



Dot Distribution Maps to identify Part-Time Distance Learning Programs (iCEPS) Campuses in Universiti Teknologi MARA

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ABSTRACT

The existing iCEPS webpage continues to display program information in a list format, requiring users to manually scroll through the list to access all the available UiTM programs. This presentation of data in a list format is inefficient for analysis as it necessitates users to imagine and visualize the geographical location of the campuses themselves. This study aims to investigate the feasibility of utilizing a dot distribution map to assist users (candidates) in their search and selection of campuses for pursuing part-time distance learning at the diploma or degree level, as offered by the Institute of Continuing Education and Professional Studies (iCEPS) at Universiti Teknologi MARA (UiTM). In this study, a methodology to enhance the user experience in selecting campuses for part-time distance learning programs at the diploma or degree level was implemented. This includes initializing a map using the Google Maps JavaScript API, generating markers on the map to represent campus locations, and implementing tooltips to provide essential information when users interact with the markers. The webpages with the dot distribution maps are presented as the findings of study. It is effectively visualizing the locations of iCEPS campuses across various branches in Peninsular Malaysia, Sabah and Sarawak. These dot distribution maps offer an interactive and user-friendly platform that allows users to access detailed information about the courses offered at each campus. The implications of this study point to a significant reduction in the time, costs, and health-related concerns associated with users' travelling. By providing an efficient means of campus selection through dot distribution maps, prospective learners can minimize the time spent commuting, reduce expenses on accommodation, food, and travelling thus promoting convenience, financial savings, and well-being.

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1. Introduction

In the era of rapidly advancing technology, the utilization of innovative tools and techniques has become dominant in various fields. Among these, dot distribution maps, interactive visualization, and big data have arisen as transformative technologies with the potential to revolutionize decision-making processes. Dot distribution maps provide a dynamic and visually intuitive means of representing data, allowing users to gather valuable insights through spatial analysis [1]. On the other hand, interactive visualization empowers users to engage with data actively, enabling them to explore



complex information in a user-friendly and comprehensible manner [2][3]. Concurrently, the proliferation of big data has brought forth a wealth of information that, when harnessed effectively, can drive informed decision-making, and facilitate more efficient resource allocation.

The utility of these technologies extends far beyond mere data representation, but their integration as a decision support tool has the potential to yield significant benefits across various domains. One such domain that continues to gain considerably from the adoption of these technologies is higher education. Specifically, institutions like the Institute of Continuing Education & Professional Studies (iCEPS) within Universiti Teknologi Mara (UiTM) that face unique challenges and opportunities in the realm of education. Catering to a diverse array of adult learners, iCEPS is committed to providing high-quality part-time distance learning programs that align with the needs and aspirations of Bumiputera learners.

The current version of the iCEPS webpage, as seen in Figure 1 remains in a list format. Although the webpage has undergone recent updates, users are still required to scroll through this list to access all the programs offered by UiTM. Notably, the webpage lacks a search function, necessitating users to manually locate programs by scrolling through the list. This manual search process is notably time-consuming for users seeking their desired programs. Moreover, the current data presentation format proves inefficient for analysis, as it compels users to imagine and mentally visualize the geographical locations of campuses themselves.

