Journal of the Korea Convergence Society
Vol. 12. No. 9, pp. 21-30, 2021

ISSN 2233-4890 / eISSN 2713-6353
https://doi.org/10.15207/JKCS.2021.12.9.021

Consultation Management Model based on Behavior Classification of Special-Needs Students

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특수학생들의 행동 분류 기반의 상담관리 모델

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Abstract Unlike behaviors that are generally known, information regarding unspecific behaviors is insufficient. For an education or guidance regarding the unspecific behaviors, collection and management of data regarding the unspecific behaviors of special-needs students are needed. In this paper, a consultation management model based on behavior classification of special-needs students using machine learning is proposed. It collects data by photographing the behavior of special students in real time, analyzes the behavior pattern, composes a data set, and trains it in the suggestion system. It is possible to improve the accuracy by comparing the behavior of special students photographed later into the suggestion system and analyzing the results by comparing it with the existing data again. The test has been performed by arbitrarily applying unspecific behaviors that are not stored in the database, and the forecast model has accurately classified and grouped the input data. Also, it has been verified that it is possible to accurately distinguish and classify the behaviors through the feature data of the behaviors even if there are some errors in the input process.

Key Words : Special Student, Unspecified Behavior, Machine Learning, Image Processing, TensorFlow

요 약 일반적으로 알려져 있는 행동에 비해 일반적으로 알려져 있지 않은 불특정 행동들에 대한 자료들은 부족한 실정이다. 특수학생들의 불특정 행동들에 대한 교육이나 지도를 위한 데이터 수집 및 관리가 필요하다. 본 논문에서는 기계 학습을 이용한 웹 기반의 특수학생 상담관리 모델을 제안한다. 실시간으로 특수학생들의 행동을 촬영하여 데이터를 수집하고, 행동패턴을 분석하여 데이터 셋을 구성하고 제안 시스템에 학습시킨다. 추후에 촬영되는 특수학생들의 행동을 제안시스템에 입력 및 분석을 통하여 기존 데이터와 비교하여 나온 결과를 다시 학습하여 정확도를 향상 시킬 수 있다. 데이터베이스에 저장되어 있지 않은 불특정 행동들을 임의로 행하여 테스트를 진행하였으며 예측 모델은 입력 데이터를 통해 정확하게 분류 및 그룹화 하였다. 또한 진입 과정에서 약간의 오차가 있더라도 행동의 특징 데이터를 통해 행동을 정확하게 구분 및 분류하는 것이 가능하다는 것을 확인 할 수 있었다.

주제어 : 특수학생, 불특정 행동, 기계 학습, 영상처리, 텐서플로우

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Received August 31, 2021 Revised September 9, 2021
Accepted September 20, 2021 Published September 28, 2021

1. Introduction

In case of special-needs students who have disorders, some unspecific behaviors that are different from the typically known behaviors by individuals are accompanied. In case of the behaviors that haven been known previously, teachers can become aware of details regarding the education plan or the response and establish a plan to response or a guide according to the behaviors, but in case of unspecific behaviors that haven't been known previously, specific data is insufficient. Also, there are many cases that the education environment and curriculum that are appropriate to the education site haven't been established[1]. There are a lot of difficulties in fully understanding the plan and data to guide various special-needs students even though there have been a lot of studies regarding the education curriculums and actual practices in the institutions that foster special teachers. Also, the provision of tailored education that is appropriate for special-needs students is not complete yet[2]. In case of students with autism, they may severely fear a certain sound, repeatedly make a strange sound, excessively or impulsively behave, show limited concentration, get annoyed, or even harm themselves[3]. In case of students with a severe autistic disorder, various and serious problems such as self-injury and offensive action may appear in an unspecific state, which is considered as urgent and serious problematic behaviors since it can lead to cases that threatens bodies or lives of themselves or others[4]. In order to enhance such problems and improve the special education, various and extensive data regarding the special training needs to be collected. In this paper, a model that provides the disorder type of the related student and the guidance plan to the user by comparing and analyzing the behavior data that gets input after organizing the unspecific behaviors of special-needs students that haven't been known previously, analyzing the data, and letting the system learn the data using TensorFlow and the machine learning is recommended. The behavior pattern data of the special-needs students that has been input by the user gets analyzed by the proposed model, and the data gets classified by its type. And then, data that is similar to the behavior pattern of the special-needs student gets searched from the database and is provided to the user. It is anticipated that it would help the user to enhance the behavior and treat the disorder through the consultation with the special-needs students using the data related to the treatment history and guidance plan using the analysis result data, and also anticipated that new education index regarding the special training would be provided in future using this data.

