



# IMF Karar Verir, Makine Öğrenir: Uluslararası Örgütlere Yapay Zeka Yaklaşımı

Merih Angın, Koç Üniversitesi

IV. Karmaşık Sistemler ve Veri Bilimi Çalıştayı,  
8 Mayıs, 2022



# International Monetary Fund

IMF decision-making **factors**

economic parameters

political processes





# IMF Decides, Machine Learns: An AI Approach to IOs

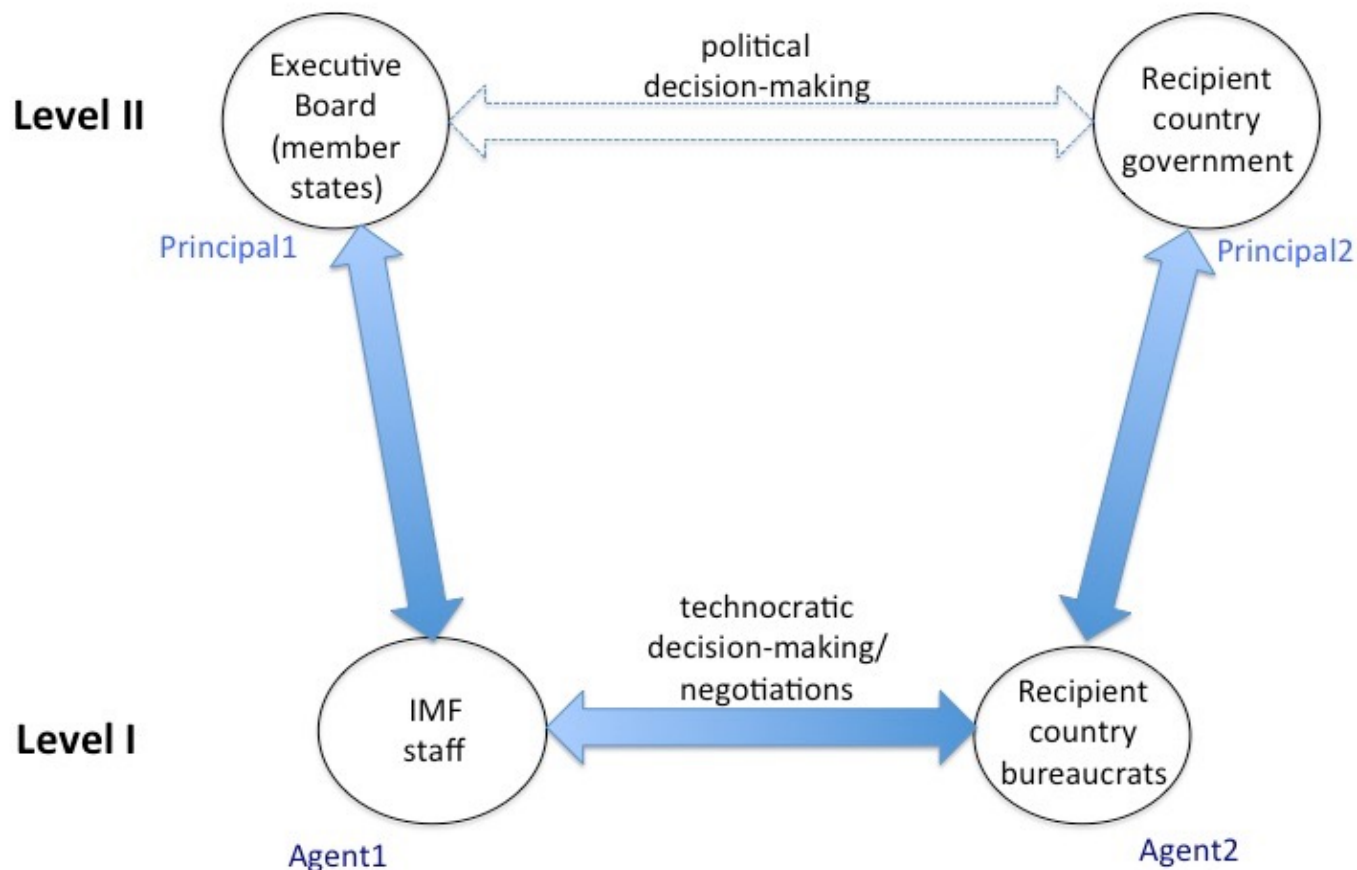
## Research question

What factors influence the number and scope of conditionality of an IMF program? And how do those factors play into shaping the design of the programs?





