**UNIVERSITY OF PITEȘTI**

**FACULTY OF SCIENCES, PHYSICAL EDUCATION AND INFORMATICS**

**MASTER PROGRAM "ADVANCED TECHNIQUES FOR INFORMATION PROCESSING"**

**MASTER THESIS**

**Scientific Coordinators,**

**Conf. univ. dr. Doru Constantin**

**Dr. Inf. Corina Sararu**

**Graduate,**

**ROTARU Elena-Daniela**

**PITEŞTI**

**2022**

**UNIVERSITY OF PITEȘTI**

**FACULTY OF SCIENCES, PHYSICAL EDUCATION AND INFORMATICS**

**MASTER PROGRAM "ADVANCED TECHNIQUES FOR INFORMATION PROCESSING"**

**Automation Testing with RPA in Industrial Environments**

**Scientific Coordinators,**

**Conf. univ. dr. Doru Constantin**

**Dr. Inf. Corina Sararu**

**Graduate,**

**ROTARU Elena-Daniela**

**PITEŞTI**

**2022**

**Table of Contents**

[**INTRODUCTION** 4](#_Toc107221841)

[**CHAPTER 1. Technologies used** 6](#_Toc107221842)

[1.1 What is RPA? 6](#_Toc107221843)

[1.2 How does RPA work? 7](#_Toc107221844)

[1.3 The evolution of RPA 8](#_Toc107221845)

[1.4 What are the benefits of RPA? 9](#_Toc107221846)

[1.5 Applications of RPA 11](#_Toc107221847)

[1.6 What are the challenges of RPA? 14](#_Toc107221848)

[1.7 Test Automation using RPA 15](#_Toc107221849)

[1.7.1. The decision on what test cases to automate 16](#_Toc107221858)

[1.7.2. Select the Right Automated Testing Tool 17](#_Toc107221859)

[1.7.3. Divide Your Automated Testing Efforts 18](#_Toc107221860)

[1.7.4. Create Good, Quality Test Data 18](#_Toc107221861)

[1.7.5. Create Automated Tests That Are Resistant to Changes in the UI 19](#_Toc107221862)

[**CHAPTER 2. Development Tools** 20](#_Toc107221863)

[2.1 UiPath Inc. 20](#_Toc107221865)

[2.2 UiPath Products 23](#_Toc107221866)

[2.3 UiPath Studio 27](#_Toc107221867)

[2.3.1. UiPath Studio’s User Interface 28](#_Toc107221872)

[2.3.2. UiPath Studio Activities 32](#_Toc107221873)

[2.3.3. Test Automation Best Practices 35](#_Toc107221874)

[2.4 Desktop Application 36](#_Toc107221875)

[2.4.1. SQLServer Database 36](#_Toc107221877)

[2.4.2. MovieBase Application 45](#_Toc107221878)

[2.4.2.1. The Application’s Visual Studio Project 45](#_Toc107221879)

[2.4.2.2. The Application’s User Interface 49](#_Toc107221880)

[**CHAPTER 3. Automation Testing with UiPath Studio** 53](#_Toc107221881)

[3.1 Test Automation Movies Project Overview 53](#_Toc107221883)

[3.2 Test Automation Implementation 55](#_Toc107221884)

[**CONCLUSIONS** 57](#_Toc107221885)

[**Bibliography** 58](#_Toc107221886)

[**LIST OF FIGURES AND TABLES** 58](#_Toc107221887)

# **INTRODUCTION**

The chosen subject for my dissertation work is “Automation Testing with

RPA in Industrial Environments”.

In the business world, there is always scope for improvement. Enterprises are constantly looking for ways to improve performance levels and gain an edge over the competition. In the digital age, automation is available everywhere. Many businesses worldwide are adopting process automation as a key strategy to stay ahead in the run.

There are a lot of reasons test automation is beneficial, and by adhering to automated testing best practices you can ensure that your testing strategy delivers the maximum return on investment (ROI). Automated testing will shorten development cycles, avoid cumbersome repetitive tasks and help improve software quality.

Thorough testing is crucial to the success of a software product. Automated testing, in which Quality Assurance teams use software tools to run detailed, repetitive, and data-intensive tests automatically, helps teams improve software quality and make the most of their always-limited testing resources.

Test automation tools like UiPath help teams test faster, allows them to test substantially more code, improves test accuracy, and frees up QA engineers so they can focus on tests that require manual attention and their unique human skills.

Selecting an automated testing tool is essential for test automation. There are a lot of automated testing tools on the market, and it is important to choose the automated testing tool that best suits your overall requirements.

[The](https://searchcio.techtarget.com/Ultimate-guide-to-RPA-robotic-process-automation) RPA is growing in popularity because it can reduce costs, streamline processing and drive better customer experiences. Another attraction of RPA software is that business units can implement it without their having to learn new tools or ask IT teams for support and without changing an organization's underlying IT infrastructure.

As RPA has grown in popularity, however, enterprises are seeing the need to integrate RPA process automations in their IT systems, especially in Software Testing.

Chapters from the dissertation paper are about the theoretical context of the concept and development of the RPA testing application (Chapter 1), about the development environ-ment (Chapter 2), also about the implementation of the Automatic Testing program (Chapter 3).

Title of the first chapter is: “Technologies used”, in which there are described and explained RPA (Robotic Process Automation) notions .

Second chapter is called “Development Tools” and refers to the development environment in which the applications were created (UiPath Studio and Visual Studio).

Third chapter, “Automation testing with UiPath Studio”, refers to the design, implementation and functionalities for the RPA application, also testing the application, conclusions and future improvements.

# **CHAPTER 1. Technologies used**

## What is RPA?

Digital transformation is directly influenced by the people adopting it, not technology. New skills, new roles, a culture of openness to change, and permanent external exploration make digital transformation more than a strategic and technological project. Digital transformation can be anything from IT infrastructure modernization to optimization or new digital business models.

Digital transformation is widely used in the public sector to describe initiatives such as putting services online or legacy modernization. RPA can accelerate these processes (for example, by moving data from scanned documents into digital applications, freeing the human in charge of this task to perform more high-value activities).

RPA is a type of software that mimics the activity of a human being in carrying out a task within a process. It can do repetitive stuff more quickly, accurately, and tirelessly than humans, freeing them to do other tasks requiring human strengths such as emotional intelligence, reasoning, judgment, and interaction with the customer. It can automate repetitive, manual and rule-based processes, with low exception rates and standard electronic readable input. Is non-invasive, scalable and can work in any industry. RPA reduces costs rapidly and increases ROI[[1]](#footnote-2). When combined with AI and machine learning, it can capture more context from the content it is working with by reading text or handwriting with optical character recognition (OCR), extracting entities like names, invoice terms or addresses using natural language processing (NLP), and capturing more context from images, such as automatically estimating accident damage in an insurance claim picture.

Today, multiple technologies revolve around RPA to enhance automation results. The reason why is growing in popularity is that it can reduce costs, streamline processing and drive better customer experiences. Another attraction of RPA software is that business units can implement it without their having to learn new tools or ask IT teams for support -- and without changing an organization's underlying IT infrastructure.

Newer RPA tools use AI, machine vision and natural language processing to mitigate breakage problems. Modern RPA platforms also provide some integration with centralized IT governance and management capabilities, making it easier to scale the use of RPA across the enterprise.

## How does RPA work?

RPA robots can handle tasks just as humans do. Only much faster and with more accuracy. It mirrors the way people are accustomed to interacting with and thinking about software applications. RPA's ability to copy the way humans perform a computer-based process has contributed to its popularity compared with automation tools such as application programming interfaces (APIs) or low-code development that are more scalable but less intuitive or require expert knowledge to use.

RPA alone can process solely structured digital documents. Together with AI and ML models, it can process, for example, scanned invoices—which are unstructured, digitally converted documents. RPA interacts with an application through the User Interface. With Native Integrations, automation development is much simpler for commonly used applications like SAP or Salesforce.

Advanced analytics help you measure automation performance against business KPIs (like time or money saved).

Long-running workflows enable you to orchestrate complex automated processes. It facilitates synchronous and asynchronous interactions between human users and robots for maximum effectiveness and resource allocation.

The simplest RPA bots can be created by recording the clicks and keystrokes as a user interacts with an app. When problems emerge, a user can simply watch how the bot is connecting with the app and identify the steps that need to be fine-tuned.

In practice, these basic recordings often serve as a template for building more robust bots that can adapt to changes in screen size, layout or workflows. More sophisticated RPA tools use machine vision to interpret the icons and layout on the screen and make adjustments accordingly.

Some RPA tools are also able to use these initial recordings to create hybrid RPA bots that start by simply recording an existing workflow and then dynamically generating a workflow automation on the back end. These kinds of hybrid bots take advantage of the simplicity of RPA development and the scalability of native workflow automation.

In other RPA implementations, process mining and task mining tools are used to automatically capture business process workflows that serve as starting templates for RPA automations. The process mining can analyze the logs of ERP and CRM applications, for example, to automatically generate a map of common enterprise processes. Task mining tools use a locally running app with machine vision to capture a user's interactions across multiple apps. All the major RPA vendors are starting to develop these kinds of process mining integrations. Process Mining and Task Mining allow you to scientifically discover automation use cases in the organization by analyzing back-end and front-end data.

RPA tools can also be connected to AI modules that have capabilities like OCR, machine vision, natural langue understanding or decision engines, resulting in what is called intelligent process automation. These capabilities are sometimes packaged into cognitive automation modules designed to support best practices for a particular industry or business process.

With the collaboration between an human and a software robot, the tasks can be performed much faster and with more accuracy. All the rule-based and repetitive actions could be moved from the human to the robot. The RPA robot performs the necessary logins and all the background searches, for example.

## The evolution of RPA

RPA is built on the success of macro technologies developed for automating manual tasks within applications like Excel. In the 1980s, these capabilities were extended to many enterprise applications using highly customized data-scraping applications. A number of testing tool vendors beefed up their automation capabilities at the turn of the century to help automate user interaction testing and load testing.

The actual term RPA was coined in 2012 by Phil Fersht, founder and lead analyst at HFS Research. The technology plodded along until about 2018 when it exploded in popularity as companies undertook digital transformation and RPA platform capabilities improved. Today it is one of the fastest growing categories of enterprise application automation.

Today, RPA software is particularly useful for organizations that have many different and complicated systems that need to interact together fluidly. For instance, if an electronic form from a human resource system is missing a zip code, traditional automation software would flag the form as having an exception and an employee would handle the exception by looking up the correct zip code and entering it on the form. Once the form is complete, the employee might send it on to payroll so the information can be entered into the organization's payroll system.

With RPA technology, however, software has the ability to adapt to interact with the payroll system without human assistance.

## What are the benefits of RPA?

***1) More Accurate Data Entry***

RPA data entry is more accurate than manual data entry. Software bots aren’t prone to human error and they don’t get tired or distracted. There are no typos and no entries going in the wrong field. The exact degree of accuracy depends on the optical character recognition (OCR) that the bot software uses.

***2) No Down-Time***

Software bots can work all the time – 24-hours a day every single day of the year – at 100% capacity. RPA doesn’t take holidays, doesn’t sleep, won’t need sick days, and never has an “emotionally unproductive” day. It’s perfectly understandable that human employees need those things. Bots help make sure there is time for them to enjoy their vacations, get enough sleep, and take care of their health rather than scrambling and working overtime to keep up with data entry.

***3) Increased Productivity***

The fact that RPA can do round-the-clock data entry without pausing to fix errors means it gets more work done than a human doing the same job could. Typically, a data entry bot can do the work of 4 to 8 regular employees. And if you had in-house employees who were handling the data entry before you started using bots, they now get the chance to focus their energy on more productive tasks. Plus, having the data entered automatically in an easily searched format makes it easier for employees to use the information, which increases their productivity as well.

***4) Fast Implementation***

Getting data entry bots up and running goes quickly. Implementing a new RPA software system certainly happens much faster than training a new person. You can have data entry software bots up and running in just days. In contrast, if you wanted to hire a new human employee you’d be taking time to sort through resumes, conduct interviews, go through the hiring process, and then train them once you finally find someone.

***5) Easy To Scale***

If you ever get too much work for your robotics process automation to handle there is a simple solution. Just add extra bots. Implementing of a databot takes about 4 to 5 weeks only. Once configured, the databot can be cloned to accommodate any work volume. That’s much easier than hiring and training new employees for data entry tasks. RPA creates a system that’s very easy to scale with your growing business. You just contact your software provider, let them know what you need, and they’ll get it set up.

***6) No Training Time***

If your process changes and the bots need to learn something new, you can either train new bots or alter their programming. That goes much faster than training employees in new tasks. And that’s also going to save you the money it would cost for existing employees to take time away from other tasks to train new hires.

***7) They’ll Never Quit***

With RPA, you don’t have to worry about employees quitting or dealing with turnover. Bots don’t care how hard they’re working, whether or not they’re happy in their jobs, or how many repetitive tasks they get stuck with. They never retire or decide it’s time to move on to a different job. In short, bots mean you’ll never have to worry about hiring and training new employees for data entry again.

***8) Repatriate Jobs***

People are often concerned about robotic process automation taking jobs away from real people. But a lot of companies who need manual data entry already aren’t hiring local employees for those tasks. They’re outsourcing their data entry overseas. Since the bots would be managed/hosted here in the USA, using RPA actually repatriates jobs.

***9) Tighter Security***

When human employees are entering data there is always a certain amount of risk. No one likes to think their employees would betray them, but the simple fact is that most fraud happens internally. And even when you can trust your employees, having them enter sensitive data can still be a privacy concern. Bots don’t understand the significance or meaning of the data they’re working with, which protects the privacy of your vendors and clients. Plus, bots don’t have to save/memorize passwords like a human so there is less risk of password breach.

***10) Minimal IT Resources***

Maintaining software bots requires minimal IT resources. In some cases, IT doesn’t need to get involved at all. Your RPA systems will be managed by the software provider. They’re responsible for maintenance, updates, etc. That takes the burden off IT (which probably already has more work than they can handle) and saves your company money.

***11) Efficiency gain & Cost savings***

The payback time for RPA (Robotic Process Automation) projects - where a databot is used to take over manual processes - is usually shorter than one year, with efficiency gains of up to 300% compared to human implementation. Extra profit can be achieved by having one databot carry out multiple processes.

***12) Employee satisfaction***

Do an RPA project to send annoying, repetitive work to a databot, so employees can focus on tasks with a higher added value, less repetitive and more creative.

***13) Customer Satisfaction***

Your data can work 24/7/365, and at all times fulfill the expectations of your customers faultlessly.

## Applications of RPA

RPA can be used for real, quantifiable benefits in a lot of industry branches like: Data Analytics, Manufacturing, Telecommunication, Professional Services, Banking, Education, Healthcare, Public Sector, Insurance, Non-Profit/NGO and so on.

***Nielsen*** is an American company focusing on data, information and measurement for fast-moving consumer goods, consumer behavior and media. Is an S&P 500 company, it operates in over 100 countries and has over 50.000 employees. With the deployment of UiPath robots the company has managed to help automate many of its back-office functions in Finance, IT and Customer Support. Nielsen has also developed a hybrid Center of Excellence that is made up by 12 core members and an additional 150 champions from business units across the organization. This has allowed Nielsen to expedite automation efforts that will help accelerate its path to digital transformation. After this improvement, over 365.000 hours of manual work were automated, 179 projects were delivered and over 30 functions were engaged across over 40 countries.

