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A Machine Learning and Computer Vision Application to Robustly Extract Winnings from Multiple Lottery Tickets in *One Shot*

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Abstract

Mega Millions and Powerball are among the most popular American lottery games. This article provides a practical software application that can conveniently examine and evaluate several lottery tickets for prizes using just the images. The application accepts as input a directory containing the images of lottery tickets and utilizes machine learning and computer vision to extract lottery ticket data, lottery name, lottery draw date, 5-digit lottery numbers, 2-digit lottery "ball" numbers, and the lottery multiplier. The application also retrieves winning lottery data that corresponds to the lottery draw date using a public database API. This is compared with data collected from each lottery ticket image to establish matches, and the corresponding prize amount is computed. The current version of the application supports GPU usage, and image orientation has no impact on its functionality. It is believed that a considerable portion of the U.S. public participating in the Powerball and Mega Millions lotteries will find such an application beneficial and handy.

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Introduction

Playing lottery games is a popular activity in the United States (Bernadette McKinney & Swain, 1993; Tom Huddleston Jr, 2022). Though different types of lottery games exist, Mega Millions (MM) and Powerball (PB) are among the most played lottery games in the United States. Recently, the jackpot prize of the Mega Millions lottery rose to $1.28 billion. This was considered as one of the biggest jackpot prizes, and it was won by a single lottery ticket purchased in Illinois, USA (Tom Huddleston Jr, 2022). MM and PB lottery games consist of 'drawings' on specific days during the week when the lottery machine picks random number balls. While Monday, Wednesday, and Saturday are for PB, Tuesday and Thursday are for MM. These drawings are telecasted live, and the winning numbers obtained from the lottery machine are made available on the official websites of Mega Millions and Powerball. Before the drawings, people can buy lottery tickets containing either selected numbers or quick-pick numbers (randomly generated by the officially licensed machine). Powerball and Mega Millions are coordinated by the Multi-State Lottery Association (MUSL) (Multi-State Lottery Association, 2022). Therefore, the most strict security standards are followed to prevent malicious interference. A single PB or MM lottery ticket can be as low as $2.00. These lottery games are popular among the people of the United States due to the low cost of participation and trustworthiness.

The frequency of playing PB and MM and the number of tickets purchased per drawing vary substantially among lottery ticket purchasers. Nonetheless, all ticket purchasers play with the hope of winning the jackpot or other potential monetary prizes. To verify the prize won, the ticket holder must compare the numbers on their lottery ticket with the winning numbers drawn during a live telecast or go to a local store that sells the lottery to get the ticket checked for the prize won. Furthermore, it is the responsibility of the lottery ticket holder to claim the prize after they have verified that they have indeed won a prize.

There have been many instances in the United States when individuals misplaced their lottery tickets and were never able to verify their prize (O'Brien, 2021). To buttress this, $77 million and $51.7 million Powerball jackpot prizes, as well as $68 million and $46 million Mega Million jackpot prizes have remained unclaimed (The Lotter, 2022). Hence, a significant concern for the people that play the lottery indicates that they are not aware of the numbers on the ticket.

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This is especially true when playing the lottery with quick pick numbers. Such individuals continually stress over the possibility that if they had the ticket, they may have had the winning numbers and would have won a substantial amount of money. Although there is an extremely low possibility of winning the jackpot, such apprehension leads to unhealthy stress on the individual's mind and impacts their day-to-day lives, which can span from days to weeks. Also, due to busy lifestyle, they might have forgotten to check the lotto ticket numbers and just stacked their tickets with the previous unchecked tickets, with each ticket adding to the stack size. Such cases run the risk of individuals forgetting about the ticket expiration date (1 year for PB and MM) and ticket holders not being able to claim the lottery prize (Mega Millions, 2022a; Powerball, 2022b). In addition, manually checking the number of matches of each lottery ticket with the winning numbers (available on the lottery website) is a repetitive and tedious task. Therefore, there is a high probability of making errors, such as mismatching the number, which would lead to monetary losses for the individual. However, even if they choose to visit the lottery machine positioned in the nearby gas store or convenience store, they would still have to spend time repeatedly scanning each of their bulk tickets to determine the winnings.