# The Two-Level P-A Model







# IMF Program Analysis

## Main arguments:

The number and scope of conditionality in an IMF program:

- crisis intensity
- political system fragmentation
- Executive Board's discontent with program design





# Data & Methods

- Macroeconomic indicators
- IMF conditionality dataset
- Archival research
- Elite/expert interviews
- IMF Executive Board meeting minutes
- Quantitative analysis : statistical regressions
- Qualitative analysis: case studies (Turkey, Romania and Greece)
- Computational Simulation





# Data & Methods, cont'd

- A machine learning model for predicting
  - the loan size
  - number of IMF conditions
  - waivers during program implementation
  
- Sentiment analysis on
  - individual board member sentiments
  - alliances between representatives of different countries



# Sentiment Analysis

## ➤ Polarity classification

### classes

- negative
- neutral
- positive



- recommender systems
- product quality assessment
- finance
- election prediction
- critical event detection





# Data Collection and Processing

## ❖ IMF Executive Board Meeting Minutes

- 611 PDF files between 1983 and 2015
- nearly 36,000 pages
- more than 20 annotators
- 2 annotators assigned to each file

## • Processed so far:

- ✓ 270 PDF files
- ✓ nearly 20,000 pages
- ✓ 97,444 sentences
  - ✓ Positive : 30,248
  - ✓ Neutral : 47,321
  - ✓ Negative : 19,875



# IMF Executive Board Meeting Minutes

## Executive Board meeting minutes for Turkey's 1994 program

- 17 -

EBM/94/60 - 7/8/94

Even if the slow recovery of the public investment ratio, which is projected to reach only 7.5 percent in 1998, reflects at least partially a shift to the private sector, I am not certain if this would be sufficient. Perhaps the staff could explain the dynamics of the public investment developments envisaged over the medium term, and what the intentions of the authorities are in this respect. For example, how fast are the original public investment cuts assumed to recover? I presume that the original--1994--reduction in public investment does not reflect privatization, as the major privatization effort is planned for 1995. Have public investments--excluding commercial public enterprises--been regarded as sufficient, or sufficiently well targeted, in the past?

If there are no other areas where expenditures could be substantially reduced, the Turkish authorities may have to consider further revenue enhancement measures. Perhaps the shares of revenue and expenditure measures in the deficit reduction need to be reversed as Turkey proceeds from stabilization to consolidation--to two thirds revenue increase, one third expenditures reduction.

Having an economic crisis, of course, is not to be recommended. Nevertheless, it can be quite useful, as it may provide the authorities with an opportunity to make a clear break with the past. The program we discuss today could mark the beginning of a new era for economic management in Turkey. This program is courageous. Courageous, because it has prescribed a strong medicine, a sharp reduction in public expenditures and tight monetary policies. But it will also require endurance to maintain macroeconomic stability so as to provide a strong framework for economic growth in the long run.

Ms. Lissakers said that she wished to support what Ms. Srejber had said about the nature of fiscal retrenchment in Turkey, especially with respect to the impact of retrenchment on public investment. The distribution of expenditure cuts across categories was important, and the long-term sustainability of the fiscal situation was of concern. In putting together a medium-term scenario, the staff focused the attention of the Turkish authorities on the necessity of preserving public sector investment, and perhaps of doing more on the revenue side rather than cutting expenditure across-the-board.