***Schneider Electric*** is a European multinational company providing energy and automation digital solutions for homes, buildings, data centers and infrastructure, by combining technologies, real-time automation, software and services. Wanting to process, translate, print and scan specifications and technical documentation for its products and services and to better respond to the ever changing business context, the company employed UiPath robots, easily set up for taking over the document preparation process and the order processing for new supply chains, bringing important benefits like: 2 days and ½ for developing the project for processing documentation with UiPath and a reduction of the time for order processing with 99%.

***Orange Spain***, part of the Orange Group (the largest worldwide telecommunication companies) is once of the biggest mobile network operators in Spain, with over 11 million clients. In 2016 the company started a huge transformation to become digital, yet at the same time focused on the needs of the customers. It was decided from the beginning they wanted to use RPA so they set up the Orange Robot Factory, wanting to create at least one robot per week. The results were immediately visible, with 17 processes automates in the first 3 months and 2 million interactions done by robots in the first 6 months. At the end there were over 400 robots created and deployed, 250 employees trained in RPA on UiPath Academy and saving over 34 millions EUR in a little more than 2 years.

***Deloitte*** is one of the Big Four accounting companies and one of the largest professional services networks in the world. It provides audit, financial advisory, risk advisory, consulting, tax and legal services through a number of 312.000 professionals globally. Wanting to automate all the repetitive and manual tasks that take away precious time which could be used for customer engagements, Deloitte started its RPA journey with high impact processes like billing and onboarding. As the results from using automation started to appear, employees were encouraged to develop their own automations through a citizen developer program. Among the benefits it can be enumerated: 2200 employees were trained in UiPath and RPA and over 50 automation opportunities were identified immediately after launch.

***The New York Foundling*** is one of the New York City’s largest and oldest child welfare agencies. Its services include foster care, adoptions, mental health services, educational programs and many other community-based services. A large portion of the activities carried out by the clinicians of the New York Foundling involved filling in and archiving paper documents, as well as navigating and inputting data between five different systems. The data entry process was automated with the help of RPA, resulting in 4 hours per week saved for each of the clinicians and over 100.000 hours saved annually in total for the staff of the agency.

***Heritage Bank*** is Australia’s largest mutual bank, established in 1875 and providing all retail products, including home loans. The bank aimed to become “a digital bank with physical presence”, to build scalability and efficiency across the entire customer experience chain, from back office to front office. For this purpose, the bank chose UiPath and set up a dedicated Center of Excellence, supported by business champions in all departments. It managed to automated processes across the entire organization, getting to the point where every employee was interacting in one way or another with robots and started to make use of AI and Machine Learning in cognitive processes, such as Financial Crime Reporting or Living Expense Report Compiling. The end results were fascinating: 80 automated processes with a level of accuracy of 98% and 500 hours saved on loan application verification process.

***The University of Auckland*** is New Zealand’s leading university, with more than 40.000 students supported by 5.500 staff members. When they decided to implement RPA, they started with a full redesign of the processes chosen for automation, both in terms of how the activities were performed and the associated business rules. Then UiPath robots were deployed to take over some of the most significant and time-consuming processes - the student transcript process and the supply setup process. The success of this initiative opened the path to setting up an internal Center of Excellence to drive the RPA journey. But even more importantly, it convinced the University of Auckland to add RPA to their technical curricula through UiPath's Academic Alliance program. They managed to save 23.000 hours annually through automation with a success rate of 99% for all processed requests for automated processes in Finance and 70% turnaround time reduction for the supplier setup process.

***Max Healthcare*** is one of the largest healthcare services providers in India. It has a network of 12 hospitals and 5 medical facilities, as well as more than 2,300 doctors offering treatment across 29 specialties. Max Healthcare had a high number of daily activities that involved large volumes of patient information performed entirely manually. This posed many challenges: the long time needed and the high error rate, the archiving and retrieval of information, the security of documents and the sudden spikes in frequency and volumes of data. The RPA journey of Max Healthcare began with 3 processes in areas where maximum impact could be achieved quickly: claims processing and data reconciliation. And the robots delivered on the expectations, by being able to navigate between multiple applications and environments, bringing important money and time savings. The automation reduced 70% turnaround time for claims processing and 65% turnaround time for data reconciliation processes, also helped recover over 130.000 dollars from pending payments over 1 year.

***The Copenhagen Municipality*** is the largest municipality in Denmark and one of the four municipalities that constitute the capital of Denmark. It serves more than 630,000 inhabitants living in Copenhagen's historical city center and the neighboring areas. As the city expands rapidly, the municipality's staff has to maintain the high-quality service for a growing population (over 20% over the last 10 years), and with the same or even a reduced budget. And although the Municipality was highly digitized, they knew how difficult it was to integrate between different applications and environments. And this is where RPA delivered, with its unique ability to go through data, work between systems and skip integrations. The Copenhagen Municipality started a pilot with automating the entire paperwork for an HR process which was already digitized. The pilot convinced them that RPA was the solution, so they started scaling by setting up an internal Center of Excellence and gradually increasing the number of automations and robots, all while investing into building the excitement for RPA across the organization. This translated into many staff members upskilling with the free resources from UiPath Academy. Also led to the existence of 54 robots serving the employees, 75 key business processes were automated and 8.500 hours per year were saved for a single process automated.

***American Fidelity*** is an insurance company focused on teachers, the public sector, and other groups that offers benefits strategies to empower customers to make the best benefits decisions possible. American Fidelity is constantly on the lookout for new ways to automate and streamline important processes, especially those that help it provide better customer service. The RPA story started with a proof of concept - an automation built in less than one week to move data from the mainframe to a spreadsheet. It was a hit, and the employee who was responsible for the task was thrilled of the outcome. The company then quickly automated other several other tasks related to customer-facing processes, and now moved to integrate RPA with machine learning in order to tackle cognitive processes, such as customer email classification. As a result, 10 intelligent automations were deployed, combining RPA with automated machine learning, the accuracy grew to 100% in tailored content for clients and over 100 tasks were automated.

Seeing these examples we can conclude that we can apply automation in any industry as each of them has automation potential and the automation benefits are far more than just saving costs:

1. Automation is industry agnostic - no matter how you look at it, there are

automation use-cases in any business.

1. Automation doesn't just impact revenue and time - automating repetitive

tasks also leads to an improved customer and employee experience, eases the AI operations, ensures compliance, and makes the decision-making process faster.

## What are the challenges of RPA?

There are a number of challenges related to RPA, which have limited its use.

***Scalability***. Enterprises have struggled to scale RPA automation initiatives because, although RPA's software bots are relatively easy to implement, they can be hard to govern and manage and therefore hard to scale.

***Limited abilities.*** While its name includes the words "process automation," many critics have pointed out that RPA software tools automate tasks. More work is often required to stitch multiple tasks together into a process. Craig Le Clair, an analyst at Forrester Research, has cautioned enterprises to observe the "rule of five" in building RPA applications because they tend to break when a bot must make more than five decisions, manipulate more than five apps or make more than 500 clicks.

***Security.*** RPA bots sometimes need to access sensitive information to complete their tasks. If they are compromised, they pose an additional security risk for firms.

***Limited resiliency.*** RPA failures can occur when applications change in ways that are not anticipated by developers.

***New QA issues.*** Bots require a variety of new QA practices to ensure they continue to work as intended.

***Privacy.*** Bots may be involved in working with personally identifiable information governed by privacy requirements. Teams need to ensure this data is processed in conformance with local data protection laws such as GDPR. For example, if an RPA bot moved data outside of a given country without encryption that would be a violation of Article 44 of GDPR. RPA vendors are starting to seek ISO 27701 certification as a foundation for managing sensitive information.

***Efficiency.*** RPA bots manually plod through an application in the same way a human does. This may not be as efficient as automating applications through APIs or workflow automations baked into the application itself.

## Test Automation using RPA

As most people in the software industry know, there are distinct differences between manual testing and automated testing. Manual testing requires physical time and effort to ensure the software code does everything it’s supposed to do. In addition, manual testers have to make a record of their findings. This involves checking log files, external services and the database for errors. If you’re familiar with manual testing, you know this process can be extremely time-consuming and repetitive.

The fundamental difference between manual and automated testing is straightforward. With manual testing, a human is responsible for single-handedly testing the functionality of the software in the way a user would. Automated testing is done through an automation tool, so more time can be spent on higher value tasks, such as exploratory tests while automating time-consuming tests, such as regression tests. While you do need spend time maintaining test scripts overall, you will increase your test coverage and scalability.

The benefit of manual testing is that it allows a human mind to draw insights from a test that might otherwise be missed by test automation. Automated testing is well-suited for large projects, projects that require testing the same areas over and over, and projects that have already been through an initial manual testing process.

There are a lot of reasons [test automation](https://smartbear.com/product/testcomplete/overview/) is beneficial, and by adhering to automated testing best practices you can ensure that your testing strategy delivers the maximum return on investment (ROI). Automated testing will shorten your development cycles, avoid cumbersome repetitive tasks and help improve software quality.

Thorough testing is crucial to the success of a software product. If the software doesn’t work properly, chances are strong that most people won’t buy or use it…at least not for long. But testing to find defects – or bugs – is time-consuming, expensive, often repetitive, and subject to human error. Automated testing, in which Quality Assurance teams use software tools to run detailed, repetitive, and data-intensive tests automatically, helps teams improve software quality and make the most of their always-limited testing resources. Test automation tools help teams test faster, allows them to test substantially more code, improves test accuracy, and frees up QA engineers so they can focus on tests that require manual attention and their unique human skills.

In the process of automation testing multiple aspects need to be taken in count:



### The decision on what test cases to automate

It is impractical to automate all testing, so it is important to determine what test cases should be automated first.

The benefit of automated testing is linked to how many times a given test can be repeated. Tests that are only performed a few times are better left for manual testing. Good test cases for automation are ones that are run frequently and require large amounts of data to perform the same action.

You can get the most benefit out of your automated testing efforts by automating:

* Repetitive tests that run for multiple builds.
* Tests that tend to cause human error.
* Tests that require multiple data sets.
* Frequently used functionality that introduces high risk conditions.
* Tests that are impossible to perform manually.
* Tests that run on several different hardware or software platforms and configurations.
* Tests that take a lot of effort and time when manual testing.

Success in test automation requires careful planning and design work. Start out by creating an automation plan. This allows you to identify the initial set of tests to automate, and serve as a guide for future tests. First, you should define your goal for automated testing and determine which types of tests to automate. There are a few different types of testing, and each has its place in the testing process. For instance, unit testing is used to test a small part of the intended application. To test a certain piece of the application’s UI, you would use functional or GUI testing.

After determining your goal and which types of tests to automate, you should decide what actions your automated tests will perform. Don’t just create test steps that test various aspects of the application’s behavior at one time. Large, complex automated tests are difficult to edit and debug. It is best to divide your tests into several logical, smaller tests. It makes your test environment more coherent and manageable and allows you to share test code, test data and processes. You will get more opportunities to update your automated tests just by adding small tests that address new functionality. Test the functionality of your application as you add it, rather than waiting until the whole feature is implemented.

When creating tests, try to keep them small and focused on one objective. For example, separate tests for read-only versus read/write tests. This allows you to use these individual tests repeatedly without including them in every automated test.

Once you create several simple automated tests, you can group your tests into one, larger automated test. You can organize automated tests by the application’s functional area, major/minor division in the application, common functions or a base set of test data. If an automated test refers to other tests, you may need to create a test tree, where you can run tests in a specific order.

### Select the Right Automated Testing Tool

Selecting an automated testing tool is essential for test automation. There are a lot of automated testing tools on the market, and it is important to choose the automated testing tool that best suits your overall requirements.

Consider these key points when selecting an automated testing tool:

* Support for your platforms and technology. Are you testing .Net, C# or WPF

applications and on what operating systems? Are you going to test web applications? Do you need support for mobile application testing? Do you work with Android or iOS, or do you work with both operating systems?

* Flexibility for testers of all skill levels. Can your QA department write

automated test scripts or is there a need for keyword testing?

* Feature rich but also easy to create automated tests. Does the automated testing

tool support record-and-playback test creation as well as manual creation of automated tests; does it include features for implementing checkpoints to verify values, databases, or key functionality of your application?

* Create automated tests that are reusable, maintainable and resistant to changes

in the applications UI. Will my automated tests break if my UI changes?

* Integrate with your existing ecosystem. Does your tool integrate with your

CI/CD pipeline such as Jenkins or Azure DevOps? Or your test management framework such as Zephyr? What about a defect-management system like Jira, or a source control such as Git?

* Ability to test enterprise applications. Does your tool offer out-of-the box

support to test packaged applications such as SAP, Oracle, Salesforce, and Workday?

### Divide Your Automated Testing Efforts

Usually, the creation of different tests is based on the QA engineers’ skill levels. It is important to identify the level of experience and skills for each of your team members and divide your automated testing efforts accordingly. For instance, writing automated test scripts requires expert knowledge of scripting languages. Thus, in order to perform these tasks, you should have QA engineers that know the script language provided by the automated testing tool.

Some team members may not be versed in writing automated test scripts. These QA engineers may be better at writing test cases. It is better when an automated testing tool has a way to create automated tests that do not require an in-depth knowledge of scripting languages.

A keyword test (also known as keyword-driven testing) is a simple series of keywords with a specified action. With keyword tests, you can simulate keystrokes, click buttons, select menu items, call object methods and properties, and do a lot more. Keyword tests are often seen as an alternative to automated test scripts. Unlike scripts, they can be easily used by technical and non-technical users and allow users of all levels to create robust and powerful automated tests.

You should also collaborate on your automated testing project with other QA engineers in your department. Testing performed by a team is more effective for finding defects and the right automated testing tool allows you to share your projects with several testers.

### Create Good, Quality Test Data

Good test data is extremely useful for data-driven testing. The data that should be entered into input fields during an automated test is usually stored in an external file. This data might be read from a database or any other data source like text or XML files, Excel sheets, and database tables. A good automated testing tool actually understands the contents of the data files and iterates over the contents in the automated test. Using external data makes your automated tests reusable and easier to maintain. To add different testing scenarios, the data files can be easily extended with new data without needing to edit the actual automated test.

Typically, you create test data manually and then save it to the desired data storage. However, UiPath provides you with the support in creating Table variables and Excel files that store test data. This approach lets you generate data of the desired type (integer numbers, strings, boolean values and so on) and automatically save this data to the specified variable or file. Using this feature, you decrease the time spent on preparing test data for data-driven tests.

Creating test data for your automated tests is boring, but you should invest time and effort into creating data that is well structured. With good test data available, writing automated tests becomes a lot easier. The earlier you create good-quality data, the easier it is to extend existing automated tests along with the application's development.

### Create Automated Tests That Are Resistant to Changes in the UI

Automated tests created with scripts or keyword tests are dependent on the application under test. The user interface of the application may change between builds, especially in the early stages. These changes may affect the test results, or your automated tests may no longer work with future versions of the application. The problem is automated testing tools use a series of properties to identify and locate an object. Sometimes a testing tool relies on location coordinates to find the object.