Since most of the population have access to smartphones, it would be quite useful and convenient if one could take pictures of the lottery tickets containing the numbers and pass these pictures to an application that can identify not only the particular tickets that have won prizes, but also the price amount. Hence, even if a person misplaced multiple tickets but had saved the pictures of the PB or MM tickets, they can check if they have won any monetary prizes or not. This will help curb the fear of "missing out" in regards to the possibility of their lottery ticket containing winning numbers. If there is an application that can pass on the folder containing pictures of several lottery tickets which individuals might have taken earlier, they would not have to worry about the mismatch between the lottery ticket numbers and the winning numbers. Also, they would not have to devote additional time to visit the local store to scan the stack of lottery tickets.

Thus, this article presents a prototype application that utilizes machine learning and computer vision to extract lottery ticket data from the PB and MM lottery ticket pictures in order to calculate the monetary price won. A folder containing all the lottery ticket images can be passed to this application in bulk. The prototype application will automatically check all the lottery tickets in the folder for winnings. However, unless specified, lottery tickets refer only to the MM and PB lottery tickets.

Although there are few applications that offer to check the lottery winnings, each of them differs in functionality. Nonetheless, a major shortcoming is the inability to analyze several lotto tickets at once or not being able to extract the draw date from the lotto ticket image to check for winnings. The latter case is especially cumbersome if the user has to input the lottery draw date for several

lottery tickets. This negates some of the benefits of checking the winnings through a phone app compared to manually checking the lottery website through the local lottery machine. Furthermore, the very few apps that utilize image processing techniques on the lottery ticket reveal a significant processing bottleneck since such apps rely on smartphone processing power for the image processing task. This is relatively inefficient, error-prone, and time-consuming. Image processing, especially Optical Character Recognition (OCR), is GPU-optimized. Hence, the GPU renders the process of checking lottery tickets fast and efficient (Castaño-Díez et al., 2008).

In addition, it provides a convenient way to extract and check multiple lotto tickets by utilizing state-of-the-art or machine learning and computer vision algorithm using a GPU. The algorithm can extract the lottery ticket numbers and the lottery draw date so as to determine if the lottery ticket is PB or MM from the image. The application also calculates the prize won from each lottery ticket image. Thus, the prototype application is a hands-off method for checking lottery ticket numbers. It is strongly believed that such an application will bring practical usage, convenience, and peace of mind to a large segment of the United States population that play the PB and MM lottery games.

Methods

The procedure on the user end consists of taking the pictures of the PB or MM lottery tickets using smartphones or any other device and collecting them into a single folder. Subsequently, the user runs the application and passes the path that points toward the folder containing all the pictures in the application.

The application is written using Python version 3.7.13 (Van Rossum & Drake, 2009). In general, the overall workings of the application can be divided into three steps. In the first step, the application retrieves the lottery winnings information from an open database. The application extracts useful data from the lottery ticket in the second step. In the third step, the application compares the lottery numbers extracted from the lottery tickets, with the winning lottery numbers randomly selected on the drawing date indicated on the lottery ticket. After that, the application calculates the amount won from each lottery ticket picture the user provided.

During the first step, the application utilizes Socrata Open Data API to obtain the winning numbers for the particular draw date extracted from the lottery ticket (Socrata, 2022). The Socrata Open Data API allows access to open data resources from governments, non-profits, and NGOs around the world. The sodapy-2.1.1 package was utilized as a python client for the Socrata Open Data API (xmunoz, 2022). The Socrata Open Data API extracts the last 150 rows from the Mega Millions and Powerball datasets. The last 150 winning numbers span a timeframe of 1.5 years, and Mega Millions and Powerball lottery tickets are not valid after one year (Mega Millions, 2022a; Powerball, 2022b).

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As a second step, the application runs an Optical Recognition Task (OCR) by utilizing the EasyOCR version 1.4.2 algorithm (Awalgaonkar et al., 2021; JaidedAI, 2022) on each lottery ticket image to extract the lottery type (Mega Millions or Powerball), lottery ticket numbers, lottery 'ball' numbers (MegaBall and Powerball), the multiplier (Megaplier or Power Play), and the lottery draw date. EasyOCR is an excellent choice for text recognition from images since its underlying framework consists of ResNet (Allen-Zhu & Li, 2019). It is regarded as a cutting-edge machine learning architecture for image recognition and LSTM (Staudemeyer & Morris, 2019), which is a well-established neural network architecture for text generation. In addition, EasyOCR supports text recognition from photos in more than 42 languages, thereby allowing applications built on it to be easily adapted for international use.

