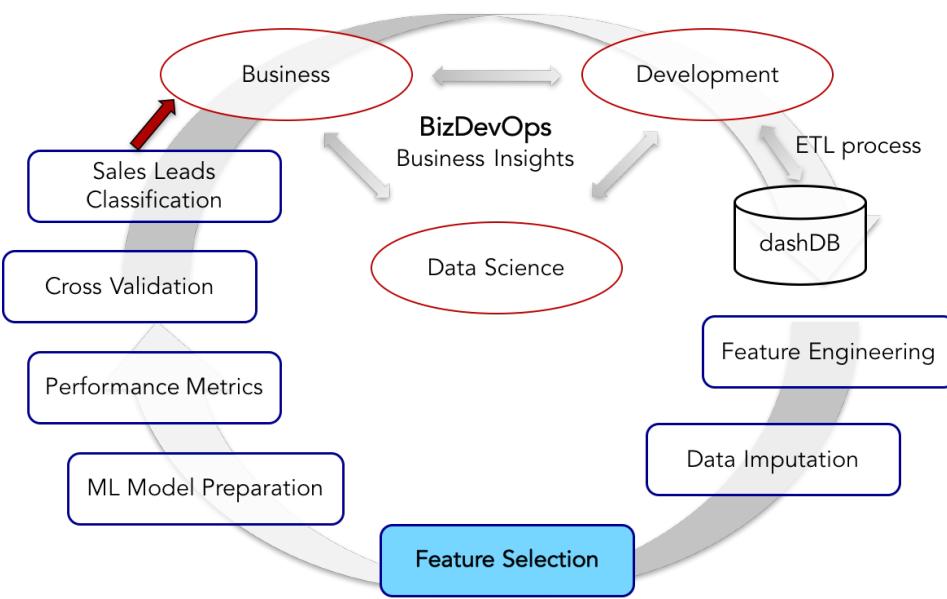
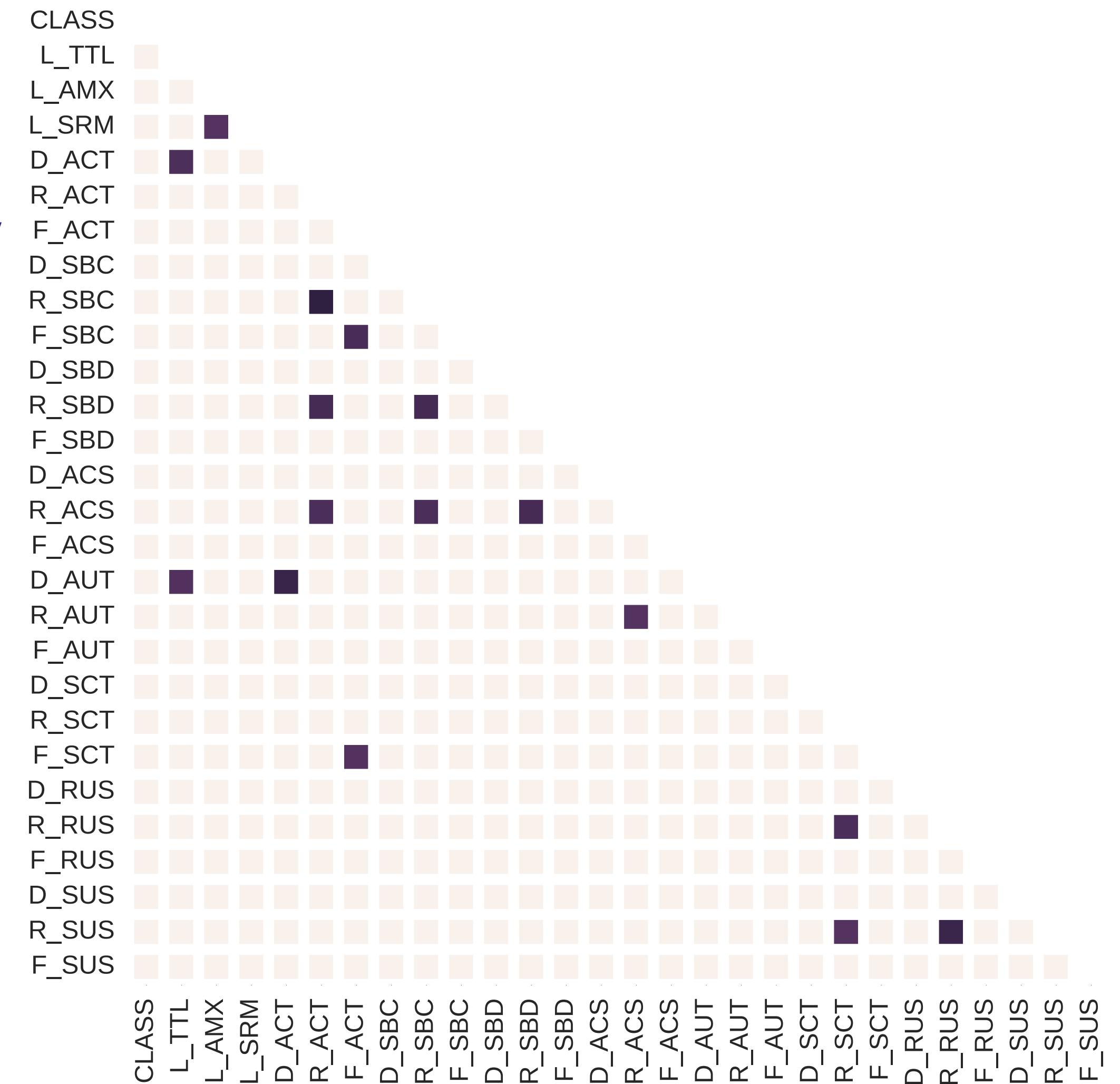
Feature Selection - C_85

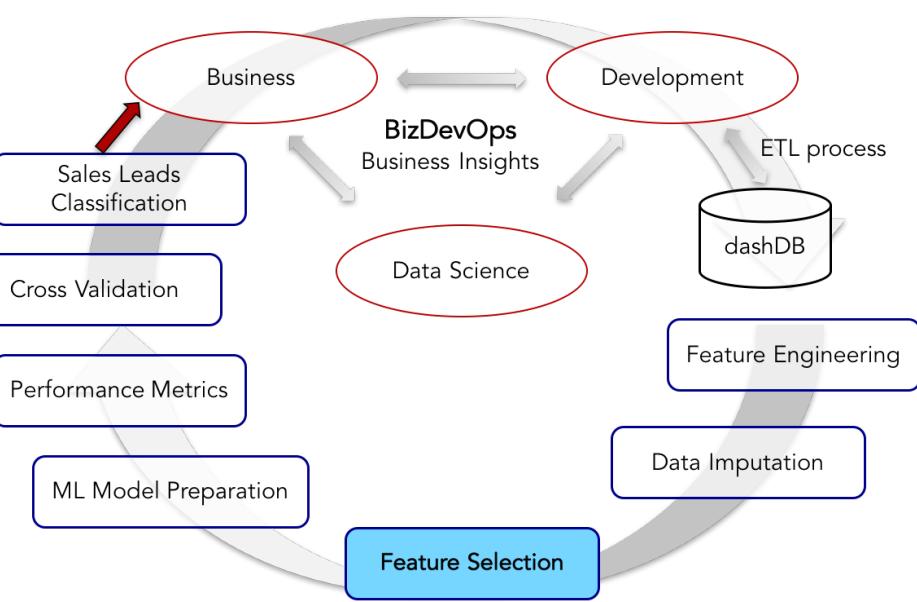
Using **Pearson's correlation**, eliminate highly correlated features:

(R_SBC, R_SBD, R_ACT*), (D_ACT, D_AUT*),
(F_SBC, F_ACT*), (R_ACS*, R_SBD),
(D_AUT, D_ACT*), (R_SUS*, R_RUS),
(L_SRM, L_AMX*), (D_ACT*, L_TTL),
(D_AUT, L_TTL), (R_AUT*, R_ACS),
(F_SCT*, F_ACT), (R_ACS*, R_ACT),
(R_ACS*, R_SBC), and
(R_RUS*, R_SUS, R_SCT)

over THR. |0.85|

* We dropped the red ones.