For instance, if the control caption or its location has changed, the automated test will no longer be able to find the object when it runs and will fail. To run the automated test successfully, you may need to replace old names with new ones in the entire project, before running the test against the new version of the application. However, if you provide unique names for your controls, it makes your automated tests resistant to these UI changes and ensures that your automated tests work without having to make changes to the test itself. This also eliminates the automated testing tool from relying on location coordinates to find the control, which is less stable and breaks easily.

# **CHAPTER 2. Development Tools**



## UiPath Inc.

UiPath Inc. provides an end-to-end automation platform that offers a range of robotic process automation (RPA) solutions primarily in the United States, Romania, and Japan. The company offers a suite of interrelated software to build, manage, run, engage, measure, and govern automation within the organization. Its platform combines artificial intelligence with desktop recording, back-end mining of both human activity and system logs, and intuitive visualization tools, which enables users to discover, analyse, and identify processes to automate in a centralized portal; offers low-code development environments that allows users in an organization to create attended and unattended automations without any prior knowledge of coding; deploys robots in highly immersive attended experiences or in standalone, unattended modes behind the scenes, and can leverage native connectors built for commonly used line-of-business applications; offers centralized tools designed to manage, test, and deploy automations and ML models across the enterprise; allows customers to manage long running processes that orchestrate work between robots and humans; and enable users to track, measure, and forecast the performance of automation in their enterprise and help businesses ensure compliance with business standards. In addition, the company provides maintenance and support for its software, as well as professional services, such as training and implementation services to facilitate the adoption of its platform. It serves banking, healthcare, financial services, and government entities.

The company started in 2005 as a 10-people team based in Bucharest, led by Daniel Dines and it was called “DeskOver”. In the beginning, they outsourced automation libraries and software to some of the world’s biggest companies. In 2015, the company changed its name to UiPath. Also in 2015, after receiving seed funding from Accel Partners and earlier investors, the company also opened offices in London, New York City, Bangalore, Paris, Singapore, Washington, D.C., and Tokyo. That’s when the company was really born and rebranded as an RPA company. By April 2016, the company had released its Front Office and Back Office Server suites, and also released its Studio Community Edition. Within six months, the company had 10,000 active members, and more than 250 enterprise customers.

In 2017, UiPath reported 590 employees and moved its headquarters to New York to be closer to its international customer base. UiPath and Automation Anywhere dispute the market leadership in the robotic process automation software market. There is therefore no doubt that UiPath is one of the largest players in the RPA market. In particular from 2017 onwards, they are witnessing a steep increase in the number of customers, which is also reflected in the company’s estimated valuation of $7 billion in March 2019. It is one of the largest companies in the global AI landscape. Specifically for the Benelux and Europe, UiPath is a dominant player.

In June 2019, research firm Gartner announced that from 2017 to 2018 UiPath moved from #5 to #1 in RPA market share. In September, UiPath was ranked #3 on the Forbes Cloud 100. The company was the featured cover story of the September 30, 2019 Forbes print edition with UiPath CEO Daniel Dines called "Boss of the Bots".

In October 2019, UiPath announced the acquisition of Ukrainian process documentation company StepShot and Dutch process mining company ProcessGold. Also in October, the company announced UiPath Explorer, a new product using technology from the acquired companies; a robot communication tool called UiPath Apps; a low code robot programming tool called UiPath StudioX; an embedded analytics tool called UiPath Insights; and UiPath Connect, a tool that allowed every employee to find new processes to automate.

UiPath uses 76 technology products and services including HTML5, Google Analytics, and jQuery its employees are showing high interest in [CyberArk](https://www.crunchbase.com/bombora_topic/c072d018-9da3-4349-a5f7-a84cb3334229), [Cross Dock](https://www.crunchbase.com/bombora_topic/c9ffb58e-2e9c-4ec1-9a90-350b2a9d01af), and [Revenue Growth Management](https://www.crunchbase.com/bombora_topic/a992e80b-ccb7-43b7-ba00-21898c2bba9c).

UiPath is actively using 137 technologies for its website among which are included Viewport Meta, IPhone / Mobile Compatible, and Google Font API.

[UiPath](https://www.crunchbase.com/organization/uipath) is ranked 48,199 among websites globally based on its 2,169,960 monthly web visitors.

On the financial side, the company has raised a total of [$2B](https://www.crunchbase.com/search/funding_rounds/field/organizations/funding_total/uipath) in funding over [11](https://www.crunchbase.com/search/funding_rounds/field/organizations/num_funding_rounds/uipath) rounds. Their latest funding was raised on [Feb 1, 2021](https://www.crunchbase.com/search/funding_rounds/field/organizations/last_funding_at/uipath) from a [Series F](https://www.crunchbase.com/search/funding_rounds/field/organizations/last_funding_type/uipath) round. On the stock market is registered under the ticker [NYSE:PATH](https://www.google.com/finance?q=NYSE:PATH) and their stock opened with $56.00 in its Apr 21, 2021 IPO. [UiPath](https://www.crunchbase.com/organization/uipath) is funded by [31](https://www.crunchbase.com/search/principal.investors/field/organizations/num_investors/uipath) investors, among which [Alkeon Capital](https://www.crunchbase.com/organization/alkeon-capital) and [Tiger Global Management](https://www.crunchbase.com/organization/tiger-global) are the most recent ones. [The](https://www.crunchbase.com/organization/uipath) company has a post-money valuation in the range of over [$10B](https://www.crunchbase.com/search/organization.privcos/field/organizations/privco_valuation_range/v_10000000) as of Feb 1, 2021.

UiPath has evolved to become the only RPA platform in the market built to support the full automation lifecycle from discovery to measurement. Its product portfolio continues to stay at the forefront of innovation, continuously expanding its traditional RPA offering capabilities to include tools like process mining, embedded analytics, improved AI fabric components, SaaS-based RPA, and test automation.

UiPath is considered one of the fastest RPA solutions in the industry as well – often 3-4x faster than other RPA products (for example those from Blueprism or Automation Anywhere).

Its ease of development is also significantly greater than competitors like Blue Prism, where the notably higher coding skills required make implementation much more time-consuming.

In addition, the attended capabilities of UiPath are unmatched. Even today, attended functionality offered by Automation Anywhere is limited in its monitoring and deployment, and in the case of Blue Prism , almost nonexistent. UiPath delivers the combination of attended and unattended automation that many customers desire.

Other key UiPath strengths include:

* ***Long Running Workflows.***

Traditionally, automation is expected to work on its own from start to finish, without human interaction. Unfortunately, that excludes the significant number of business processes that require approval or inputs as part of their workflows. UiPath offers a platform that enables interaction and collaboration between digital and human workforces, opening the door for many more automations in a cost-effective and actionable manner.

* ***Machine Learning and Predictive Analytics***.

Implementing Machine Learning (ML) models has proved challenging. Not only are they expensive and difficult to maintain, but major changes like COVID render their predictive analytics capabilities useless. UiPath offers out-of-the-box, drag-and-drop ML models that can be consumed by all organizational sizes at a fraction of the usual cost. They can also be customized and fixed much quicker than traditional in-house development.

* ***Seamless Interconnectivity.***

The openness of the UiPath platform and its seamless interconnectivity with almost all major enterprise products and applications enables superior business process management. Key advantages include open APIs, integration with 3rd-party analytics and dashboard systems, and the ability to invoke code.

* ***UiPath Document Understanding combines RPA and artificial***

***intelligence (AI) to achieve end-to-end document processing.***

It helps organizations extract and interpret data from different documents, from AP invoices to loan or employee applications. The tool works with a wide range of documents from structured to unstructured; recognizes different objects like tables, handwriting, signatures, or checkboxes; and can deal with various file formats.

* ***Citizen Development.***

In line with its vision for “a robot for every person,” UiPath recently launched StudioX. This innovative, no-code tool is an optimized version of its design studio that enables non-technical users to create simple automations for themselves or their departments. That way, employees can take the initiative to automate tasks that make their lives easier but don’t fit the criteria for a company-wide initiative.

* ***Customer Satisfaction.***

UiPath receives high marks in every measure of customer satisfaction. Besides its impressive G2 ratings, UiPath scores the highest of the three largest RPA software vendors in Gartner’s Peer Insights – earning 4.6/5 stars (and by far the most customer reviews) detailing evaluation and contraction, integration and deployment, service and support, and product capabilities. UiPath has devoted significant resources to encouraging customers’ success by a continuous focus on learning resources, online training, and an active developer community. It also supports customers with frequent updates and crowdsourced knowledge sharing.

* ***Flexible Licensing Model and Low Cost of Entry.***

UiPath was one of the first RPA software vendors to democratize RPA, allowing organizations to get started with an affordable low annual investment. This becomes a huge advantage when putting together the initial business case for automating repetitive business processes, as it helps make RPA's traditionally fast payback even faster.

## UiPath Products

The main idea behind the fact that automation is driving the digital transformation enterprise is that automation is expanding from RPA to a combination of technologies that enable the end-to-end automation lifecycle.

The automation lifecycle is a phased approach for implementing and scaling automation enterprise-wide as shown below, in figure 2.1.

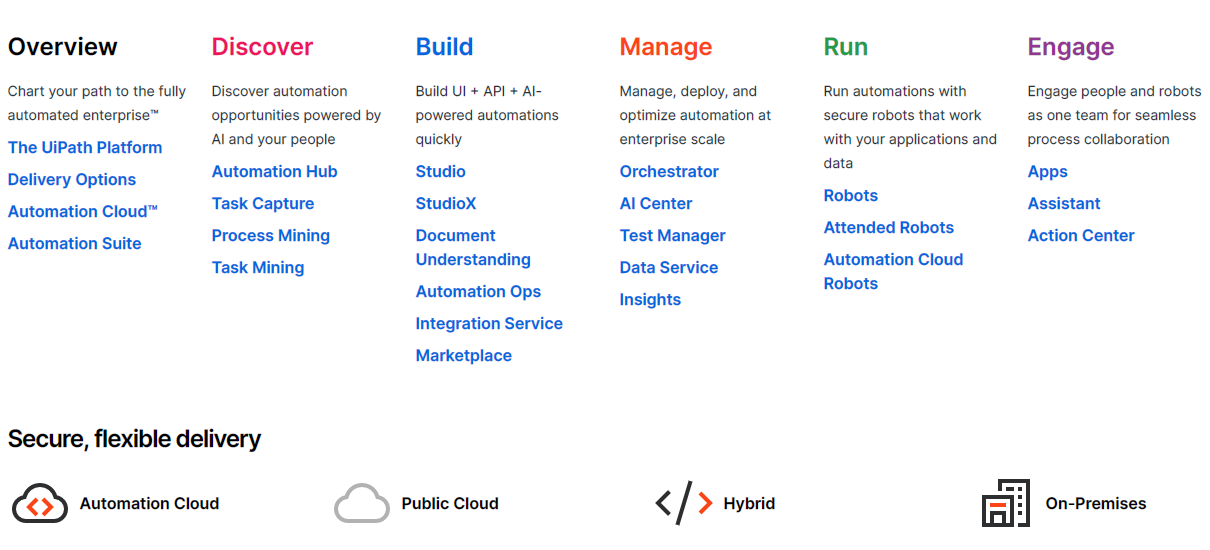


Figure 2.1 UiPath Products (Source: (https://www.uipath.com))

In Discover, the focus is on defining process governance and using data to pick the right processes for automation. Automation opportunities are identified by the employees or by AI-powered technologies.

In the Build phase, there are automation solutions that cater to:

* professional automation developers - offering powerful development and debugging tools, advanced integrations, as well as world-class UI automation capabilities.
* business users - rapidly automating their business apps without the need for developer resources or coding skills.

The Management capabilities help test, deploy, manage and optimize the performance of the robot fleet and of the AI capabilities.

Running robots has to offer flexibility, matching the types of processes automated, the type of human-robot collaboration, and the existing setup.

Engagement between human users and the robots happens in a simple manner, whenever it is needed.

UiPath's main product is the UiPath Automation Platform. The platform combines a family of low-code visual integrated development environment (IDE) products called Studio for process creation, with client-side agents called Robots that execute those processes. The processes are deployed, monitored and managed remotely with a central management tool called Orchestrator.

Additional available software includes:

***UIPath AI Center*** (previously AI Fabric) - orchestrates and inserts AI into business processes.

***UiPath Action Center*** - a communication tool for instances where robots need to connect with humans for direction, described by the company as “human in the loop.”

***UiPath Apps*** - a low-code application development platform.

***UiPath Assistant*** - a launchpad for automations that a company provides to its computer workers. It sits on the computer desktop and gives people easy access to selected automations that help them with their tasks.

***UiPath Automation Hub*** (previously UiPath Connect Enterprise) - a tool allows every employee at an organization to help find, suggest and track new processes to automate.

***UiPath Document Understanding*** - software that extracts, interprets and processes data from PDFs, images, handwriting and other communication media.

***UiPath Insights*** - a modular data dashboard that provides analytics for UiPath's automated processes.

***UiPath Process Mining*** (previously ProcessGold) - a tool that uncovers new automation opportunities by analyzing application logs.

***UiPath StudioX*** - a platform with simplified coding that allows workers to build their own robots to simplify their own work.

***UiPath Test Suite*** - automates and centralizes testing to ensure the quality of every automation and application before they go live.

UiPath's software products are available as native software or using the Software as a Service (SaaS) model.

UiPath also hosts the UiPath Academy, to provide job training and certification in the field of Robotic Process Automation.

Getting started with UiPath does not require large investments. For smaller organizations and evaluation purposes, a free “community” version can be downloaded. The great thing is that this version already contains all the functionalities of the paying version. The purchase of the paying “enterprise” version will face major objections with annual licensing costs for the basic set-up below € 5,000. Even a complete package, including Orchestrator (for managing several databots and / or RPA scripts), is clearly less expensive than with the 2 large competitors, Automation Anywhere and BluePrism.

UiPath’s interface is user-friendly: it is structured in a logical, visual way. Processes are presented in a Visio-like workflow making it easy to maintain an overview. Previously built activities can be re-used from a library via drag & drop, where you will find them via a practical search function. Provided the structure is well thought through, modules can be reused without much effort. UiPath also has a recorder that makes it possible to record how a human carries out a process as the basis for the RPA script.

Besides the fact that the community version is made available free of charge, training material is also available online in the UiPath Academy. There are certificates attached to completing the various training modules, which can be achieved when online tests are completed with positive results. In addition to the Academy, there is also a very active UiPath Forum where developers find each other for questions and for the exchange of experiences. Customers with a paying license can also call on the support services of UiPath itself, similar to a traditional help desk.

Attended and unattended are concepts that often come back when it comes to RPA. This is the difference between an end user who directly controls the databot and, in a certain sense, enters into a dialogue with it, versus a databot that processes its tasks behind the scenes, without human involvement. Both RPA scenarios are supported by UiPath and the combination of both is possible within the same environment.