Furthermore, Pillow (PIL) version 7.1.2 (Kemenade et al., 2022), an open-source python imaging library, was utilized to fix the orientation of the lottery ticket image since it is possible for the user to take pictures that are rotated by multiples of 90 degrees. However, such pictures can cause text recognition issues as the data extracted from the rotated picture may not be accurate. The Exif Tags module of the Pillow library provides a convenient way to read the Exif data from the lottery ticket pictures in order to determine the orientation of the image. By utilizing OpenCV version 4.5.4, a real-time optimized computer vision library, the orientation of the images was set to 0 degrees before the OCR task (opencv, 2022). Additionally, the OpenCV library was utilized to create visible bounding boxes around the text recognized from the lottery ticket image post-OCR task (see results and discussion section).

EasyOCR is built on PyTorch, which is an open-source machine learning framework for research and production (Paszke et al., 2019). For ease of use, the information extracted from the lottery ticket is indicated in the following format: Lt, Ldt, 5d, 2db, and m. This corresponds to lottery type, lottery draw date, 5-digit lottery numbers, 2-digit lottery 'ball' numbers, and the lottery multiplier, respectively. Following the same convention, lottery winning information is indicated as Lt, Ldt, W5d, W2db, and Wm. Accordingly, 'W' signifies winning values.', while Lt 'and 'Ldt' represent the lottery type and draw date, respectively. For example, Lt= 'Mega Millions' and Ldt = '5/24/22'. The application can also recognize and extract information from single-play on a lottery ticket, i.e., one set of 5d, 2db, m, and multiple plays on a single lottery ticket, i.e., > 1 set of 5d, 2db, and m (see results and discussion section).

As a third step, the application checks for matches between each set of Lt, Ldt, 5d, 2db, and m extracted from the lottery ticket image, as well as Lt, Ldt, W5d, W2db, and Wm obtained via Socrata Open Data API. Subsequently, it calculates the amount won by taking into account whether the Lt was Mega Millions or Powerball since they differ in the prize money corresponding to the matches (Mega Millions, 2022b; Powerball, 2022a). For each lottery ticket

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picture, the application appends the picture name of the lottery ticket into a text file. This includes all sets of Lt, Ldt, 5d, 2db, m, Lt, Ldt, W5d, W2db, Wm, the number of matches for each set of Lt, Ldt, 5d, 2db, m, and the amount won.

For faster processing and to obtain results within a shorter timeframe, the use of GPU is recommended (Castaño-Díez et al., 2008). Since the EasyOCR module supports GPU (JaidedAI, 2022), the application utilized the Tesla V100-SXM2 GPU with 16 GB memory to produce the results presented in this article (Xu et al., 2018). Furthermore, to increase the accuracy of text recognition, it is recommended that the user takes a picture of the content provided within the black demarcation lines on the lottery ticket. This is indicated in Figure 1 by the green arrows. Since it can be tedious to only include information within the black lines, it is not a strict requirement but a recommended guideline. Even if the picture contains content information beyond the black demarcation lines, the application can still obtain Lt, Ldt, 5d, 2db, and m information accurately.

Figure 1. How to Take Picture of the Lottery Tickets

Figure 1 depicts a Mega Millions ticket. The application works accurately when the picture is taken based on the content between the black lines on the lottery ticket. The green arrows indicate these black lines in the current figure. Taking the picture this way should serve as a guideline and not as a strict requirement. This is because even if the user takes a picture that contains some text outside the black lines, the application is still able to accurately capture the numbers and draw dates (see Figure 2 B and Figure 3 B).

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Results and Discussion

Figure 2 depicts the Mega Millions (MM) and Powerball (PB) lottery ticket pictures with blue bounding boxes containing the text recognized by the application. Figures 2A and B depict the MM tickets, while Figures 2 C and D illustrate the PB tickets with single play (left), i.e., a single set of Lt, Ldt, 5d, 2db, m and multiple plays (right), as well as multiple sets of Lt, Ldt, 5d, 2db, and m, respectively. Figure 2 depicts that the OCR task was executed efficiently, and the Lt, Ldt, 5d, 2db, and m information was captured in separate bounding boxes, thus making it easier to extract in a textual format.

Since the focus is on the Lt, Ldt, 5d, 2db, and m information from the ticket, the application further processes all the text recognized from the lottery ticket by the OCR task. In brief, the processing step involved selecting an array of texts containing the matching keyword or selecting text based on a set pattern using regex (Aho, 1991). Also, non-relevant text was discarded and not utilized by the prototype application.

