

PhD end of Year 1 Probation report

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1 Project overview

Microservices are gaining more and more popularity as an architectural style for building modern applications. Unlike monolithic applications, microservices are loosely coupled components, that can be deployed and maintained independently and developed using different technologies. They do introduce a number of benefits including accelerating innovation given the speed at which applications can be built and new services taken to market. Agility in terms of how easily microservices can be modified, say for instance to adapt to a change in the market. Scale as microservices as cloud appears to be the preferred platform for deploying microservices, and one of the values that cloud computing does provide is elasticity and scale, and last but not least security. With microservices it is possible to provide fine-grain security access control by giving access to users to only part of the application that they need to access. This is the opposite to monolithic applications that tend to follow an egg-shell approach to security where most the security control is done at the perimeter and if passed that level of security and non-authorized used could get pretty much anywhere within the application.

While the value of microservices has already been demonstrated through a number of publications, there is a debate on whether or not microservices are a totally different concept or just an evolution of web services. There are similarities between microservices and web services that feed that debate even further. For instance, both technologies use similar communication protocols RESTful communications. That being said there is still a significant gap in terms of how these technologies are advertised, published, discovered and composed. Web services typically use protocol like UDDI (Universal Description Discovery and Integration) to advertise web services in a registry also known as UDDI registry or WSDL to describe the web service interface. Once web services are published in a registry with their properties, they can be discovered automatically by any consumer. And with the discovery feature it makes the composition of web services relatively easy. A number of technologies for web services that are available today such as Oracle BPEL protocol. Microservices in the contrary do not yet have a central registry or repository where they could be defined and published nor there exists a mechanism for microservices discovery or composition. Microservices classification, automated discovery and composition into applications is the gap that this research is trying to fill.

2 Research questions

RQ1: Ho to classify microservices? The popularity and the number of microservices that are available today call for the need for a taxonomy to help classify microservices based on common sets of attributes. This research question will help understand what semantics, characteristics or dimensions that relate or separate microservices thereby enabling their classification.

RQ2: How could such classification enable the discovery of microservices? If we are able to identify semantics and characteristics by which microservices could be classified or grouped in families of microservices then we need to look into those characteristics could be fed into a discovery mechanism to automate the discovery of microservices.

RQ3: To what extent is the composition of microservices could be automated based on their discovery? Having found a way of automating the discovery microservices, we need to look at how microservices composition could be the trigger for the discovery process.

RQ4: How do we translate end users' requirements into composed microservices-based applications? How can we enable users to feed their requirements in plain English into the microservices composition framework and get a composed application as an output?

3 Why are the research questions interesting?

I believe the selected research and the questions that it aims to answer will help fill a knowledge gap that exists today around microservices. Having the ability to classify, discover and compose microservices would be valuable at industry level as it would reduce efforts wasted in trying to build microservices that already exist thereby reducing development time and costs. The outcome of this research will also lay the foundation for defining standards by which microservices should adhere, though outside the scope of this project it may be a good opportunity to further this research. Last but not least, these research questions are a very interesting challenge for me and will give me the opportunity to acquire significant knowledge in an area of interest namely microservices.

4 How it will be done?

The project requires an extensive review of existing literature on service composition. Similar work has been done already on Web services which would be a good leverage for this project. One of the steps that needs to be done prior to the composition of microservices taking place is their classification. Part of this project will be focused on devising a taxonomy for classifying microservices. This will require a thorough examination of their attributes or artefacts both functional and non-functional. Once we have a taxonomy in place, the step would be to build a registry which microservices can use to advertise their capabilities, and a discovery engine that will discover microservices based on specific capabilities provided as requirements by a user. After the matching services have been discovered, the microservices composition can execute to produce a composed application that fulfil the user requirements. Figure 1 and 2 below depict the different stages of the project.

