Data Science Institute

Python for Data Science

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Middle Tennessee State University
April 6, 2019

https://github.com/capigian/charleston

I AM true BLUE

```
mt_dsi['using data for good'].max()
```

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Overview of Presentation

- Focus for today
  - Learn a little about  , the Data Science Institute and what we are doing at MTSU.
  - Help debunk misperceptions of how and who can learn machine learning.
  - Understand the generalities of ML and how it can be applied
  - Establish a process for building machine learning solution that actually solves a problem.
  - Work through a problem showing one process

https://github.com/capigian/charleston

mtsu.edu/dsi

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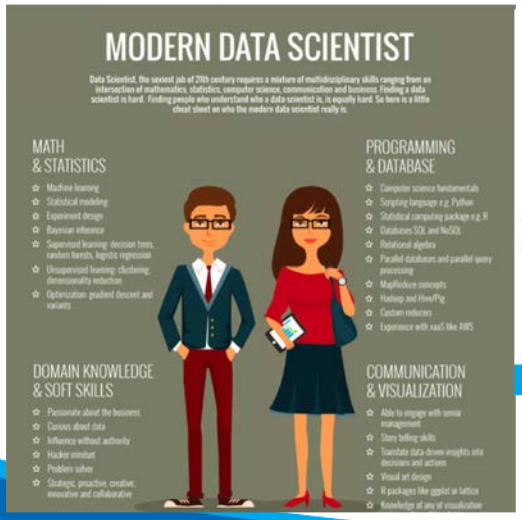
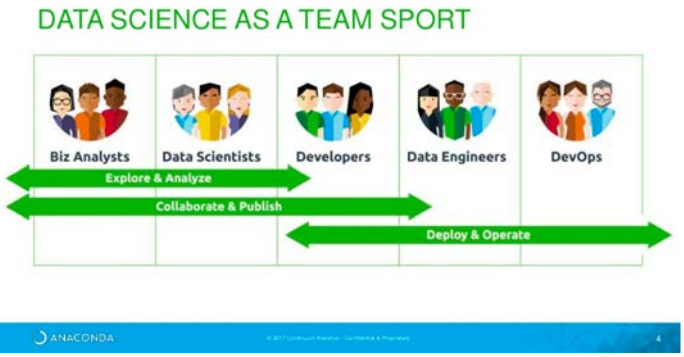
What a Data Scientist?





Start to think of Data Science as a team sport.

Anaconda - Continuum Analytics

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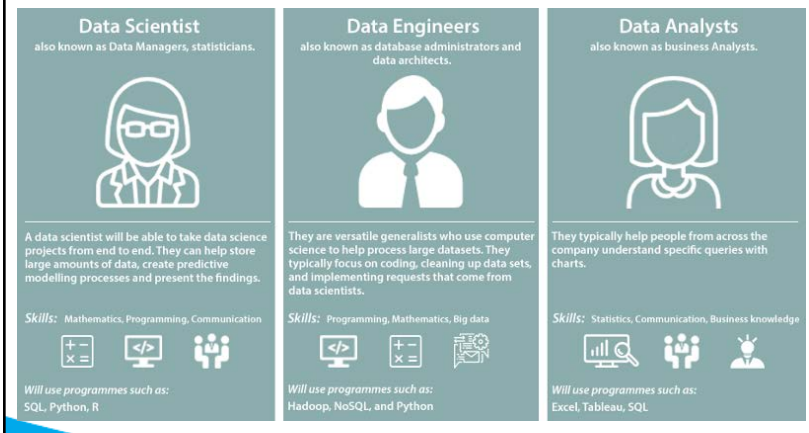
What skills do you need?