More and more, and certainly within the larger corporate environments, the work environment of the end user has been virtualized. For example with the help of Citrix. Not all databots can cope with this, since the screen only shows a projection of the actual application, and not the application itself. UiPath scores particularly well in working in these types of environments, and has various functionalities to deal with this depending on the specific set-up.

With UiPath Go, UiPath has a catalog of reusable components, a kind of mini script that can be used by RPA developers or can serve as inspiration for their own RPA developments. These are built by independent developers and are made available in an app store-like manner, often for free or for a limited fee.

Following on from the previous point, it is important that a databot recognizes various types of input, both from the on-screen applications as well as from digitized documents. UiPath has the built-in OCR engines from both Google and Microsoft. These provide a satisfactory result when it comes to recognition of information on a screen. When it comes to reading scanned documents, the optional but also fully integrated Abbyy OCR engine delivers a great result.

In addition to a growing network of partners, UiPath has its own local representation in both the Netherlands and Belgium. This means our RPA can contact a partner in their own language if desired.

For many, the low entry threshold and extensive support make UiPath an excellent starting point for their RPA journey. However, as soon as the corporate environment imposes important safety, robustness, scalability requirements, working with an experienced RPA implementation partner is crucial. Particularly setting up an Orchestrator, a super-bot that controls, follows up and coordinates all other databots, requires the kind of know-how that only comes with experience.

UiPath’s RPA software is based on the .Net platform. The syntax of variables and formulas are also in line with this, and developers with experience in this area are one step ahead. However there are subtle differences that require attention to ensure proper functioning of the databot.

UiPath is a good choice for every organization. Regardless of whether it is a first careful RPA proof of concept or a thorough automation that involves a large number of employees and processes.

The low entry threshold and wide applicability make it easy to build up experience fast and build a good short-term business case. Provided the developments are sufficiently well thought out, the UiPath RPA platform also provides everything you need to deploy at a large scale. An experienced RPA implementation partner comes highly recommended.

## UiPath Studio

UiPath Studio is advanced automation software that gives everyone, from business users to advanced RPA developers, the right automation canvas to build great software robots and organizations the right governance tools to manage them all.

The application is the most popular automation development environment from UiPath and it includes:

* Robust debugging tools
* Workflow recorders, wizards, selectors, and Document Understanding to automate any desktop or web application
* Source control integration with Git, TFS, FSTS, VSTS, and SVN
* Command palette supporting search across libraries, activities, projects, and open workflows
* Custom code integration with VB.NET, Python, AutoHotkey, JavaScript, PowerShell, and Java direct into automations
* Activities libraries with pre-built templates, RPA components, and AI components
* Reuse of resources to speed up automation with Object Repository and native integration with Data Entities

UiPath Studio is used for building automations for Windows or Linux, publishing projects to Orchestrator and run unattended jobs on both operating systems. UiPath Studio encapsulates both simple and complex solutions for application integration and automating third-party applications, administrative IT tasks, and business IT processes.

The coding is done either in VB or C#, a multitude of packages and activities can be used and

new activities and options are added all the time, for a complete cross-platform experience.

UiPath Studio is at the heart of automation with UiPath products. Activities form into comprehensive workflows in Studio, which are then executed by the Robot and published to Orchestrator.



Figure 2.2 UiPath Characteristics (Source: (https://docs.uipath.com/))



### ***UiPath Studio’s User Interface***

UiPath Studio contains multiple panels for easier access to specific functionalities. They can be docked, act as floating windows, or the Auto-hide option can be enabled from the drop-down list. In the picture below you can see an overview on UiPath Studio.

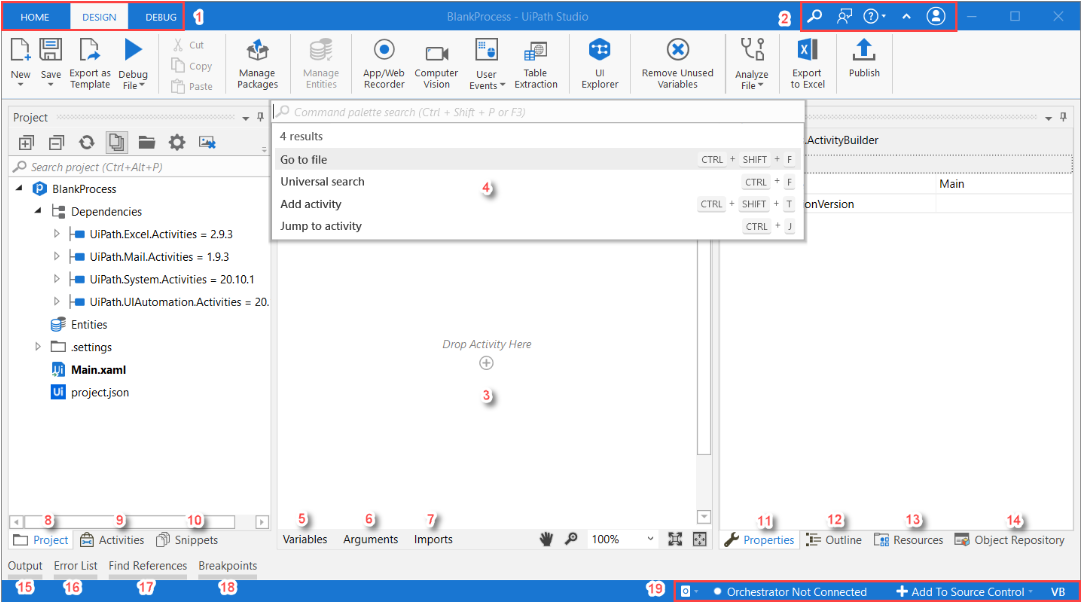


Figure 2.3 Overview of UiPath Studio(Source (https://docs.uipath.com/) )

In the right upper corner of the application( the part numbered with “1” in Figure 2.3) there is the Ribbon, which can be expanded by clicking the Minimize/Expand button and it contains the following **Ribbon Tabs**:

1. Home

Using the Home tab is possible to create and open projects, configure Studio, or access help and license information from the Studio Backstage View - this is the view you see when you first open Studio. You can also get here by clicking Home in the upper-left corner of the window. Here you can create and open projects, configure Studio, or access help and license information.

1. Design

In the Design tab sequences can be added, also flowcharts and state machines in the project, activities packages can be installed and managed, build interactions with UI elements, export workflows to Excel, and then publish the project to Orchestrator or custom feeds.

1. Debug

The Debug tab can be used to debug the workflow, while using debugging tools to set breakpoints, monitor the execution of activities step by step, and adjust the debugging speed.

Logs can be opened to view details regarding execution and any changes made to the project.

The **Title Bar** (see Figure 2.3, #2) can open the Command Palette using the Search button , send Feedback, access Help resources and sign in into the user’s account, or just display it if the user is already logged in.

The **Designer** **panel** (see Figure 2.3, #3) displays the current automation project, enables making changes to it, and provides quick access to variables (see Figure 2.3, #5), arguments (see Figure 2.3, #6) and imports (see Figure 2.3, #7).

It is possible to navigate within a diagram by double-clicking the activity you want to view. The path is displayed as breadcrumbs in the header of the Designer panel. When using multiple displays scaled differently the text in the input field part of some activities might be improperly shown.

The **Command Palette** (see Figure 2.3, #4) incorporates:

* Add activity - here activities from installed packages can be found and added ,
* Universal search - search snippets, activities, variables, arguments, files, imports and project dependencies can be found ,
* Go to file - to open other types of files, like screenshots or Excel files with their respective default application on the machine and
* Jump to Activity - helps find and focus specific activities in large workflows search bars. When opened, the Jump to activity bar displays the list of all activities in the .xaml file currently focused in the Designer panel.

The **Project panel** (see Figure 2.3, #8) enables you to view the contents of the current project, add folders, open the file location, manage dependencies, and adjust project settings. Files can be added to the project by copy and pasting them directly into the Project panel or using drag and drop.

Context Menu for projects can become visible on right-click anywhere in the Project panel. A different subset of options is available depending on where in the panel you right-click, the type of project, and whether the project is added to source control.

Among the options included in the Context Menu can be found:

* Open Project Folder - opens the local folder containing the project
* Project Settings - opens the project settings window for adjusting project preferences
* Add - opens a list of items that can be added to the project: folder, sequence, flowchart, state machine, global handler, workflow, or, in test automation projects, test case.
* Import Files - opens the File Explorer window to import files into your project. By default, the \*.xaml filter is applied to list only workflow files, but you can change it to all files to import other file types. Imported is added to the imported file name if it coincides with the name of a workflow from the current project.
* Add to Source Control - adds the current project to source control using Git Init, Copy to Git, Add to TFS, or Add to SVN options.
* Open - opens the selected files using the default program.
* Open File Location - opens the local folder containing the file.
* Rename - enables you to rename the selected file or folder, and opens the Rename Item window. The item is renamed in all occurrences.
* Copy - copies the selected files or folders to the clipboard. You can then paste them in the project panel or in the Windows file explorer.
* Paste - pastes files or folders that were copied to the clipboard.
* Delete - deletes the selected item only from your local machine.
* Select for Compare - selects the current file for comparison.
* Set as Main - sets the selected .xaml file as Main in the project definition, meaning that the project execution starts with that file.
* Enable Entry Point - marks the selected workflow file as an entry point for the process, making it possible to select it as the workflow to run first when using the Invoke Process and Run Parallel Process activities in other processes, or when starting a job from Orchestrator.
* Create Test Case - creates a test case that invokes the selected workflow file.
* Run Test Cases / Debug Test Cases - runs or debugs multiple selected test cases.

The **Activities panel** (see Figure 2.3, #9) shows available activities that can be added to the current workflow. Activities can be searched by name and optionally by description using the search box at the top of the panel, navigate through them using navigation keys, and press Enter to add the selected activity to the currently opened file.

The **Snippets panel** (see Figure 2.3, #10) enables easily reuse of automations. It includes, multiple samples and snippets and others can be added by clicking the Add Folder button and selecting another directory.

The **Properties panel** (see Figure 2.3, #11) is contextual and enables you to view and change the properties of a selected activity. When selecting two activities in the same workflow, common properties can be modified from the Properties panel.

The **Outline panel** (see Figure 2.3, #12) displays the project hierarchy, and all available nodes. You can highlight activities in this panel by selecting them in the Designer panel, or you can go to a specific activity by selecting it in the Outline panel.

The **Resources panel** (see Figure 2.3, #13) in Studio can load assets, queues, processes, and entities, provided that the Robot is connected to Orchestrator. Read the Connecting Robots to Orchestrator page to find the steps.

The **Object Repository** (see Figure 2.3, #14) ensures the management, reusability, and reliability of UI elements by capturing them as objects in a DOM-like repository, sharable across projects. It allows for creating and reusing UI taxonomies inside and across automation projects. With Object Repository an UI API for any application can be build and shared with the team within minutes. This part can only be used in the modern experience with modern activities.

The **Output panel** (see Figure 2.3, #15) enables you to display the output of the Log Message or Write Line activities, among other things. Exceptions for packages are also displayed in this panel.

The **Find References panel** (see Figure 2.3, #16) displays results for references you search for in your project. To find every place in the project where an element is referenced, right-click it and select Find References.

The **Error List panel** (see Figure 2.3, #17) displays errors found in the file or project during the validation process, together with errors generated by Workflow Analyzer rules.

The **Breakpoints panel** (see Figure 2.3, #18) displays all breakpoints in the current project, together with the file in which they are contained. Right-click an item in the **Breakpoints** panel opens the context menu with the some options like delete, focus, enable, disable and settings.

In the **Status bar** (see Figure 2.3, #19), you can view status information and access options related to Orchestrator and source control, like Orchestrator/Cloud Connection, Orchestrator Status, Source Control, Project Language and Project Compatibility.

### ***UiPath Studio Activities***

UiPath Activities are the building blocks used in UiPath Studio and designed for creation of a clear and smooth automation process. Depending on what packages are installed, there are various numbers of Activities in UiPath, for each and every functionality.

UiPath Studio includes by default several activity packs, along with the following default process dependencies: UiPath.Excel.Activities, UiPath.Mail.Activities, UiPath.System.Activities and UiPath.UIAutomation.Activities.

There are a lot of activities, organized in categories, such as:

* App Integration
* Computer Vision
* Integrations
* Orchestrator
* Programming
* System
* UIAutomation
* UiPath
* User Events
* Workflow

The App Integration activities focus on handling different files, of different formats:

* Write CVS, Read CVS
* Excel Application Scope, Write Cell, Save Workbook, Close Workbook, Close Workbook, Write Range, Read Range
* Get POP3 Mail Message, Send SMTP Mail Message

AI Computer Vision eliminates the reliance on selectors, while still maintaining familiar workflows for RPA developers. With an increase in visible screen elements, more automations are possible. The AI Computer Vision pack contains refactored fundamental UIAutomation activities such as Click, Type Into, or Get Text. The main difference between the CV activities and their classic counterparts is their usage of the Computer Vision neural network developed in-house by our Machine Learning department. The neural network is able to identify UI elements such as buttons, text input fields, or check boxes without the use of selectors. Created mainly for automation in virtual desktop environments, such as Citrix machines, these activities bypass the issue of inexistent or unreliable selectors, as they send images of the window you are automating to the neural network, where it is analyzed and all UI elements are identified and labeled according to what they are. Smart anchors are used to pinpoint the exact location of the UI element you are interacting with, ensuring the action you intend to perform is successful.

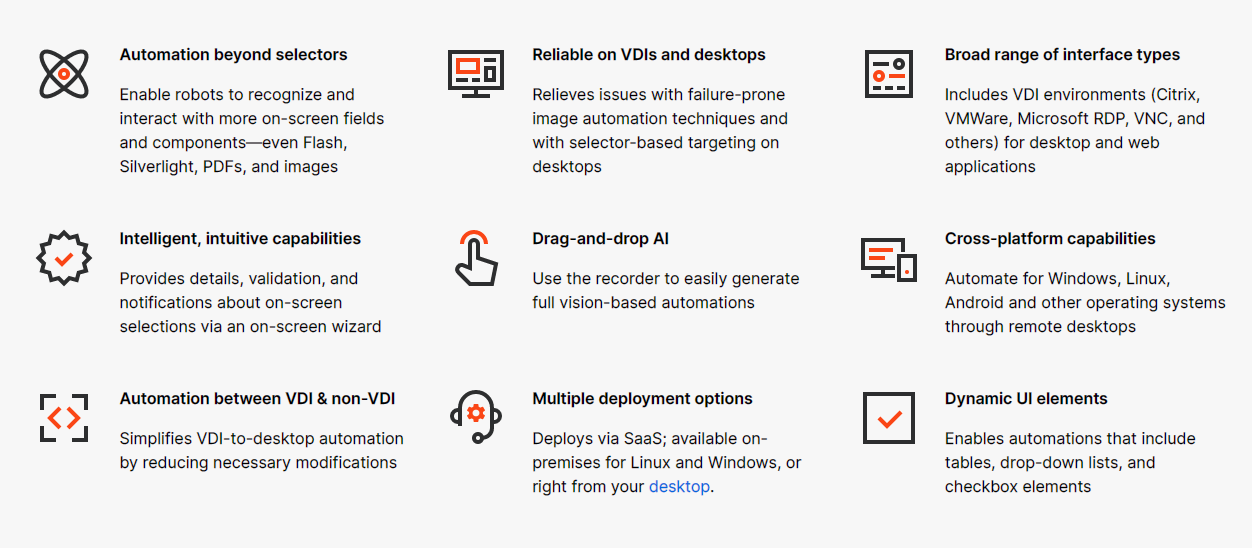


Figure 2.4 Characteristics of AI Computer Vision (source: (https://docs.uipath.com/))

Get Asset, Set Asset, Get Credential and Set Credential are activities in the Orchestrator category. Get Asset gets a specified Orchestrator asset by using a provided AssetName, while Get Credential gets a specified Orchestrator credential by using a provided AssetName, and returns a username and a secure password.