2. Related Works

2.1 TensorFlow

TensorFlow is a machine learning system that has been disclosed by Google in 2015 based on the open source. It is a machine learning system that can be operated in a large size system or multi-platform environments, and it was implemented using a data flow graph method based on open source library. The base unit is a computation graph, and the graph is expressed as a directional graph using nodes and edges[5,6]. Each node can be diversely output based on various inputs[7]. Following Fig. 1 is an example of a neural network of two-level hidden layers. Right one is a symbol diagram of the neural network, and the left one visualizes the computation graph of TensorFlow using TensorBoard tool. It uses $X = (X_1, X_2)$ vector as the input[8].

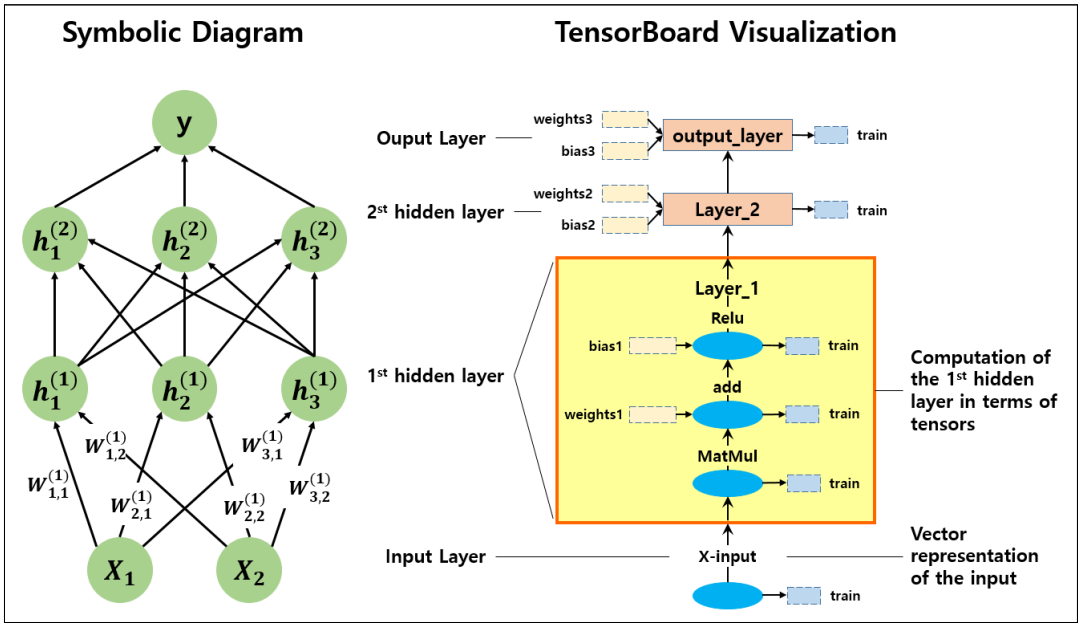

Fig. 1. An Example of a Neural Network with Two Hidden Layers

A value of the first hidden layer can be computed as shown in [Formula 1] below, and it is expressed as a nonlinear function of weighted linear combination. It can be expressed in TensorBoard Visualization as shown in [Formula 2] below. It is a process of finding the most optimal value by repeating the sum of products of input values(X) and weights(W).

$$h_1^{(1)} = \max(0, W_{1,1}^{(1)} X_1 + W_{1,1}^{(1)} X_2 + b_1^{(1)}) \quad (1)$$

$$h^1 = \max(0, W^{(1)} x + b^{(1)}) \quad (2)$$

The second hidden layer value can be computed similar to the value of the first hidden layer. Although there are many cases that a neural network is actually configured in a complex structure, the computation can be expressed in simpler and more detailed way through a graph structure visualization of TensorBoard which is composed of dialogues. The detailed information regarding the computation is displayed in the first hidden layer, and the other layer and the function computation detail get compressed and displayed as a single node[8]. Recently, TensorFlow supports various machine learning algorithms, and it is utilized in many studies as it has efficient and flexible structure for the working environment and the development environment.