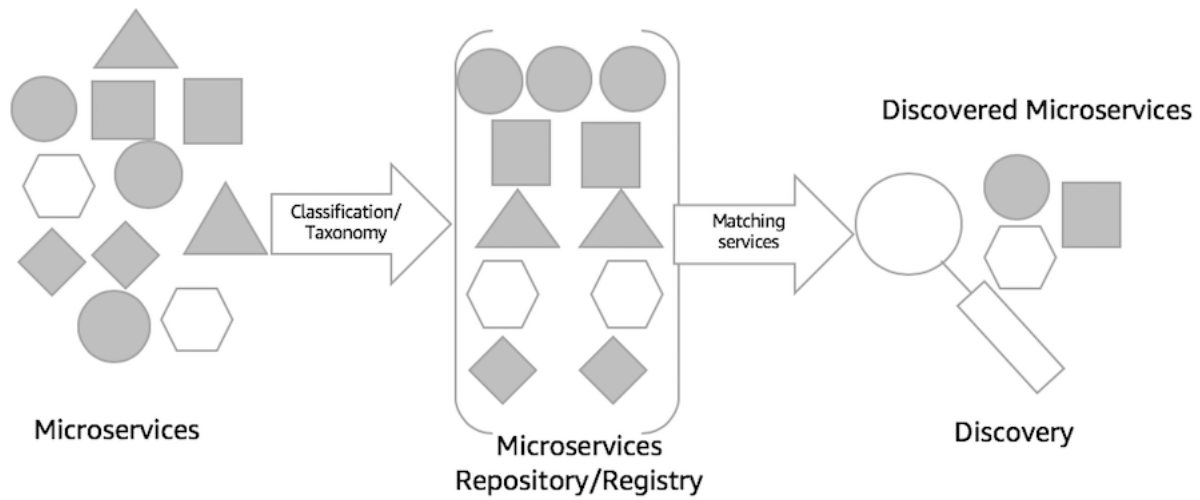


Figure 1 – Microservices classification, repository and discovery

Figure 1: Microservices classification.

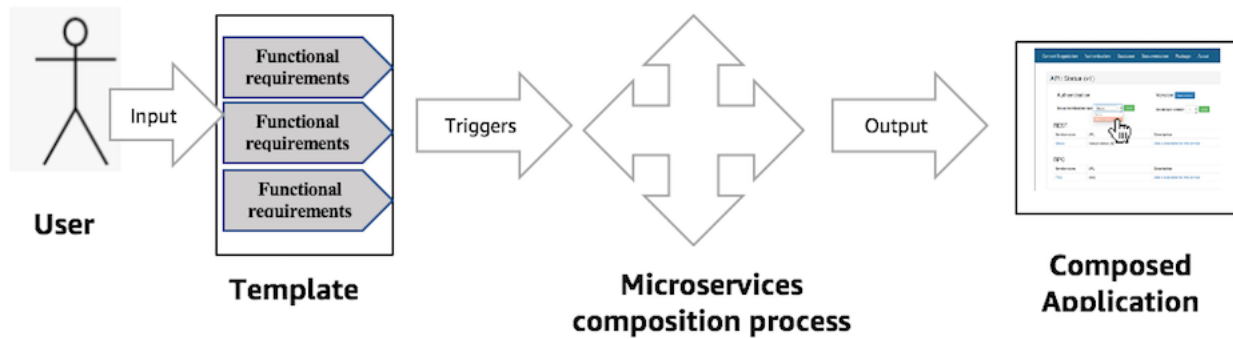


Figure 2 – Microservices composition phase

Figure 2: Microservices composition.

5 Project work packages

The project will be broken down into the following work packages:

1. **Classification**

The classification process will help with identification and grouping of microservices based on common properties. This will require identifying the right semantics and producing a taxonomy to enable the classification process.

2. **Repository and Registry**

In order to enable the discovery of microservices there would need to be stored into some type of repository with their attributes saved into some sort of registry, which the discovery engine can query to retrieve those microservices that meet the query criteria.

3. **Discovery module**

The discovery module as its name implies will serve the purpose of discovering microservices prior to their composition into the desired application taking place. The discovered microservices will be persisted into a buffer or temporary storage before being processed

4. **User input module**

In order for user to obtain a specific functionality powered by a specific service or set services, he or she will be required to provide a number of specifications in plain English as input. This process may be guided that is a user is restricted to specific type of inputs (e.g. an input form with specified attributes that need to be filled or menu selections), or completely open meaning user have the freedom to type any text they want to express their requirements and the model will interpret their inputs to produce the needed functionality in the form of coordinated microservices. The decision to use a guided or open approach for user inputs will depend on the complexity and the feasibility of one over the other within the scope of this project which means that one approach may constitute an opportunity for further research.