Among Programming activities most common are:

* Add Data Row, Remove Data Row, For Each Row, Get Row Item – concerning data table
* Comment, Comment Out, Log Message – debug related

In the System category there are multiple activities such as:

* Sequence, which enables the creation of linear processes comprised of many child activities
* Switch, which enables you to execute a single course of action out of multiple options, based on a preset condition
* Try Catch catches a specified exception type in a sequence or activity, and either displays an error notification or dismisses it and continues the execution
* Assign allocates any value to a variable or argument
* Delay waits for a specified amount of time before continuing the workflow
* If enables your project to take one of two different courses of action, depending on whether a specified condition is met.
* Close Application, Open Application, Start Process – application related
* Message Box, Input Dialog
* Wait for Download, Read Text File, Copy File, Create Folder – file related.

The blocks in the UIAutomation category are diverse and related to diverse topics:

* Attach Window and Close Window – window oriented
* Click Text, Get Full Text, Extract Structured Data, Get Visible Text – text related
* Navigate To, Close Tab, Attach Browser, Open Browser – browser related
* Click Image
* Image Exists
* On Element Appear
* Type Secure Text, Send Hotkey, Type Into
* Click
* Activate, Check, Get Text, Set Text, Select Multiple Items, Select Item, Element Exists, Find Element – element related

In the Workflow category there are multiple activities related to the flowchart and

control:

* Flowchart, Flow Decision
* Retry Scope, Repeat Number Of Times, For Each, While, Do While, Continue, Break
* Invoke Workflow File - synchronously invokes a specified workflow, optionally passing it a list of input arguments.

### Test Automation Best Practices

To make the most out of their testing efforts, the users should consider some test automation best practices, based on application testing:

* Test cases should be independent of each other. One test case should not depend on another test case’s run.
* A test case should have one specific purpose only. Each test workflow should contain only one verification.
* Every feature should have a unit test. If exceptions are allowed, a separate test for each test case should be created.
* In a Given-When-Then test case structure, if the Given part is getting too extensive and unmanagable, the test case should be redefined. It could need more granularity or refactoring.
* Test cases should be maintained and updated after any change request.
* Consider establishing a Test Management logic to have a single way of defining test cases.
* To increase reusability between individual test projects, as well as between test and RPA projects, [libraries and object repository](https://docs.uipath.com/studio/docs/about-libraries) should be used whenever possible.
* Include the tests in the CI/CD pipeline.
* Functional tests as part of the CI pipeline should be run as quickly as possible as to not delay the build. Therefore, these tests should be executed in parallel on as many robots as possible.
* Activity names should reflect the action taken. For non-obvious behaviors, using annotations on all activities should be considered.
* Consider using detailed logging and exception handling to debug the process and avoid false negative results.
* Plan for recovery or retry for errors at different stages to avoid failed results.
* Consider having a folder structure dedicated to testing and using the same test case naming convention across all projects.
* Use assets for variables that are likely to change and used many times.
* For scenarios where an application’s state must be validated before proceeding with certain steps in a process, consider applying validation measures. These measures can include using extra activities that wait for the desired application state before other interactions (hardcoded delays are not considered good practice).
* Consider using simulate click/ type or send windows messages, whenever possible.
* Test cases should not be deleted, moved or renamed outside of Studio. Perform these actions in Studio only. Use Import Test Cases in case there is a test cases from another project that should be referenced.

## Desktop Application

The desktop application is a simple C# and SQLServer user interface which performs basic CRUD operations using Windows Forms with buttons, different types of form controls and datagridviews.



### SQLServer Database

The SQL Server Database is called DBMovies and was created in Microsoft SQL

Server Management Studio version 18.12.

The purpose was to create a database in which information about a catalogue of films can be kept, showing how appreciated they were. Information includes movie titles, genre, actors, directors, etc.

-each actor can play in several movies and in one movie several actors can play;

-each director can direct several films, and one film can be directed by several directors.

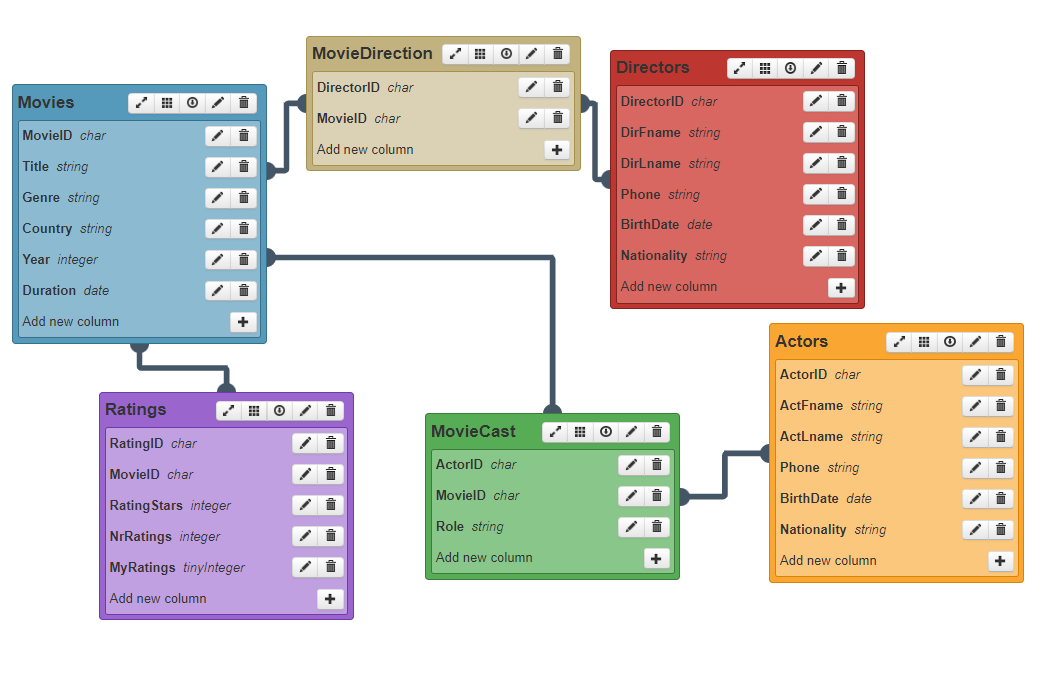


Figure 2.5 DBMovies Database Diagram

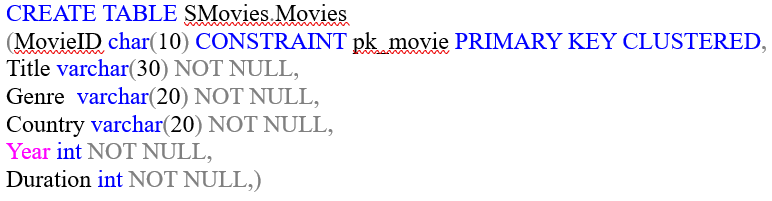
To build the database, first it needed to be created using the following command: 

To avoid using the default schema (dbo), a schema named SMovies was created:

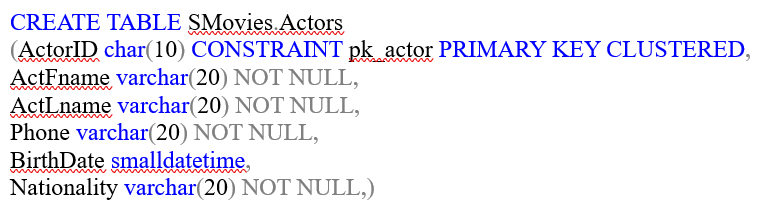


The database tables were created next:

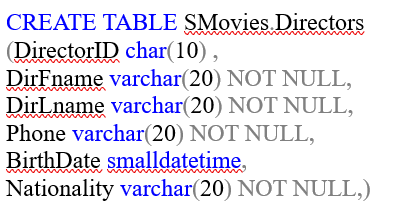
**Movies**:



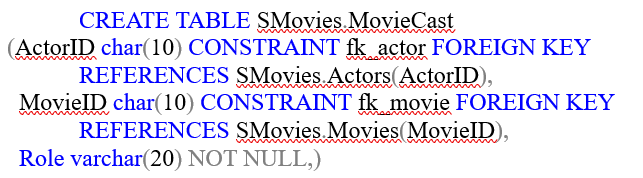
**Actors**:



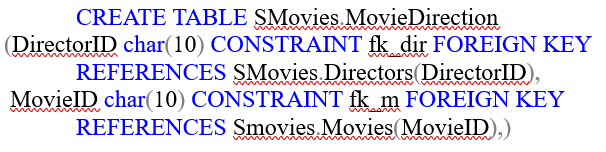
**Directors**:



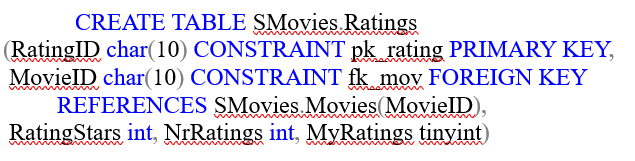
**MovieCast**:



**MovieDirection**:

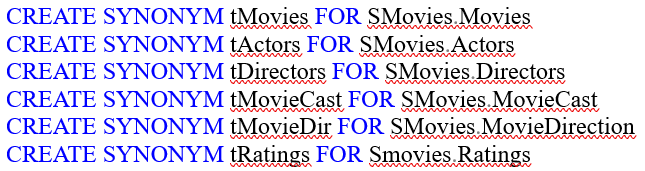


**Ratings**:



Then a series of constraints about some columns values that should not be NULL, DEFAULT values for some columns, like ‘USA’ as default value for Country or CHECK type constraint to limit the values for RatingStars between 1 and 10. For referential integrity, constraints for ON DELETE CASCADE and ON UPDATE CASCADE were added for tables MovieCast, MovieDirection and Ratings.

To be able to access tables easier, synonyms were created for each table:

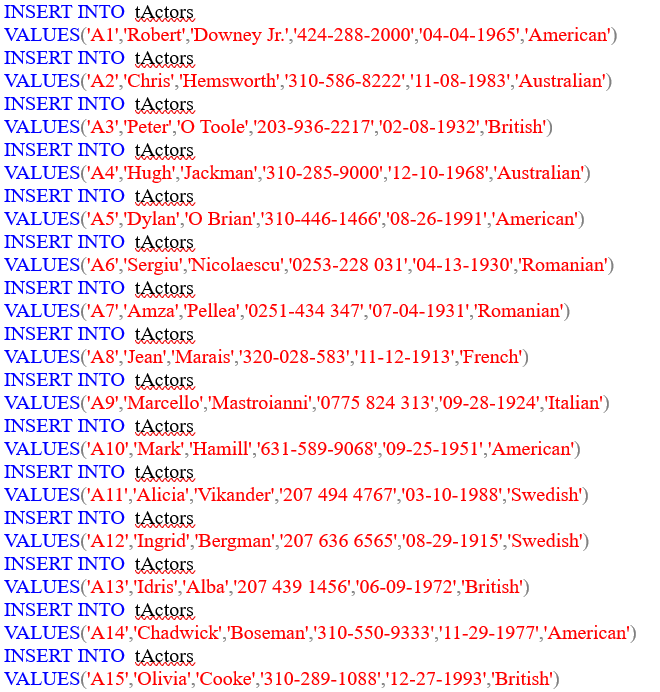


To insert new lines in a table or in a view the command INSERT was used for each table:

-in table Movies



-in table Actors



-in table Directors



-in table MovieCast

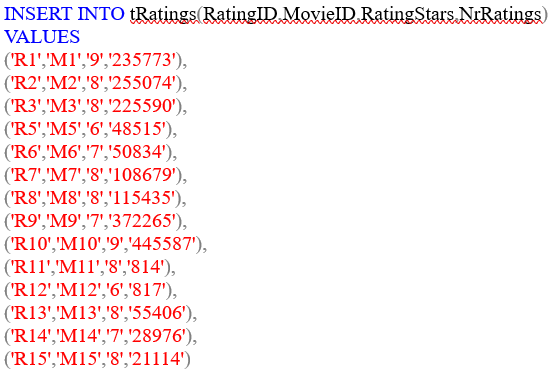


-in table MovieDirection





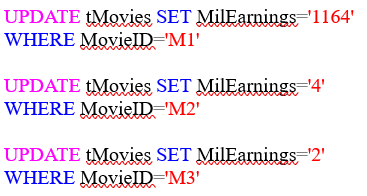
-in table Ratings



-- a column with earnings for each movie in table Movies



--rows were added in the MilEarnings column

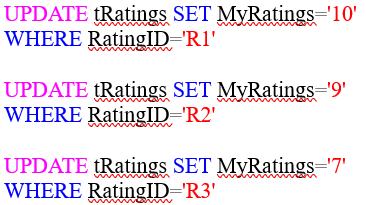


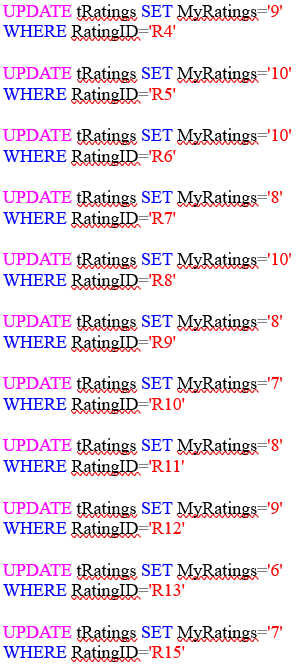


--create a new column in tRatings MyRatings

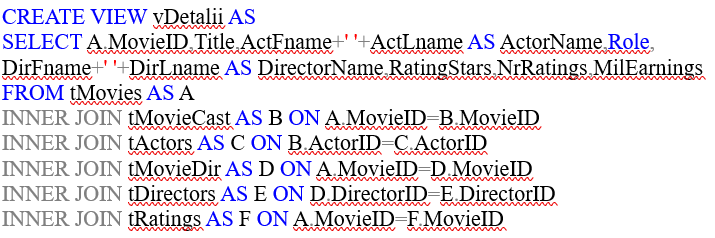


--added rows in column MyRatings





To display all the data in a more compact and detailed way, a view was created, selecting all the relevant columns:



### MovieBase Application

The MovieBase project is made up of multiple Windows Forms and the

right environment to ensure the application can connect to the DBMovies database, read and write data from/to the mentioned database. The MovieBase Application was developed in Microsoft Visual Studio Professional 2017, version 15.9.49, using C# programming language and an SQLServer Data Connection.