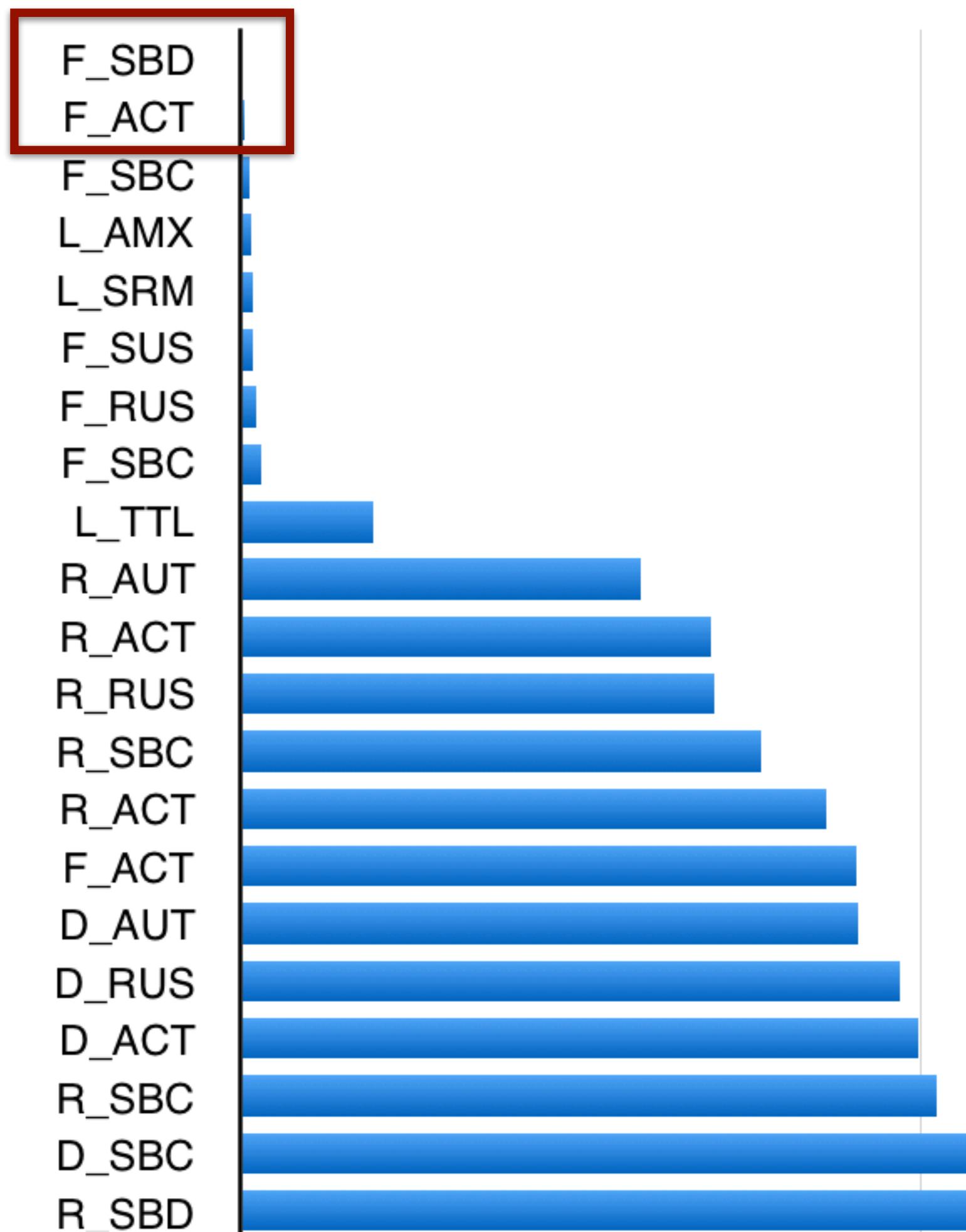




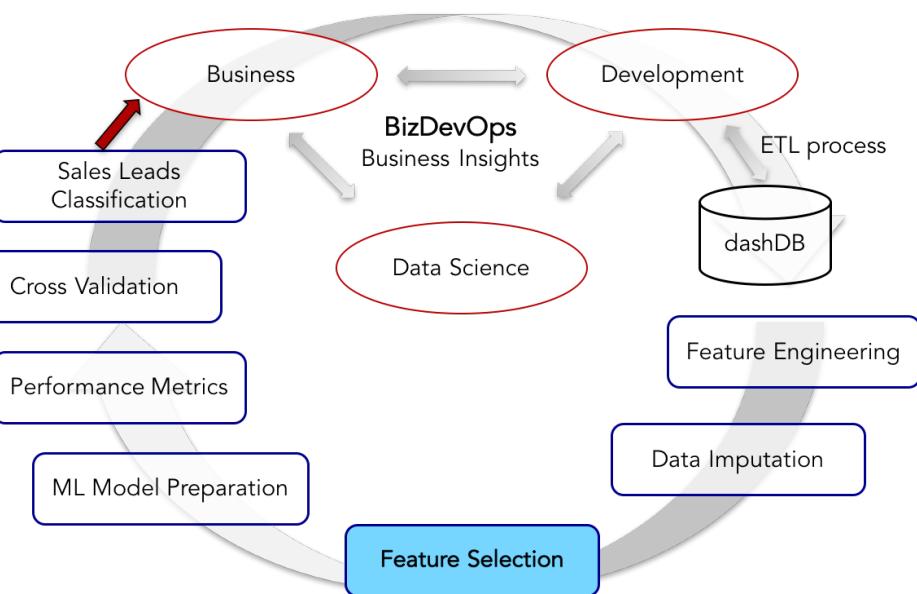
Feature Selection - L_V1

■ Variance

Eliminate very **low-variance** features:
F_ACT*, **F_SBD***
 (less than 2000)