Mr. Kanada made the following statement:

There was no improvement in Turkey's economic performance in 1993: in particular, the fiscal balance worsened owing to the slippage on the PSBR and the external current account rapidly deteriorated reflecting strong domestic demand. Furthermore, owing to the exchange market crisis early this year, the external

-1

Mr. Kanada made the following statement:

There was no improvement in Turkey's economic performance in 1993: in particular, the fiscal balance worsened owing to the slippage on the PSBR and the external current account rapidly deteriorated reflecting strong domestic demand. Furthermore, owing to the exchange market crisis early this year, the external



# IMF Executive Board Meeting Minutes, cont'd

Country	Year	Sentence	Sentiment	Author
Bulgaria	2004	Mr. Mozhin and Mr. Lissovolik submitted the following statement:	0	Mr Lissovolik;Mr Mozhin
Bulgaria	2004	We thank the staff for a comprehensive and lucid paper.	0	Mr Lissovolik;Mr Mozhin
Bulgaria	2004	Bulgaria is making important progress in consolidating the achievements of its economic reforms, which in recent periods have been duly rewarded by upgrades of credit rating agencies.	1	Mr Lissovolik;Mr Mozhin
Bulgaria	2004	At the same time the staff report rightly notes that on some of the fronts vulnerabilities have increased, most notably this concerns the high level of the external gap.	-1	Mr Lissovolik;Mr Mozhin
El Salvador	1990	Ms. Powell made the following statement:	0	Ms Powell
El Salvador	1990	The staff notes that in the last five years, economic growth in El Salvador averaged around 1.5 percent a year, and the external position deteriorated--a result of armed conflict, adverse external developments, and political uncertainty.	-1	Ms Powell
El Salvador	1990	The new authorities in El Salvador should, therefore, be congratulated for the initiative they are taking to reduce imbalances and secure stronger economic growth in that country.	1	Ms Powell
El Salvador	1990	By their recent actions, which included a tightening of monetary policy and the unification of the exchange rate, the authorities have shown a strong commitment to this process, and the program they have outlined for 1990 and 1991 deserves our support.	1	Ms Powell
El Salvador	1990	It is clear that the ability of the authorities to successfully implement this program will depend critically on a resolution of the military conflict.	0	Ms Powell



# Processing Rules for Annotators

❖ labels are same

positive	and	positive	=	positive
neutral	and	neutral	=	neutral
negative	and	negative	=	negative

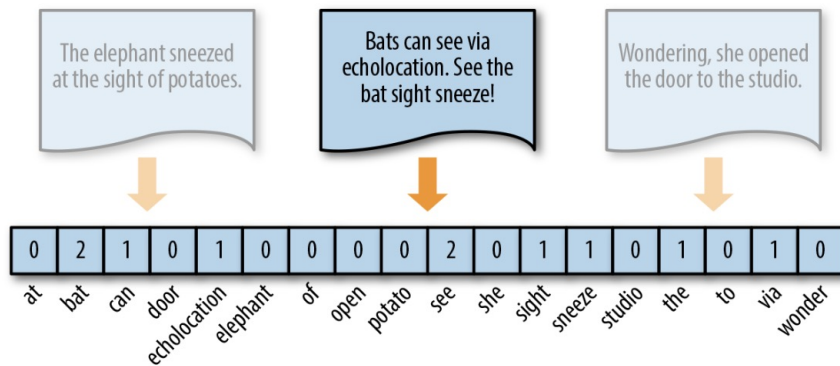
❖ labels are different

positive	and	neutral	=	positive
negative	and	neutral	=	negative
positive	and	negative	=	weighted randomized selection (according to annotators' reliability scores)



# Experimental Settings: Feature Extraction Methods

## ➤ Bag of Words (BoW)



## ➤ N-gram

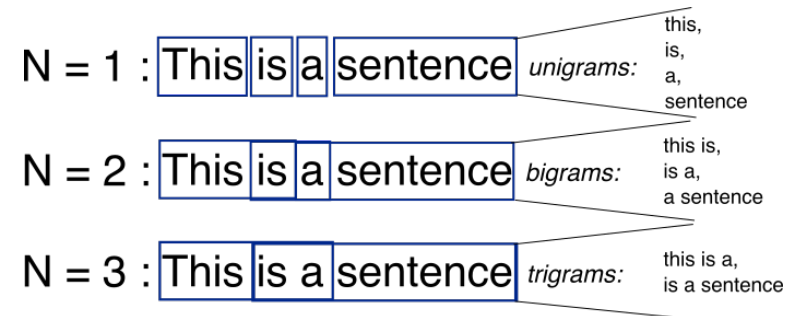


Image source: <https://deepai.org/machine-learning-glossary-and-terms/n-gram>

Image source: <https://towardsdatascience.com/from-word-embeddings-to-pretrained-language-models-a-new-age-in-nlp-part-1-7ed0c7f3dfc5>

