Data Science Applications

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Big Data Management

Big Data Management Group (BigDaMa)

Group leader

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PhD Students

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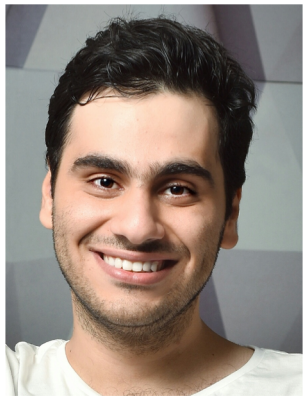
Data Cleaning
Machine Learning

Felix Neutatz

Feature Engineering
Machine Learning

Maximilian Dohlus

Data Lake Integration
Data Profiling



Mahdi Esmailoghli

Stream Data Analytics

Goal of the Seminar

- Learn to find and use scientific papers
- Build a system that benefits from integrating different sources
- Gaining experience in building components of an analytical application
- First-hand experience of applied machine learning

Prerequisites

- Reading and Presenting in English
- Being literate in at least one programming language
  - Preferably python or java
- Having enthusiasm for formally solving problems
- Having successfully attended the data integration lecture

Seminar Organization 1

1. Pick a group, select top 3 topics, propose solution – Deadline Sunday 12:00 am
2. Assignment of topics 24.10.
3. Find relevant literature and datasets for your application 31.10.
4. Discuss the paper with your advisor – Individual meetings (10% of the grade)
5. Give a 20+5 minutes presentation on ongoing progress– 28/29.11 (30% of the grade)
6. Give a 20+10 minutes final presentation – End of semester (30% of the grade)
7. Write an 8 Page summary on your system– Deadline February 20th (30% of the grade)

First Presentation

- How do you manage the data at hand?
- What is your application going to solve?
- Which resources are you going to use?
- Preliminary results and demo

Second Presentation

- Discuss your system and sell its advantages with experimental results
- Your written manuscript will have a similar structure.

Topics

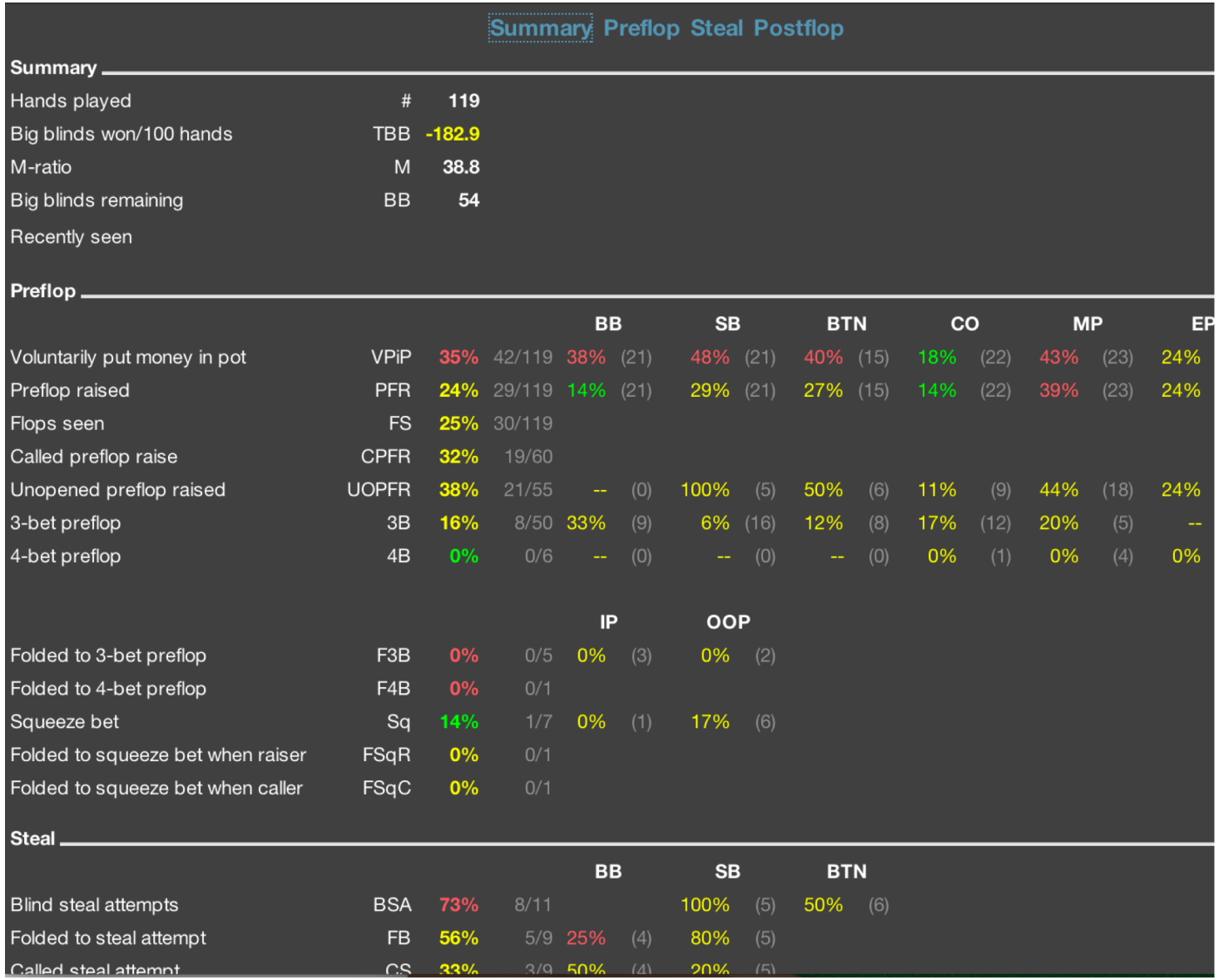
- Each topic has a data handling aspect and a machine learning task
  - Poker assistant
  - Predicting World Cup matches
  - Summarizing Daily news
  - Data Cleaning for Machine Learning
  - Outlier Explanation

