Djob Mvondo
Associate Professor

Personal Data

Place and Date of Birth:	Cameroun | 31 March 1998 | 23 years
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Email:	barbe-thystere.mvondodjob@univ-rennes1.fr
Website:	djobiii2078.github.io
Research Team:	IRISA, Team Wide
	University of Rennes 1, France
Research Interests:	♦ Operating System
	♦ Virtualization
	♦ Cloud Computing
	♦ Distributed fault tolerance
	♦ Security

Education

Sep 2021 - Now

Associate Professor in Computer Science at the **University of Rennes 1**, France
Member of the WIDE team of the IRISA lab. My main interest concerns performance and security in virtualized infrastructures.

Dec 2020 - Dec 2021

Postdoc in Computer Science at the **University of Edinburgh**, Scotland
Member of the ICSA team of the School of Informatics, I work with Antonio Barbalace on scheduling in virtualized systems. Our main goal is to provide pseudo-formal models to better understand and design adequate schedulers to improve throughput and reduce I/O latencies.

Mar 2018-Dec 2020

Ph.D. in Computer Science at the **University of Grenoble Alpes**, France
Affiliation : LIG (Laboratoire d'Informatique de Grenoble)
Title : *Resilience and sizing in virtualized environments*
Defended on the 18th December 2020, with the jury composed of:

M.	Pascal	Felber	President of jury/Reviewer	Switzerland
M.	Willy	Zwanepoel	Reviewer	Australia
M.	Marc	Shapiro	Examiner	France
M.	Renaud	Lachaize	Examiner	France
M.	Alain	Tchana	Co-supervisor	France
M.	Noël De	Palma	Supervisor	France
M.	Daniel	Hagimont	Guest	France

Sep 2011-Sep 2017

Master II in Computer Science, Cameroon
Received at the **National Advanced School of Engineering**, Yaoundé, Cameroon
Advisors: Prof. Daniel Hagimont, Prof. Alain Tchana, and Ass. Prof Boris Teabe
Defended on the 08th September 2017.

Aug 2011

G.C.E Advanced Level at Yaoundé, Cameroun
Received at **Pi and Ju International Anglo-saxon College**.

My research overview

I try to do relevant systems research. My main goal is to improve (or redesigning) virtualized systems. Regarding the latter intent, since my internship, I work at improving resource sizing and fault tolerance of components in a virtualized infrastructure. Most of my work resulted in hacks in standart open-source operating systems kernels such as Linux and FreeBSD, and standart virtualization systems such as Xen and KVM. These tweaked systems are open-sourced and available to the research community at djobiii2078.github.io/#experience. The work achieved till now has been published in several conferences and workshops, including four (6) major international conferences in the system field. I present a brief summary of 5 publications. My current work is in the previous ones' continuity, improving and building effective virtualized systems for both IaaS, PaaS, SaaS, and FaaS.

Publications and scientific production

In the System field, it is much more difficult to get a paper accepted in an outstanding conference than in an outstanding journal. Hence, conferences are most selective than journals (see https://homes.cs.washington.edu/~mernst/advice/conferences-vs-journals.html).

Therefore, my research are mainly published in conferences. For the conference rankings, I used the 2021 Australian Ranking (http://portal.core.edu.au/conf-ranks/) which ranks conferences and journals with A*, A, B and C.

International Publications

Djob.x **Tell me when you are sleepy and what may wake you up!**
Djob Mvondo, Antonio Barbalace, Alain Tchana, Gilles Muller
To appear in SOCC'21
In this paper, we provide evidence of the two level schedulers in virtualized infrastrctures and discuss several research questions. We propose several solutions worth exploring that consists in revisiting hypervisor and host OS scheduler designs to reduce the CPU time wasted on idle units. Our proposal leverages the concepts of informed scheduling, and monitoring for internal and external events. Based on the aforementioned solutions, we propose our initial implementation on Linux/KVM.