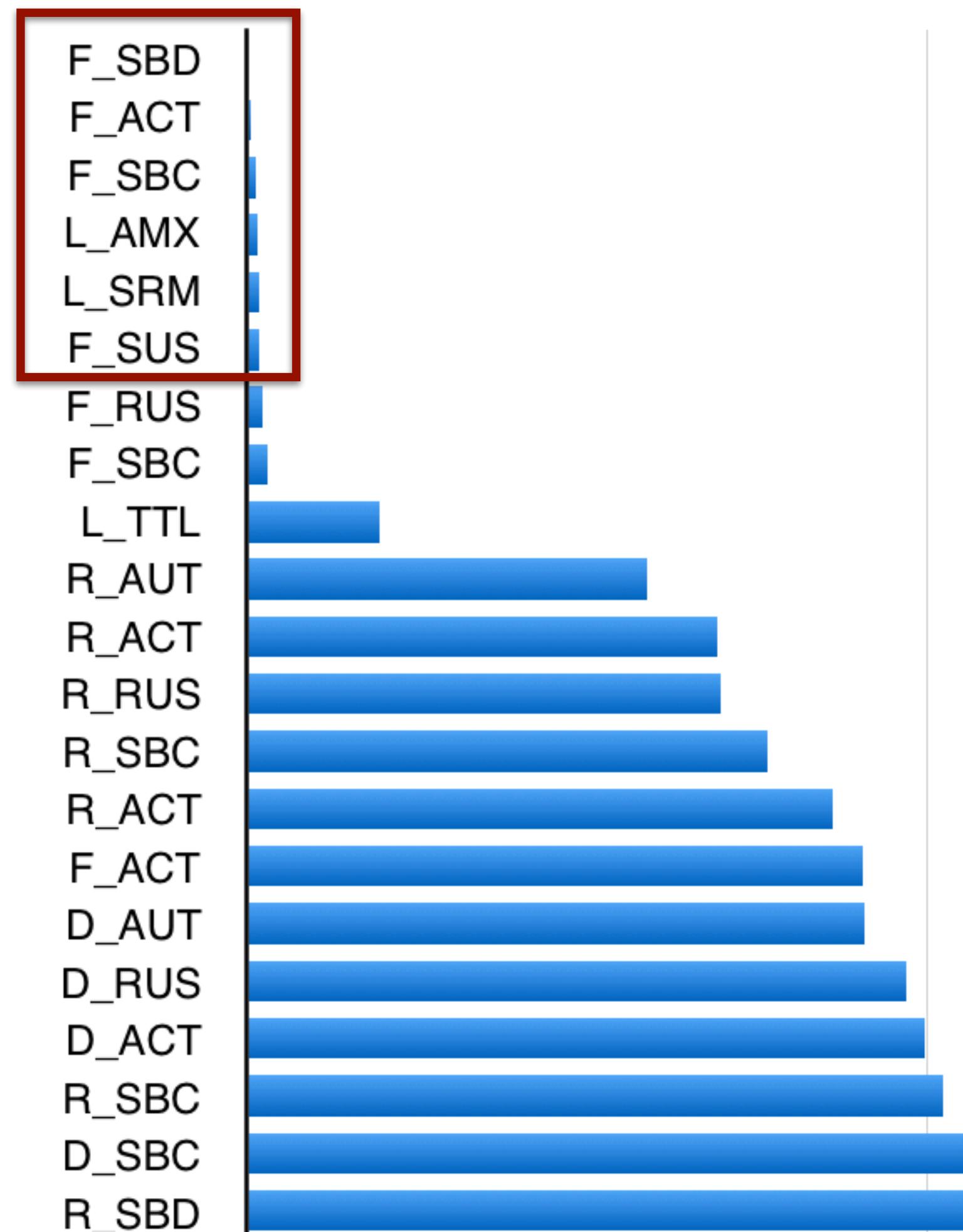


* We dropped the red ones.



Feature Selection - L_V2

Eliminate very **low-variance** features:
F_ACT*, **F_SBD***,
F_SUS*, **L_SRMR***,
L_AMX*, and **F_SBC**
(less than 3500)

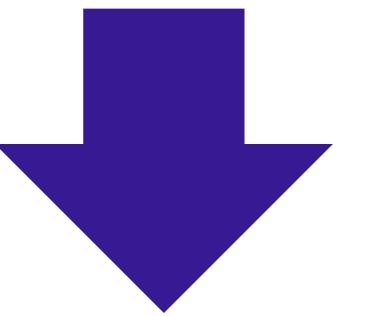


* We dropped the red ones.

Model Preparation

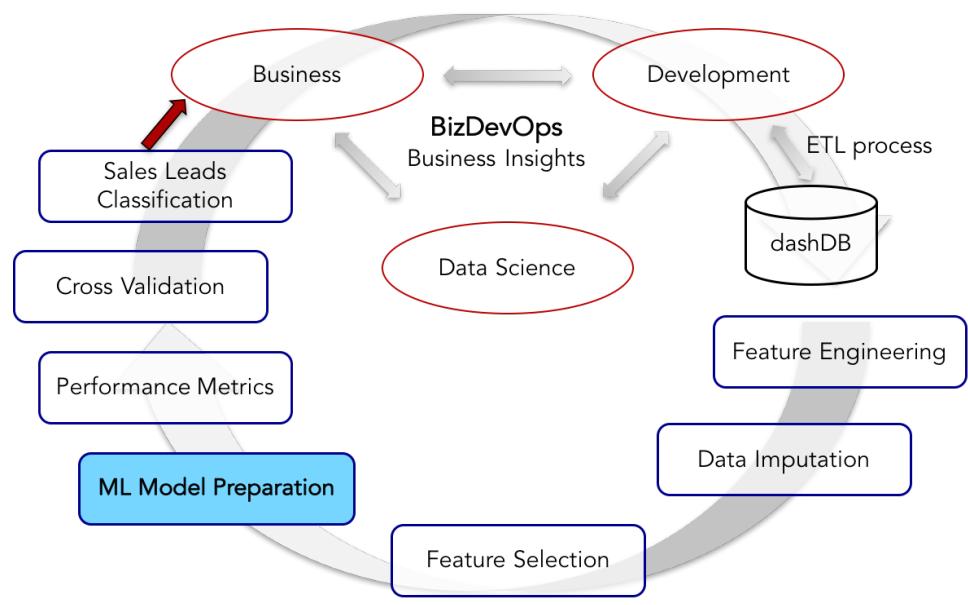
five groups of features:

ALL, C_95, C_90, C_85, L_V1, L_V2



- logistic regression (**LR**)
- k-nearest neighbor (**KNN**)
- naive Bayes (**NB**)
- decision tree (**DT**)
- random forest (**RF**)
- adaptive boosting (**AB**)
- gradient boosting (**GB**)

- weighted RF (**WRF**)
- weighted AB (**WAB**)
- weighted GB (**WGB**)



Performance metrics

On our **class-imbalance situation** where a few customers vs. the majority of non-paying customers, we have to consider:

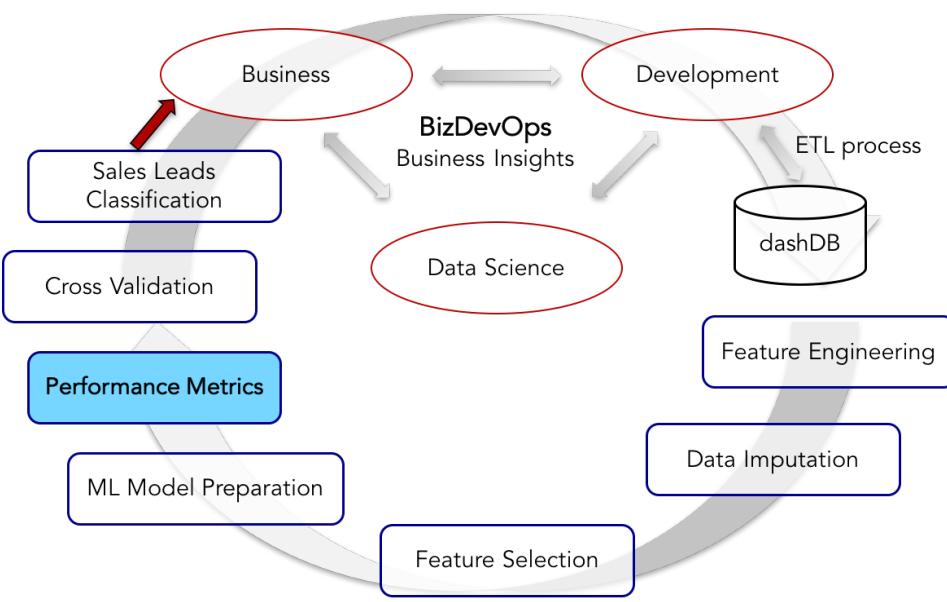
1. accuracy of positive classification:
2. accuracy of true-positive value:

$$\text{Precision} = \text{TP} / (\text{TP} + \text{FP})$$

$$\text{Recall} = \text{TP} / (\text{TP} + \text{FN})$$

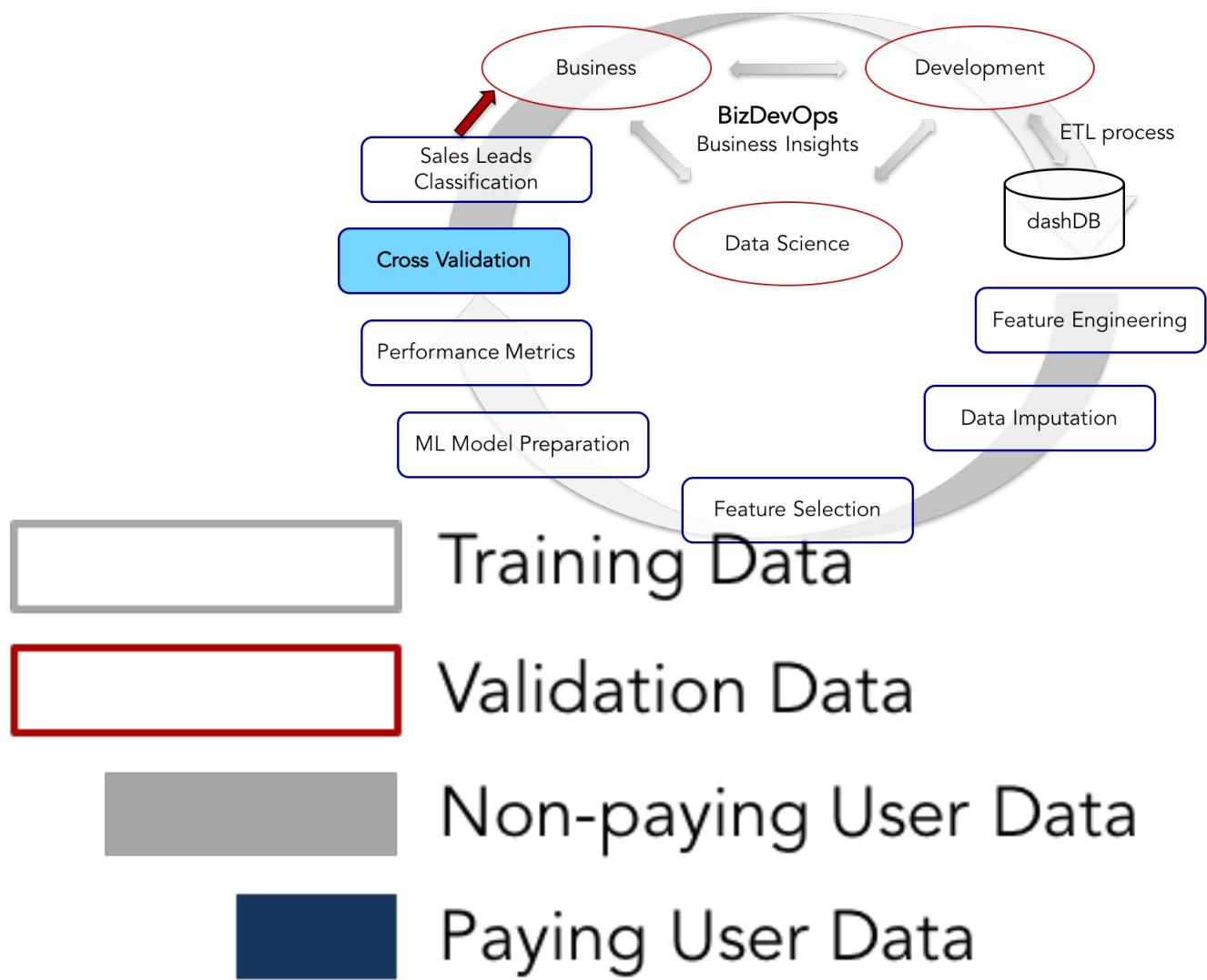
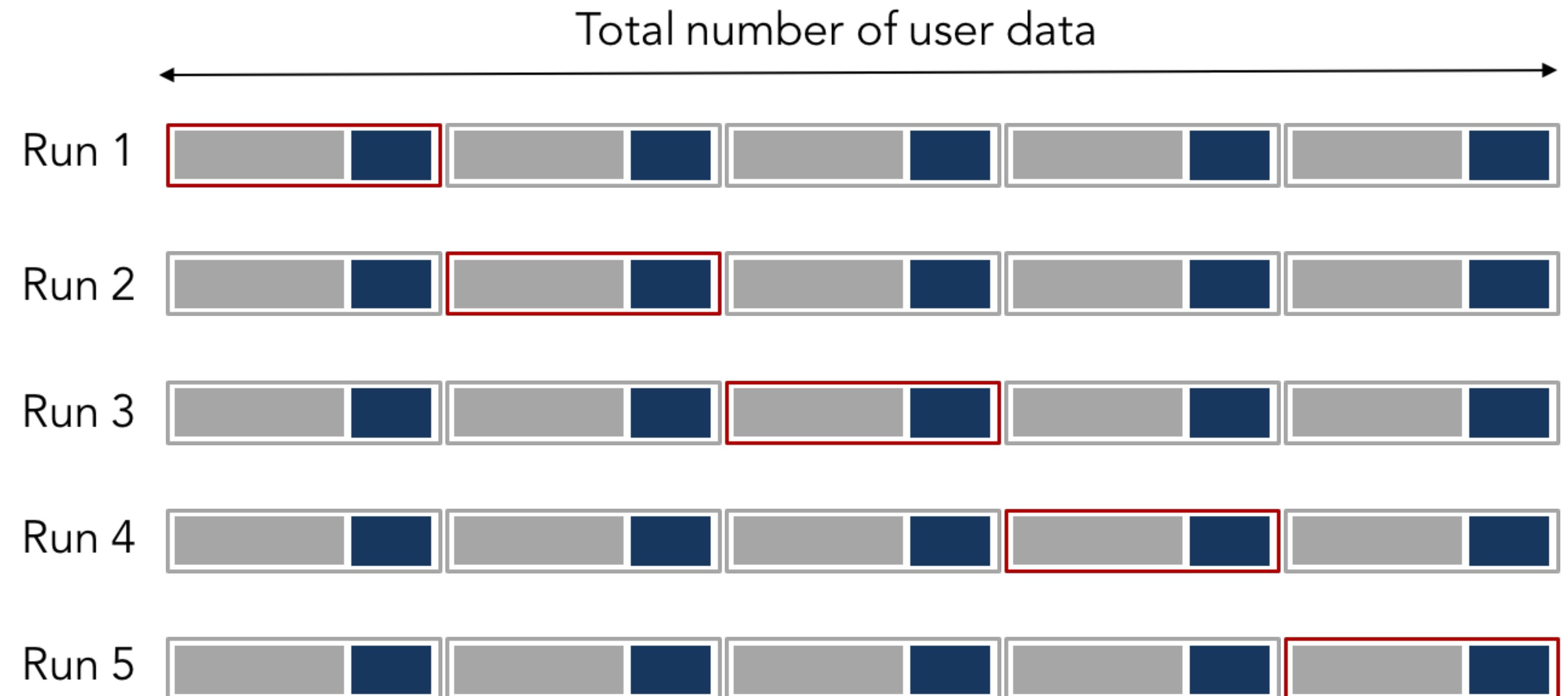
harmonic average