Use Case: Texas Holdem Poker

Challenges:

- Assessing how strong your hand is in the current pot?
- How strong could your opponent be?
- What is the most profitable play in the current situation?

Statistics that you can obtain:



Summary Preflop Steal Postflop

Summary

Hands played	#	119
Big blinds won/100 hands	TBB	-182.9
M-ratio	M	38.8
Big blinds remaining	BB	54
Recently seen		

Preflop

				BB		SB		BTN		CO		MP		EP
Voluntarily put money in pot	VPiP	35%	42/119	38%	(21)	48%	(21)	40%	(15)	18%	(22)	43%	(23)	24%
Preflop raised	PFR	24%	29/119	14%	(21)	29%	(21)	27%	(15)	14%	(22)	39%	(23)	24%
Flops seen	FS	25%	30/119											
Called preflop raise	CPFR	32%	19/60											
Unopened preflop raised	UOPFR	38%	21/55	--	(0)	100%	(5)	50%	(6)	11%	(9)	44%	(18)	24%
3-bet preflop	3B	16%	8/50	33%	(9)	6%	(16)	12%	(8)	17%	(12)	20%	(5)	--
4-bet preflop	4B	0%	0/6	--	(0)	--	(0)	--	(0)	0%	(1)	0%	(4)	0%

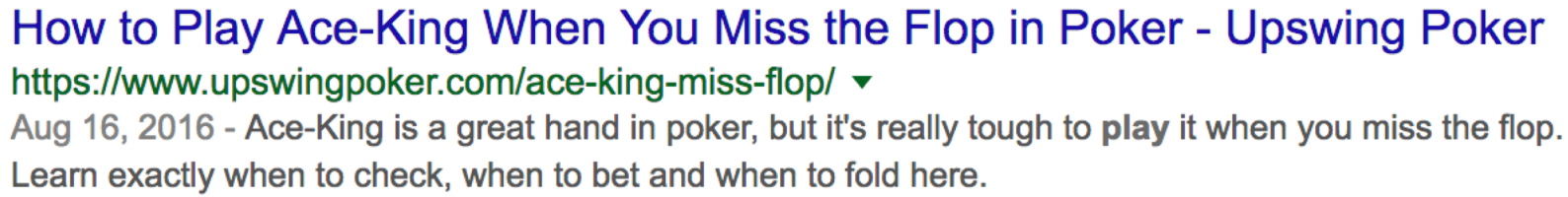
				IP		OOP	
Folded to 3-bet preflop	F3B	0%	0/5	0%	(3)	0%	(2)
Folded to 4-bet preflop	F4B	0%	0/1				
Squeeze bet	Sq	14%	1/7	0%	(1)	17%	(6)
Folded to squeeze bet when raiser	FSqR	0%	0/1				
Folded to squeeze bet when caller	FSqC	0%	0/1				