Djob.1 **Extending Intel PML for Hardware-Assisted Working Set Size Estimation of VMs**
Stella Bitchebe, **Djob Mvondo**, Alain Tchana, Laurent Réveillère, Noel De Palma
To appear in proceeding of the ACM SIGPLAN/SIGOPS International Conference on Virtual Execution Environments 2021
VEE 2021 - Rank A

We perform a study of PML (Page Modifcation Logging), a feature proposed by Intel to improve virtual machines checkpointing and live migration. Based on our findings, we introduce page reference logging (PRL), an extended version of PML that allows both read and write memory accesses to be tracked without impacting user VMs, thus more suitable for WSS estimation. We propose a WSS estimation system that leverages PRL and show how it can be used in a data center exploiting memory overcommitment. We validate our contribution using the Gem5 hardware simulator.

Djob.2 **OFC: an opportunistic free caching system for FaaS platforms**
Djob Mvondo, Mathieu Bacou, Kevin Nguetchouang, Lucien Ngale, Stephane Pouget, Josiane Kouam, Renaud Lachaize, Jinho Hwang, Tim Wood, Daniel Hagimont, Noel De Palma, Batchakui Bernabé, Alain Tchana
To appear in proceedings of European Conference on Computer Systems 2021
EUROSYS 2021 - Rank A

Code source: https://gitlab.com/lenapster/faascache/

Due to FaaS (Function As A Service) stateless nature, FaaS applications must frequently interact with an external data store, which limits their performance. To mitigate this issue, we introduce OFC, a transparent, vertically and horizontally elastic in-memory caching system for FaaS platforms, distributed over the worker nodes. OFC provides these benefits cost-effectively by exploiting two common sources of resource waste: (i) most cloud tenants overprovision the memory resources reserved for their functions because their memory footprint is non-trivially input-dependent and (ii) FaaS providers keep function sandboxes alive for several minutes to avoid cold starts. We validate our contribution using Apache OpenWhisk as FaaS system, OpenStackSwift as storage system, and RAMCloud as in-memory cache.

Djob.3 **Fine-Grained Fault Tolerance For Resilient Virtual Machine Monitors**
Djob Mvondo, Alain Tchana, Renaud Lachaize, Daniel Hagimont, Noel De Palma
In proceedings of IEEE/IFIP International Conference on Dependable Systems and Networks
DSN 2020 - Rank A
DOI: 10.1109/DSN48063.2020.00037
Code source: https://github.com/r-vmm/R-VMM

We highlight that a core component (privileged virtual machine — pVM) in mainstream hypervisors is the least robust component and that the existing fault-tolerance approaches provide limited resilience guarantees or prohibitive overheads. We present three design principles (disaggregation, specialization, and pro-activity), as well as optimized implementation techniques for building a resilient pVM without sacrificing end-user application performance. We validate our contribution on the mainstream Xen platform.

Djob.4 **Closer: A new design principle for the privileged virtual machine OS**
Djob Mvondo, Boris Teabe, Alain Tchana, Daniel Hagimont, Noel De Palma
In proceedings of IEEE International Symposium on Modeling, Analysis, and Simulation of Computer and Telecommunication Systems
MASCOTS 2019 - Rank A
DOI: 10.1109/MASCOTS.2019.00016

We presents Closer, a principle for designing a suitable OS for the pVM. Closer consists in respectively scheduling and allocating pVM's tasks and memory as close to the involved client VM as possible. By revisiting Linux and Xen hypervisor, we present a functioning implementation of Closer. The evaluation results of our implementation show that Closer outperforms standard implementations.

