

A novel method to manage and highlight charts using AI

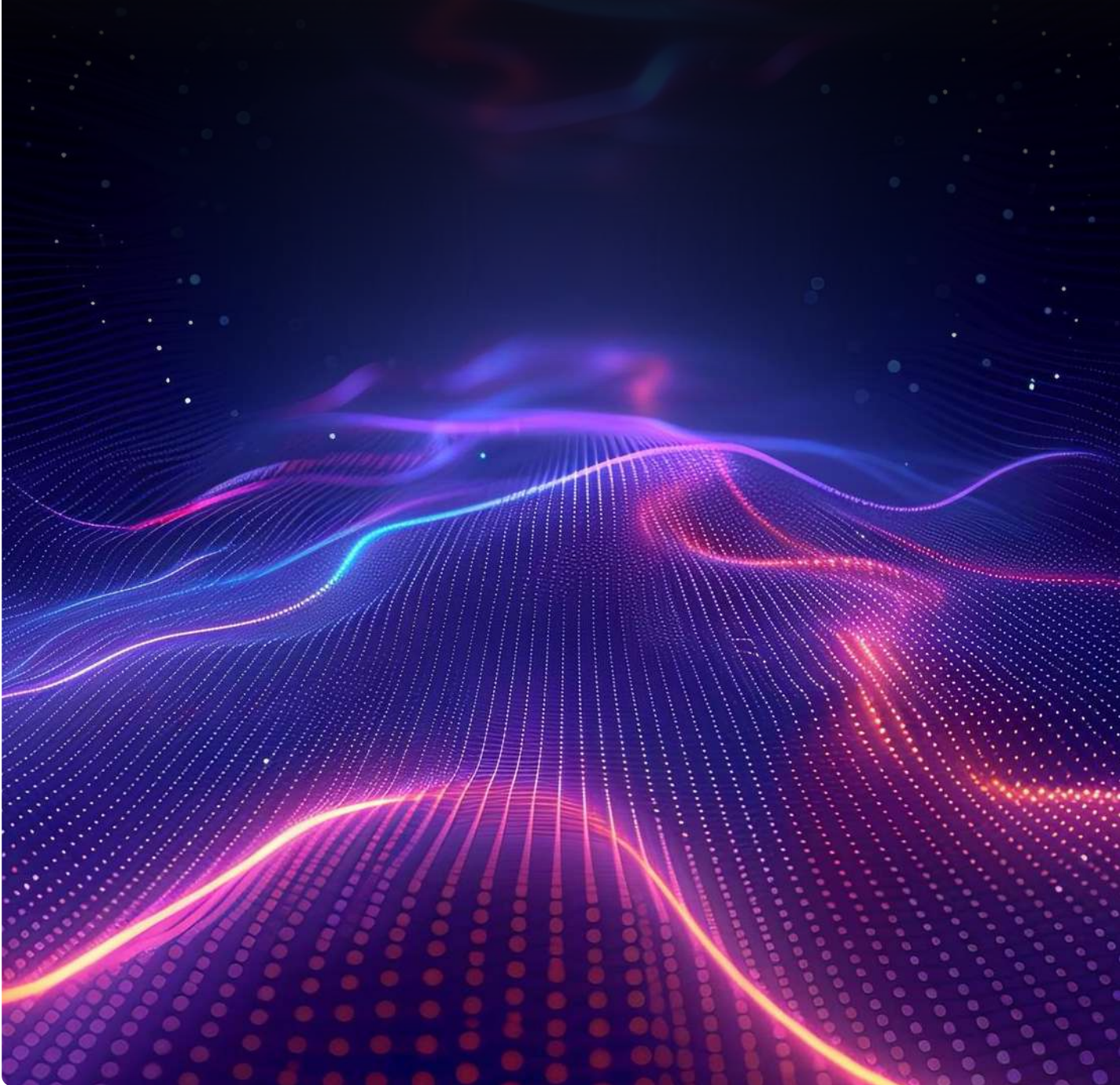


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Abbreviations

AI	Artificial Intelligence
OCR	Optical character recognition
CV	Computer Vision
DL	Deep Learning
JPG	Joint Photographic Experts Group
Bmp	Bitmap
PNG	Portable Network Graphics
WebP	Web Picture Format
CSV	Comma Separated Values
CAGR	Compound Annual Growth Rate