Data Scientists

- Knowledge of database like MySQL.
- Knowledge of Java, Python , R Programming.
- Knowledge of various analytical functions.
- Expertise in Math, Statistics, correlation, data mining, and predictive analysis.
- Knowledge of Machine Learning, Clustering

Data Analysts

- Hands-on experience with data warehousing and business intelligence concepts.
- In-depth exposure to SQL and analytics.
- Data Storing and retrieving skills and tools.
- Proficient in data architecture.
- Proficiency in decision making
- Familiar with various ETL tools

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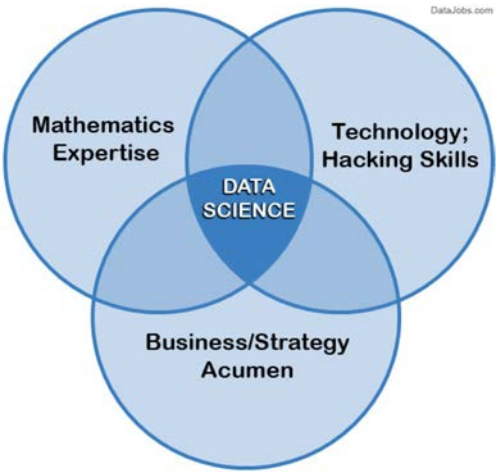
Which skills should you learn first?

Depends on your objective and your interest.

Regardless of interest, you must have an education and skills.

Skills alone is not good enough.



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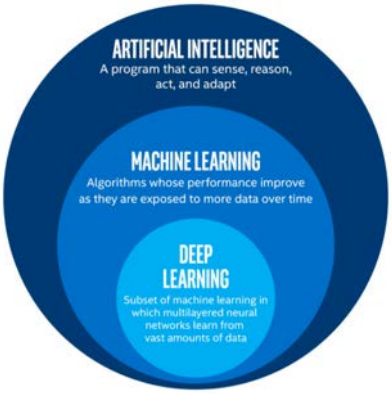
What is machine Learning?

- **Machine learning** is an application of artificial intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being explicitly programmed.



Machine learning focuses on the development of computer programs that can access data and use it learn for themselves.

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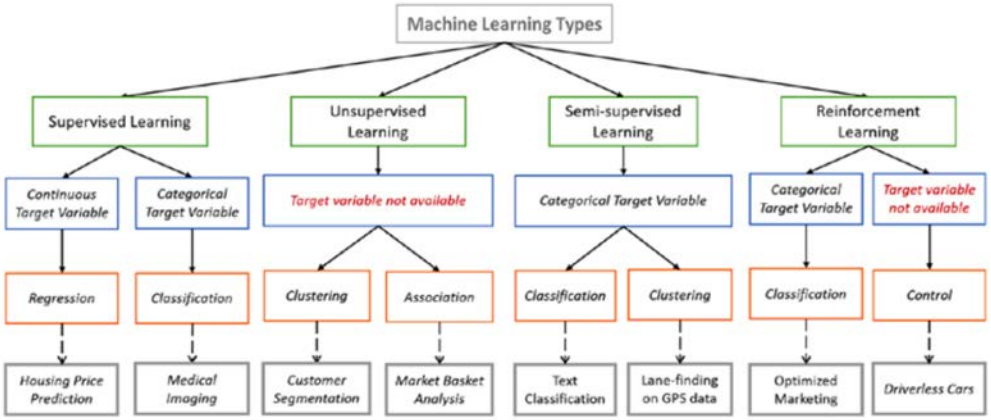
Different Types of Machine Learning