5. **Execution module**

This module is the component that is responsible for the execution of composition of the discovered microservices and ultimately produce the composed application, which is expected to fulfill the user's requirements.

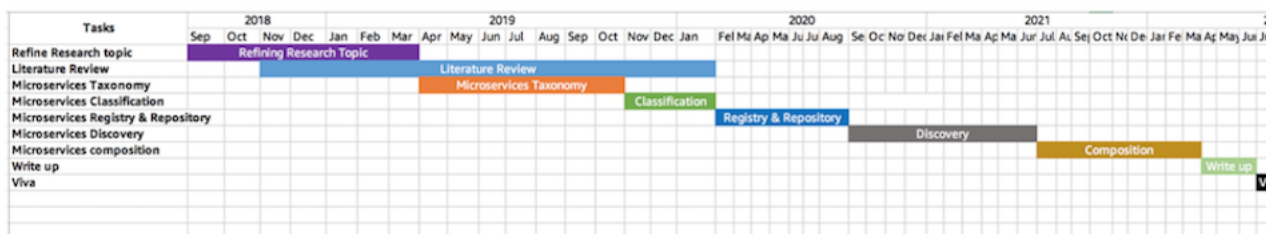


Figure 3: Research project plan

6 Project Plan

7 Progress report

Table 1 below shows a report of the progress made on the research, while table 2 shows a list of trainings & seminars that I have attended so far, and lastly table 3 contains all the meetings I have had with my supervisors.

Activity	Status	Comment
Literature review – Part 1	Completed (See appendix)	
Taxonomy & classification of microservices paper	In progress (See appendix)	Currently refining the methodology
Microservices repository and registry	Not started	
Microservices discovery	Not started	
User input module	Not started	
Microservices composition	Not started	

Training	Date
Research Integrity (Training)	Completed on 5th Aug. 2019
Neuroscience-inspired artificial intelligence: a case study of the retina (Seminar)	Attended on 5th Oct. 2018
Failing with Style: Why and How we Should Encourage Humans to Fail with Highly Capable Systems (Seminar)	Attended on 12th Oct. 2018
Digital processes: correctness, compliance and adoption considerations (Seminar)	Attended on 19th Oct. 2018
Generating C from Scala	Attended on 26th Oct. 2018
Logical characterization of hybrid conformance (Seminar)	Attended on 15th Nov. 2018
A New Linear Logic for Deadlock-Free Session Typed Processes (Seminar)	Attended on 23rd Nov. 2018
Detection under UAV with Convolutional Neural Network (Seminar)	Attended on 18th Dec. 2018
Developing the Graph-based Methods for Optimizing Job Scheduling on Multicore Computers (Seminar)	Attended on 18th Jan. 2019
On Reversibility and Continuous Integration (Seminar)	Attended on 25th Jan. 2019
AR Experience Capturing and Sharing (Seminar)	Attended on 7th Feb. 2019
Synthesis to Rational Synthesis: a Game-Theoretic Approach (Seminar)	Attended on 29th Mar. 2019
Multi-objective search for effective testing of Cyber-Physical Systems (Seminar)	Attended on 16th Sep. 2019