Abstract

In the digital world, where data has become the new oil, data representation has become equally important. Graph representation serves as one of the most common methods used to represent the data for effective communication. Currently, in major business domains such as medical, semiconductor, finance and others, graph validations play a vital role in live and static data reporting, making the validation of data plotted in the graph an imperative. There are numerous automation tools available in the market that not only support specific or complex use cases, but also generic requirements. Automation and visualization of these intricate graph validation scenarios face numerous obstacles. For instance, while plotting the line graph, different color lines representing unique categories may intersect based on data content. Differentiating and highlighting the intersecting color lines in a graph through automation might be challenging. In most of the cases, the entire graph validation process is manually done, which requires a lot of time and effort.

This white paper proposes a method to pass a text as an input that will identify the graph along with the legend (color) associated with the text. Utilizing this legend as a reference, the system traverses through the entire graph identifying and highlighting the plot corresponding to the legend. The solution supports various patterns of graphs using Computer Vision (CV) and Deep Learning (DL) techniques with high accuracy.

Introduction

Data visualisation serves as a crucial tool to facilitate human beings comprehending and analyzing the data better. Graphical representation is the simplest and most common way of data representation among all the techniques. In general, the data available in the reports are plotted as lines, bars, pie and other ways in the forms of graphs as represented in Fig. 1. Graphs can be used to effectively analyse the data and effortlessly represent various metrics, statistics and many more. In general, the numeric data generated during transactions in various business sectors, where the reports need to be visualized to display the transaction summary, it becomes mandatory to validate the data represented in the graph and check for any mismatch with the report.

For instance, in test case execution, scenarios might arise where an input will be a string must be matched within the output image. The user/tester typically identifies the legend associated with the input string and traces it in the graph's x and y-axis. The proposed solution involves extracting text from the source image as input, which could be in JPG, Bmp, PNG or WebP format. This text associated with a legend needs to be located within the image. Once the legend is identified, the solution focuses on the graph area to find and highlight the feature/pattern matching the legend's color.

In addition, the input text and its associated color on the x-axis will also be highlighted. Since graphs may contain multiple input text, each with its legend and these values may intersect with each other, traditional tools struggle to validate the values in the graph effectively.

In sectors like medical, marketing, finance and others, where a plethora of numeric data is generated in real-time, graphical representation serves as an invaluable tool for analysis. Visualizing data trends helps in summarizing and visualizing the available trends. However, when plotting categories of data using unique colors, the capturing and highlighting intersection of these lines pose a complex task, considering the color values get changed. For example, when blue and yellow intersect, the color at the intersection will get changed resulting in a break in traceability making it appear as two different representations even though it is a single data set representation.

Overcoming this challenge requires automated techniques that recognize intersecting lines as a single representation. Another hurdle is distinguishing similar colors used to differentiate different categories, such as pale blue and light blue. Similarly, less-intense colors like light pink also pose a challenge when the background is white. These kinds of challenges can be overcome by evolving artificial intelligence techniques to successfully differentiate and highlight these automatically.