Djob.5 **Memory flipping: a threat to NUMA virtual machines in the Cloud**
Djob Mvondo, Boris Teabe, Alain Tchana, Daniel Hagimont, Noel De Palma
In proceedings of IEEE International Conference on Computer Communications
INFOCOM 2019 - Rank A*
DOI: 10.1109/INFOCOM.2019.8737548
Code source: https://github.com/djobiii2078/i-flipping

Memory flipping is a memory page exchange mecanism between the hypervisor and a virtual machine (VM) during emission/reception of network packets. On NUMA architectures, the latter mecanism has a huge impact on the location of memory pages on NUMA nodes (that become distant). We propose a page relocation mecanism that prevents performance degradation due to memory flipping.

Djob.6 **When eXtended Para - Virtualization (XPV) Meets NUMA**
Vo Quoc Bao Bui, **Djob Mvondo**, Boris Teabe, Kevin Jiokeng, Patrick Lavoisier Wapet,

Alain Tchana, Gaël Thomas, Daniel Hagimont, Gilles Muller, Noel De Palma
In proceedings of European Conference on Computer Systems
Eurosys 2019 - Rank A
DOI: 10.1145/3302424.3303960
Code source: https://github.com/bvqbao/numaVirtualization

We presents eXtended Para-Virtualization (XPV), a new principle to efficiently virtualize a NUMA architecture. XPV consists in revisiting the interface between the hypervisor and the guest OS, and between the guest OS and system runtime libraries (SRL) so that they can dynamically take into account NUMA topology changes. We present a methodology for systematically adapting legacy hypervisors, OSes, and SRLs.

NATIONAL PUBLICATIONS

Djob.7 **FaaSCache: Système de Cache mémoire opportuniste et sans surcoût**
Kevin Nguetchouang, Lucien Ngale, Stephane Pouget, **Djob Mvondo**, Mathieu Bacou, Renaud Lachaize
Journées Cloud 2020

Djob.8 **Memory Flipping: How NUMA affects virtual machines ?**
Djob Mvondo, Boris Teabe, Daniel Hagimont, Noel De Palma
COMPAS 2018

Djob.9 **SGX Performance Improvement Using A Smart Function Colocation Algorithm**
Eric Mugnier, **Barbe Thystère Mvondo Djob** and Alain Tchana
COMPAS 2019

Djob.10 **Hardware Assisted Virtual Machine Page Tracking**
Stella Bitchebe, **Djob Mvondo**, Alain Tchana, Laurent Réveillère, Noel De Palma
COMPAS 2019

POSTERS

♦ **Type I vs Type II hypervisors. Let's End this !**
Djob Mvondo, Alain Tchana, Noël De Palma.
GDR RSD 2020

♦ **Hardware Assisted Virtual Machine Page Tracking**
Stella Bitchebe, **Djob Mvondo**, Alain Tchana, Laurent Réveillère, Noel De Palma
Compas 2019

♦ **When eXtended Para-Virtualization (XPV) Meets NUMA**
Bao Bui, **Djob Mvondo**, Boris Teabe, Kevin Jiokeng, Lavoisier Wapet, Alain Tchana, Gaël Thomas, Daniel Hagimont, Gilles Muller, Noel DePalma
Eurosys 2019

♦ **Memory Flipping: How NUMA affects virtual machines ?**
Djob Mvondo, Boris Teabe, Daniel Hagimont, Noel De Palma
Compas 2018

Publications summary

Conference type	Rank A/A* (CORE)	Total
International Conferences	6	7
National Conferences	-	4
Total	**6**	**11**

Mentoring Activity

♦ **Xing Tong**, Ph.D. student at University of Edinburgh, Scotland, UK.
Currently Tong's TECHNICAL SUPERVISOR.
Period: Jan 2021 - Now
Title: Enhancing popcorn linux

The focus of Tong's work is to improve the popcorn Linux compiler to introduce RDMA functionalities. To this end, we also use the RISC-V simulator to emulate a disaggregated environment where we can have preliminary observations that will drive the project's progress.