State	Program Code	Program Title	Description	
KELANTAN	AC110	Diploma Perakaunan	Ijazah Sarjana Muda Pengurusan Sistem Pasabai (Kepujian)	
	AM110	Diploma Pentadbiran Awam	Sarjana Muda Pentadbiran Perniagaan (Kepujian) Pemasaran	
	BA111	Diploma Pengajian Perniagaan	Sarjana Muda Pentadbiran Perniagaan (Kepujian) Kewangan	
	BA118	Diploma Pengurusan & Teknologi Pejabat	Sarjana Muda Sains Maklumat (Kepujian) Pengurusan Sistem Maklumat	
	BA119*	Diploma Pengajian Perbankan		
	IM110	Diploma Pengurusan Maklumat		
	TERENGGANU	AM110	Diploma Pentadbiran Awam	Sarjana Muda Sains Pentadbiran (Kepujian)
		BA118	Diploma Pengurusan & Teknologi Pejabat	Ijazah Sarjana Muda Pengurusan Sistem Pasabai (Kepujian)
				Sarjana Muda Pentadbiran Perniagaan (Kepujian) Pemasaran
PERLIS	AS201*	Sarjana Muda Sains (Kepujian) Biologi		
	AS113*	Diploma Teknologi Polimer	Sarjana Muda Sains (Kepujian) Fizik	
	AS115*	Diploma Kimia Perindustrian	Sarjana Muda Sains (Kepujian) Kimia dengan Pengurusan	
	AS120*	Diploma Sains	Sarjana Muda Sains (Kepujian) Teknologi Polimer	
	BA111	Diploma Pengajian Perniagaan	Sarjana Muda Sains (Kepujian) Kimia Gunaan	
	AS245*		Sarjana Muda Sains (Kepujian) Teknologi Maritim	
	AS254*		Sarjana Muda Pentadbiran Perniagaan (Kepujian) Pemasaran	
	BA240		Sarjana Muda Pentadbiran Perniagaan (Kepujian) Kewangan	
	BA242		Sarjana Muda Pentadbiran Perniagaan (Kepujian) Pengurusan Sumber Manusia	
	BA243		Sarjana Muda Pentadbiran Perniagaan (Kepujian) Pengurusan Sistem Maklumat	
CS240				
ARAU, KANGAR	AS201*	Sarjana Muda Sains (Kepujian) Biologi		
	AS113*	Diploma Teknologi Polimer	Sarjana Muda Sains (Kepujian) Fizik	
	AS115*	Diploma Kimia Perindustrian	Sarjana Muda Sains (Kepujian) Kimia dengan Pengurusan	
	AS120*	Diploma Sains	Sarjana Muda Sains (Kepujian) Teknologi Polimer	
MELAKA	AM110	Diploma Pentadbiran Awam	Sarjana Muda Sains Pentadbiran (Kepujian)	
	AM228		Sarjana Muda Pentadbiran Perniagaan (Kepujian) Kewangan	
	BA242		Sarjana Muda Pentadbiran Perniagaan (Kepujian) Pemasaran	
	BA243		Sarjana Muda Pentadbiran Perniagaan (Kepujian) Pengurusan Sumber Manusia	
	SERI IKKANDAR	AM110	Diploma Pentadbiran Awam	Sarjana Muda Perancangan Bandar Dan Wilayah (Kepujian)
		AP111*		Diploma Perancangan Bandar Dan Wilayah (Kepujian)
		AP114*		Sarjana Muda Ukur Bahan (Kepujian)
		AP115*		Sarjana Muda Ukur Bahan (Kepujian)
		AP229		Sarjana Muda Sains Pengurusan Pembinaan (Kepujian)

Figure 1. iCEPS programs directory

The contributions of this study are twofold: Firstly, it demonstrates the practical implementation of innovative technologies, including dot distribution maps, interactive visualization, and big data analytics, within the context of higher education. Specifically, our research showcases how these technologies can be leveraged to address the challenges faced by institutions such as iCEPS at UiTM in providing part-time distance learning programs to a diverse and geographically dispersed learner base. By enhancing the accessibility and usability of program information and optimizing resource allocation, this study presents a concrete framework for educational institutions to modernize their decision support systems.

Addressing a notable research gap in the field of higher education with dot distribution map, this study aims to explore and implement the integration of this technology with a specific focus on addressing the unique challenges faced by iCEPS at UiTM. The iCEPS website plays an important role in attracting prospective candidates. It is a critical resource for candidates to discover the diverse

range of programs available, understand the logistical aspects of campus locations, access essential course details, and make informed decisions that align with their educational goals and preferences. Furthermore, the website's usability and accessibility significantly influence candidates' perceptions of the institution's commitment to transparency, innovation, and meeting the evolving needs of adult learners, making it a key factor in attracting and retaining qualified candidates.