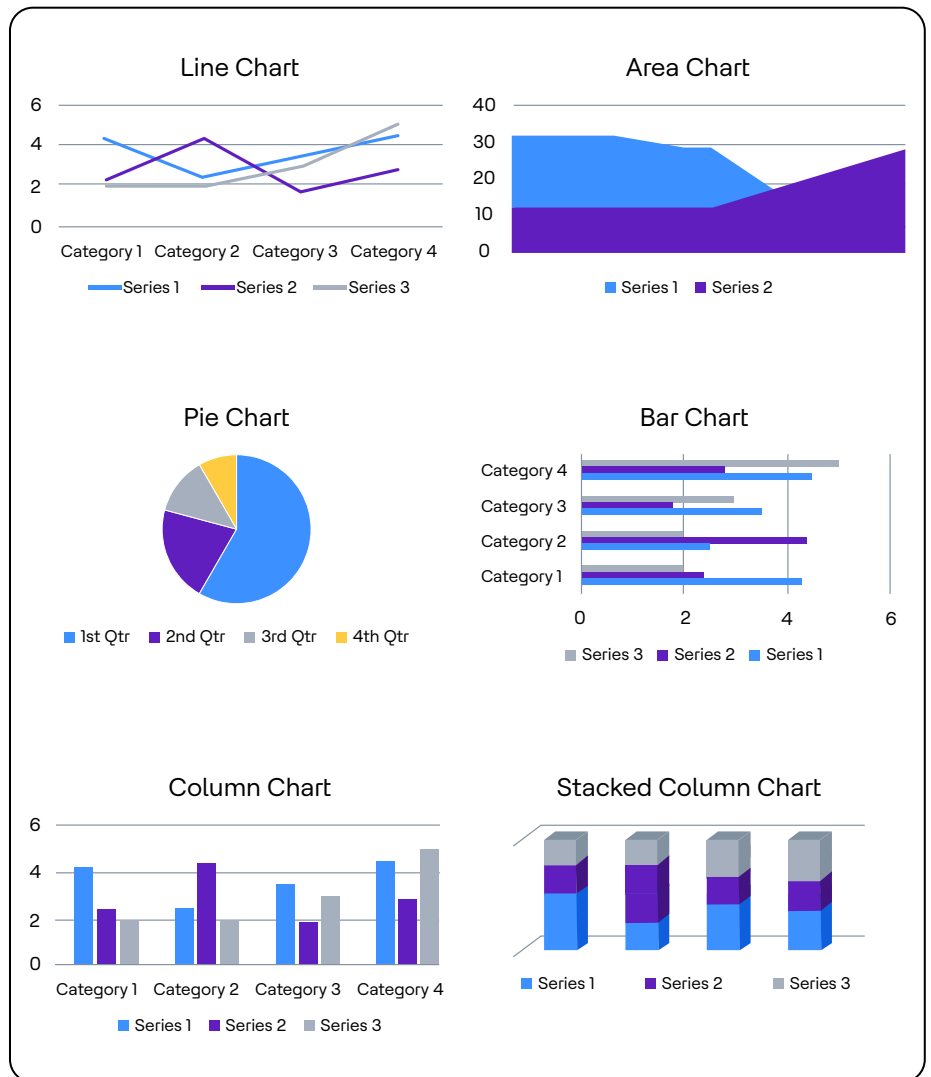


Figure 1: Different types of graphs

This white paper proposes a solution using CV and DL techniques. Both these techniques are fields of AI where DL trains a computer to think and work like a human while CV deals with digital images and videos to comprehend information the system can utilize to derive an outcome facilitating humans to automate tasks. Identifying specific data points from a representational graph is crucial in validation of test case, which can be time-consuming and taxing, if done manually.

This solution provides an automated solution to this problem, which not only assists the system to identify the data values that a tester requires, but also help segregate it from the rest of the graph, reducing the time in a manual method.

Market trends

The global AI market is projected to experience a significant growth spurt, with a Compound Annual Growth Rate (CAGR) of 21.6% from 2023 to 2030. This growth will be propelled by an increase in relevant partnerships, collaborations and AI applications. In 2022, the market size was valued at \$428 billion and is expected to reach \$2,025.12 billion by 2030. The report covers various AI-based solutions, including AWS Chabots, OpenAI Codex and Azure AI. The growth of the market is fuelled by the rising demand for hyper-personalized services, evolving business complexities, government initiatives and investments in AI technologies.

Furthermore, the AI-enabled testing tools market is forecasted to reach \$2.03 billion by 2033, growing at a CAGR of 16.9% from 2023. Factors driving this growth include the need for efficient customer services and operating networks in the telecommunications industry, the adoption of AI-enabled testing tools to reduce operational burdens and the increasing demand for accurate data delivery. Additionally, advancements in technologies such as AI and IoT, as well as urbanization, modernization and increasing disposable incomes, are contributing to the market's expansion.

Problem statement

- To identify the input text from a given image along with the legend (color) associated with it
- The detected color needs to be traced, validated and highlighted in the graph area

Solution

In the realm of testing processes/cycles, particularly when the test data may be represented as a graph, the validation of test data representation is crucial to ensuring the accuracy of graphical representation. The input to the solution is a static image with a text string that may be the name of a field, value or variable associated with or present within the image.

The input string will be identified with the legend (color) associated with it for representation within the image. The legend may be in the form of a small square, circle, rectangle or any other shape filled with a color. This legend may be to the right, left, top or bottom of the input text and the solution is capable of identifying.

The solution will extract the features from the legend area and traverse through the targeted graph area to detect similar features in the x-axis and y-axis. This solution is designed with intelligence to identify and highlight the legend in the graph area. The solution will distinguish between other legends and the legend under validation using CV and text extraction techniques without any manual intervention.