Steal

				BB		SB		BTN	
Blind steal attempts	BSA	73%	8/11			100%	(5)	50%	(6)
Folded to steal attempt	FB	56%	5/9	25%	(4)	80%	(5)		
Called steal attempt	CS	33%	3/9	50%	(4)	20%	(5)		

Further helpful data

- Identify player patterns
- Connect your dataset to external datasets:
  - Other hand histories
- Web sources:



Data: Hand history

PokerStars Hand #175821392060: Hold'em No Limit ($0.02/$0.05 USD) - 2017/09/18 16:35:37 ET
Table 'Dawson' 9-max Seat #4 is the button
Seat 1: ShadarNyr ($10.80 in chips)
Seat 2: Natch_Flush ($9.63 in chips)
Seat 3: totojkee ($5.15 in chips)
Seat 4: Luigi_198909 ($5 in chips)
Seat 5: karakasss ($4.95 in chips)
Seat 6: BigDaMaHero ($5 in chips)
Seat 7: SwimmingPool ($5 in chips)
Seat 8: (PSY)De_Ange ($5 in chips)
Seat 9: Langolier86 ($5.37 in chips)
karakasss: posts small blind $0.02
BigDaMaHero: posts big blind $0.05
*** HOLE CARDS ***
Dealt to BigDaMaHero [Tc 6d]
SwimmingPool: raises $0.10 to $0.15
(PSY)De_Ange: folds
Langolier86: folds
ShadarNyr: folds
Natch_Flush: folds
totojkee: folds
Luigi_198909: folds
karakasss: folds
BigDaMaHero: folds
Uncalled bet ($0.10) returned to SwimmingPool
SwimmingPool collected $0.12 from pot
*** SUMMARY ***
Total pot $0.12 | Rake $0
Seat 1: ShadarNyr folded before Flop (didn't bet)
Seat 2: Natch_Flush folded before Flop (didn't bet)
Seat 3: totojkee folded before Flop (didn't bet)
Seat 4: Luigi_198909 (button) folded before Flop (didn't bet)
Seat 5: karakasss (small blind) folded before Flop
Seat 6: BigDaMaHero (big blind) folded before Flop
Seat 7: SwimmingPool collected ($0.12)
Seat 8: (PSY)De_Ange folded before Flop (didn't bet)
Seat 9: Langolier86 folded before Flop (didn't bet)

Tasks

- Information extraction
  - Crawling data sources
  - Parsing data
  - Making data structured
- Storage and indexing
  - Designing data model
  - Providing efficient load/save operations
- Application
  - Modeling states and actions
  - Designing game play strategies

Information Extraction

- Some papers
  - Etzioni, Oren, et al. "Web-scale information extraction in knowitall:(preliminary results)." *Proceedings of the 13th international conference on World Wide Web*. ACM, 2004.
  - Chang, Chia-Hui, et al. "A survey of web information extraction systems." IEEE transactions on knowledge and data engineering 18.10 (2006): 1411-1428.
  - Cowie, Jim, and Wendy Lehnert. "Information extraction." *Communications of the ACM* 39.1 (1996): 80-91.
  - Banko, Michele, et al. "Open information extraction from the web." *IJCAI*. Vol. 7. 2007.
  - Gabor Angeli, Melvin Johnson Premkumar, and Christopher D. Manning. Leveraging Linguistic Structure For Open Domain Information Extraction. In Proceedings of the Association of Computational Linguistics (ACL), 2015.

Information Extraction

- Some libraries and tools
  - For requesting web pages
    - E.g., Requests: HTTP for Humans
      - http://docs.python-requests.org/en/master/
  - For parsing texts
    - E.g., Beautiful Soup
      - https://www.crummy.com/software/BeautifulSoup/bs4/doc/
    - E.g., Scrapy
      - https://scrapy.org/
  - For natural language processing
    - E.g., NLTK
      - https://www.nltk.org/
  - For information extraction
    - E.g., Stanford OpenIE
      - https://nlp.stanford.edu/software/openie.html
    - E.g., MITIE: MIT Information Extraction
      - https://github.com/mit-nlp/MITIE