As earlier mentioned, the application checks for matches between each set of Lt, Ldt, 5d, 2db, and m in the third step. This is extracted from the lottery ticket image and the Lt, Ldt, W5d, W2db, and Wm calculates the prize won. Figure 3 depicts the output information for each lottery ticket presented in Figure 2. The outputs corresponding to all the lottery pictures in the application are printed into a file and stored locally on the device at a user-defined location. Figure 3 further highlights the convenience of the application. For example, Figure 3D corresponds to the application output for a Powerball ticket that won $12. This illustrates that the output contains the name of the picture, the name of the lottery (all sets of Lt, Ldt, 5d, 2db, and m from the lottery ticket and Lt, Ldt, W5d, W2db, and Wm from the Socrata database) all the matches, and the accurately computed prize amount which was $12. Furthemore, since an individual may have many tickets, it can be cumbersome to select the lottery ticket that won the prize. Hence, during the process of appending all the outputs to the text file, the application writes out "YOU WON!" in ASCII art (Waller, 2022) format on the lottery ticket that won any amount of money that is > $0.

Through this article, a practical application has been provided with the utility to check the MM and PB lottery tickets quickly and conveniently for prizes that are currently not readily available. However, further improvements can enhance the usefulness of this application. Although the application is currently available as a Google Colab notebook (Prashanth et al., 2021) on GitHub (VikramjitSinghRathee, 2022), it can be helpful to convert this application into a smartphone app which would increase the reach of this application to wider audiences. Nevertheless, the shortcoming of creating a corresponding smartphone application is the access to powerful GPU, such as the Nvidia Tesla V100 (Xu et al., 2018), which is not readily available and requires utilization charges if cloud services are utilized (Google Cloud, 2022). Thus, changes are required in the

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application algorithm to maximize the utilization of mobile processors on smartphones (Akenine-Moller & Strom, 2008), while maintaining the image processing abilities of the application currently implemented as a Colab notebook. Since the current version of the application only supports PB and MM lottery tickets, adding functionality for other lotteries such as Cash4Life (Pennsylvania Lottery, 2022) and Lucky for Life (Lucky for Life Lotteries, 2022) would increase the reach of the application to a wider audience.

Figure 2. Lottery Numbers, Balls, Multiplier, and Draw Date Captured from the Lottery Tickets

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Figure 2 depicts the text from the lottery tickets which the application captures. The blue boxes show the texts extracted by the application in each lottery ticket, which is processed further to obtain Lt, Ldt, 5d, 2db, and m data. A and B correspond to single play and multiple plays MM lottery tickets, respectively. On the other hand, C and D correspond to single and multiple plays PB lottery tickets, respectively.