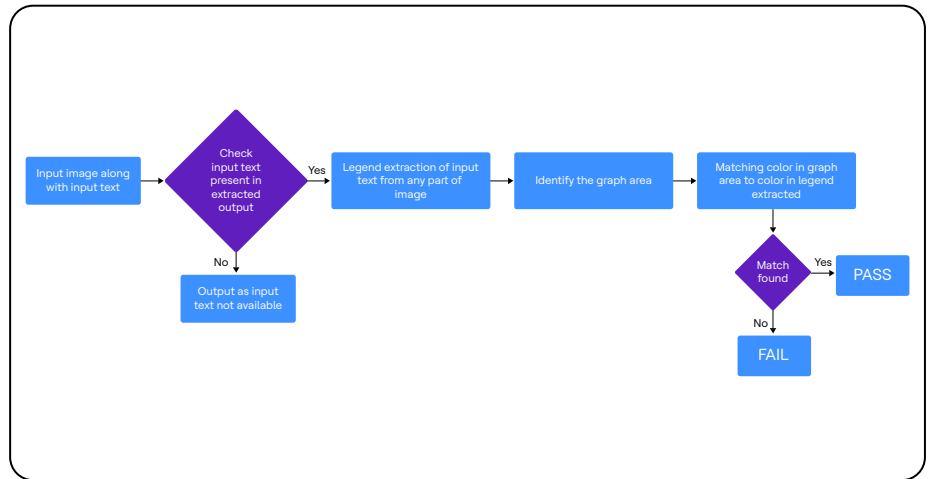


Figure 2: Flow chart for solution

Fig. 2 above describes the workflow of the solution. The initial step involves the input image is being processed by a DL model specialized in text extraction which in turn is utilized to identify the legend. The pixel information obtained from the legend is searched in the graph area to provide the output. Subsequently, when the image gets uploaded to the solution, it undergoes a transformation into the color space that effectively distinguishes various colors mirroring the way the human eye perceives color.

Simultaneously, a string value is passed assisting in the identification of the legend in the graph. A DL model is leveraged to extract all the text in the image and match them with the string passed as the input. Once a match is found, the legend closest to the found match is selected as the targeted color to be validated in the graph area. This legend is then traversed through the entire graph area under consideration to find all possible matches. A match is found only if the pattern has the same color representation as the legend. All such matches are marked in the image to be stored and displayed as the output.

An example of the highlighted output is shown in Fig. 3, 4 and 5. If the solution can highlight any portion in the graph area from the original image, then the solution will be validated as 'PASS' or 'FAIL'.