Storage and Indexing

- Simple DBMS
  - Postgres
- Key-value-store
  - MongoDB
- Document indexer
  - Elastic search

Application

- Some papers
  - Sutton, Richard S., and Andrew G. Barto. *Reinforcement learning: An introduction*. Vol. 1. No. 1. Cambridge: MIT press, 1998.
  - Dahl, Fredrik A. "A reinforcement learning algorithm applied to simplified two-player Texas Hold'em poker." *European Conference on Machine Learning*. Springer, Berlin, Heidelberg, 2001.
  - Bowling, Michael, et al. "Heads-up limit hold'em poker is solved." *Science* 347.6218 (2015): 145-149.
  - Shi, Jiefu, and Michael L. Littman. "Abstraction methods for game theoretic poker." *International Conference on Computers and Games*. Springer, Berlin, Heidelberg, 2000.
  - Billings, Darse, et al. "Approximating game-theoretic optimal strategies for full-scale poker." *IJCAI*. 2003.
  - Baker, Roderick JS, and Peter I. Cowling. "Bayesian opponent modeling in a simple poker environment." *Computational Intelligence and Games, 2007. CIG 2007. IEEE Symposium on*. IEEE, 2007.

Application

- Some libraries and tools
  - For machine learning
    - E.g., scikit-learn
      - http://scikit-learn.org/stable/
    - E.g., Tensorflow
      - https://www.tensorflow.org/
  - For reinforcement learning
    - E.g., TensorForce
      - https://github.com/reinforceio/tensorforce

Predicting World Cup 2018 Matches

- The main focus of this project is on collecting various data from various sources and integrating them
- You should collect and integrate various data such as
  - Population of the countries
  - Their annual budget
  - Price of their players
  - Rank of their national football team
- Given a football match such as "France vs Croatia (Final)", your model should predict the wining probability for each of the teams

Predicting World Cup 2018 Matches

- A paper
  - [1] Suzuki, Adriano Kamimura, et al. "A Bayesian approach for predicting match outcomes: the 2006 (Association) Football World Cup." Journal of the Operational Research Society 61.10 (2010): 1530-1539.
- Some data sources
  - [2] https://www.scoreboard.com/en/soccer/world/world-cup/results/
  - [3] Auer, Sören, et al. "Dbpedia: A nucleus for a web of open data." The semantic web. Springer, Berlin, Heidelberg, 2007. 722-735.