The contribution of this study is the demonstration of the practical implementation of innovative technologies, including dot distribution maps and interactive visualization to be leveraged to address the challenges faced by institutions such as iCEPS at UiTM in providing part-time distance learning programs to a diverse and geographically dispersed learner base.

2. Literature Review

Big data, as defined in various studies [4], encompasses a vast and sophisticated landscape of data sets, characterized by their sheer volume, diverse data management capabilities, social media analytics, and real-time data sources. These datasets can be broadly classified into structured and unstructured formats. The defining attributes of big data, often referred to as the "Three Vs" [5], include the volume of information, signifying the massive quantities of data involved; the velocity, which relates to the speed at which data is generated and collected; and the variety, which encompasses the extensive scope of data points, encompassing data types and sources. As highlighted by recent research [6], the relentless growth of data is an undeniable reality of the digital age, and the evolution of analytics technology continues to advance in parallel. Consequently, the capacity to effectively manage and harness big data is poised to become increasingly pivotal in various domains, including higher education. In this context, data visualization techniques are emerging as powerful tools to navigate and extract meaningful insights from the vast and complex volumes of data, addressing the analytical challenges posed by big data and enhancing decision-making processes.

2.1 Data Visualization

The presentation of data using tables, graphs, maps, and charts in a pictorial format refers to data visualization [7]. It is useful to group a lot of data points, data relationship understanding, address questions in real-time, and determine where to focus research quickly [8]. The main objective of data visualization is also explained by [9] which is to communicate information through graphics clearly and effectively [10]. Data visualization plays a key role in the process of data discovery and better decision making as it can collect several data points, grasp data relationships, address problems in real-time, and determine where to concentrate analysis more quickly [7]. According to [11], decision-making is influenced by various graphs of visual analytical results using data visualization techniques such as hierarchical, mapping, multidimensional, network, and temporal.

Data visualization arises as an indispensable tool across numerous domains, as it can narrative raw data of complex information into visually digestible formats [2]. In the academic sphere, data visualization enhances educational experiences, enabling educators and students to explore data, gain deeper insights, and foster data-driven learning. Across all domains, data visualization is a catalyst for innovation, promoting data-driven decision-making and fostering a deeper understanding of intricate [12].

2.2. Dot distribution map

Dot distribution map, also referred to as a density map, displays a spatial distribution of geo-referenced data using a simple graphical element [13]. It is a technique of cartography to view discrete absolute values. Dots equal in size and defined value are used to achieve this. A certain number of dots are used to depict a data value according to the dot value and these dots usually form dot clusters. The value of the data must be rounded to a multiple of the dot value. By counting the dots and multiplying the number with the value of the dot, the visualized data value can be roughly determined [14].

This project uses dot distribution map because it is the most suitable technique to visualize the location of the UiTM campus that offered a part-time study. This technique displays the location data in point-based hence it will be able to display the locations accurately using dots. In this project, a UiTM campus will be represented as a dot on the map.

2.3 iCEPS

Institute of Continuing Education & Professional Studies (iCEPS), Universiti Teknologi Mara (UiTM) is chosen as the dataset domain. iCEPS is one of the Malaysian leading providers of part-time distance learning programs and is committed to achieving the learning needs of adult learners of Bumiputera. iCEPS is previously known as the Institute of NEO Education (iNED) before the center was rebranded in October 2019. In 1973 when UiTM started venturing into part-time off-campus and distance learning educational programs, iCEPS played its major role in educating adult learners, all phases of life across a various range of interests.

iCEPS is responsible to provide knowledgeable and skillful human capital for the nation at the same time strengthening strategic partnerships with stakeholders. This study focuses on the users who are interested in pursuing part-time distance learning study in diploma or degree program offered by iCEPS, UiTM It is an opportunity for working adult to further and acquire a quality tertiary education because iCEPS provide additional opportunities for Bumiputera in pursuing higher education.