♦ **Hu Zhenhao**, Master Student at the University of Edinburgh, Scotland, UK.
Currently Hu Zhenhao SUPERVISOR during his Master Internship at the ICSA laboratory of the School of Informatics, Scotland, UK.
Period: Jan 2021 - June 2021
Title: SpeedyStart: Exploiting cloud environments to speed cloud tenants VM boot.

Zhenhao's work consists of analyzing VM boot sequences to find a way to speed the boot time of VMs in Cloud environments. Our main idea is to reuse boot steps performed by previous VMs. We also explore the limitations of naive techniques such as save/restore. We aim to produce a new boot protocol to plug into AWS EC2, Google Cloud, and Azure Cloud.

♦ **Lucien Arnaud**, Master Student at Polytechnic Yaounde, Cameroon.
TECHNICAL SUPERVISOR during his Master Internship (Mar-Sep 2020) at LIP, ENS Lyon, France.
Period : March-September 2020
Title : ESTIMATION DES BESOINS EN RESSOURCES DES FAAS AU TRAVERS DE L'APPRENTISSAGE AUTOMATIQUE : CAS DE LA PLATEFORME FAAS APACHE OPENWHISK

Arnaud's work mainly focused on producing ML models to predict the memory usage of function in FaaS systems. We explore different function processing types, text, image, and video. In the end, we produced J48 models (using weka) and achieved up to 99% accuracy. This work was part of our accepted publication at EuroSys'21 `[Djob.2]`*.*

Arnaud is currently a Ph.D. student at the University of Picardie Jules Vernes, France.

♦ **Kevin Nguetchouang**, Master Student at Polytechnic Yaounde, Cameroon. TECHNICAL SUPERVISOR during his Master Internship (Mar-Sep 2020) at LIP, ENS Lyon, France.
Period : March-September 2020
Title : IMPLÉMENTATION DU STOCKAGE MÉMOIRE POUR LES ENVIRONNEMENTS FAAS. CAS D'OPENWHISK.

Nguetchouang's work focused on profiling function execution times on FaaS systems such as Amazon Lambda. We used 5 image processing (in Python) and 5 video processing functions in JavaScript. We profiled execution times under different inputs locality situations. The result of this profiling provided an estimation of the potential improvement of a local cache system. This work was part of our accepted publication at EuroSys'21 `[Djob.2]`*.*

Nguetchouang is currently a Ph.D. student at ENS Lyon, France.

♦ **Kouam Djuigne Josiane**, Master Student at Polytechnic Yaounde, Cameroon.
TECHNICAL SUPERVISOR during her Master Internship (May-Sep 2019) at I3S, Nice, France.
Period : March-September 2019
Title : IMPLÉMENTATION D'UN SYSTÈME DE STOCKAGE IN-MEMORY POUR LES SERVERLESS

Josiane's work focused on proposing a prototype of an in-memory cache system for FaaS systems. We built a prototype using Apache Openwhisk as the FaaS system, Redis, Open-StackSwift, and RAMCloud (in-memory cache system). We bypassed some limitations due to the size of data blocks to be cached. This work was the starting point of our accepted publication at EuroSys'21 `[Djob.2]`.

Josiane is currently a Ph.D. student at Inria, Paris-Saclay, France.

♦ **Stella Bitchebe**, Master Student at Polytechnic Yaounde, Cameroun.
TECHNICAL SUPERVISOR during her Master Internship (Mar-Sep 2018) at IRIT, Toulouse, France.
Period : March-September 2018
Title: TECHNIQUE D'ESTIMATION DU WORKING SET BASÉE SUR LE PML (PAGE MODIFICATION LOGGING)

Bitchebe's work focused on evaluating the PML feature in recent Intel processors. We mainly focused on power usage and VM's working set size estimation accuracy. This work was the starting point of our accepted publication at VEE'21 `[Djob.3]`.