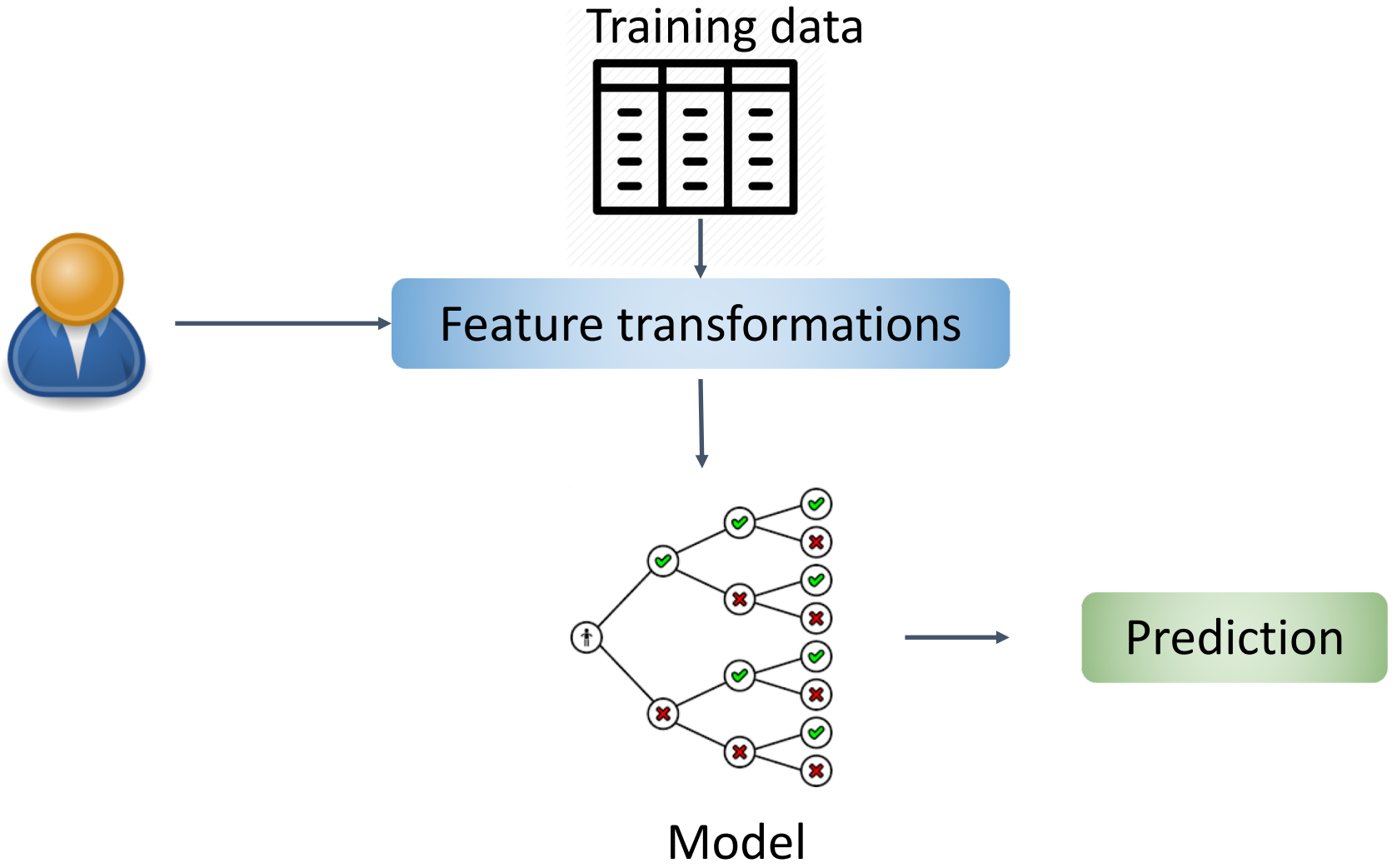
Summarizing Daily News

- The goal of this project is to build an online approach collecting and clustering the data
- You should build a system to collect news from various sources such as
  - News agency web sites
  - RSSes
  - Twitter
- Your system should cluster the collected news to present the summary of the hot daily news based on the clusters

