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Exchange Rate Directional Forecasting using Sentiment Analysis on Social Media in Indonesia 2015

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Abstract

Exchange rate markets are quite sensitive to unexpected news and events. Over the last few years, investor's sentiments toward exchange rate have been used to provide early indicators and predict future movements. This research use data mining of investor's sentiments through social media, news articles, websites, blogs, forums, and group discussion to model and forecast exchange rate. Daily data on the nominal exchange rate of major global currencies— USD, EUR, and JPY against the IDR (Indonesian Rupiah) are collected from the entire year of 2015.

The methodologies used in this paper are big data analysis using LWIC (Linguistic Inquiry and Word Count) and event analysis.The expected outcome of this research is that the market sentiment can significantly predict the future price of the currency and find out which channel that can strongly predict the future prices. The exchange rate model or trend can also be useful information for institutional investors, individual traders, corporations, or even governments.

Keywords: Sentiment analysis, Data mining, Exchange rate, Social Media, LWIC, Event analysis

1. Introduction

Distance no longer become problem when it comes to communicate between people. Along with rising improvement of technology, people can use various ways to communicate with others and share information without barriers. One of the information-sharing tools that seems to be the most frequently used is social media. Social media shown significant increases in usage over time. Social media has become more user-friendly, accessible, and reachable. This condition leads to high dependence of people on the utilization of social media.

One of the social media that certainly becomes inseparable in people daily lifestyle is

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Twitter. As a micro-blogging platform, Twitter enables its user to connect with others and keep informed on what people are up to. Recent study by comScore, Inc. found out that Indonesia has the highest activities and penetration of its Twitter users in the world, with the percentage of 20.8 percent among all Internet users in the social networking world.

These facts indicate that Twitter's popularity is no doubt in Indonesia. According to behavioural finance theory, it is believed that one's decision making can potentially drive by other's thoughts and opinion. Moreover, it can be said that Twitter has potential to give great impacts to individual decision making by posting from Twitter which describe current public moods and opinions about certain topic or issues.

Moreover, data from Social Bakers shows Indonesia is the 4th largest in the world in terms of number of users, after the United States, India and Brazil. User interaction on Facebook is also quite high. From the results of research conducted by TNS Insight revealed that the Indonesian people accessing Facebook far more often (5.7 times per week) compared with online activities and other traditional media.

These condition leads to other development of usability of Twitter and Facebook from personal usage to an analytic tool for predicting future outcomes, such as financial trends. Thus, because of its easy usage, low cost, and its ability to reflect real time events, researcher use news information and social media as the data source which focusing on postings related to exchange rate.

Exchange rate has an important role in financial world, which include corporation who import and export raw materials or goods. Basically, a devaluation or depreciation will make the exporting and importing firms benefit. In the other side, an appreciation makes the exported goods more expensive and can decrease the competitiveness between the exporting firms. The other effects on the fluctuations of exchange rates are elasticity of demand, economic growth in the other countries, percentage of raw materials imported, inflation, and fixed contracts.

The fluctuation of exchange rate also gives significant impact to the government and private companies who possess foreign loans. Government and companies who held foreign loans has the obligation to pay certain amounts according to the current exchange rates, except they had already exercise prevention such as hedging, options, or futures. The condition of the countries' balance of payment may also be affected by the fluctuation of exchange rate.

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The research is arranged on purpose to analyze how news information and social media works in Indonesia's exchange rate towards the other country, whether information provided by the media have causal relationship with the result of increasing and decreasing rate of Indonesian Rupiahs. If the outcome indicates strong causal relationship, then news information and social media can be used as a new method for forecasting exchange rate to manage and obtain more accurate data of exchange rate of Indonesian Rupiah.

This study is constructed to project the use of social media and online news information sentiment activity to the future currency price in Indonesia. Therefore, this study is aim: 1. To find whether the micro-blogging activity can affect to the currency price in Indonesia.

2. To find whether there are significance between sentiment analysis and structure analysis to project the power of the social media activity and online news information to predict future currency price.
3. To find if there are any correlation between the sentiment analysis on social media and online news information to the currency price in Indonesia.

The rest of the paper is structured as follows. Section 2 presents the literature review; section 3 presents the research method, section 4 presents the data analysis, the final section presents the conclusion and Recommendations

2. Literature Review

2.1 Social Media and Micro-Blogging Activity

Micro-blogging is one of many forms of blogging activity that allows the users to share some updates and publish them in order to be viewed by anyone or restricted individuals who can be chosen by the users. Micro-blogging also helps its user to post brief digital content, such as text, pictures, short video, and links. Recently, the use of micro-blogging activity in the social media has gained phenomenal growth.