towardsdatascience.com

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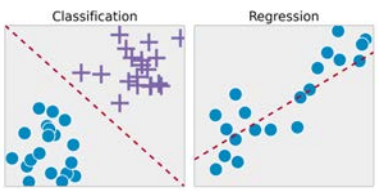
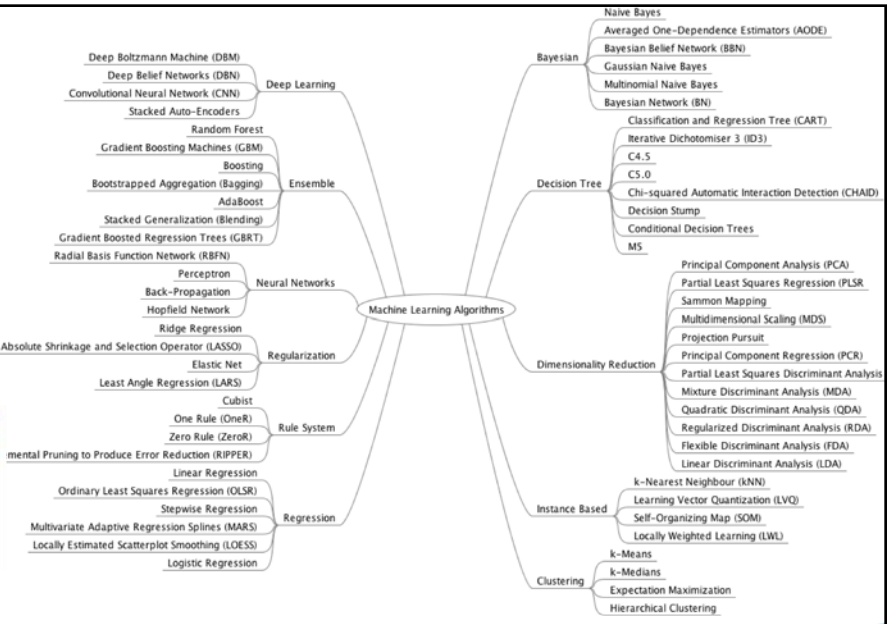
Machine Learning Algorithms Mind-Map





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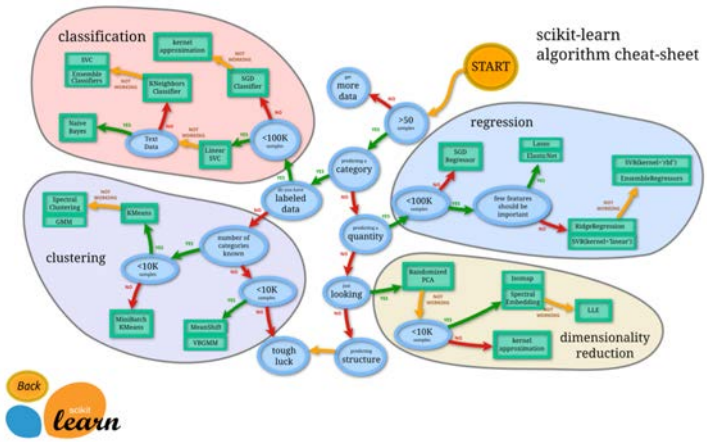
Scikit-Learn for Machine Learning Algorithm Selection



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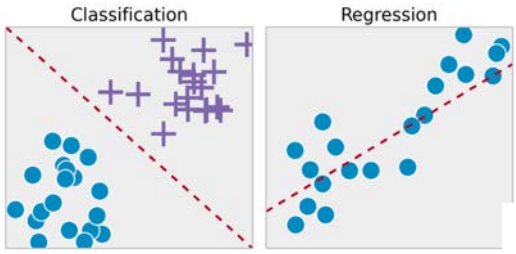
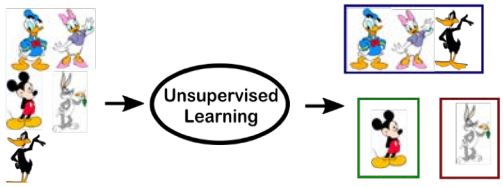
Supervised vs. Unsupervised

Supervised



https://www.kdnuggets.com/2018/04/supervised-vs-unsupervised-learning.html

Unsupervised



	Supervised Learning	Unsupervised Learning
Discrete	classification or categorization	clustering
Continuous	regression	dimensionality reduction

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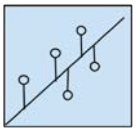
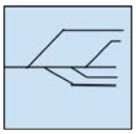
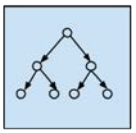
Types of Algorithms