### The Application’s Visual Studio Project

The project has a class called Program.cs and six Windows Forms which display the list of Movies, Actors and Directors, also forms for CRUD operations for the Movies section.

In the Program.cs file there are a couple of classes (Program and Global), which contain multiple static variables declared and the ConnectionString, obtained from the properties of the created DataConnection in the Server Explorer section of the project. Also, here is where the main form is set.

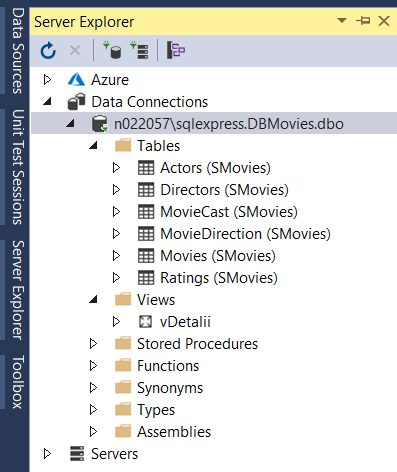
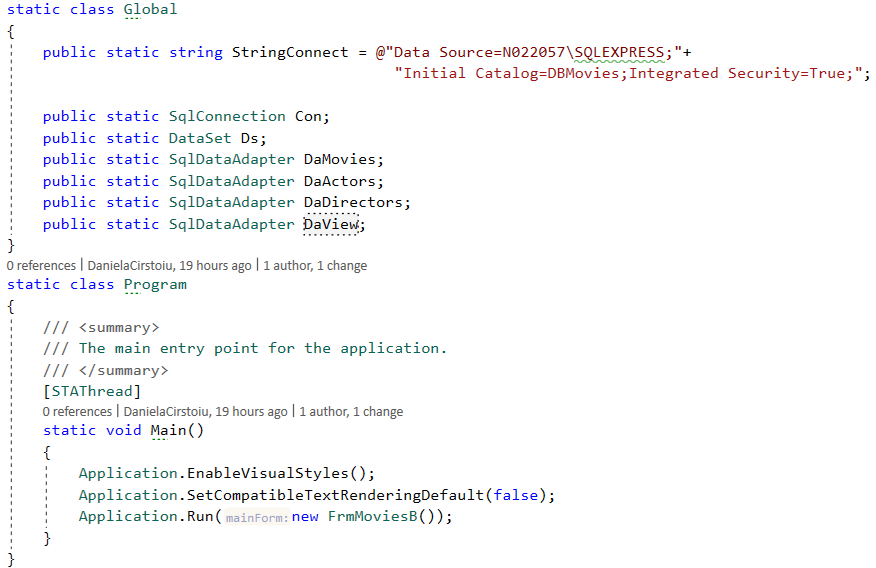


Figure 2.6 Server Explorer

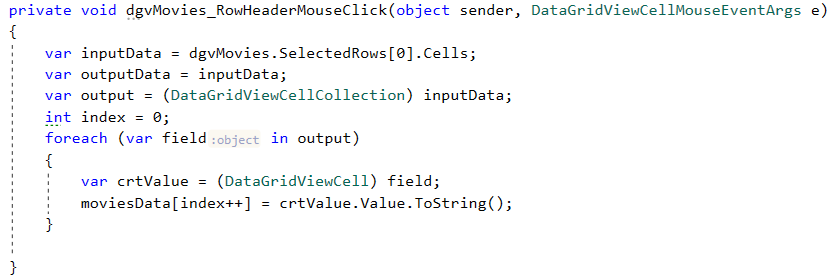


In the main Windows Form prerequisites are set for loading with success data from the database tables. An SQL connection is initialized, then opened, a new DataSet is created also, data from the tables is selected with the help of a new SQLDataAdapter, introduced in the DataSet and then the connection is closed.



From this main form each the other forms are opened also, through a Click event.

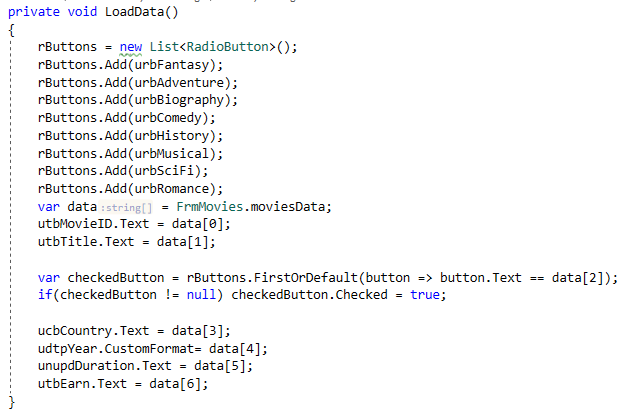
In the next class (FrmMovies) the loading of the data in the Data Grid Views is done, the instructions for opening the forms to add and update movies and the code to be executed when the RowHeaderMouseClick event is fired. Also the logic behind removing the selected row from the DataSet and DataGridView.



In the FrmAddMovies a DataTable is used and a new DataRow defined and then filled with the values from the elements on the form using an SQLCommand with an insert string. The table is updated and then the changes are accepted by the DataAdapter.



In the FrmUpdateMovies.cs class the data of the row selected in the previous form is loaded in the text boxes and other elements from the current form.



The update for the selected item is done through an SQLCommand, using an Update Command with parameters. The table and DataSet are then updated and the changes are accepted.



### The Application’s User Interface

The application’s starting window is the MovieBase main page. There are three buttons : Movies, Actors and Directors and each of them open a page to view the mentioned data tables.

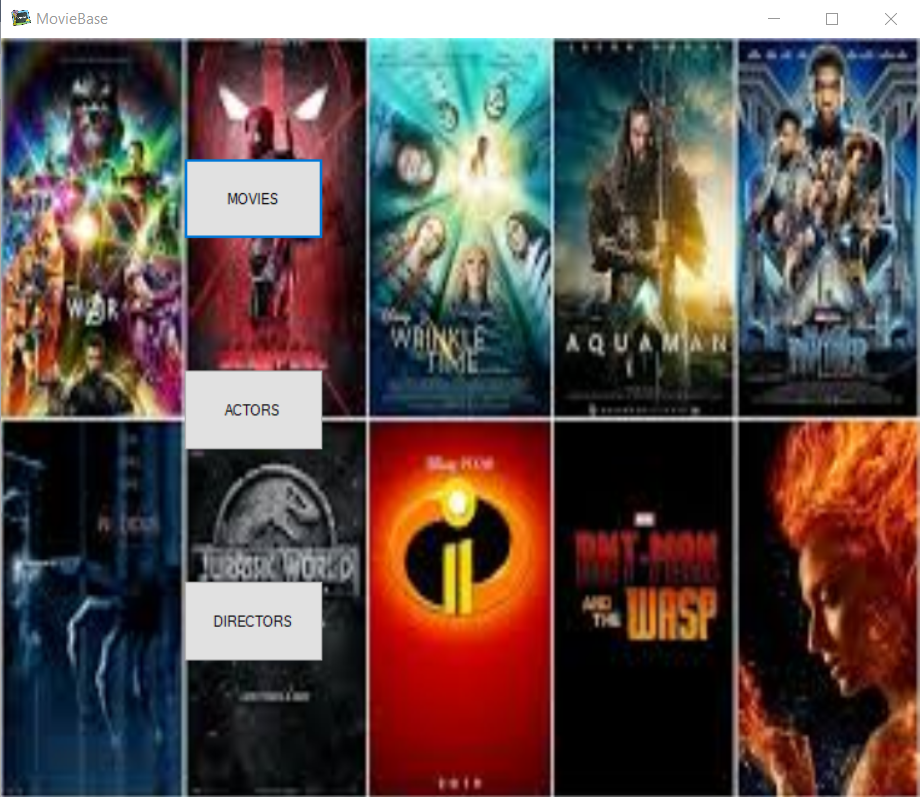


Figure 2.7 Main Window: MovieBase

MovieBase/Actors:

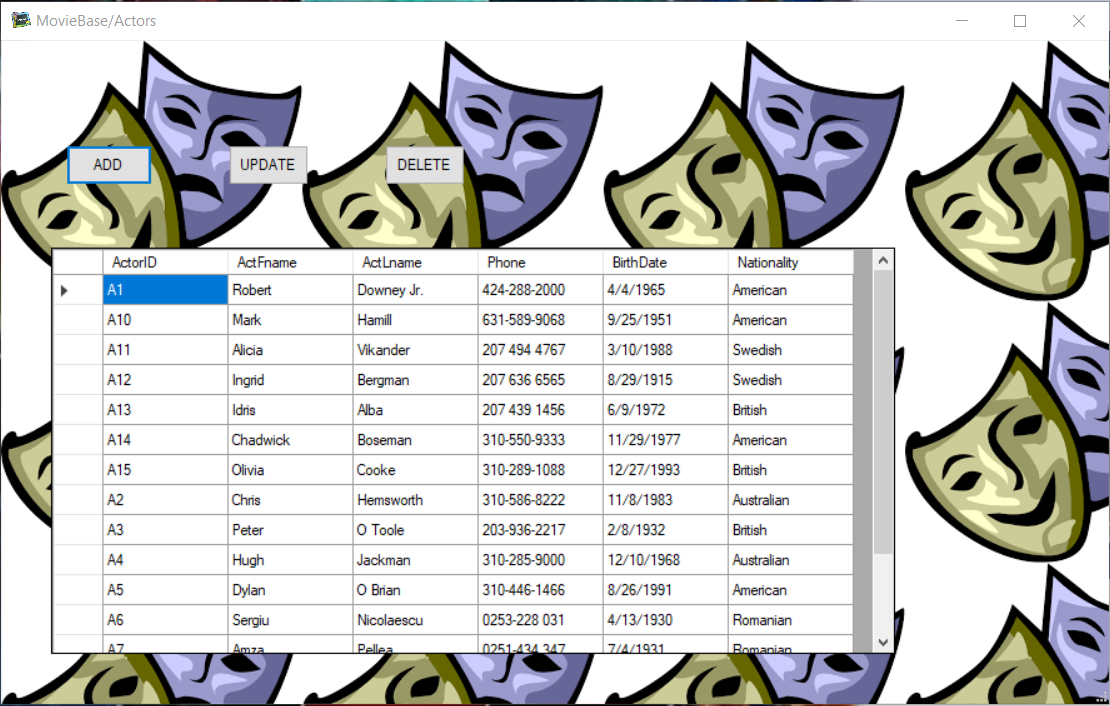


Figure 2.8 Actors Window

MovieBase/Directors:



Figure 2.9 Directors Window

MoviesBase/Movies:



Figure 2..0 Movies Window

The MoviesBase/Movies form has a couple of DataGridViews, in the first there are all the columns and rows of the Movies table displayed and in the second one the values from the database view which was created to contain each movie details with their actors, the movie role for that actor and directors that worked on it.

The Add and Update buttons on the form open each a form to be able to add a new movies or modify a selected one, whereas the Delete button just deletes the selected row.

MovieBase/AddNewMovie

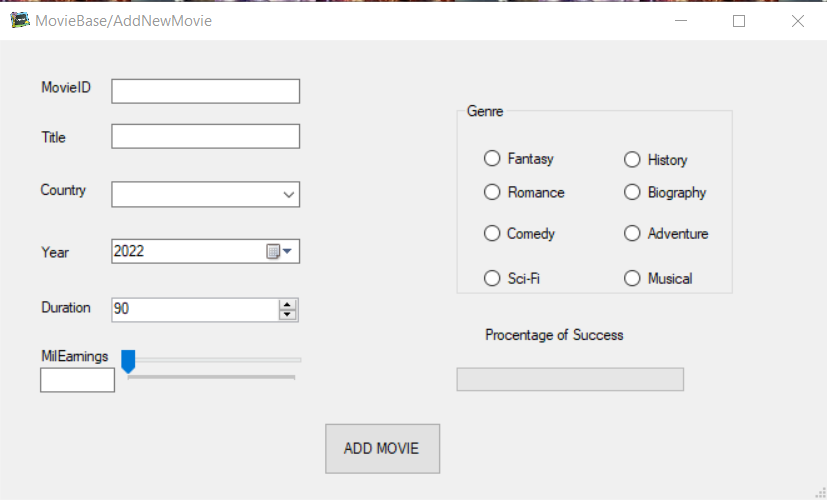


Figure ..11 Add Movie Window

MovieBase/UpdateMovie:

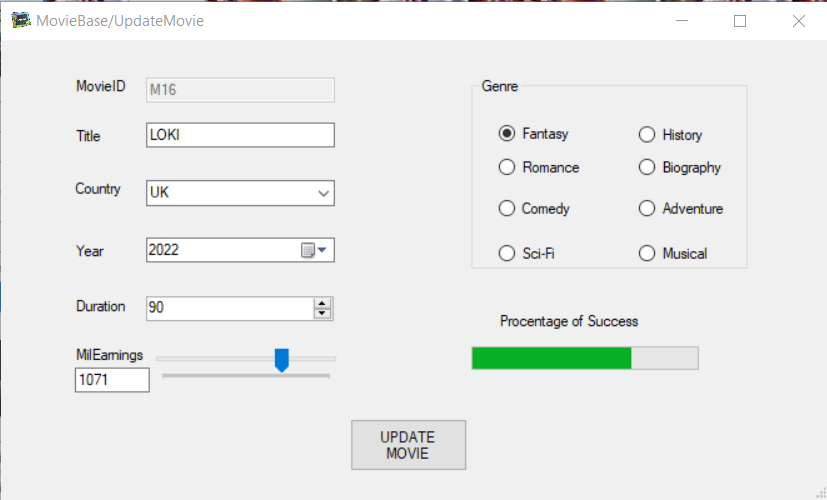


Figure 2.12 Update Movie Window

# **CHAPTER 3. Automation Testing with UiPath Studio**



## Test Automation Movies Project Overview

With UiPath Studio, implementing desktop automation across a wide variety of UIs is quick and easy. Application testing requires working with large data sets to verify workflow execution and cover corner cases. Through data-driven testing, you can run the same test using different data variations within a single test case.

The UiPath application is called Test Automation Movies Project and the programming language behind the blocks contained is Visual Basic.

The project has Attended Automation and the Modern Design Experience enabled. Computer Vision, OCR, UI Automation Classic, UI Automation Modern, Testing and System Activities are also available.

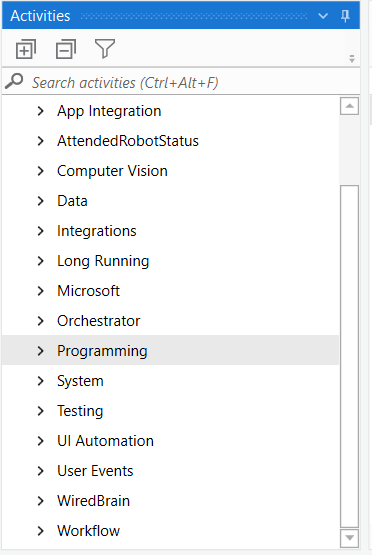


Figure 3.. Available Categories for Activities in Test Automation Movies Project

The project’s structure and available activities can change very easily by installing or uninstalling different packages, depending on what activities we need to use. For my project I installed (together with the packages that were already preinstalled when starting a new project- inherited from Windows-Legacy) a series of packages: Microsoft.Activities.Extension, Microsoft.Activities.UnitTesting, Microsoft.Form.Activities, Microsoft.Persistence.Activities, Microsoft.System.Activities, Microsoft.Tableau.Activities, Microsoft.Testing.Activities, Microsoft.Terminal.Activities,UiPath.UIAutomation.Activities, UiPathTeam.AttendedRobotStatus.Activities, WiredBrain.Datatable.common.