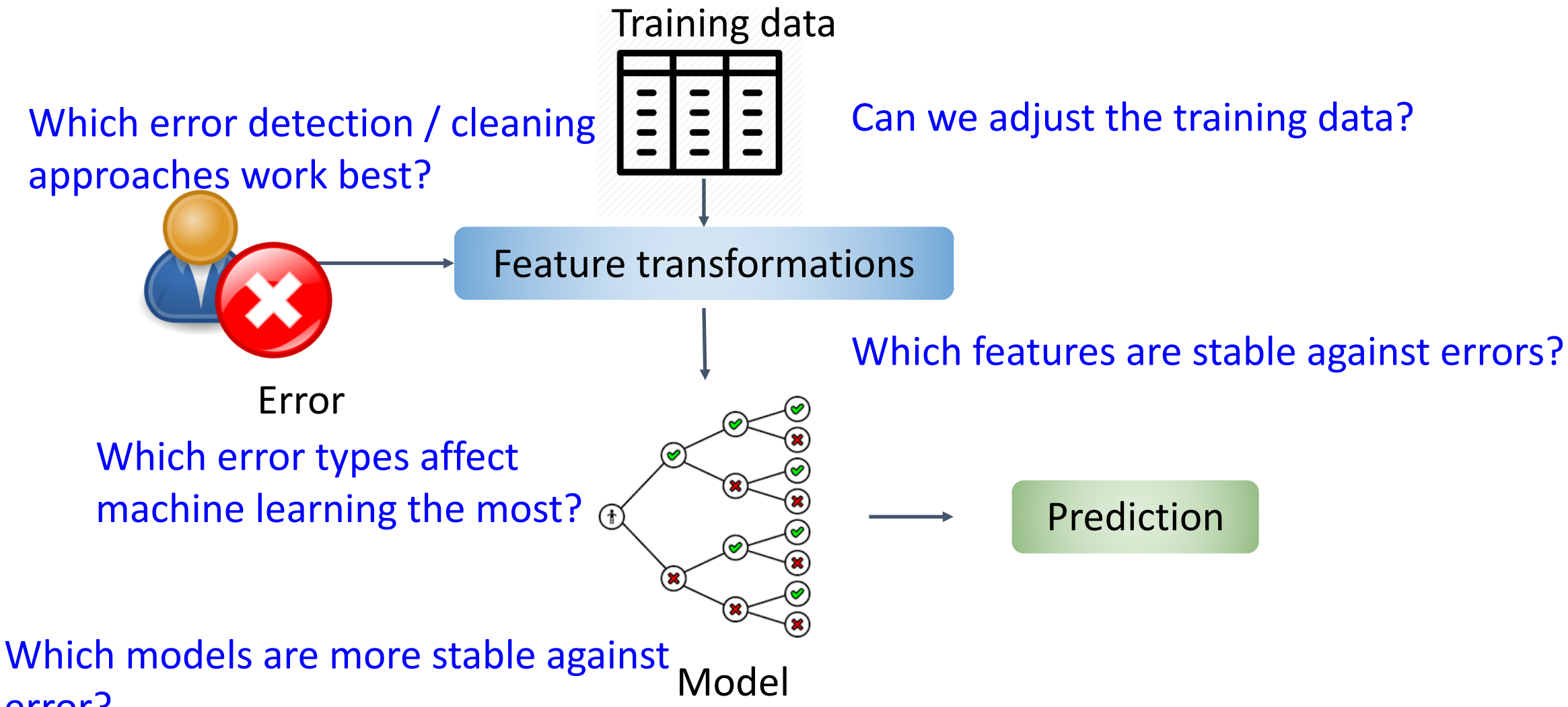
Summarizing Daily News

- A paper
  - [1] Huang, Anna. "Similarity measures for text document clustering." Proceedings of the sixth new zealand computer science research student conference (NZCSRSC2008), Christchurch, New Zealand. 2008.
- A data source
  - [2] http://feeds.bbci.co.uk/news/world/rss.xml

Data Cleaning for Machine Learning



Data Cleaning for Machine Learning



Tasks

Paper: Read about data cleaning in general:

Abedjan, Z., Chu, X., Deng, D., Fernandez, R.C., Ilyas, I.F., Ouzzani, M., Papotti, P., Stonebraker, M. and Tang, N., 2016. Detecting data errors: Where are we and what needs to be done?. *Proceedings of the VLDB Endowment*, *9*(12), pp.993-1004.

Datasets: Kaggle datasets, such as House Price Prediction, Wine Rating Prediction

Feature Engineering: Be creative! Start with simple features, such as one hot encoding.

Models: Try different models, such as XGBoost and Linear Regression.

Error Types: Use our error generator framework to create different test scenarios.

Cleaning Methods: Start with traditional cleaning methods using our abstraction layer framework. Then, use novel approaches, such as ActiveClean and ED2.

Extra: Come up with ways to augment the training to improve the model performance in case of errors.

Comparison of SVM and Random forest regarding to outlier Explainability

- Read “Anomaly detection: a survey”:
  - https://dl.acm.org/citation.cfm?id=1541882.
  - First 6 sections of the paper should be read.
  - Students should just know the techniques, challenges and limitations of techniques (No need to go into the details of techniques).
- Read an outlier explanation paper.
  - The paper will be announced.
- Read section 2.2 of EXstream paper.
  - https://par.nsf.gov/servlets/purl/10033440
  - Why this paper is of the opinion that Decision Tree and Logistic Regression are not suitable for explanation?

Comparison of SVM and Random forest regarding to outlier Explainability

- Implement an SVM and a Random forest outlier detection algorithm.
- Apply them on a labelled dataset such as KDD Cup 1999 dataset:
  - http://kdd.ics.uci.edu/databases/kddcup99/kddcup99.html
- Explain detected outliers manually.
  - Using responsible features and values.
- Compare learnt models' ability in explaining detected outliers.
  - Learnt hyperplane in SVM
  - Learnt rules in Decision trees
- Compare the explanations of SVM and Random Forest with manual explanation (as ground truth) and report TP, FP, TN, and FN.
- Compare the explanation results with Macrobase as a state-of-the-art solution.

Next step:

- Submit until Sunday 12:00 am
  - Create groups of two students
  - Make a top 3 list of topics
  - Write an application/ implementation proposal (300 words)
  - CC in your email your group member!
- Meeting next week: Topic assignment