(Positive) **F1 Score**



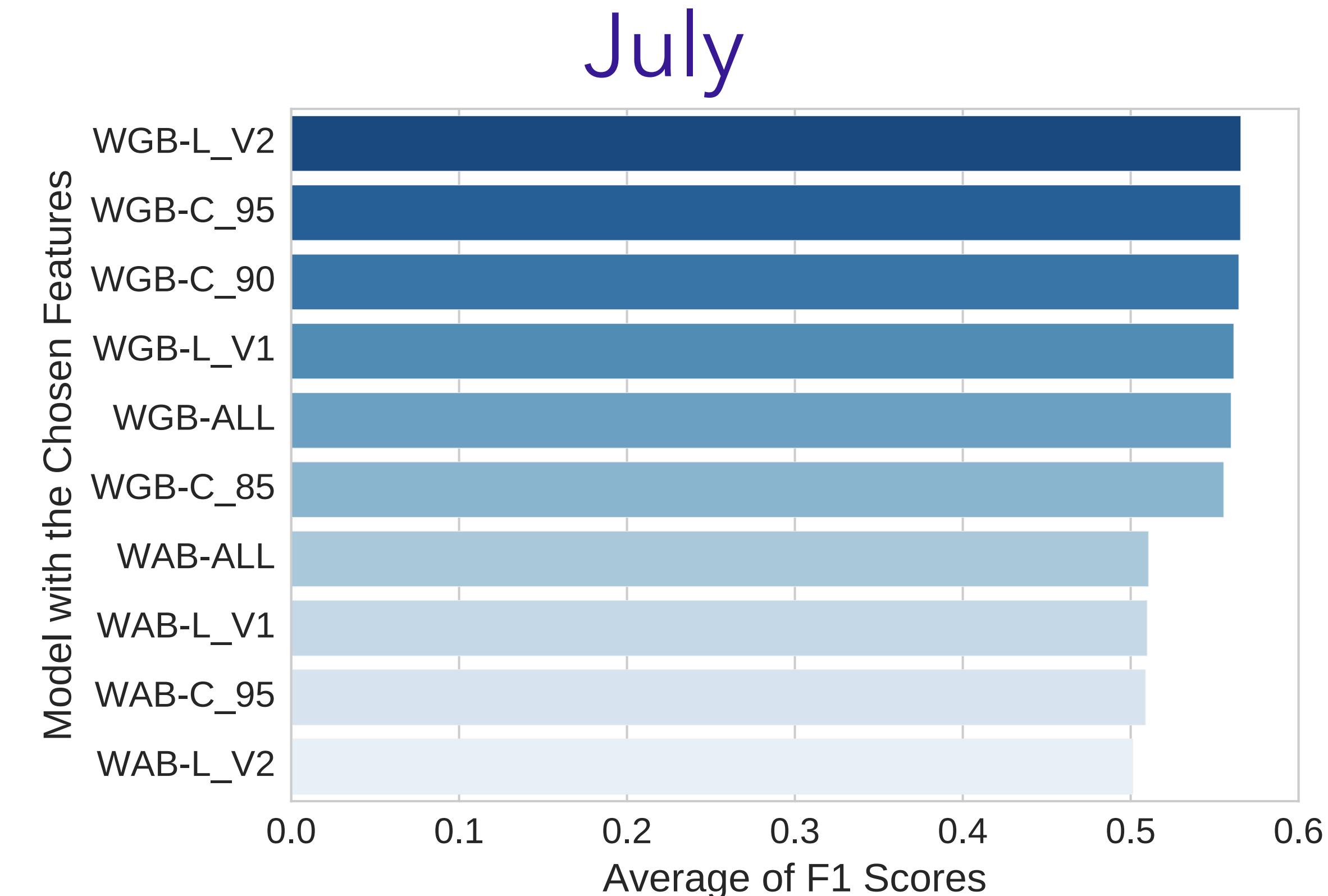
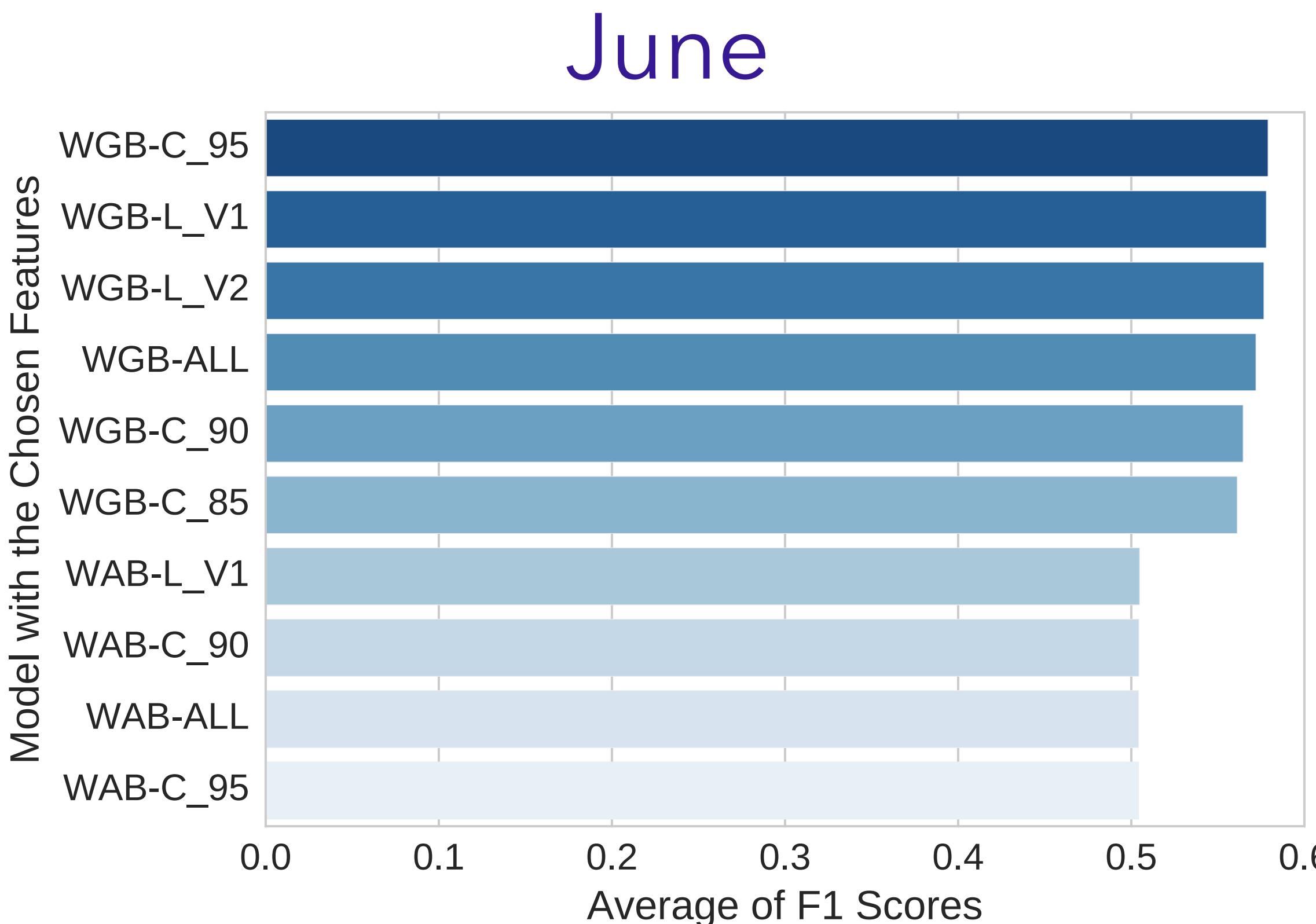
Cross Validation

Stratified 5-fold cross validation to deal with our **class-imbalance situation.**



Performance Comparison (1)