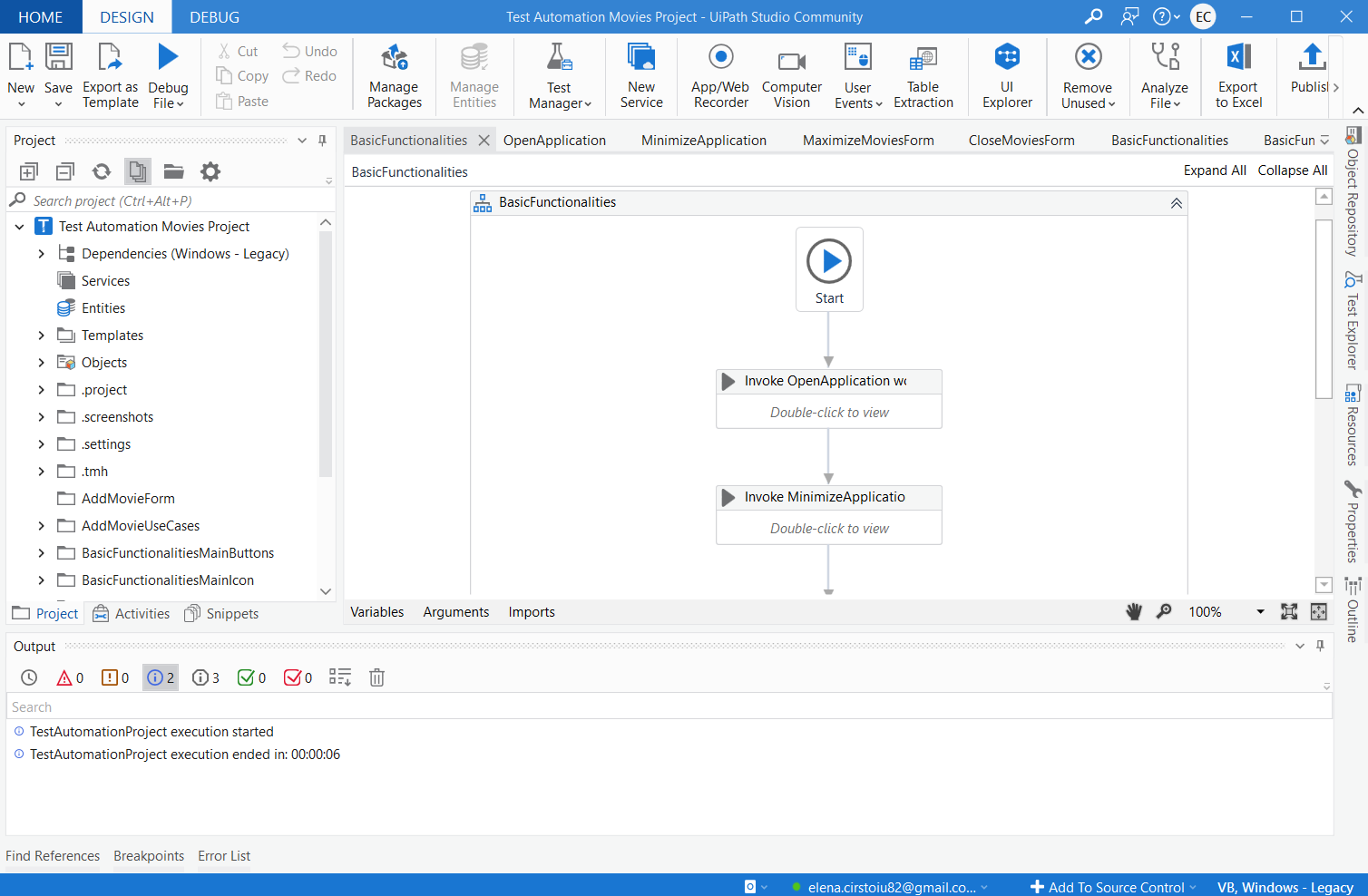
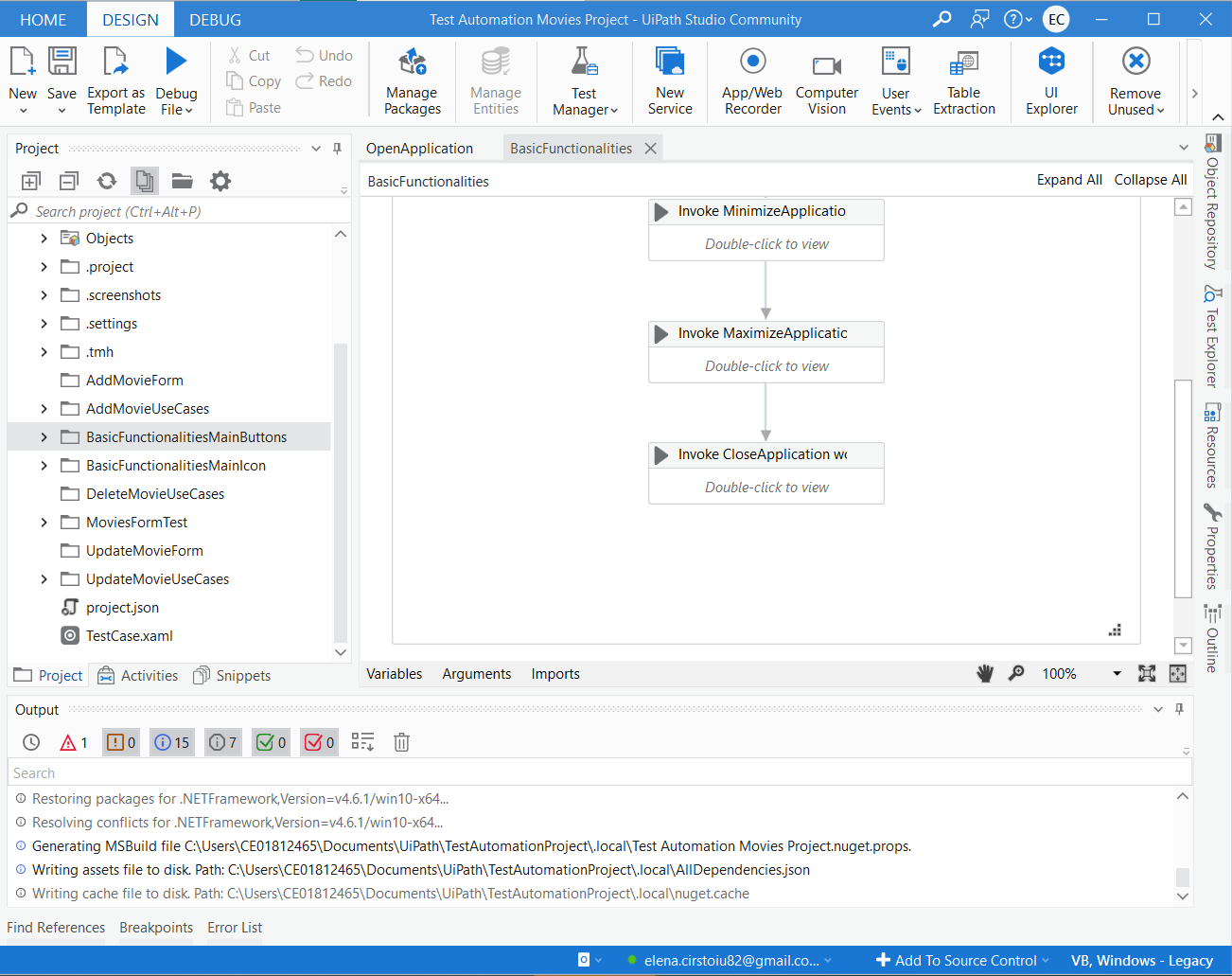


Figure 3.. Overview of the Test Automation Movies Project-1

In the project, the different test cases are organized in different folders, each of them having a certain specificity. For example, in the folder BasicFunctionalitiesMainButtons there are tests which open the application, close it, minimize it or maximize it. Because these actions are very common throughout the project, the Flowchart containing them, called BasicFunctionalities.xaml is also exported as a Template, which can be modified in different ways, depending on the window for which the above mentioned actions are performed.



*Figure 3.0.3 Overview of the Test Automation Movies Project-2*

Aside from testing basic functionalities of each window of the MovieBase Application, there are also a multitude of use cases which need to be tested, for both Add Movie and Update Movie sections.

Some of the use cases I approached are: adding a standard movie with preset parameters, checking the existence of values in the fields of the adding window, check if the same movie can be added twice, updating a movie when one of the fields is changed, a different one every time, check if the removal of one of the movies is done with success and so on.

## Test Automation Implementation

In this UiPath application I aim to develop a testing plan as complete as possible, while trying to highlight all the functionalities and features of the MovieBase desktop application.

Creating a testing checklist is an integral part of the process of writing test cases. Some of the scenarios of such testing checklist include: Graphical User Interface Testing, Functional Testing, Platform Compatibility Testing, Performance Testing.

Testing of the user interface (called a GUI when it’s graphics based vs. a simple text interface) is called GUI testing and allows testing the functionality from a user’s perspective.

The purpose of Graphical User Interface (GUI) Testing is to ensure the functionalities of software application work as per specifications by checking screens and controls like menus, buttons, icons, etc. Sometimes the internal functions of the system work correctly but the user interface does not let a user perform the actions. Other types of testing would miss this failure, so GUI testing is good to have in addition to the other types.

In the BasicFunctionalitiesMainButtons there are four workflows: OpenApplication.xaml, MinimizeApplication.xaml, MaximizeApplication.xaml and CloseApplication.xaml, which are all contained in the Flowchart BasicFunctionalities.xaml, in blocks of type Invoke.

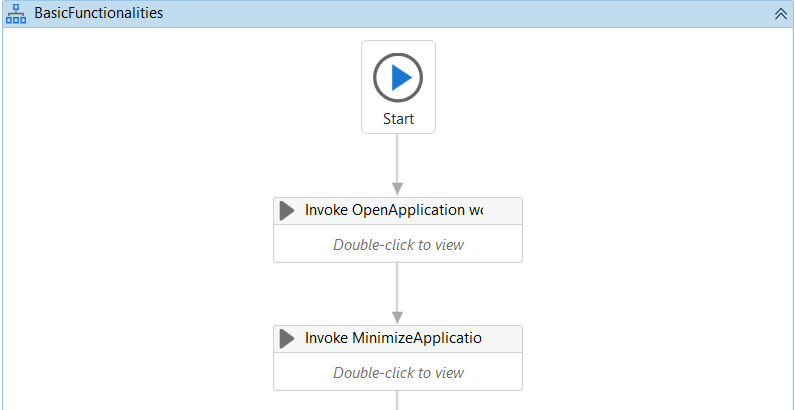
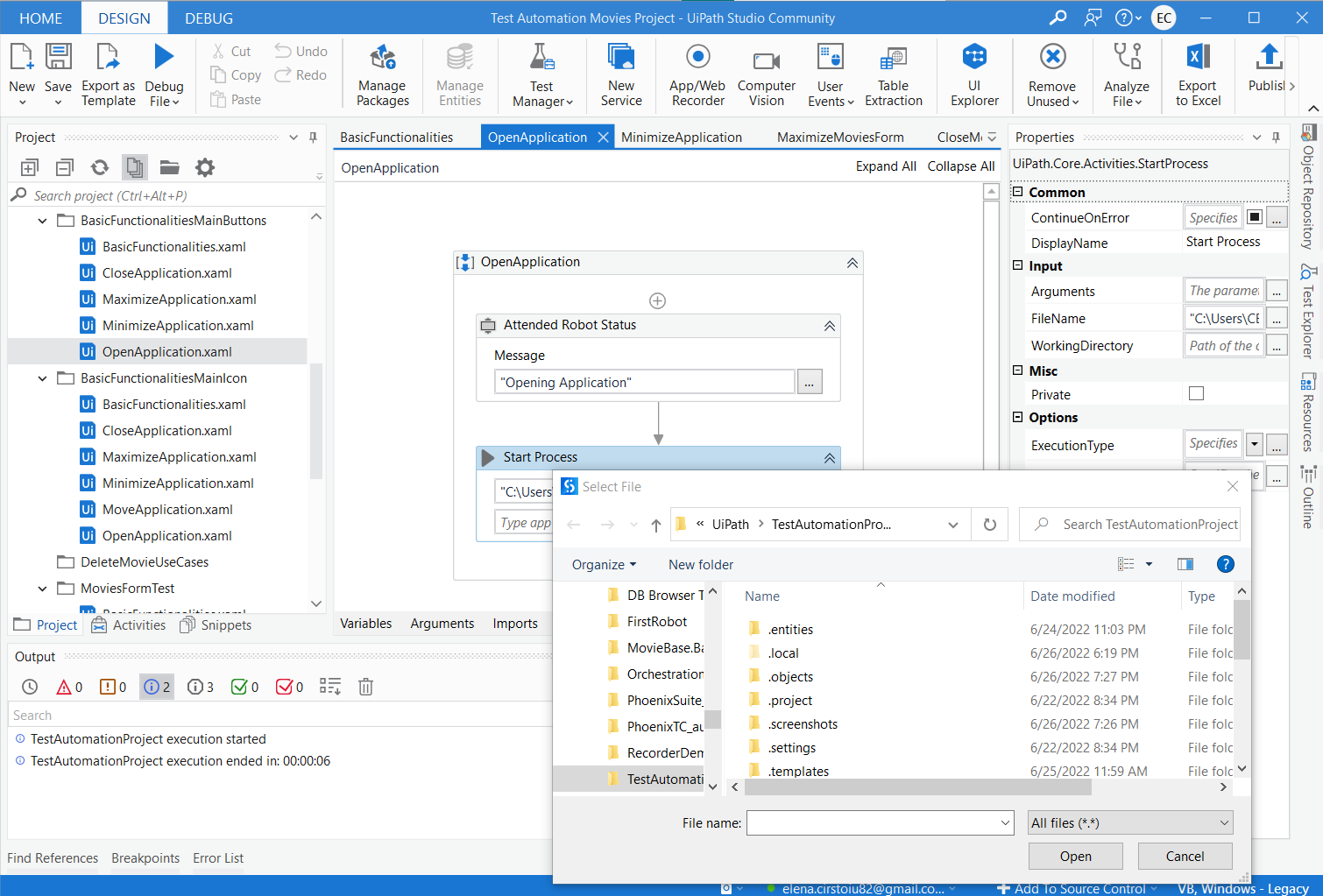


Figure 3.. BasicFunctionalities.xaml Flowchart

In OpenApplication.xml there are two blocks: the first is an Attended Robot Status, which displays a colorful message in the down right corner of the screen and the StartProcess block, which reads a string containing the path of the application that needs to be opened. The block allows also browsing to find the right location.