The highlighted type of social media in this research is micro-blog. This research uses data source from Twitter postings (called tweets) since it has performed phenomenal growth over the last couple of years. There are many users that communicate and stay connected to exchange quick and frequent answers about certain topics, especially in Indonesia where the number of

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Twitter users has significantly increased. Based on the surveys held by Semiocast, a social media research company,it is proven that Twitter activities is popular in Indonesia.

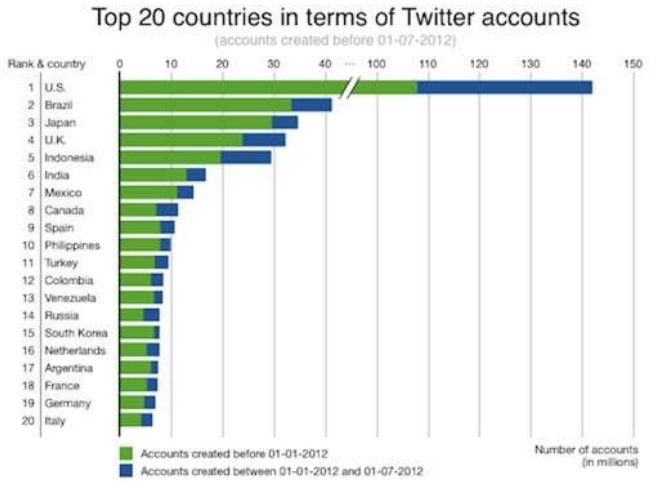

Figure 2.1 Survey Result of ―Top 20 Countries in Terms of Twitter Accounts‖ (Semiocast, 2012)

Furthermore, Twitter feeds have been used by numerous researchers and financial institutions to predict the future real-world outcomes of various disciplines along with exponential growth of micro-blogging activities. They analyzed the correlation can be seen from tweets' sentiments. Compared with other types of social media, it has the advantages of its ease of use and real-time events representative.

2.2 Sentiment Analysis

Sentiment analysis is one of the tools used to identify and extract subjective information in particular sources. This analyzing tool includes the application of natural language processing, computational linguistics, and text analytics. Sentiment analysis is conducted in order to determine the emotional state of the writer evaluation or judgment regarding particular topic. The basic level of conducting a sentiment analysis is classifying the emotions behind particular information, whether it expressed happy level, angry level, or sad level. There are many ways to conduct a sentiment analysis. There has been a large amount of research in the area of sentiment classification such as researched done by Hu Liu, Alex Davies, SentiWordNet techniques, OpinionFinder, and GPOM. All of those methods are good tools to analyse public's mood in the

form of text or tweet. As has been explained before, researchers that have used them as the tools, Johan Bollen and friends in ―Twitter Moods Predict the Financial Market‖, found an accuracy of 87,6% with a reduction of Mean Average Percentage Error by greater than 6%. Thus, this study will use Language Inquiry Word Count (LWIC) model because it is the most popular method that have been used by the previous resources.

However, implementing those tools in conducting sentiment classification in Indonesia would be quite difficult due to language gap. Most of the tools provide word list in English which will be disadvantage for sentiment analysis towards tweets written in Bahasa. The weakness is less comprehensive analysis since the postings are written in Bahasa thus they need to be translated to English. The translated messages are likely to lose its exact meanings due to incompatible word list that have corresponding meanings. Therefore, this research will not use any of those recent tools, but it will try to construct qualitative approach to be compatibly implemented for research in Indonesia.

2.3 Exchange Rate

Exchange rate is the comparison between price of a nation's currency to another nation's currency. Basically, exchange rate has two major components, which are domestic currency and foreign currency. A currency is represented by a three-character ISO code. Based on the law, a direct quotation expressed the price of unit of foreign currency in terms of the domestic currency. In the other hand, an indirect quotation expressed the price of unit of domestic currency in terms of the foreign currency. A cross currency or cross rate is known for an exchange rate which does not have domestic currency from one of the two components of the currency.

Foreign exchange market, or known as forex, is a market where currencies from all over the world are traded by institutional investors, speculators, banks, or even governments. Foreign exchange market is considered the largest market in the world because it has operational hours of 24 hours and traded in various markets which allows traders the ability to trade currencies constantly.

2.4 Event Analysis

The main purposes of event analysis as qualitative approach are:

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- to examine the background or the underlying events of the peaks or the downturns of tweets posted in a particular day within the time period of 2015.
- to find out the influencers regarding social media posting and online news information toward foreign currencies that have the ability to encourage public whether to buy or not to buy foreign currencies.