2.2 CNN(Convolutional Neural Network)

CNN computes a neural network by applying the convolution computation, and it is utilized in various areas including interpretation of a natural language and recognition and classification of images and videos [9,10]. It is to extract features from a certain part of an image and make a forecast according to the features that have been extracted, which has very high accuracy[11].

Following Fig. 2 is a typical structure of CNN, and it can be divided into two parts in large. The first part is a part that extracts features of an image that has been input, and the second part is a part that distinguishes the target.

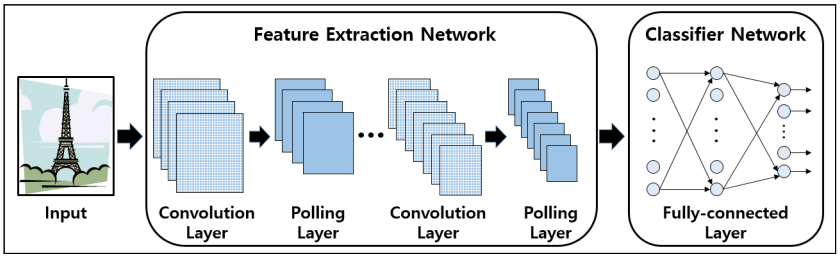

Fig. 2. The structure of general Convolutional Neural Network

In the part that extracts features of an image, there are Convolutional Layer and Pooling Layer. Convolution Layer extracts features from the image data that has been input. Unlike previous Fully Connected Layer, it maintains the configuration of input and output data of each layer and effectively recognizes the features of nearby images while maintaining the spatial information of the image that has been input. It applies multiple filters, and it extracts and learns the features of the image by using ReLU(Rectified Linear Unit). Pooling Layer collects the features of the image that have been extracted in the Convolution Layer. It extracts the features of the image and segments into patches that have the size of N x M. There are two ways of the segmentation: there is an average pooling that computes the average values in each patch, and there is a maximum value pooling that selects the biggest value in the patch. Once the feature extraction phase is completed, the image gets classified and output through an artificial neural network in Fully-connected Layer in order to identify the target that has been input[12]. The use of the CNN is increasing in the area related to the video thanks to the research performance result of the AlexNet[13], and technologies to apply even more neural layers to the convolution neural network are getting developed as the concepts such as NIN(Network in Network)[14] and GooGLeNet[15] are proposed.

3. Proposed Model

3.1 Model Configuration

Following Fig. 3 is a configuration diagram of the proposed model, and it is composed of 3 parts in large. It is composed of System Users to send the behavior data of special-needs students from the user to the system server, System Server to analyze and manage the data that has been input by the user and Storage that the data gets stored. The system server is composed of layers that execute independent processes, and it converts the data that has been created in each phase to the structure that can be used in each phase so that it can be used in the next phase. It collects the data that has been input and performs data cleaning task that converts the data to the structure that is appropriate for the model analysis. Once the cleaning task is completed, the system performs the learning through the machine learning using the data that has been converted through the cleaning task. Once the system completes the learning, it classifies the learning result data and stores in the database.

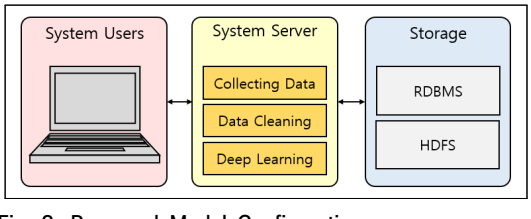

Fig. 3. Proposed Model Configuration

The platform that is used in the proposed system has actively utilized the open source, and it is implemented based on SpringMVC framework. The storage uses relational database that analyzes the data that gets input by the user and stores the result value, and Hadoop Distributed File System for storing images and data. Hadoop Distributed File System is composed of one (1) master server and three (3) slave servers, and each server uses Hadoop 2.7.7 version based on Linux Operating System.

3.2 System Process

Following Fig. 4 shows overall processes of the proposed model, and it is composed of 6 phases in large.