## ➤ Term Frequency-Inverse Document Frequency (TF-IDF) : BoW based on TF-IDF values





# Experimental settings: BERT

Devlin et al. (2019)

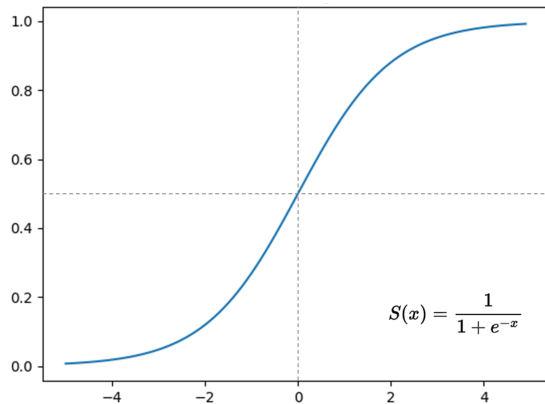
*“BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding”*

- ❖ Better performance over legacy methods
- ❖ An easy-to-use pre-trained model / No feature engineering needed
- ❖ Context-sensitive
- ❑ Utilized pre-trained models
  - RoBERTa-large
    - fine-tuned on 15 data sets from diverse text sources (reviews, tweets, etc.)
  - FinBERT
    - fine-tuned on Financial PhraseBank

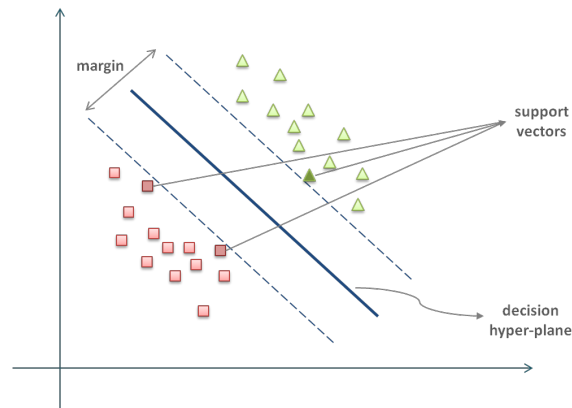


# Experimental Settings: ML Techniques

## Logistic Regression (LR)



## Support Vector Machines (SVM)



## Random Forest (RF)

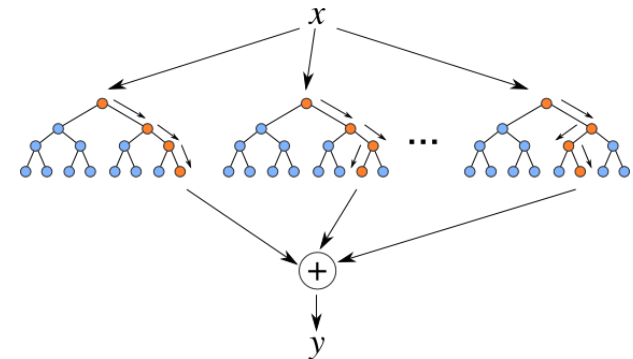


Image source: <https://levelup.gitconnected.com/random-forest-regression-209c0f354c84>



# Experiment Results

## Results of Feature Extraction Methods

<u>Method</u>	<u>Number of features</u>	<u>Accuracy</u>		
		<u>LR</u>	<u>SVM</u>	<u>RF</u>
BoW	17,527	0.852	0.851	0.822
N-gram	33,770	0.827	0.826	0.755
TF-IDF	17,527	0.853	0.854	0.816

## Results of BERT Models

<u>Model</u>	<u>Accuracy</u>	<u>Execution time (min.)</u>
RoBERTa-large	0.819	81
FinBERT	0.609	24
Fine-tuned BERT	0.972	937



# Future Research

- multi-class classification performance including the neutral-labelled sentences
- extracting valuable information such as
  - alliance between countries
  - countries that are getting sweeter deals than the others
- building a language model for public use by fine-tuning all IMF data with BERT



# Thank you for listening!

---

For any questions/comments:

[mangin@ku.edu.tr](mailto:mangin@ku.edu.tr)