3. Methodology

Following are the steps of the development, began with data collection, reorganize data, initialize map, generate marker, generate tooltips, and display the visualization.

i. Data Collection

To identify the sources of data relevant to the project, which may include campus locations, program details, and other pertinent information. Gather data from various sources, such as databases, spreadsheets, or APIs, ensuring data accuracy and consistency. It is important to clean and preprocess the collected data to rectify errors, remove duplicates, and format it for compatibility with the mapping tool.

ii. Reorganize Data

The data are structured in a format suitable for mapping, ensuring it includes necessary attributes like campus names, geographical coordinates, and program details. Furthermore, the data need to be categorized and organized logically, making it easier to access and visualize. Then, it is needed to perform any required data transformations, such as geocoding campus addresses to obtain precise latitude and longitude coordinates.

iii. Initialize Map

This task is to choose an appropriate mapping platform or library, such as Google Maps JavaScript API, and initialize a blank map canvas. Then need to configure the map's initial settings, including zoom level, center coordinates, and map style. Lastly, need to ensure that the mapping environment is conducive to overlaying data markers and tooltips seamlessly.

iv. Generate Markers

Generate markers is to develop a script or program to read the reorganized data and dynamically create markers for each campus on the map.

v. Generate Tooltips

Generate tooltips that provide detailed information when users interact with the markers. It is important to ensure that tooltips are responsive to user actions, such as hovering or clicking on markers.

vi. Display the Visualization

This task is to integrate the generated markers and tooltips into the initialized map canvas. Additionally, it is important to implement user-friendly navigation and interaction features, such as zooming option.

3.1 Implementation of dot distribution map

To implement this dot distribution technique, there are some important techniques that needed to be used before creating the webpage application.

i. Google map JAVA Scripts API

Google Maps API consists of data structure collection, object classes, or functions that a programmer can use with JavaScript, PHP, or other scripting languages [14]. There are four basic map features by the Google Map JavaScript API which are roadmap, satellite, hybrid, and terrain. The users can have a better understanding of the cartographic information with quick response time as the Google Maps API provides an efficient framework and user-friendly interaction toward the users [15].

ii. Initiate map

The base map of this project is Google Maps. Loading the Maps JavaScript API needs the application programming interface (API) key. In the webpage development, a script tag should be included to initialize and display Google Maps. Figure 2 shows the initialization of the map code.

```
<script async defer
src="https://maps.googleapis.com/maps/api/js?key=YOUR_API_KEY&callback=initMap">
</script>
```

Figure 2. Map code initialization

The Uniform Resource Locator (URL) link in Figure 3 above refers to the JavaScript file location. The symbols and definitions needed to use JavaScript API will be loaded by the JavaScript file. The written function will be called by the callback parameter once the Google Maps JavaScript API is fully loaded.

iii. Generate marker

A standard image is used by the marker by default. To generate a plot on the map, the coordinate of location consists of the latitude and longitude are needed. Figure 3 shows the codes for the plotting using latitude and longitude is done by the marker.

```
var marker = new google.maps.Marker({
  position: { lat: -25.344, lng: 131.036 },
  map: map
});
```

Figure 3. To generate marker

Based on Figure 3, *google.maps.marker* is the initial properties of the marker and has been specified. The marker will be plotting the map according to the position. The *lat* is the value of the location latitude while *lng* is the value of the location longitude. The marker will be placed on the specified map.

iv. Generate tooltips

According to [16], Google Maps JavaScript API provided features to enable the users to interact with the map. The marker information will be displayed by the tooltips. The tooltips will display common information such as name, address, and location description. Figure 4 shows how tooltips are generated.

```
<div class="tooltip">AP114
<span class="tooltiptext">UiTM Seri Iskandar</span>
</div>
```



Figure 4. Example of tooltips

The title will be displayed as a tooltip based on Figure 5. Once the user moves the cursor to the marker, the string UiTM Seri Iskandar will be displayed. The coding will be added under the variable marker and the string can be replaced with other information that wants to be displayed.