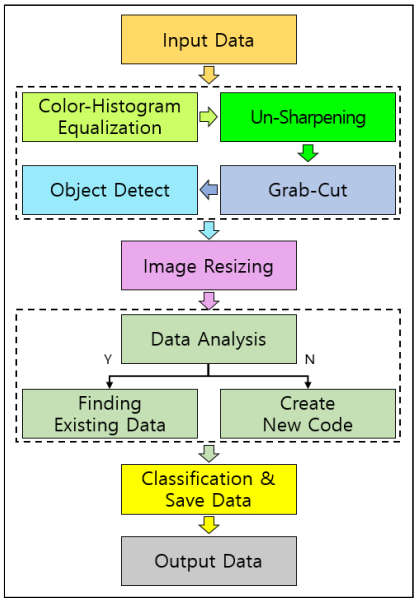

Fig. 4. Proposed Model Process

First, it is a phase that the behavior data of special-needs students gets input by a user. Second, the related area gets highlighted by raising the contrast using the color histogram equalization in order to highlight the object in the image of data that has been input by the user, and raising the clarity of the object to be extracted using Un-sharpening. Once the preceding task is completed, a task of extracting the area of the object that the user wants from the entire image area beside the background from the whole image by using Grab-Cut algorithm is performed. The result value gets extracted from the object that has been extracted from the whole image using binary method and Blob. Third, the size of the image that is acquired from the previous phase gets adjusted to a constant size in order to optimize the learning performance of the system. If the sizes of the images get unified, the time for the system learning and the accuracy of the analysis get improved. Fourth, in case the data that the size of the image has been adjusted is analyzed and determined to be the behavior pattern that had been already stored, the code of the behavior pattern would be searched, and the same code would be assigned for the related data. In case it is determined to be an unspecific behavior pattern that didn't exist previously, a new code would be created and assigned. Fifth, the data of which the code has been assigned gets stored in the database. Sixth, after the data of which the analysis and classification have been completed gets stored in the database, the data that is the same type as the data which has been input gets searched in the database and provided to the user.

3.3 Classification of Codes by Disorder Types

The proposed model is a system that can be applied to the consultation and the medical treatment by collecting the data regarding unspecific behaviors of special-needs students, learning the data, and providing the analysis result, and two preprocessing tasks are required in large in order for the proposed system to learn the data. The first task is to classify and store the behavior pattern data by each disorder type by collecting the behavior pattern data by each

disorder that has already existed in the database and assigning the code. The second task is to classify each behavior pattern into disorder types by letting the proposed model learn the behavior data that has been collected.

Following Table 1 is the classification of behavior patterns into each disorder, which is used in the proposed model. It is classified into 12 behavior patterns in total: they are Physical Disability, Disability of Brain Lesion, Intellectual Disability, Autistic Disorder, Emotion Behavior, Developmental Disability, Mental Disorder, Communication disorder, Learning Disability, Other health impairment, Visual Disability and Hearing Disability.

Table 1. Disability Types & Codes

Type of Disabled	Code	Type of Disabled	Code
Physical Disability	PD_00	Mental Disorder	MD_00
Disability of Brain Lesion	DBL_00	Communication Disorder	CD_00
Intellectual Disability	ID_00	Learning Disability	LD_00
Autistic Disorder	AD_00	Other Health Impairment	OHI_00
Emotion Behavior	EB_00	Visual Disability	VD_00
Developmental Disability	DD_00	Hearing Disability	HD_00

If the behavior data of special-needs students gets input into the proposed model, a code that is corresponding among the 12 disorder behaviors which are stored in the database would be assigned by analyzing the behavior data pattern, and the behavior data would be stored in the location where the same type of data is stored. If a data that has not been learned in the preprocessing phase gets input, it would determine that the data is a new data that hasn't been learned, create and assign an arbitrary new code, and store in the database by classifying the data into a new category.

3.4 Image Classification & Learning

Following Fig. 5 shows the processes that the proposed model classifies images and learns. Behavior pattern data by each disorder gets labeled through a data set phase for letting the proposed model learn the data regarding the behavior pattern data by each disorder type with the second preprocessing task, and the image size, clarity and contrast get optimized in order to enhance the image analysis performance. The data that has been created in the previous phase gets classified through CNN according to behavior patterns of each disorder type, which gets learned by the proposed model. It judges whether it succeeded or failed by analyzing the image by comparing the behavior pattern data that has been input by the user with the behavior pattern data that has been stored in the database.