The process of event analysis works as follows:

1. Construct timeplots of aggregate number of tweets and total sentiment scores for each day to see the trends of social media and online news activities related to topics of foreigen currencies prices.
2. Plot the highest and the lowest point of number of posting and sentiment scores.
3. Conduct information mining about events in a specific period in accordance with the highest or the lowest point in timeplot graphs.
4. Find the linkages between the trends and the events occur at that time within the peaks and the downturns in timeplot graphs.
5. Find the strongest channel that give largest contribution in predicting the future prices of foreign currencies based on their sentiment scores.
6. Specify the influencer within constrained subgraphs that has most connections with other users.

3. Methodology

3.1 Data Collection

This phase use both sets of secondary data. The first source is data collection of exchange price which is generated from Yahoo! Finance historical data for daily period within January 1st, 2015until May 31st, 2015 obtained from *finance.yahoo.com*, using the close hours at 12.00 AM in Indonesian local time (GMT +7). The second source is the data which is generated from Media Wave software named Kibana which can automatically find relevant topics through the year of 2015 related to exchange prices of USD-IDR, EUR-IDR, and JPY-IDR with boolean system of AND, OR, and NOT. For qualitative approach, this research use Language Inquiry Word Count and sentiment analysis after data filtering according to its relevance.

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3.2 Data Processing

The main analysis is conducted by using linear regression. The dependant variable is the exchange rate prices while the independent variables are sentiments from Twitter, Facebook, online news, group discussions, and online forums.

3.2.1 Data Calculation

After the coding of all features has been obtained, the next step is to calculate number of each feature for each day within the time interval that has been determined. This research uses two different lags which are lag 0 and lag -1 in days.

3.2.2 Sentiment Analysis

Sentiment analysis is a method to identify opinion or subjectivity of a text towards a topic or an object, to ensure tweets that have been selected are relevant and adequate to reflect mood of authors. From a single tweet, there are numerous interpretation can be obtained from individuals. Therefore, sentiment analysis is required as a quantitative measurement of tweets' sentiments; positive, neutral, or negative. The sentiment keywords or dictionaries can be found through what people post in the social media and online news information.

3.2.3 Sentiment Scoring

Thisresearchuses direct observation for measurement of tweets' sentiments. The initial tweets werescored into three sentiment categories; -1, 0, and +1. Each category reflects different mood of the author as defined below.

Table 3.1 Sentiment Scoring Indicator

Score	Description
+1	Indicates positive sentiment and high buying or selling interest towards current currency price, potentially influence others to buy or sell currencies
0	Neutral sentiment towards currencies and author aims only to spread news/information
-1	Indicates negative sentiment and low buying or selling interest towards current currency price, potentially influence others not to buy or sell currencies

Table 3.2 Sentiment Language

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Indonesian Word	English Translation	Sentiment Score
Menguat	Strengthened	+1
Naik	Up, rise, increase, escalate	+1
Perkasa	Strong	+1
Penguatan	Strengthening, reinforcement	+1
Kuat	Strong	+1
Positif	Positive	+1
Melemah	Weakened, fall off	-1
Turun	Down, sink, subside	-1
Anjlok	Drop	-1
Pelemahan	Weakening, impairment	-1
Tertekan	Oppressed	-1
Ambruk	Collapse, crumble, tumbling	-1
Terpuruk	Worsen	-1
Stabil	Stable	0
Bertahan	Survive, last, withstand	0
Tetap	Still, consistently, constant	0

All of the sentiment used for analysis is using Indonesian language. However, researcher does not insert any local language into the sentiment measurement.

3.2.4 Statistical Data Tests

Independent variables obtained from previous steps – features and sentiment scores – then will be tested using reliability test and validity test in order to ensure the consistency and accuracy of data. The tests are done by using SPSS Statistics.

3.2.4.1 Linear Regression

Linear regression could tell how to make a model based on one or more variables to predict values of numerical variables (Levine, 2012). In the regression analysis, there are two

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variables determined as dependent and independent variable. Dependent variable is the variable that the author wishes to predict; meanwhile independent variable is variables used to make the prediction. Linear regression could identify the type of relationship which exist between the independent and dependent variables, which is used to measure the changes in the independent variable, and to know whether there are unusual observation.

There are simple linear regression and multiple linear regressions. Simple linear regression in which a single numerical independent variable X is used to predict the numerical dependent variable Y. The simple linear regression formula is:

$y = a + bx$ ..... (1)

Where a = Y intercept of the population

b = Slope of the population y = Dependent variable (sometimes referred to as the response variable) x = Independent variable (sometimes referred to as the explanatory variable)

The use of the equation is for projecting outcomes for time periods in the future. This research use multiple linear regressions analysis to seek the most correted variable. The author use SPSS statistic to calculate the linear regressio.