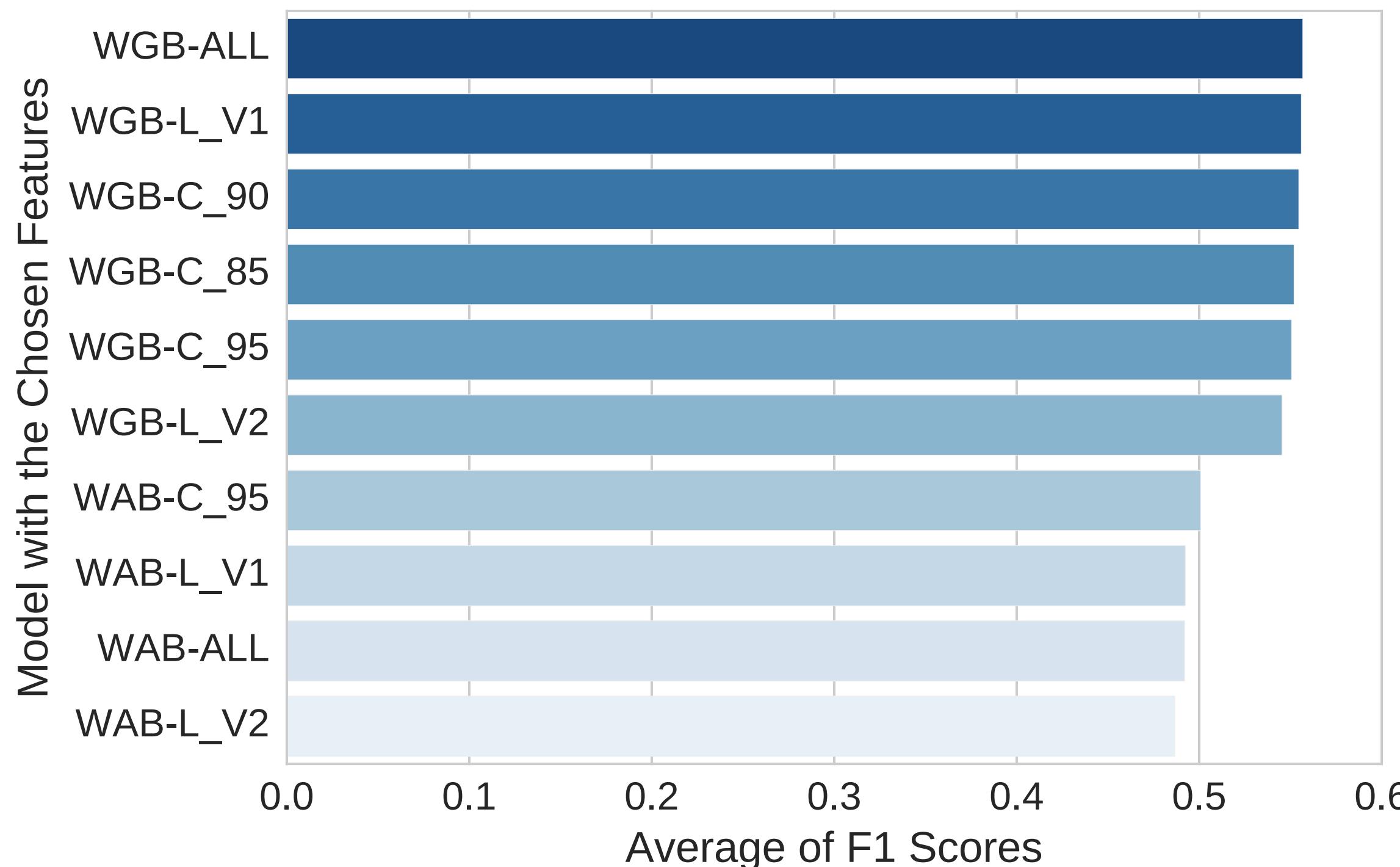
Weighted Gradient Boosting (WGB) outperformed others.



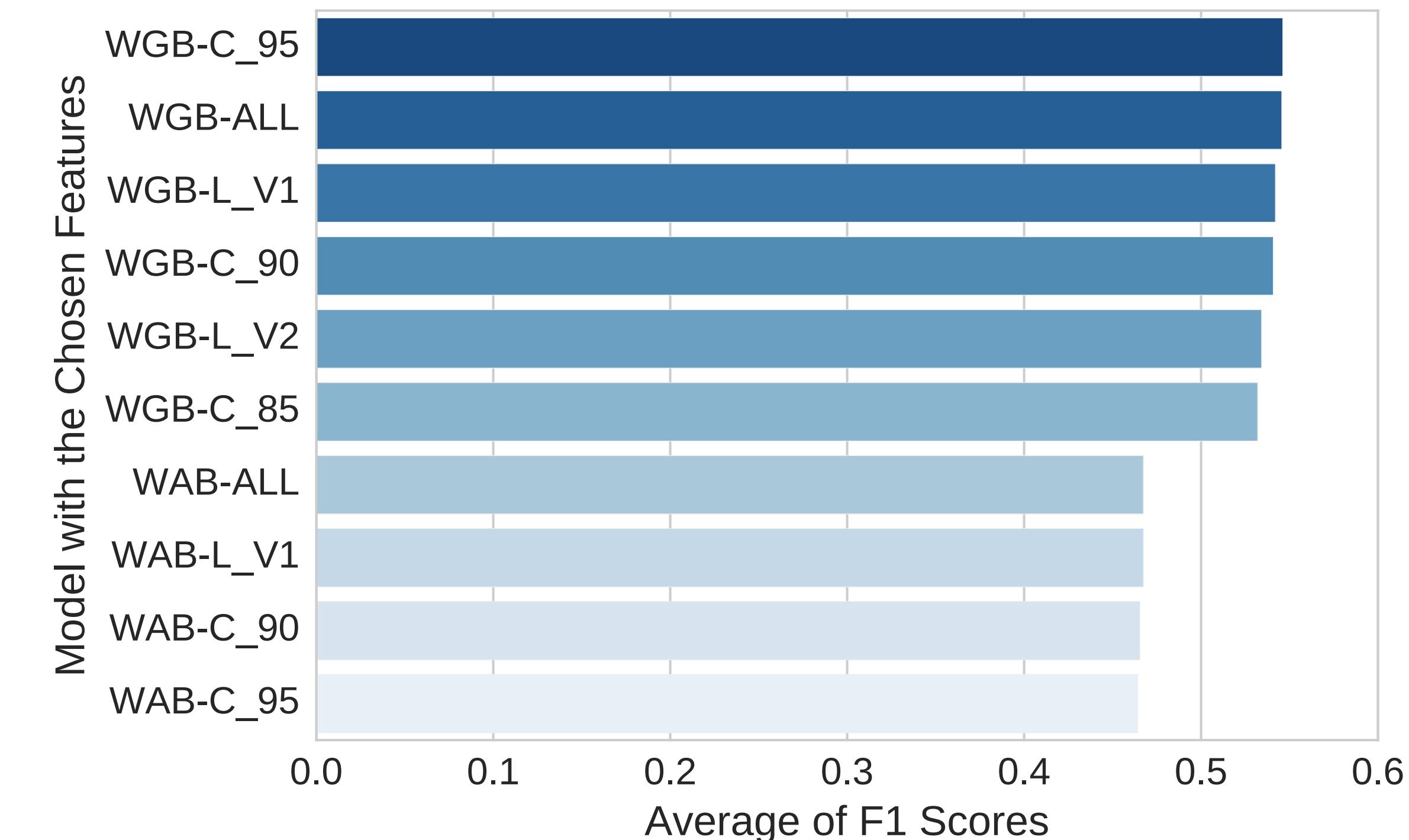
Performance Comparison (2)

Weighted Gradient Boosting (WGB) outperformed others.