4. Results and Discussion

Table 1 shows a sample of data extracted in .xlsx format consisting of the UiTM campus that offered part-time distance learning programs. All the data was collected from iCEPS' official webpage.

Table 1. Sample of data

Course code	Course name	Campus name
AC110	Diploma in Accountancy	UiTM Tapah
AC110	Diploma in Accountancy	UiTM Shah Alam
AC110	Diploma in Accountancy	UiTM Kota Bharu
AC110	Diploma in Accountancy	UiTM Kota Kinabalu

The data extracted consists of 21 UiTM campuses as of 2020. The extracted data consists of 20 UiTM campuses that offer 27 part-time distance learning diploma programs and 15 UiTM campuses that offer 59 part-time distance learning degree programs. The data includes the program code, program name, and UiTM campus.

Additional information such as address, latitude, longitude, website link, contact number, and other programs offered by the campus was added to the data. The latitude and longitude used for the location information are gathered using Google Maps. This information is needed in plotting the location on the maps. Table 2 below shows the sample of UiTM campus data after has been processed.

Table 2: Processed data of UiTM campus consists of the website link, contact number, and other programs offered by the campus.

Website	Contact	Other Courses
https://uitm.edu.my/index.php/en	03-55442000	BA118, BA118, BA119, CS143, HM111, IC110
https://kelantan.uitm.edu.my/kb/index.php/en	09-7417700	AM110, BA111, BA118, BA119, IM110
https://sabah.uitm.edu.my/	088-325151	AM110, BA111, HM111

In this study, a tooltip is generated by using a mouse event which is click. When the users click on the markers on the map display, a tooltip will display a window of information about the campus. The information includes the main program, campus name, address, contact number, other programs offered, and a website link. Figure 5 shows the visualization result of the AC110 – Diploma in Accountancy. All the 4 campuses of UiTM that offered this program are shown as plotted on the map.

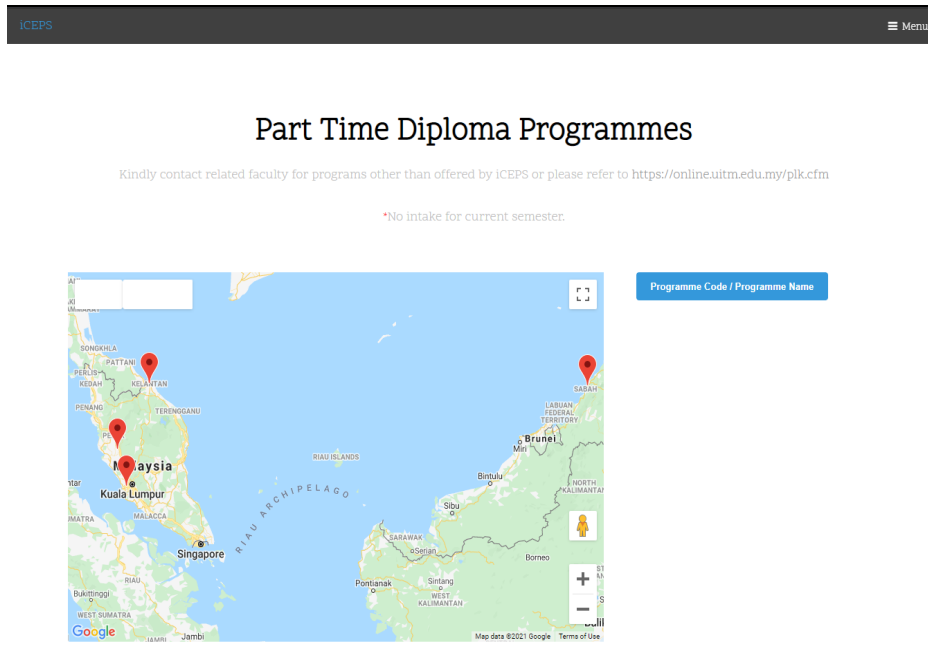


Figure 5. Visualization of dot distribution map for Diploma in Accountancy

This interface also features Google Maps. The drop-down menu featured on this page enables the users to select the part-time distance learning degree programs offered to be displayed. The users are also able to search the part-time distance learning degree programs offered by typing the keyword. When the user clicks on the Part-Time Degree page, this webpage application will display all the 15 locations of the UiTM on the map as shown in Figure 6.