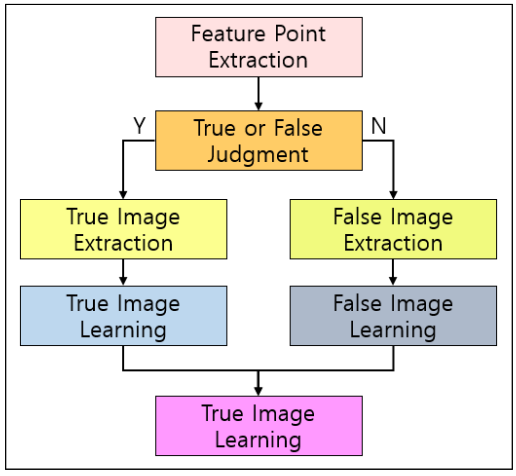

Fig. 5. Image Classification and Learning Process

If the judgement result is a success, it means the data is the behavior pattern data that already exists in the database. On the contrary, if the judgement result is a failure, it means the data is a new behavior pattern data that is not stored in the database. Depending on the success and the failure, the image gets learned through the classification by the proposed model, and the

data gets stored in the database. In this paper, 5 depth layers were configured, and learning was performed 1,000 times.

Following Fig. 6 is a graph that shows the change in the cost according to the learning progress.

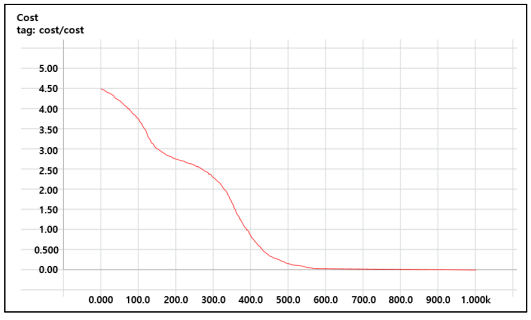

Fig. 6. Graph of change in Cost by Learning

After the propose model started the learning, the cost has gradually reduced until 400 times, and from the 500 times, it has slowed reduced. After 1000 times which are the final number of the leanings have been completed, the value of the cost acquired the data of 0.0018799152.

4. Results and Discussion

Following Fig. 7 is the main screen of the proposed model, and it is composed of buttons on the top of the screen that can input, search, and view the information. The data that has been registered recently can be viewed through Recent Data List, and the detail of system notice can be viewed in the list on the lower left side. Codes by each disorder type are located in the lower right side, and the detail can be viewed by viewing the data list related to the relevant code when each code is selected.

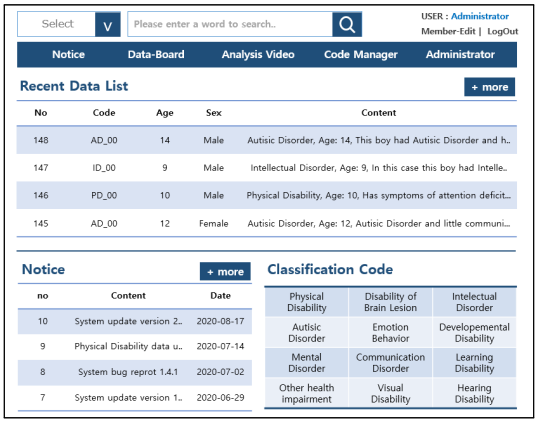

Fig. 7. Proposed Model Main Page

Following Fig. 8 is a screen that shows the detail by getting the input of the behavior data of special-needs students from the user, determining a code that is appropriate for the data after it is analyzed by the proposed model and outputting the analysis result detail. Upper left side screen is an area that records the behavior data of special-needs students with a webcam or a camera and processes it as a continuous image data when inputting the data. Lower left side screen is a machine learning configuration area of the proposed model, and it includes following configuration items.