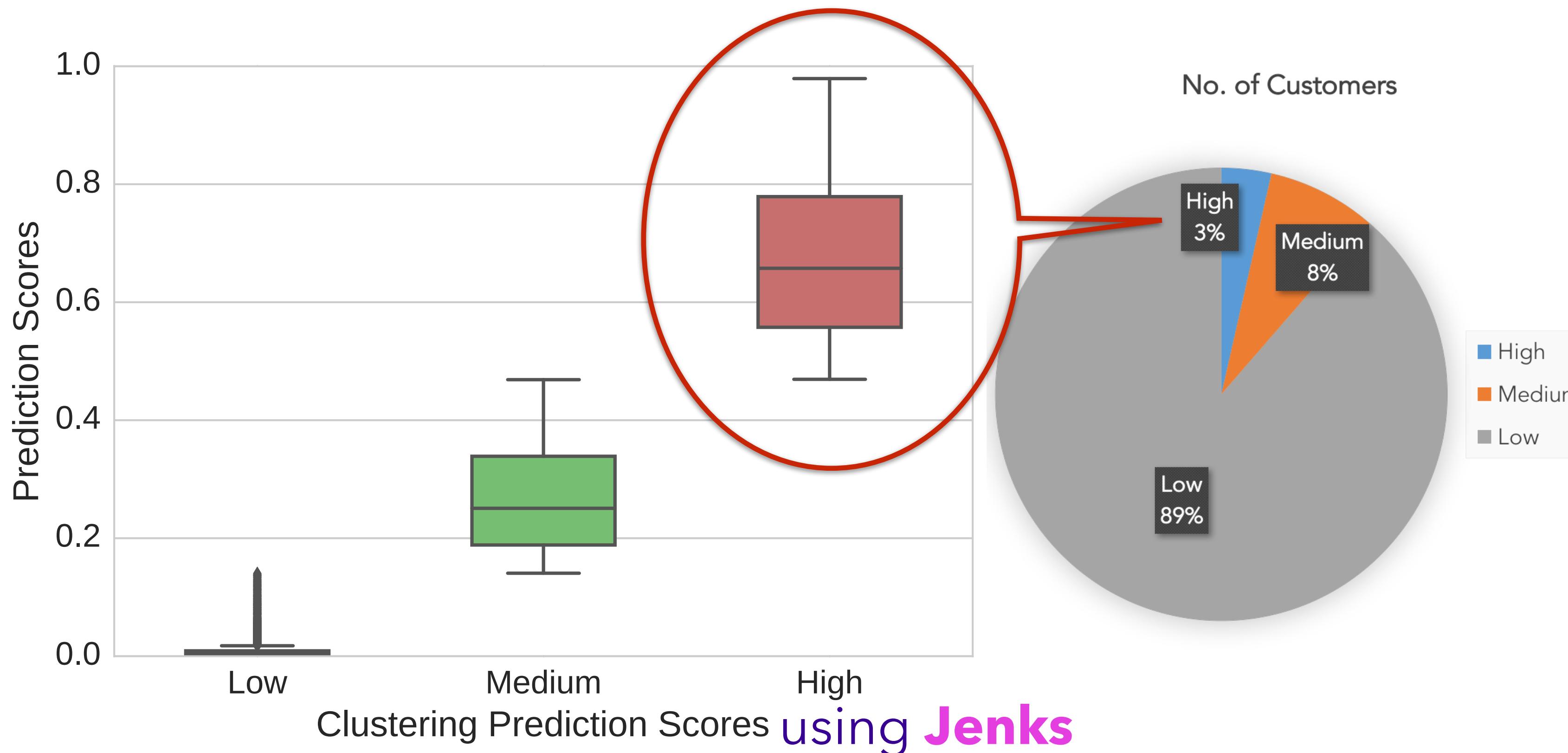
August



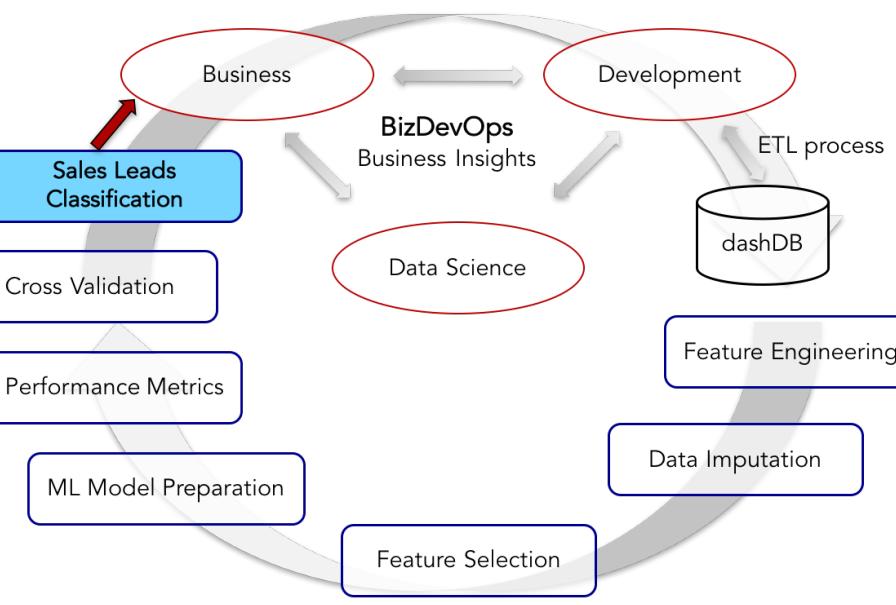
September



Sales Leads Clustering

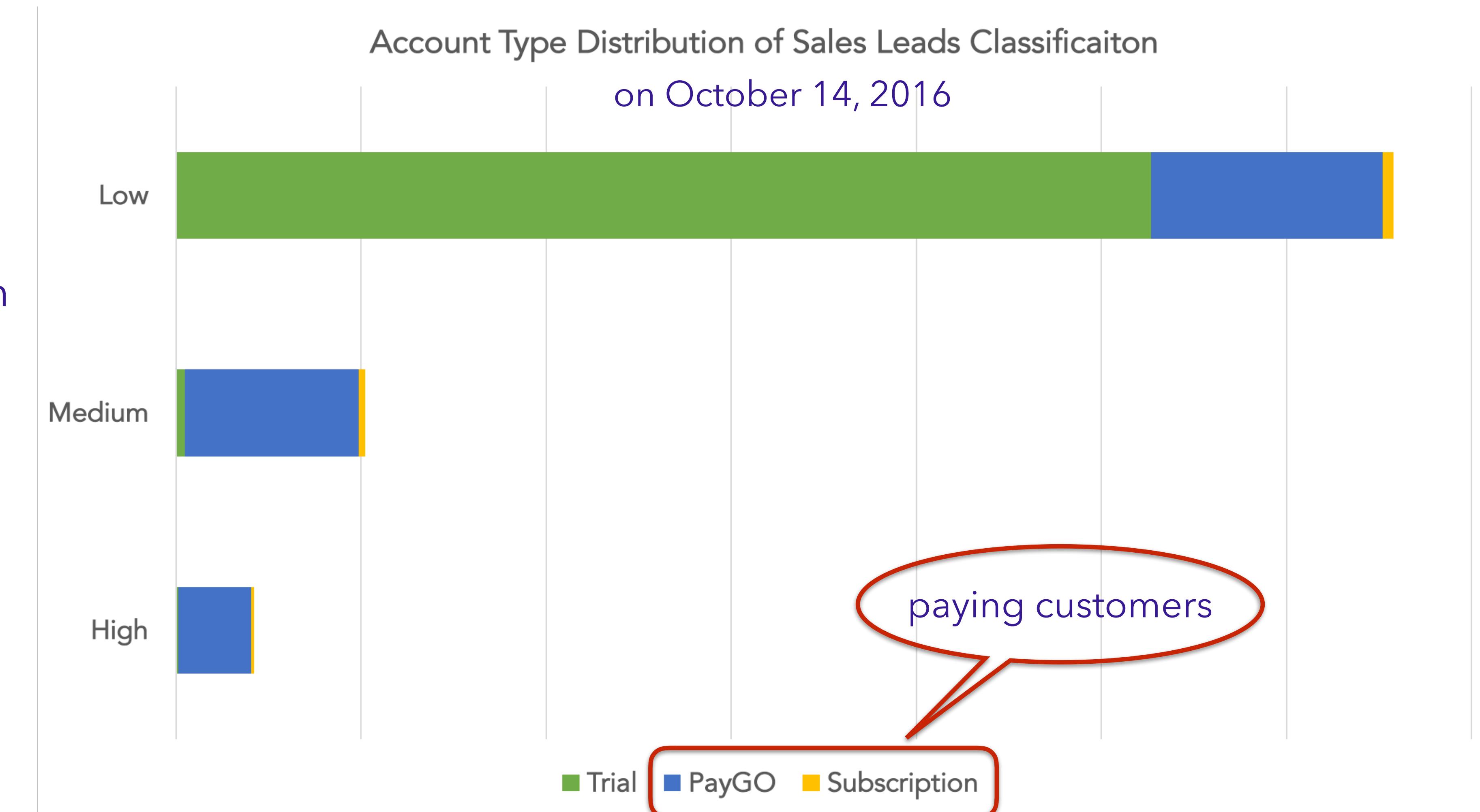


- Once we have the prediction scores from our trained model, we cluster three groups using **Jenks** algorithm.
- We deliver the **High-class** group (even 3% overall) to the Business team.