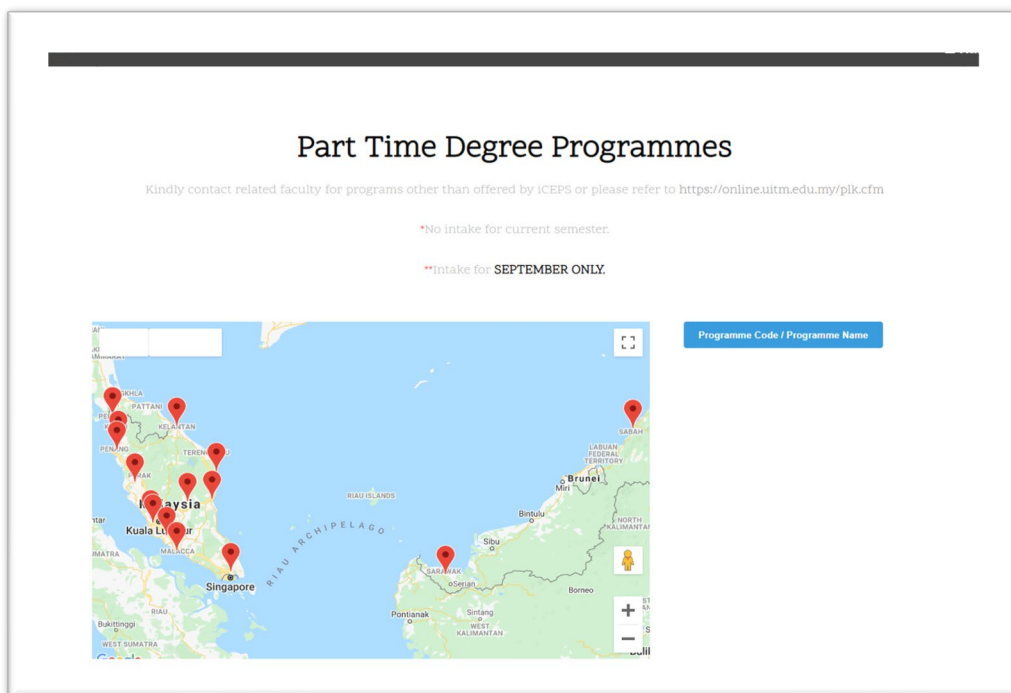


Figure 6. Part-Time Degree Map

This map eases the viewer to see the detailed information such as main program, campus name, address, contact number, other programs offered, and website link once the user clicks the marker of a program offered in tooltips as shown in Figure 7. The user is also able to search for the part-time distance learning program offered by typing the keyword of the required program such as program name or program code.