- Regression Algorithms
  - Ordinary Least Squares Regression (OLSR)
  - **Linear Regression**
  - **Logistic Regression**
  - Stepwise Regression
- Regularization Algorithms
  - **Ridge Regression**
  - **Least Absolute Shrinkage and Selection Operator (LASSO)**
  - Elastic Net
- Decision Tree Algorithms
  - **Classification and Regression Tree (CART)**
  - Iterative Dichotomiser 3 (ID3)
  - Chi-squared Automatic Interaction Detection (CHAID)

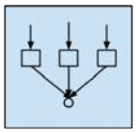

Regression Algorithms

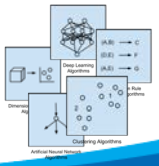

Regularization Algorithms


Decision Tree Algorithms

- Bayesian Algorithms
  - Naive Bayes
  - Gaussian Naive Bayes
  - Multinomial Naive Bayes
- Ensemble Algorithms
  - Boosting
  - Bootstrapped Aggregation (Bagging)
  - AdaBoost
  - Gradient Boosting Machines (GBM)
  - **Random Forest**
- Clustering Algorithms
- Association Rule Learning Algorithms
- Dimensionality Reduction Algorithms
- Deep Learning Algorithms
- Artificial Neural Network Algorithms
- …and many others

Bayesian Algorithms


Ensemble Algorithms



mtsu.edu/dsi

mt_dsi['using data for good'].max()

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When do you build a model?

1.
2.
3. Modeling
4.
5.
6.

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Model Building Process

1. Select a model
2. Identify and select the data that fits that model
3. Transform the data
4. Identify a business problem
5. Train/Test Split
6. Run Model

1. Business Understanding
2. Data Understanding
3. Data Preparation
4. Modeling
5. Evaluation
6. Deployment

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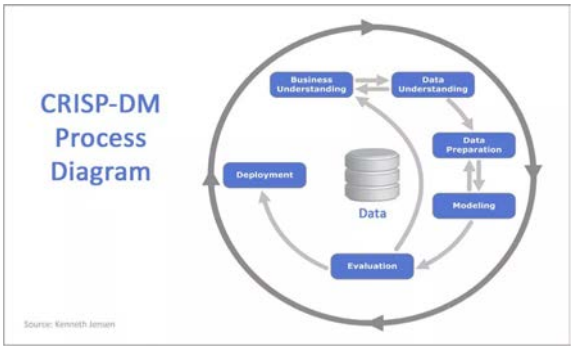
Data Analysis Process

1. Business Understanding
   a. Frame the problem and the REAL pain point
   b. Available resources, problems, goals
2. Data Understanding
   a. What data do you have available to you?
   b. Setup your workspace with tools or applications
      - Programming – Jupyter notebooks for Python or R Studio for R
      - BI/spreadsheets – Excel – PowerPivot - Tableau
   c. Import or download the data
   d. View, explore, and summarize the data
3. Data Preparation
   a. Clean up null values, outliers, mistakes
   b. Construct new data, transform or feature engineering
   c. Integrate and merge data
   d. Format data (strings, integers, floats, etc.)
   e. Create you X and y
4. **Modeling**
   a. Split your data (Train/Test Split)
   b. Setup models for machine learning/AI processes
   c. Can include visuals, dashboards or reports