Evaluation of Sales Leads Clustering

- **Account types** in October from Sales Leads three classes in September
- In the High & Medium classes, **a few trial accounts** and the majority of paying customers
- Still necessary to handle the paying customers in the low class



Discussion

- Proposed **RFDL** (Recency, Frequency, Duration, and Lifetime) analysis to measure customer behaviors.
- **Iterative** prediction framework widely applicable to an online or cloud business domain with a constant **flux of customer traffic**
- Effective **prioritization** of new customers, targeting the high profile customers
- Necessary to handle the actual high profile customers in the low class

Questions

Thank you!

<https://github.com/csung7/ieee-dsaa2016>

Chul Sung, Bo Zhang, Chunhui Y. Higgins, and Yoonsuck Choe. Data-driven Sales Leads Prediction for Everything-as-a-Service in the Cloud,
The 3rd IEEE International Conference on Data Science and Advanced Analytics (DSAA), 2016.

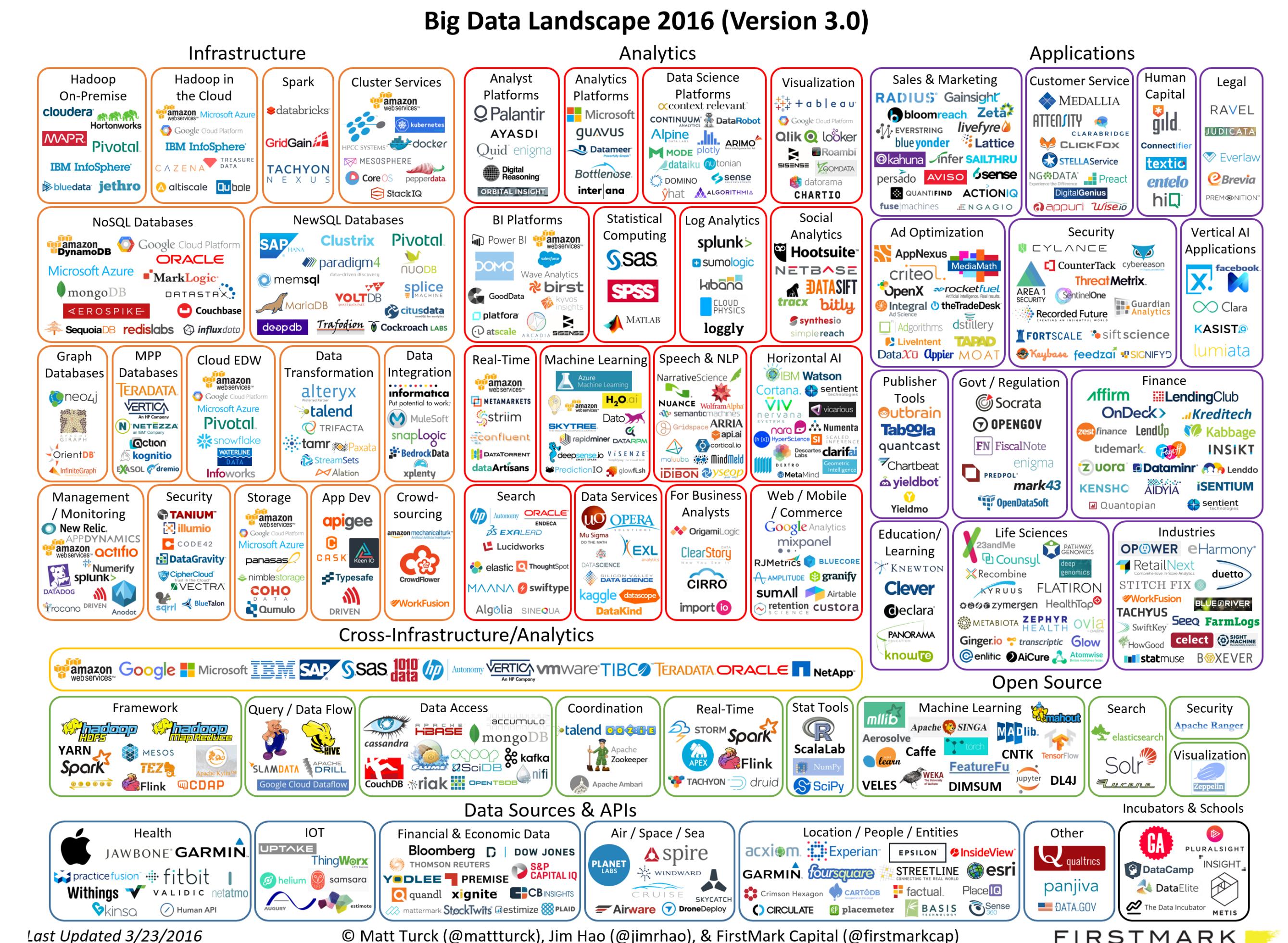
Acknowledgements

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Big Data Landscape

- Big Data Landscape in 2016
 - For interest of **Big Data** at fever pitch, big data companies standing out
 - A variety of applications on **across cloud platforms** within the enterprise

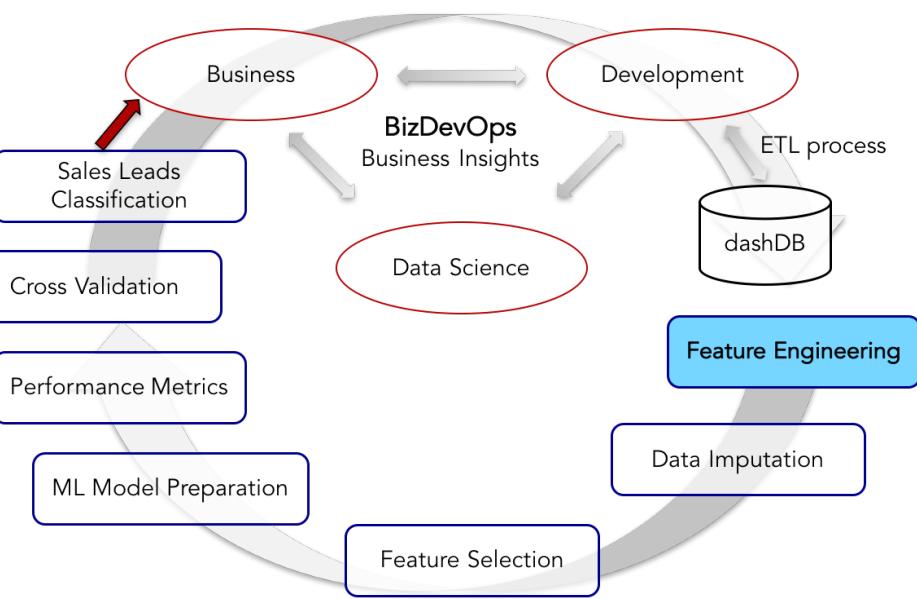


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source: <http://mattturck.com/2016/02/01/big-data-landscape/>



Feature Code Description

RFDL	Features (Abbr.)	Descriptions
R/F/D	{R/F/D}_ACT	Recency, Frequency, or Duration of application creation.
	{R/F/D}_ACS	Recency, Frequency, or Duration of application crash.
	{R/F/D}_AUT	Recency, Frequency, or Duration of application update.
	{R/F/D}_SCT	Recency, Frequency, or Duration of service creation.
	{R/F/D}_SBC	Recency, Frequency, or Duration of service binding creation.
	{R/F/D}_SBD	Recency, Frequency, or Duration of service binding deletion.
	{R/F/D}_SUS	Recency, Frequency, or Duration of service usage.
	{R/F/D}_RUS	Recency, Frequency, or Duration of runtime usage.
L	L_TTL	Lifetime of customer accounts.
	L_AMX	Lifetime of applications.
	L_SRM	Lifetime of services.
	CLASS	Labels for paying and non-paying customers.