Fig. 8. Analysis Result Through Learning Data

It is composed of Epochs Configuration that shows the status which one learning process has been completed for entire dataset, Batch Size

that configures the size of a sample that are given per a batch and Learning Rate that adjusts the learning speed of the system. Right side screen is an area that outputs the result that is acquired by analyzing the data that has been input as a graph, and the example data is the result that has been acquired by inputting the behavior data of an autistic disorder into the proposed model. It shows that the value of the autistic disorder among 12 codes that are displayed on the data analysis result graph comes out to be 88%. Lower right side screen is a recommended data list screen area that searches the behavior pattern data that has the same code as the data and provides it to the user. If an arbitrary item among output items is selected, the detail of the related item can be viewed. Following Fig. 9 is the screen of the result when the unspecific behavior data that hadn't been learned by the system was input into the proposed model. As shown in Fig. 9 earlier, all 12 items in the analysis result graph are below 20% in the right side of the screen. If there isn't any code that corresponds, a new code would be assigned for the data that has been entered, and it would be stored as a new type.

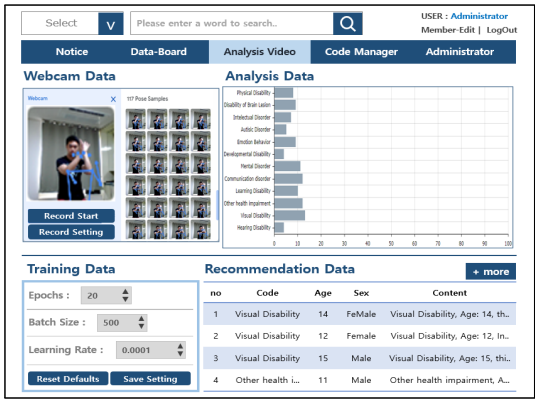

Fig. 9. Result of Analyzing Data that hasn't been Learned

As you can see in the lower right side of the screen, the behavior data that has the biggest value from the result of the analysis would be searched from the database, and the data list that has been output would be provided to the user. It is shown that the Visual Disability data that has the highest concordance rate at 14% among the analysis result and Other Health Impairment data that has the second highest concordance rate at 12% are displayed in the list in the lower right side. If an arbitrary item is selected among items that have been output, the detail can be viewed. Following Fig. 10 is a folder and file list of the behavior pattern data that is stored in the database.

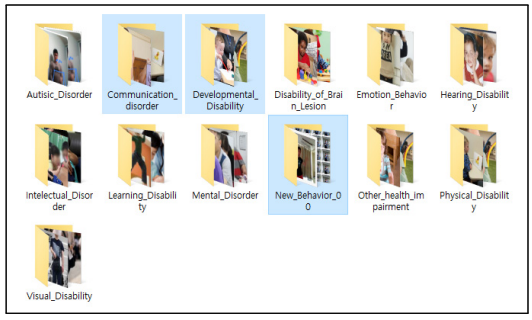

Fig. 10. List of Data Stored in the Database

It can be checked that the autistic disorder behavior data that has been input into the proposed model as a sample data and the unspecific behavior data are stored. It can be checked that the unspecific behavior data has been classified into a new category, a folder named New_Behavior_00 is created and then the unspecific behavior data that has been input is stored in the folder.

5. Conclusion

In this paper, a model that records the behaviors which appear unspecific way and aren't generally known among usual behaviors of special-needs students, groups the data which has been collected by letting the proposed model learn and analyzing the behavior pattern data through TensorFlow and machine learning, and

provides the data to a user by classifying the data by each disorder type, assigning a code to each data, and managing in overall is proposed. The user can access to various information and actual cases regarding the special-needs students through the proposed model as it provides various cases and wide range of information regarding the behavior pattern data by each disorder type, and thus establish a guidance plan accordingly. Also, it is expected that the quality of the education would be enhanced as more diverse and wider range of information on the special-needs students can be accessed, and special teachers can use the information as the data for the tailored guidance to each special-needs student and various treatments. Through this paper, it was confirmed that it has high accuracy in distinguishing behaviors by 12 disorder types that have been learned by the proposed model and the unspecific behaviors. But when behavior data of many people, not one person, was recorded and input in the data input phase, the accuracy in the behavior pattern analysis became lower. In future, a study to provide the data regarding the guidance and the education guideline that are appropriate for a special-needs student should be continued by recording the behaviors of special-needs students in actual class time in a special class or a special school, and analyzing the behaviors of special-needs students that a special teacher or an educator couldn't notice in real-time.

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