*Figure 3.0.5 OpenApplication.xaml*

To access easier the sequence of actions in a certain window a Modern activity called UseApplication/Browser was added. The activity opens the desktop application so it can be used in UIAutomation. After the activity was added in the workflow and the application was targeted, a Click activity was used also, to press on the minimize button.

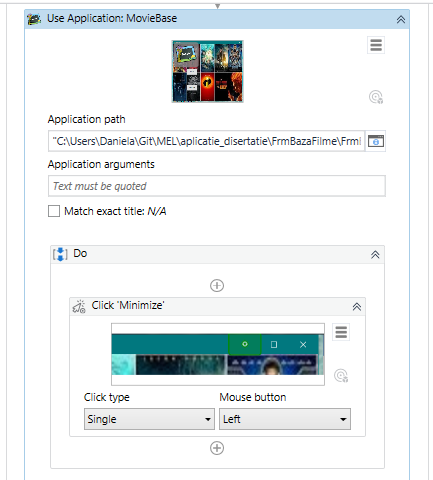


Figure 3.. Use Application/Browser to minimize the window

Another set of the same functionalities can be accessed when pressing on the application’s icon, but to use them, an extra step must be done. The activity Move Window can resize and move any window to a specific location and/or resize it to a specific dimension.

The parameters for resizing and moving can be modified from the Properties panel.

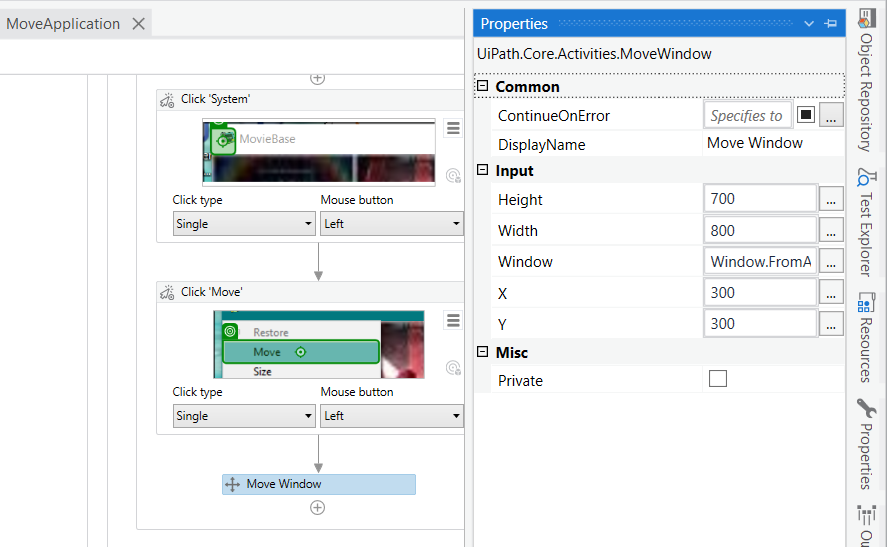


Figure 3.. Move Window Activity

Besides testing how the windows of the application behave when trying to minimize, maximize, move or close them, there are other type of tests that can be done also.

The Movies Form has a couple of DataGridViews which contain data from the Movies tables, respectively from the vDetalii View.

In the testing application there are multiple tests which select successively each row and column from the DataGridViews, making sure they can be accessed without any delay or error.

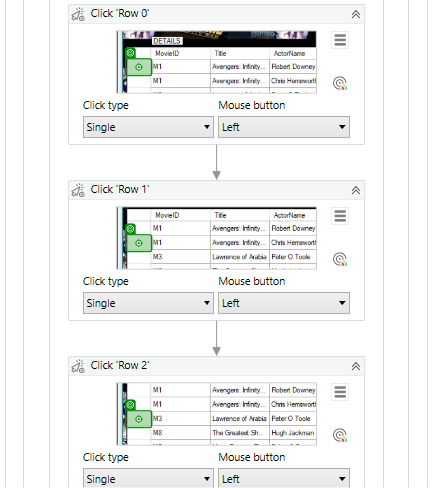


Figure 3.. MoviesFormViewSelectRows.xaml - partial snipping

For the above mentioned sequence the Object Repository was used to capture all elements on the page using recorder, so they can be easily used and inserted using drag and drop.

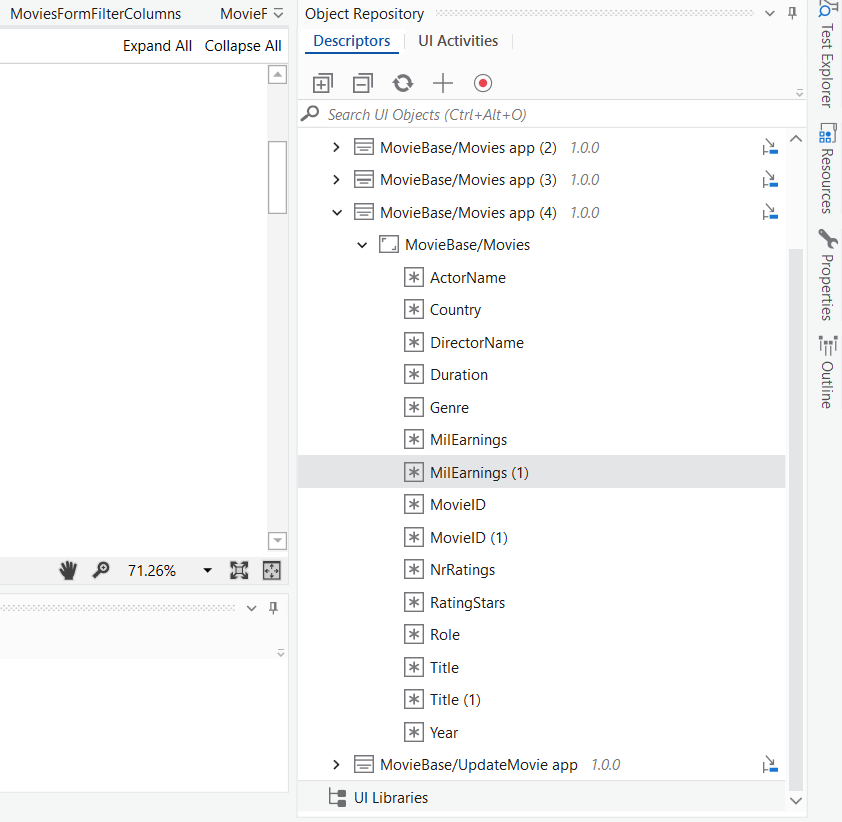


Figure 3.. Object Repository Descriptors for the Rows in DataGridViews

For the selection of columns/filtering was proceeded in the same way, using Object Repository and descriptors as result of capturing the columns from DataGridView.

One of the scenarios for testing the AddMovie window is testing the add movie process. To check if a standard movie will be added with success, a sequence was created to introduce the parameters in the fields of the window.

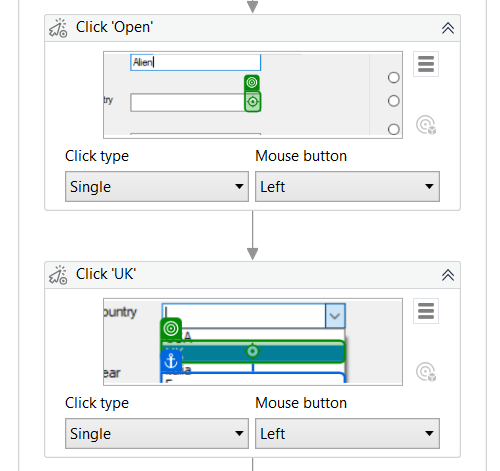


Figure . Open Dropdown and choose UK

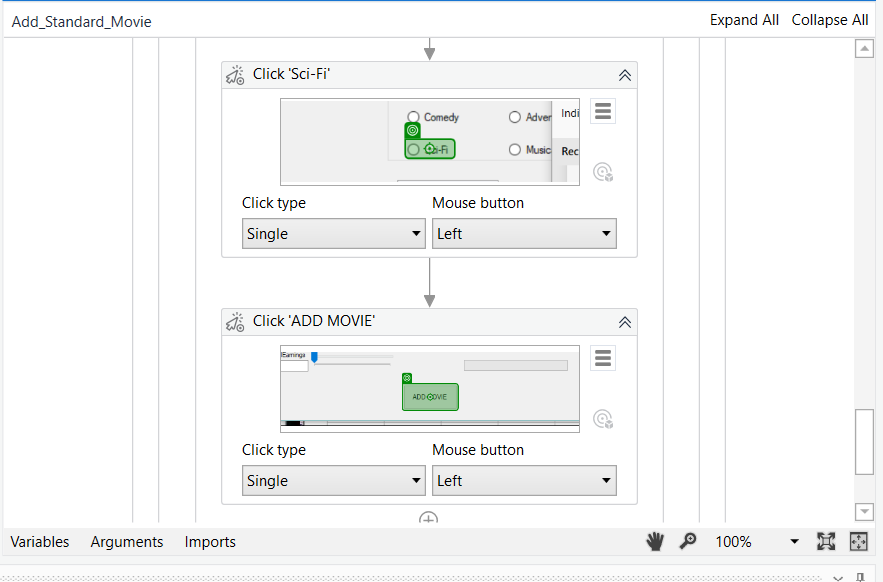


Figure . Check radio button Sci-Fi and press ADD MOVIE button

To check how the application behaves when values for the fields in the window are not provided, validation was used straight from the UiPath Studio project with the help of blocks like Verify Control Attribute. For the same purpose also Verify Expression and Verify Expression with Operator.

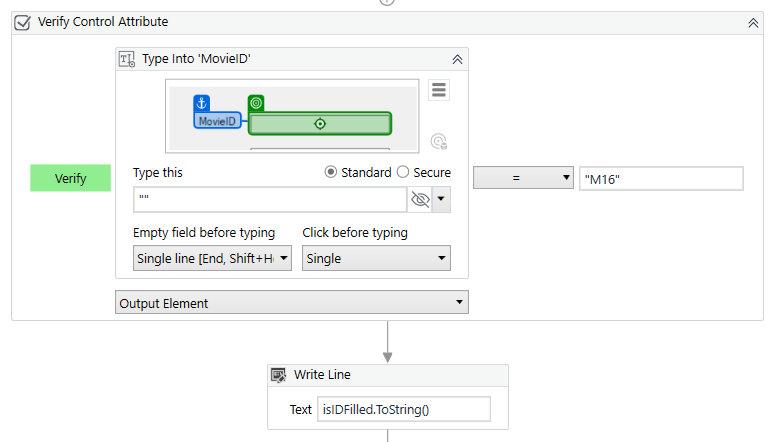


Figure . Verify Control Attribute block

When the test runs a message appears saying the Validation Failed and the value expected was not the one provided.

Another test created was to check the behavior of the application on the attempt to add a duplicate movie . An exception appeared and it was handled by displaying a message to let the user know the movie wanted was already added.

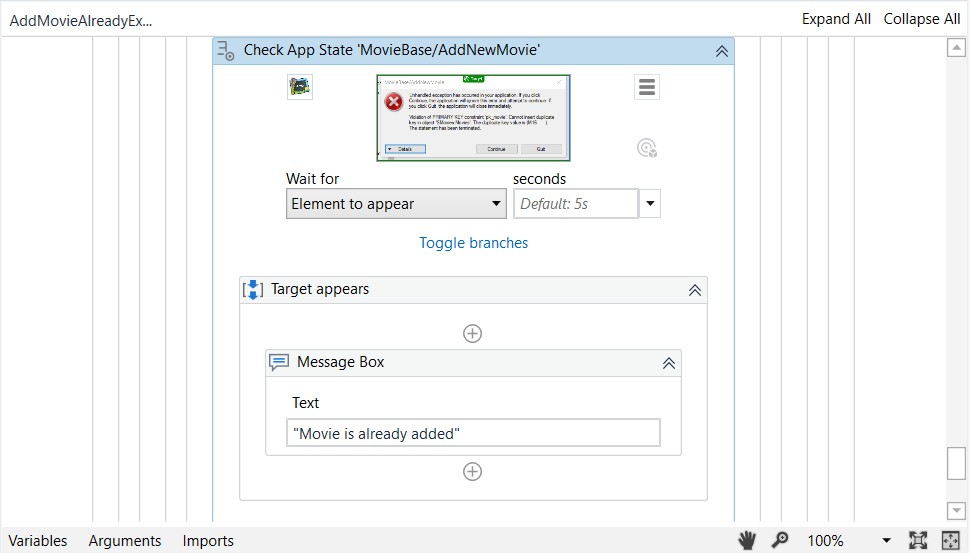


Figure . Error handling on adding duplicate movie

For the Update Movie section, tests were created in which the update is attempted with a different value each time, then with empty fields instead of values for the existing fields.

To test the complete removal of a selected movie, another test was needed.

# **CONCLUSIONS**

# **Bibliography**

1. Website: NextProcess | AP Automation, Purchasing, Capital Project, and Payment Software <https://www.nextprocess.com/blog/top-10-reasons-using-robotic-process-automation-data-entry-right-choice-business>
2. Website: Automation Platform - Leading RPA Company | UiPath <https://www.uipath.com/>
3. Website: UiPath Studio documentation <https://docs.uipath.com/studio/docs/introduction>

# **LIST OF FIGURES AND TABLES**

[Figure 2.1 UiPath Products (Source: (https://www.uipath.com)) 23](#_Toc107252616)

[Figure 2.2 UiPath Characteristics (Source: (https://docs.uipath.com/)) 28](#_Toc107252617)

[Figure 2.3 Overview of UiPath Studio(Source (https://docs.uipath.com/) ) 29](#_Toc107252618)

[Figure 2.4 Characteristics of AI Computer Vision (source: (https://docs.uipath.com/)) 34](#_Toc107252619)

[Figure 2.5 DBMovies Database Diagram 37](#_Toc107252620)

[Figure 2.6 Server Explorer 45](#_Toc107252621)

[Figure 2.7 Main Window: MovieBase 49](#_Toc107252622)

[Figure 2.8 Actors Window 50](#_Toc107252623)

[Figure 2.9 Directors Window 50](#_Toc107252624)

[Figure 2.0.10 Movies Window 51](#_Toc107252625)

[Figure 0.2.11 Add Movie Window 52](#_Toc107252626)

[Figure 2.12 Update Movie Window 52](#_Toc107252627)

[Figure 3.0.1 Available Categories for Activities in Test Automation Movies Project 53](#_Toc107252628)

[Figure 3.0.2 Overview of the Test Automation Movies Project-1 54](#_Toc107252629)

[Figure 3.0.4 BasicFunctionalities.xaml Flowchart 56](#_Toc107252630)

[Figure 3.0.5 OpenApplication.xaml 56](#_Toc107252631)

[Figure 3.0.6 Use Application/Browser to minimize the window 57](#_Toc107252632)

[Figure 3.0.7 Move Window Activity 58](#_Toc107252633)

[Figure 3.8 MoviesFormViewSelectRows.xaml - partial snipping 58](#_Toc107252634)

1. ROI is the figure for return on investment [↑](#footnote-ref-2)