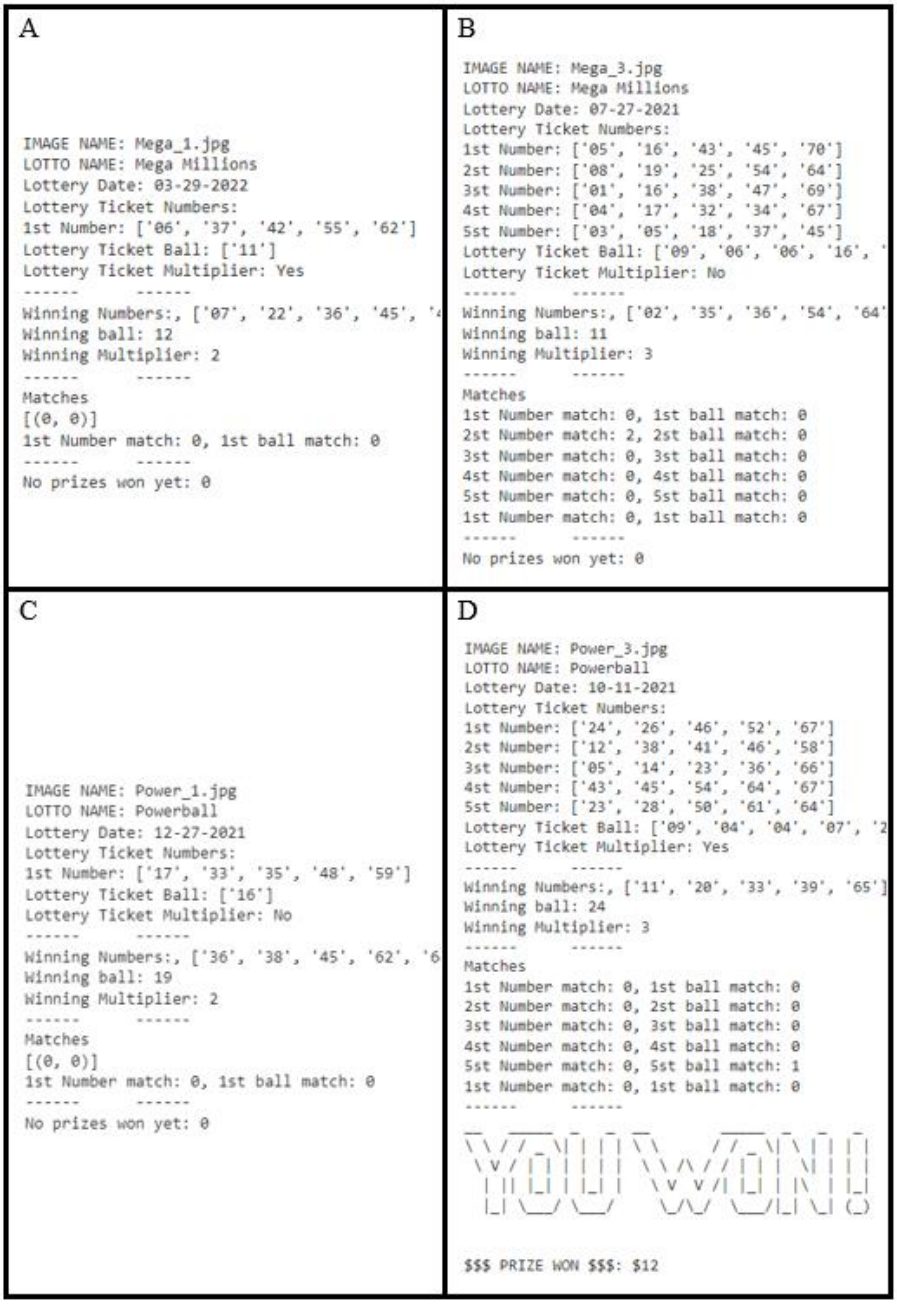

Figure 3. Output of the Application

Figure 3 depicts the final results of the application for the user's lottery tickets. D reveals the output of a PB ticket that has won a prize.

Lastly, badly taken pictures of the lottery ticket can influence the application's performance in text recognition (Ye & Doermann, 2015) and subsequently, the prize calculation. Hence, image manipulating algorithms could be implemented with the application to counter such cases. However, future studies need to be conducted to discuss the implementation of these improvements and its impact on the application's performance so as to extract information from the lottery tickets and compute prizes.

Conclusion

Mega Millions and Powerball are consistently regarded as the most popular lotteries in the United States. This article describes a Python 3.7 application that can conveniently examine and evaluate multiple tickets for monetary winnings, which is solely based on images of lottery tickets. The program accepts a folder containing photos of lottery tickets as input. Using the python imaging library Pillow and the computer vision library OpenCV, the images of the lottery tickets were processed and their orientation was corrected to 0 degrees. The application executes an Optical Recognition Task (OCR) on the Tesla V100 GPU on each lottery ticket by using the EasyOCR package. Its framework consists of machine learning architectures for image recognition (ResNet) and text generation (LSTM) to extract data such as the lottery name, the lottery draw date, 5-digit lottery numbers, 2-digit lottery "ball" numbers, and the lottery multiplier. The application also collects winning lottery data which matches the lottery draw date by using the sodapy package as a python client for the Socrata Open Data API. Subsequently, the application compares the winning lottery data with the data gathered from each lottery ticket image to establish matches and computes the associated reward amount in $. A text file is created with results corresponding to the images of lottery tickets within the folder. Since it might be tedious to locate the winning lottery ticket if the folder contains several images, the application uses ASCII art to highlight the winning lottery ticket for any prize more than $0. The researcher anticipates that a significant portion of individuals in the United States who participate in Powerball and Mega Millions lottery games will find the software program valuable and easy to use.

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Appendix

Supplementary Information - A Machine Learning and Computer Vision Application to Robustly Extract Winnings from Multiple Lottery Tickets in *One Shot*

Figure SI-1

Raw images of the additional Powerball (PB) and Mega Millions (MM) lottery tickets taken using Samsung S21 Ultra device.