5. Evaluation
   a. Fine tune your model
   b. Create a report of the findings
6. Deployment of models

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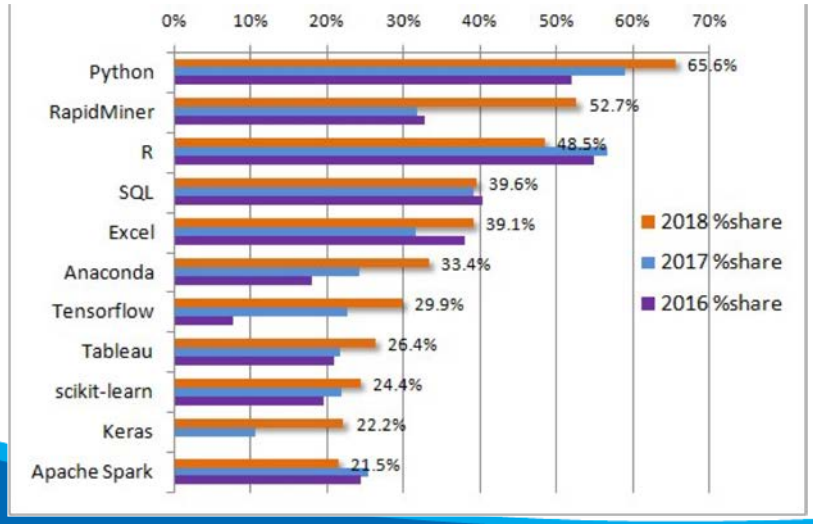
Why Python?



KDnuggets Analytics/Data Science 2018 Software Poll: Top tools in 2018, and their share in the 2016-7 polls

https://www.kdnuggets.com/2016/06/r-python-top-analytics-data-mining-data-science-software.html

`mt_dsi['using data for good'].max()`

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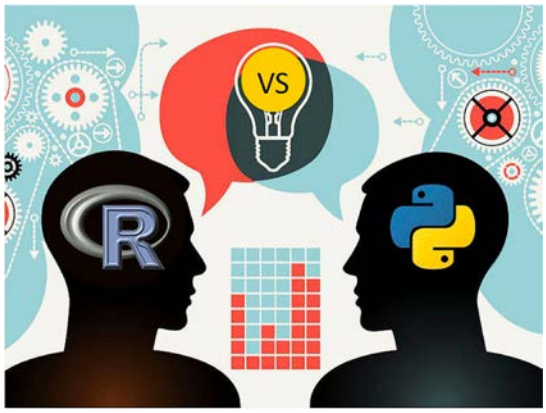
What should you use?

- Whatever you and your community want to learn and use.



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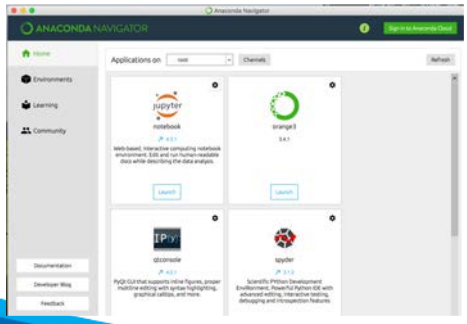
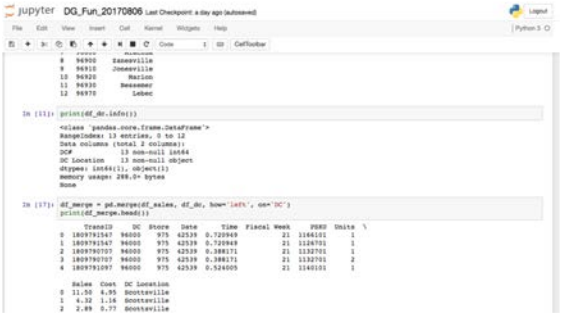
What will we use?

Anaconda
https://anaconda.org/



Jupyter Notebooks
http://jupyter.org/



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Use of Python Libraries

http://chris35wills.github.io/courses/pydata_stack/

learn	Machine learning	22 753	1 084	86	2 114	28 098	14 005	21	265	26
XGBoost LightGBM CatBoost	Machine learning	3277 1083 1509	280 79 61	9 14 20	868 363 157	11 991 5 488 2 780	5 425 1 467 369	12 14 25	364 77 75	43 69 46
eli5	Machine learning	922	6	22	39	672	89	154	42	112
SciPy	Data wrangling	19 150	608	99	301	4 447	2 318	31	193	7
NumPy	Data wrangling	17 911	641	136	390	7 215	2 766	28	132	11
pandas	Data wrangling	17 144	1 165	93	858	14 294	5 788	15	184	12
StatsModels	Statistics	10 067	153	21	234	2 868	1 240	66	479	19
TensorFlow	Deep learning	33 339	1 469	58	7 968	99 664	62 952	23	575	68
PYTORCH	Deep learning	11 306	635	16	816	15 512	3 483	18	707	24
Keras	Deep learning	4 539	671	41	1 673	29 444	10 964	7	1111	44
dist-keras elephas spark-deep-learning	Distributed deep learning	1125 170 67	5 13 11	7 5 3	41 97 116	431 913 920	106 189 206	225 13 6	161 34 22	86 70 84
Natural Language Toolkit	NLP	13 041	236	24	467					