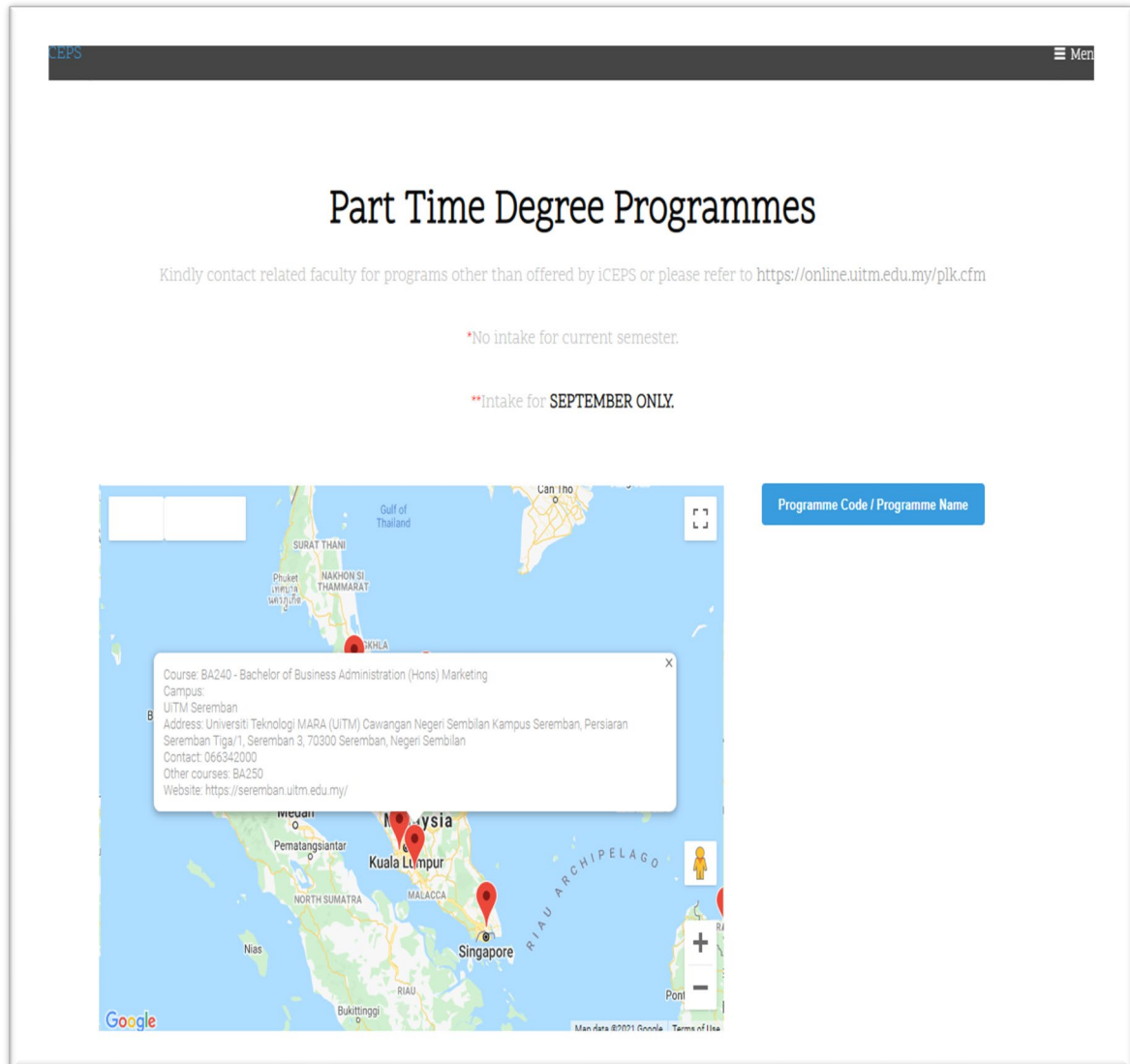


Figure 7. The dot distribution map with tooltips

5. Conclusion

The main objective of this study is to develop an interactive web-based data visualization tool, in the form of a dot distribution map, aimed at rendering the geographic locations of UiTM campuses offering part-time distance learning programs. Each UiTM campus and its geographical position is depicted using symbol markers on the map, facilitating user-friendly interaction. This interactive visualization empowers candidates with the ability to effortlessly identify campus locations that align with their preferences.

As a direct implication of this approach, prospective learners seeking to further their education can readily access program information and make informed decisions regarding enrollment at campuses conveniently situated within their proximity. By redesigning the way of selecting the campus, this initiative can significantly reduce the time expended on commuting, alleviate financial burdens associated with accommodation, food, and travel expenses, and ultimately mitigate the physical toll of extensive travel, thereby enhancing the overall well-being of learners.

The development of this dot distribution map webpage embraces the potential to be a transformative solution, not only simplifying the program selection process but also contributing to a more accessible and appealing educational practice for UiTM candidates.

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Conflict of Interest

The authors declare no conflict of interest in the subject matter or materials discussed in this manuscript.

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