Bitchebe is currently a Ph.D. student at I3S, Nice, France

♦ **Yuhala Peterson**, Master Student at Polytechnic Yaounde, Cameroon.
TECHNICAL SUPERVISOR during his Master Internship (Mar-Sep 2018) at IRIT, Toulouse, France.
Period : March-September 2018
Title : MEMORY VIRTUALIZATION OVERHEAD MITIGATION USING CONTIGUOUS MEMORY VIRTUAL MACHINES. CASE STUDY: XEN VIRTUALIZATION SYSTEM

Peterson's work focused on improving virtual machine address translation by exploiting the characteristics of contiguous memory. The main idea is to perform shifts faster than perform a lookup in the page table address. We proposed workarounds for the issue of `mmio hole` *that could hinder the applicability of our approach. This work recently led to a VEE'21 publication.*

Peterson is currently a Ph.D. student at IUN, Neuchatel, Switzerland

SCIENCE OUTREACH

TALKS

♦ **28 Jan 2021** | Invited Talk at Wide, Inria Team, Rennes, France
Impact de la résilience et du dimensionnement sur les applications dans des environements virtualisés

♦ **29 Jun - 02 July 2020** | `[Djob.3]` paper presentation at DSN 2020, Online via Microsoft Teams
Fine-Grained Fault Tolerance For Resilient Virtual Machine Monitors

♦ **12 Feb 2020** | Invited Talk at Grascomp-Eurosys Shadow PC joint Workshop 2020, Brussels, Belgium
FaasCache - Speeding up Function As A Service Execution Times

♦ **22-25 Oct 2019** | `[Djob.4]` paper presentation at Mascots 2019, Rennes, France
Closer: A new design principle for the privileged virtual machine OS

♦ **30 Apr - 02 May 2019** | `[Djob.5]` paper presentation at Infocom 2019, Paris, France
Memory Flipping: a threat to NUMA virtual machine in the Cloud

- ♦ **25-28 Mar 2019** | Eurosys 2019, Dresden, Germany
- ♦ **04-08 Feb 2019** | Invited Talk at GDR/ASF Winter School 2019, Pleynet-Sept Laux, France
  Memory Flipping: a threat to NUMA virtual machine in the Cloud
- ♦ **03-06 Jul 2018** | [Djob.8] paper presentation at Compas 2018, Toulouse, France
  Memory Flipping: How NUMA affects virtual machines ?

Mobility

- ♦ **Dec 2020 - Now** at *Edinburgh, Scotland, United Kingdom:* Postdoctoral researcher within the ICSA team of the Informatics laboratory of the University of Edinburgh.
- ♦ **Nov 2019 - Dec 2020** at *Lyon, France:* Research mission within the AVALON team of the LIP laboratory at ENS LYON.
- ♦ **Oct 2018 - Oct 2019** at *Nice, France:* Research mission within the Computer Science, Signal, and Systems laboratory in Sophia Antipolis.
- ♦ **Nov 2018** at *Grenoble, France* : Seminar within the LIG lab at Grenoble.
- ♦ **Apr 2018 - May 2018** at *Grenoble, France*: Research seminar within the LIG lab at Grenoble.
- ♦ **Mar 2017 - Sep 2017** at *Toulouse, France*: Master Internship result of a partnership between ENSP Yaoundé and IRIT lab in Toulouse.

International Collaborations

- ♦ **USA:** Timothy Wood-Associate Professor at The George Washington University (USA) and Jinho Hwang at IBM Research (USA). We worked at designing and implementing OFC, a transparent, vertically and horizontally elastic in-memory caching system for Function as a Service platforms (FaaS). This work has been accepted to Eurosys'21 **[Djob.2]**.
- ♦ **CAMEROON:** Dr. Batchakui Bernabe, Senior Lecturer at Polytechnic Yaoundé, Cameroon. We worked together with the USA folks on OFC.

Awards

- ♦ Recipient of the 2021 ASF and GDR RSD Thesis Prize

Grants

- ♦ Student Travel Grant, ASPLOS 2020.