https://activewizards.com/blog/top-20-python-libraries-for-data-science-in-2018/

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What can you use?

Technique	
Data Import	Pandas, Regular Expressions
Visualization	Matplotlib, Seaborn
Cleansing Data	Pandas, Numpy
Transforming Data	Pandas or ScikitLearn
Basic Statistics	Pandas, ScikitLearn, StatsModels
Unsupervised Learning	ScikitLearn
Supervised Learning - Regression	StatsModels or ScikitLearn
Supervised Learning - Classification	ScikitLearn
Deep Learning	Keras or TensorFlow

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Python example

Let's get started with Python and Jupyter notebooks


```
mt_dsi['using data for good'].max()
```

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Appleton Lending Co

- **Operations**
  - Over 80% of the loans provided by Appleton are personal. These loans are mostly made by borrowers in order to consolidate debt or pay off credit cards, but they may be provided for numerous reasons such as weddings, vacations, and for small businesses.
- **Strategy**
  - Over the past two years, Appleton has provided over 3 billion dollars in loans. The company provides personal loans for amounts between $1,000 and $40,000 that can be repaid over time periods of 3 or 5 years. Appleton approves loans based on credit history, credit score, debt to income ratio (dti), and the amount of the loan applied for. Appleton is highly selective with the loans it accepts, with over an 80% denial rate over the past four years. This ensures that Appleton provides high quality opportunities for itself and for lenders.

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Appleton Lending Co

- After some negative publicity at the board level, Appleton is looking to refocus its efforts on providing high quality loans. They are wanting to better understand their customers and most importantly, the difference between good loans and bad loans.
- After understanding the type of customers that they serve, they would like to improve the company's ability to predict borrowers who will default on loans. Additionally, Appleton is interested in predicting how much a borrower would be able to pay back, regardless of how large of a loan they have applied for.

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Business Understanding

1. **Business Understanding**
   - Available resources, problems, goals
2. Data Understanding
3. Data Preparation
4. Modeling
5. Evaluation
6. Deployment of models

- What are the available resources?
  - What are the key performance indicators (variables)?
- What are Appleton's expressed problems?
- What are Appleton's expressed and underlying goals?

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- What data do you have available?

Why is this data too much?

Feature	Description
member_id	A unique Appleton assigned Id for the borrower member.
loan_amnt	The listed amount of the loan applied for by the borrower. If at some point in time, the credit department reduces the loan amount, then it will be reflected in this value.
funded_amnt	The total amount committed to that loan at that point in time.
funded_amnt_inv	The total amount committed by investors for that loan at that point in time.
term	The number of payments on the loan. Values are in months and can be either 36 or 60.
int_rate	Interest Rate on the loan
installment	The monthly payment owed by the borrower if the loan originates.
grade	Appleton assigned loan grade: A, B, C, D, etc. with A being the best
sub_grade	Appleton assigned loan subgrade: A1, A2, A3, etc. with A1 being the best
emp_title	The job title supplied by the Borrower when applying for the loan.
emp_length	Employment length in years. Possible values are between 0 and 10 where 0 means less than one year and 10 means ten or more years.
home_ownership	The home ownership status provided by the borrower during registration. Our values are: RENT, OWN, MORTGAGE, OTHER.
annual_inc	The self-reported annual income provided by the borrower during registration.
verification_status	Indicates if income was verified by Appleton, not verified, or if the income source was verified
issue_d	The month which the loan was funded
loan_status	Current status of the loan
pymnt_plan	Indicates if a payment plan has been put in place for the loan
desc	Loan description provided by the borrower
purpose	A category provided by the borrower for the loan request.
title	The loan title provided by the borrower
zip_code	The first 3 numbers of the zip code provided by the borrower in the loan application.
addr_state	The state provided by the borrower in the loan application
dti	A ratio calculated using the borrower's total monthly debt payments on the total debt obligations, excluding mortgage and the requested Appleton loan, divided by the borrower's self-reported monthly income.