Table 2: Trainings & Seminars

Date	Participants	Meeting details
5th Oct. 2018	Georges – Jose & Mohammad	Kick off meeting to discuss research idea. Supervisors felt that we needed to refine the research idea and scope the project properly. Jose & Mohammad encouraged me to attend the seminars
16th Oct. 2018	Georges – Jose & Mohammad	Discussed the revised project outline. Mohammed & Jose recommended breaking the project down into work packages. Jose recommended that I setup a slack channel, and GitHub repo for better collaboration. Jose also introduced me to LaTeX, and encouraged me to learn and use it.
16th Nov. 2018	Georges – Jose & Mohammad	Reviewed draft proposal and supervisors provided guidance on how to refine the idea to make it relevant for PhD research
3rd Dec. 2018	Georges – Jose & Mohammad	Talked about the idea of putting together a survey to get input from functional experts in a target industry on how they utilize microservices and if and how the outcome of my research could help address challenges around building microservices based applications which could be automated by means of service composition
20th Dec. 2018	Georges – Mohammad	Mohammad provided guidance on which information to look for when discussing with subject matter experts and recommended doing some reading on how to conduct a survey.
25th Jan. 2019	Georges – Jose & Mohammad	Discussed the possible options going forward given the challenges I faced gathering details information on specific industry (pending a discussion I was going to have with a colleague on Amazon Serverless Application Repository module). One option being to focus on a specific industry where information on microservices would be accessible. The other one being to define a research problem only relevant in academia.
15th Feb. 2019	Georges – Jose & Mohammad	Looked at how service composition using Amazon SAR worked for a single microservices. Supervisors advised to manually compose two or more microservices to get a better understanding of what is involved in the process and potential challenges before looking at automating the process which should constitute one work package of the research. Also advised to review existing literature on Service orchestration, Service choreography, Service composition, etc.
25th March 2019	Georges – Jose & Mohammad	Discussed existing service composition methods. Jose found an interesting paper on Medley framework for service composition which he recommended that I read.
15th April 2019	Georges – Jose & Mohammad	Jose & Mohammed recommended looking into the taxonomy of microservices suggesting it might even be an opportunity to publish
2nd May 2019	Georges – Jose & Mohammad	We discussed the structure of the taxonomy paper. Mohammad advised to look at how to identify a finer classification of webservices and microservices. Have you encountered any characteristics of webservices and microservices (and their composition)?, that may be used to classify them further into some subclasses?
7th May 2019	Georges – Jose & Mohammad	Mohammad, and Jose provided feedback on my proposed structure for writing the taxonomy paper, and areas to focus on
14th May 2019	Georges – Jose & Mohammad	Supervisors recommended reading other taxonomy papers to get a better understanding on how taxonomies are written
17th May 2019	Georges – Jose & Mohammad	Mohammad recommended a number of journals for searching for good taxonomy papers. Some journals you could search in: IEEE, Transactions on Software Engineering, ACM, Transactions on Software Engineering and Methods, ACM, Computing Surveys, and Empirical, Software Engineering. Please, do search in these journals.
6th June 2019	Georges – Mohammed	Reviewed new version of the taxonomy paper and provided feedback. Supervisors insisted on clearly outlining the research questions, use a rigorous methodology which should lead to, results credible results
13th Aug. 2019	Georges – Jose & Mohammed	Reviewed new version of the taxonomy document and provided feedback. Areas to improve: Methodology
16th Aug. 2019	Georges – Jose & Mohammed	Reviewed new version of the taxonomy document and provided feedback. Areas to improve: Methodology
24th Aug. 2019	Georges – Jose & Mohammed	Reviewed new version of the taxonomy document and provided feedback
2nd Sept. 2019	Georges & Jose	Jose recommended that I should make my explanations a bit more rigorous, thinking of how I can be more convincing, that my taxonomy is generalizable; 2. Try to bring up a few points on the applicability of the taxonomy and how someone who reads my work could use it, to identify microservices (maybe conjecture about how this could be automated, to help in automated composition - which would connect to the larger idea of my work)
5th Sept. 2019	Georges & Mohammad	Mohammad recommended that I provided more clarity on the search strategy. More specifically, he stressed that I should remove the search for the related papers as it did not help answer the research questions. He said he noted some improvements but insisted on improving the methodology.
16th Sept. 2019	Georges & Jose	I shared with Jose my intent to try the option of using information retrieval/Latent Semantic Indexing (LSI)/code search which I read in some papers. Jose recommended doing a POC first to make sure that it works before using as methodology in the taxonomy paper. We also discussed the Probation report and Jose requested that I prepared the report and sent it to him so we could aim for the report meeting to take place by end September.

Table 3: Supervisors' meetings