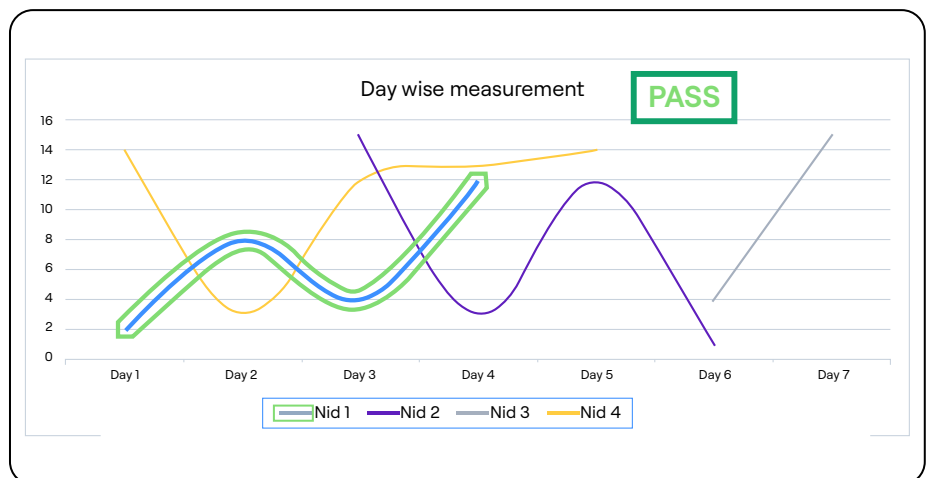


Figure 3: Line graph with input string as Nid1

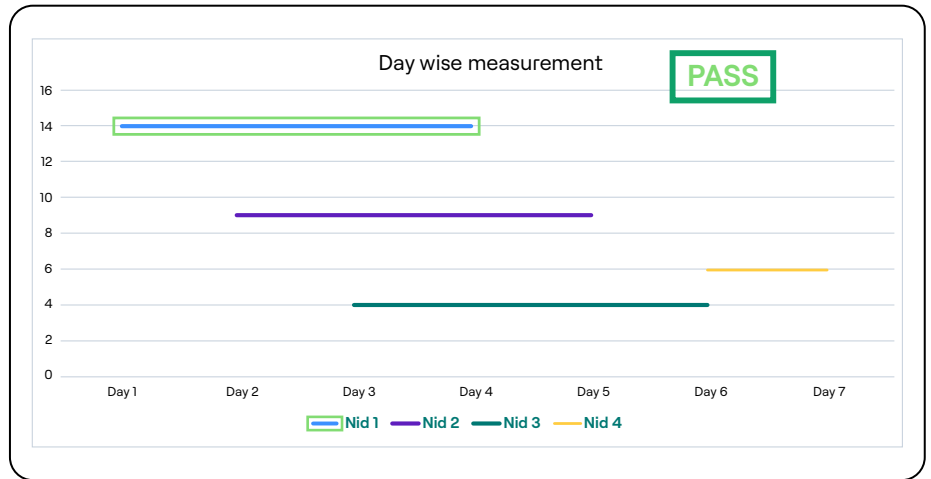


Figure 4: Line graph with input string as Nid1

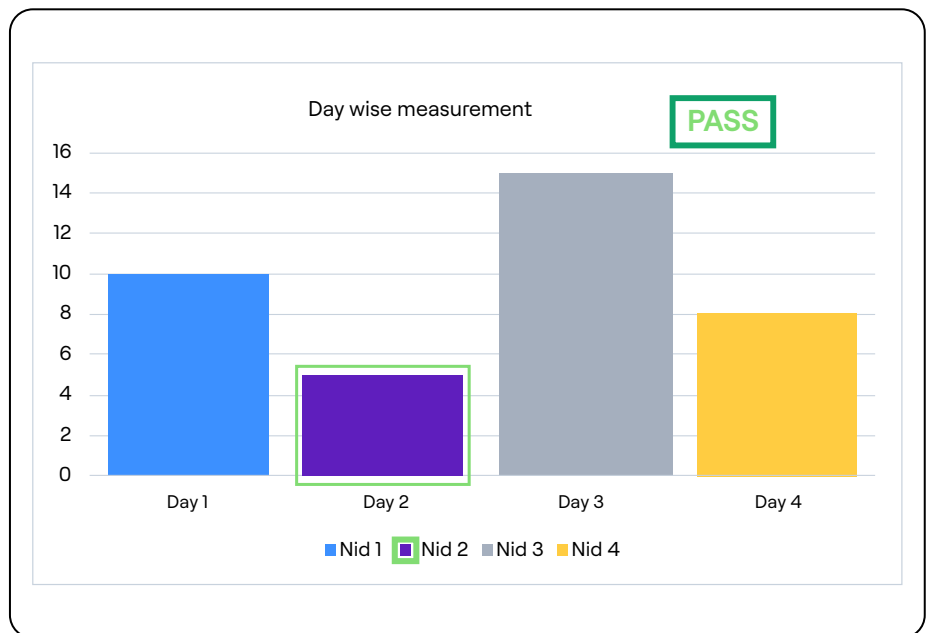


Figure 5: Line graph with input string as Nid2

Benefits

- Graph validations are done with 3X to 4X times the speed
- The solution reduces manual effort by ~25-30%
- The solution can be integrated into any framework or as a standalone
- Generates user-friendly output with highlighter
- Supports multiple-resolution images

Conclusion

The proposed solution facilitates the testing teams overcoming the hurdles faced in graph validation where an input is a text. This solution is built with smart algorithms to identify the color representation associated with input text. It can identify the plotted graph area and highlight the presence of reference color in the graph image.

In addition, input text and its associated color in the x-axis are highlighted for user reference using CV and DL algorithms. This may also help to validate any content like text, data, numbers and others available with the input image. If all the criteria for testing are fulfilled, then the solution gives a 'PASS' output, otherwise a 'FAIL' is given as output.

References

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Author information



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