dti	A ratio calculated using the borrower's total monthly debt payments on the total debt obligations, excluding mortgage and the requested Appleton loan, divided by the borrower's self-reported monthly income.
delinq_2yrs	The number of 30+ days past-due incidences of delinquency in the borrower's credit file for the past 2 years
earliest_cr_line	The month the borrower's earliest reported credit line was opened
inq_last_6mths	The number of inquiries in past 6 months (excluding auto and mortgage inquiries)
mths_since_last_delinq	The number of months since the borrower's last delinquency.
mths_since_last_record	The number of months since the last public record.
open_acc	The number of open credit lines in the borrower's credit file.
pub_rec	Number of derogatory public records
revol_bal	Total credit revolving balance
revol_util	Revolving line utilization rate, or the amount of credit the borrower is using relative to all available revolving credit.
total_acc	The total number of credit lines currently in the borrower's credit file
initial_list_status	The initial listing status of the loan. Possible values are – W, F
out_prncp	Remaining outstanding principal for total amount funded
out_prncp_inv	Remaining outstanding principal for portion of total amount funded by investors
total_pymnt	Payments received to date for total amount funded
total_pymnt_inv	Payments received to date for portion of total amount funded by investors
total_rec_prncp	Principal received to date
total_rec_int	Interest received to date
total_rec_late_fee	Late fees received to date
recoveries	post charge off gross recovery
collection_recovery_fee	post charge off collection fee
last_pymnt_d	Last month payment was received
last_pymnt_amnt	Last total payment amount received
next_pymnt_d	Next scheduled payment date
last_credit_pull_d	The most recent month Appleton pulled credit for this loan
collections_12_mths_ex_me	Number of collections in 12 months excluding medical collections
mths_since_last_major_dero	Months since most recent 90-day or worse rating
policy_code	publicly available policy_code=1 new products not publicly available policy_code=2
application_type	Indicates whether the loan is an individual application or a joint application with two co-borrowers
acc_now_delinq	The number of accounts on which the borrower is now delinquent.
tot_coll_amt	Total collection amounts ever owed
tot_cur_bal	Total current balance of all accounts
total_credit_rv	Total revolving high credit/credit limit
loan_is_bad	True if Borrower defaulted on loan. False if loan was good.

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- What is the RIGHT available data?

```
df_loandata = pd.read_csv('data/Loan_Data.csv', index_col = 0, header = 0)
df_loandata.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 49870 entries, 149512 to 4076727
Data columns (total 20 columns):
loan_amnt                    49870 non-null int64
term                         49870 non-null int64
sub_grade                    49870 non-null object
emp_length                   49870 non-null int64
home_ownership               49870 non-null object
annual_inc                   49870 non-null float64
purpose                      49870 non-null object
delinq_2yrs                  49870 non-null int64
mths_since_last_delinq       21790 non-null float64
open_acc                     49870 non-null int64
pub_rec                      49870 non-null int64
revol_bal                    49870 non-null int64
total_acc                    49865 non-null float64
collections_12_mths_ex_med   49870 non-null int64
mths_since_last_major_derog  49870 non-null int64
acc_now_delinq               49870 non-null int64
tot_coll_amt                 49870 non-null int64
tot_cur_debt                 49870 non-null int64
total_credit_rv              49870 non-null int64
loan_status                  49870 non-null object
dtypes: float64(3), int64(13), object(4)
memory usage: 8.0+ MB
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