Equation that obtained from linear regression must be tested first because it is used to know if there any existence of linear relationship between the independent and dependent vaiables, the author will test whether the null hypothesis being rejected or not. The author will use T-test for determine it.

3.2.4.2 T-test

This test is used to conduct hypothesis testing into the independent variables. An independent variable is considered to have an influence to dependent variable if it is significantly reject H0p-level less than □ level. In this research, □ = 5% is used. The hypothesis is defined as follows:

H0: b1 = 0 : an independent variable is not partially significant

H1: b1 ≠ 0 : an independent variable is partially significant

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Furthermore, the simpler way to understand which variables that can reject H_0 is looking at the significant value. If the significant value of a variables below 0.05 then H_0 will be rejected because the significan level that required is 95%.

3.2.4.3 The Correlation of Coefficient (r) and Correlation of Determination (r^2)

The correlation of coefficient (r) as mentioned before is measures the strength and the direction of a linear relationship between independent and dependent variable. The coefficient of determination (r^2) gives the measurement of how the regression represent all of the data, or whether the regression curve passes through every point in the scatter plot exactly. If that is the case, then it would be able to describe all the variation (Levine, 2006) and represents the percent of the data that is closest to the line. The range of coefficient of determination is from $0 < r^2 < 1$ and refers to the strength of the lineas association between independent variable and dependent variable.

For example, if r = 0.95 then $r^2 = 0.9025$ that means 90.25% of the total variation in independent variables (y) can be explained by the linear relarionship between x and y, while the rest 9.75% of the total variation in y remains unexplained.

4. Data Analysis

4.1 Sentiment Analysis

Researcher use Semantria– Text Analytics and Sentiment Analysis which can be used in Microsoft Excel add-ins to score the sentiment from the Twitter. First, we must input some words that will give sentiment score to the tweet. Before we regress the data, we must consider the classical assumption test by checking the normality, heteroscedasticity, and auto correlation of the data.

The variables USD/IDR, EUR/IDR and JPY/IDR passed the Kolmogorov-Smirnov normality test, Heteroscedasticity Test and auto correlation test as the Durbin-Watson (DW) score was within the acceptable level.

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USD/IDR Linear Regression

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.433(a)	**.188**	.181	.003699731

a Predictors: (Constant), Sentiment

A total data of 10.247 USD/IDR tweets are collected from January 1st, 2015 until May 31st, 2015. According to the table above, we can find out that the R Square score for the USD/IDR data is 0,188 which means that the sentiment as the independent variable can affect the price of USD/IDR currency rate as the dependent variable as much as 18,8%, while the rest are affected by the other variables.

ANOVA(b)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.000	1	.000	**29.314**	.000(a)
	Residual	.002	127	.000		
	Total	.002	128			

a Predictors: (Constant), Sentiment

b Dependent Variable: Return

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Based on the table above, we can find out the F score is 29.314 with the significance level or probability of 0.000 which is less than 0.05. That concludes that the regression model can be used to predict dependent variable which is USD/IDR currency rate. **Coefficients(a)**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	.000	.000		1.018	.311
	Sentiment	**.005**	.001	.433	**5.414**	**.000**

a Dependent Variable: Return

From the coefficients table above, we can find out the constant coefficient is 0.000 and the coefficient for sentiment is 0.005 that leads to the regression model of

$Y = 0.005X$

Which means that if there is no sentiment during one day, then the currency rate will be no change. Coefficient regression of X of 0.005 shows that every sentiment scores of 1, then the currency rate will increase by 0.005.

Besides showing the regression formula, the output above can show the significance test with t-test to find out whether there is significance impact of sentiment towards currency rate.

Hypothesis:

H0 = there are no significance impact of sentiment towards currency rate.

H1 = there are significance impact of sentiment towards currency rate.

The t-stat is 5.414 which is greater and significance score of 0.000 which is less than 0.05. The score indicates that the H0 is rejected while H1 is accepted, which leads to the conclusion that there are significance impact of sentiment towards currency rate.

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EUR/IDR Linear Regression

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.361(a)	**.131**	.125	.006256846

a Predictors: (Constant), Sentiment

A total data of 2.314 EUR/IDR tweets are collected from January 1st, 2015 until May 31st, 2015. According to the table above, we can find out that the R Square score for the EUR/IDR data is 0,131 which means that the sentiment as the independent variable can affect the price of EUR/IDR currency rate as the dependent variable as much as 13,1%, while the rest are affected by the other variables.