Responsabilities

Service to the community

- ♦ **Poster co-chair** for **EUROSYS 2022**
- ♦ Member of the **Artifact Evaluation Committee (AEC) SOSP 2021**
- ♦ **Student Volunteer** at Eurosys 2021
- ♦ Representative of non-permanent staff at the LIP laboratory for two months **(Oct. - Dec. 2020)**, ENS Lyon, France.
- ♦ **Session chair** for Session 5 for **Journées Cloud 2020** conference.

- ♦ Member of the **Artifact Evaluation Committee (AEC) OSDI 2020**

- ♦ Member of the **Social Media Team for Eurosys 2021**, alongside:
  Kostis Kaffes, Iacovos G. Kolokasis, and Vijay Chidambaram (*Publicity Chair for Eurosys'21*)

- ♦ **Student Volunteer** for the organization of the **"Journées Cloud 2020"** at Lyon
  Website designer with Stella Bitchebe : https://journeescloud20.sciencesconf.org/

- ♦ **Shadow PC** for the 2020 European Conference on Computer Systems (**Eurosys 2020**)

- ♦ **Sub-Reviewer** for the 2019 International Conference on Big Data (**IEEE BigData 2019**)
  Main Reviewer : Noel DePalma

- ♦ **Sub-Reviewer** for the CRI'19 Conference
  Main Reviewer : Alain Tchana

- ♦ **Student Volunteer** for the organization of the **Compas 2018** Conference at Toulouse

Conference organization

- ♦ Co-organiser alongside Kevin Jiokeng and Kouam Josiane of the **JOURNÉE RETOUR D'EXPÉRIENCE 2020** at Polytechnique Yaoundé, Cameroon.
  https://sites.google.com/view/retourxpenspygi2020/accueil.

- ♦ Organiser of the **JOURNÉE RETOUR D'EXPÉRIENCE 2018** at Polytechnique Yaoundé, Cameroun. https://sites.google.com/view/retour-dexperience-2018/accueil

Research team's cluster management (Ph.D. and Postdoc)

During my Ph.D., I was responsible for managing the cluster of my team. The team members, mainly the cluster, used to run experiments for their research. I had to monitor and handle management access. During my postdoc, I am also responsible for managing the team's cluster and update the wiki page used by newcomers to learn how to use the `ipmi` of every server. During my Ph.D., the cluster was composed of 5 servers, and currently (during my postdoc), I manage 15 servers (7 x86 and 8 arm).

Teaching

- ♦ **Distributed Systems**, TD+TP, ENS Lyon, France
  Teaching Assistant with Eddy Caron
  `Status:` Temporary employee (Vacataire)
  `Target:` M1 students (23 students)
  `Teaching hours:` 20
  `Academic year:` 2019 - 2020
  `Description:` I designed the practical courses for Distributed Systems 2019/2020 and accompanied the students during the practical sessions. I also designed their practical exams and corrected the students exam sheet papers.
  `Resources produced:` http://tiny.cc/ejk7tz

- ♦ **ACM Programmation Sportive**, TP, ENS Lyon, France
  Teaching Assistant with Bao Bui & Eric Thierry
  `Status:` Temporary employee (Vacataire)
  `Target:` L3 students (31 students)
  `Teaching hours:` 42
  `Academic year:` 2019 - 2020
  `Description:` This course prepares students for programming contests such as the ACM Programming Contest. We (I, Bao Bui and Eric Thierry) accompanied the students through various programming exercises on Online Judge. I was responsible of student

exam corrections.
http://perso.ens-lyon.fr/eric.thierry/ACM/

In parallel, I also help design courses for the operating system/virtualization course offered by Alain Tchana to M1 and M2 students at ENS Lyon, France. You can find the resources I produced here: http://tiny.cc/8kk7tz.