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Figure SI-2

Lottery Numbers and Draw Date Captured from additional Powerball (PB) and Mega Millions (MM) lottery ticket images. Figure SI-2 depicts the text from the lottery tickets that the application captures. The blue boxes show the texts extracted by the application in each lottery ticket, which is further processed to obtain Lt, Ldt, 5d, 2db, and m.

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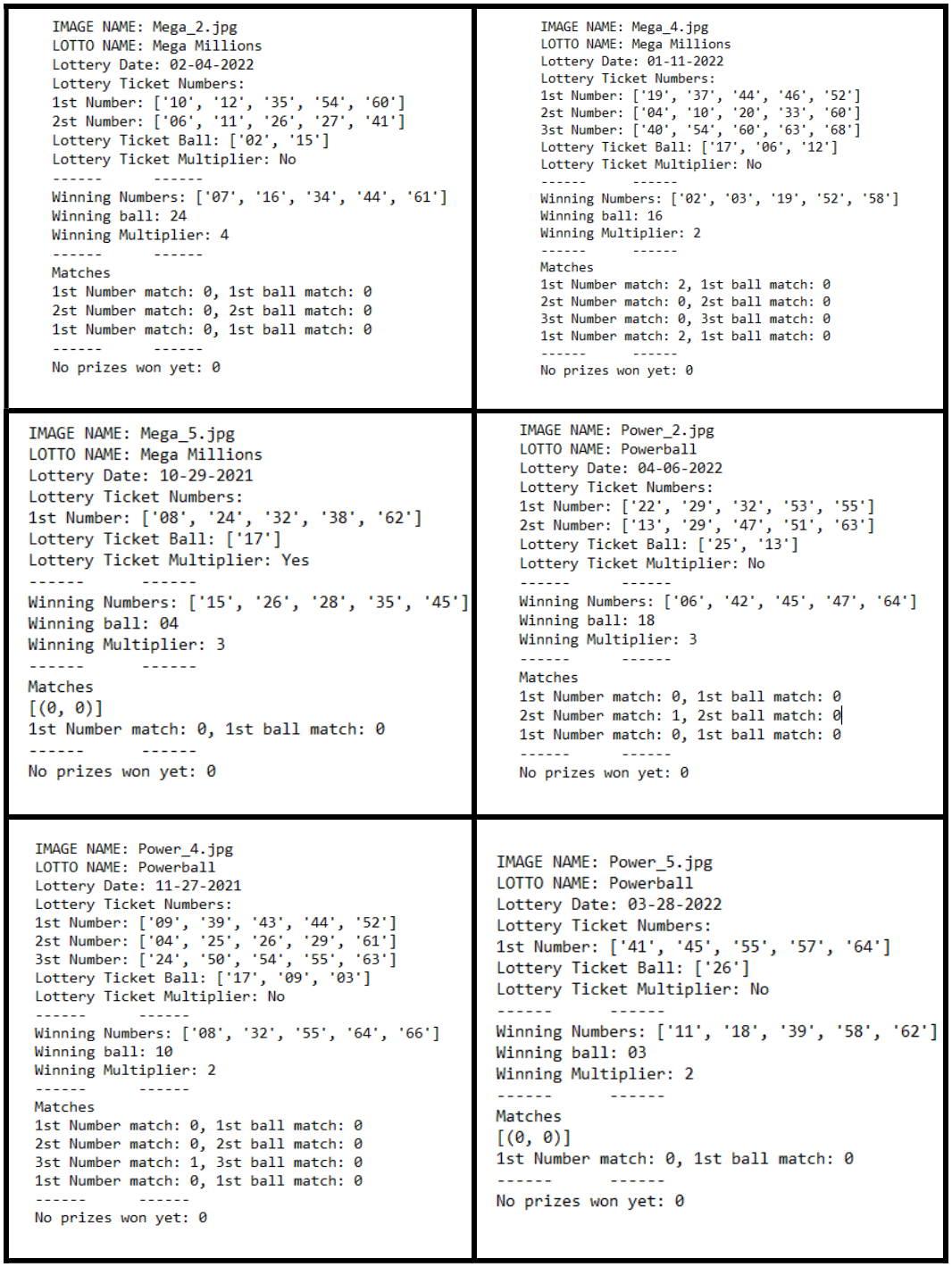

Figure SI-3

Output of the application for the additional Powerball (PB) and Mega Millions (MM) lottery tickets.