ANOVA(b)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.000	1	.000	**29.314**	**.000(a)**
	Residual	.002	127	.000		
	Total	.002	128			

a Predictors: (Constant), Sentiment

b Dependent Variable: Return

Based on the table above, we can find out the F score is 22,368 with the significance level or probability of 0.000 which is less than 0.05. That concludes that the regression model can be used to predict dependent variable which is EUR/IDR currency rate.

From the coefficients table below, we can find out the constant coefficient is 0.000 and the coefficient for sentiment is 0.011 that leads to the regression model of

Y = 0.011X

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Coefficients(a)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	.000	.000		1.018	.311
	Sentiment	**.005**	.001	.433	**5.414**	**.000**

a Dependent Variable: Return

This means if there is no sentiment during one day, then the currency rate will be no change. Coefficient regression of X of 0.011 shows that every sentiment scores of 1, then the currency rate will increase by 0.011.

Besides showing the regression formula, the output above can show the significance test with t-test to find out whether there is significance impact of sentiment towards currency rate.

Hypothesis:

H0 = there are no significance impact of sentiment towards currency rate.

H1 = there are significance impact of sentiment towards currency rate.

The t-stat is 4.730 which is greater and significance score of0.000 which is less than 0.05. The score indicates that the H0 is rejected while H1 is accepted, which leads to the conclusion that there are significance impact of sentiment towards currency rate.

JPY/IDR Linear Regression

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.318(a)	**.101**	.095	.004161794

a Predictors: (Constant), Sentiment

A total data of 1.545 JPY/IDR tweets are collected from January 1st, 2015 until May 31st, 2015. According to the table above, we can find out that the R Square score for the JPY/IDR data is 0,101 which means that the sentiment as the independent variable can affect the price of

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JPY/IDR currency rate as the dependent variable as much as 10,1%, while the rest are affected by the other variables.

ANOVA(b)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.000	1	.000	**16.740**	.000(a)
	Residual	.003	149	.000		
	Total	.003	150			

a Predictors: (Constant), Sentiment

b Dependent Variable: Return

Based on the table above, we can find out the F score is 16,740 with the significance level or probability of 0.000 which is less than 0.05. That concludes that the regression model can be used to predict dependent variable which is JPY/IDR currency rate.

Coefficients(a)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	.000	.000		.602	.548
	Sentiment	**.006**	.001	.318	**4.092**	**.000**

a Dependent Variable: Return

From the coefficients table above, we can find out the constant coefficient is 0.000 and the coefficient for sentiment is 0.011 that leads to the regression model of

Y = 0.006X

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This means that if there is no sentiment during one day, then the currency rate will be no change. Coefficient regression of X of 0.006 shows that every sentiment score of 1, then the currency rate will increase by 0.006.

Besides showing the regression formula, the output above can show the significance test with t-test to find out whether there is significance impact of sentiment towards currency rate.

Hypothesis:

H0 = there are no significance impact of sentiment towards currency rate.

H1 = there are significance impact of sentiment towards currency rate.

The t-stat is 4.092 which is greater and significance score of0.000 which is less than 0.05. The score indicates that the H0 is rejected while H1 is accepted, which leads to the conclusion that there are significance impact of sentiment towards currency rate.

5. Conclusion and Recommendation

Researcher can also conclude that all of the USD/IDR, EUR/IDR, and JPY/IDR data passed the classical assumption test for regression such as normality, heteroscedasticity, and auto correlation test. That means that the regression model can be used to show the significant result between the sentiment analysis and currency rate.

In Indonesia, the USD, EUR, and JPY currency rate towards IDR using sentiment analysis can predicted trough social media activities. Although there are many other factors which can affect the currency rate such as economic and political factors, social media factor gives significant prediction as much as 18,8% for USD/IDR rate, 13,1% for EUR/IDR, and 10,1% for JPY/IDR which show significant difference because of the amount of tweet delivered in each currency is different.

In the future, researcher can use various types of social media such as Facebook, blog, websites, discussion group, and also online news to give better result of predicting future currency rate. To make it more accurate, researcher can also use time-series analysis and intraday data for the tweet and the currency rate. The sentiment words can also broaden with using local language and social media language instead of formal language in Indonesia.

The scope limitations of this study are:

1. The social media use in this study will be only from the micro-blogging social media (Twitter), while online news information used is from some websites based in Indonesia that post topics regarding the information about currency price.
2. The data which are taken from Twitter are only the Re-tweeted one to show sentiment based on the information.
3. The currency comparison used in this research is only currencies that have most transaction in Indonesia, which are USD-IDR, EUR-IDR, and JPY-IDR.
4. Data that selected are in between from January 1st, 2015 until May 31st, 2015 which can show better trends in the market.

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