Work Experience

Mar 2017 Sep 2017	Research Internship **IRIT (Institut de Recherche en Informatique de Toulouse)**, Toulouse, France Our goal was to revisit the design of type I hypervisors such as Xen in order to propose a scheme for dynamic resource allocation (cpu+memory) for a central component which we refered as the privileged virtual machine (pVM). Furthermore, our design had to take in account novel memory architectures such as NUMA (non-uniform memory architecture) where a distance dimension renders allocation more tricky. Advisors: Prof. Daniel Hagimont, Prof. Alain Tchana, and Ass. Prof Boris Teabe
Sep 2016 Mar 2017	L1 and L2 Teaching **ENSP**, Yaoundé, Cameroun I gave courses of **Operation System** to L1 students during the first semester of 2016-2017. I also gave practical courses of **Object Oriented Programming and IHM (Interface Homme Machine)** to L1 and L2 students respectively during the same semester. Referees: Dr. Batchakui Bernabé and Ing. Moubitang
May 2016	Student Volunteer **ENSP**, Yaoundé, Cameroun As a student volunteer, I participated in the set up of the logistic for the symposium organized on the theme ”L’apport du Cloud et du Big Data dans l’économie numérique” at ENSP.. It lasted 7 days from 14-21 May 2016. Referees: Prof. Alain Tchana
Jul 2015 Oct 2016	Trainee Internship **LIRIMA (Laboratoire International de Recherche en Informatique et Mathématiques Appliquées)**, Yaoundé, Cameroun This work was a result of a collaboration between the **University of Yaoundé I** and **Ecole Polytechnique Fédérale de Lausanne (EPFL)** under the **RESCIF** banner. The idea was to design and develop a caching system in order to speed up critical media resources load time for online courses. This enabled students to access these courses despite the low network throughput. The system is currently deployed at the **National School of Engineering of Yaoundé and Institut National Polytechnique Félix Houphouët-Boigny (INP-HB) of Yamoussoukro in Ivory-Coast.** Advisor: Dr. Batchakui Bernabé
Jul 2015 Sep 2015	Trainee Internship **Ministry of Defense**, Yaoundé, Cameroun We developed a software to enable army instructors to deliver media resources for a course exploitable by military members and track the progress of each member for a given course. The software named **HELIOS** is currently deployed and used at a military unit carrying the same name **HELIOS**. Advisor: Eng. Moubitang

Extra-activities

♦ Co-founder of louma-jobs.com, louma-concours.com, and concoursinfo.com

♦ Design and Technical Director of **IGamers Cameroun**. http://tiny.cc/y3muhz

CERTIFICATIONS

Apr 2019   Introduction to TensorFlow for Artificial Intelligence, Machine Learning, and Deep Learning
by **deeplearning.ai** on Coursera
http://tiny.cc/4otrbz

Feb 2019   Google Cloud Platform Fundamentals: Core Infrastructure
by **Google Cloud** on Coursera
http://tiny.cc/3qtrbz

Jan 2018   Getting Started with Kubernetes Engine
by **Google Cloud** on Coursera
https://goo.gl/5U67rp

Dec 2017   Google Cloud Platform Fundamentals for AWS Professionals
by **Google Cloud** on Coursera
https://goo.gl/6C2r9J

Dec 2017   Responsive Website Basics: Code with HTML, CSS, and Javascript
by **University of London & Goldsmith** on Coursera
https://goo.gl/6C2r9J

Dec 2017   Machine Learning
by **Stanford University**
https://goo.gl/6C2r9J

MISCELLANEOUS

♦ Youngest African Ph.D. https://cutt.ly/ukV7Ywg.

♦ Mentioned as a youth model by the president of Cameroon in his speech for the Youth day 10 February 2021. https://cutt.ly/nkV7R7I.

INTERESTS

Technology, Open-Source, Programming
Paradoxes in Decision Making, Behavioural Finance
Football, Martial Arts (Taekwondo Black Belt), and Video Games