Short Curriculum Vitae

Name:	**Isam Mashhour Hasan Al Jawarneh**
Current affiliation:	**Postdoctoral Fellow (Research fellow)** in ***Computer Science and Engineering*** at Dipartimento di Informatica – Scienza e Ingegneria (DISI), **University of Bologna**
Place of birth:	Irbid, Jordan
Date of birth:	05 March 1981
Nationality:	Jordanian
Number of children:	1
Year of birth of the children:	2014
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Qualifications (Education since leaving school)

- In April 2020, I have been awarded the **Ph.D. degree in Computer Science and Engineering** from **UNIVERSITA' DI BOLOGNA*, Italy***.
    - ***Thesis***: “Quality of Service Aware Data Stream Processing for Highly Dynamic and Scalable Applications”. Evaluated **excellent**. Supervisor: Prof. Rebecca Montanari
- In March 2008, I received my **M.Sc. in Information Technology** from the ***Universiti Utara* Malaysia (UUM).**
    - ***Thesis***: “A data warehouse dimensional model for student academic data at Universiti Utara Malaysia (UUM)”.
- In June 2005, I completed my **bachelor’s degree in computer science** at ***Al Al-Bayt University***, Jordan.

Work Experiences

Present appointment

- In January 2020, I won a public examination for the position of ***Research Fellow*** **(postdoctoral *Fellow*)** at the Department of Computer Science and Engineering (DISI), **University of Bologna, Italy.** I covered that position at the University of Bologna starting from ***March 2020*** *until* ***now***.
    - **Project title**: Design of scalable processing system for cultural heritage data. As part of the PON "RESEARCH AND INNOVATION" 2014 - 2020-IDEHA, CUP J46C18000440008. **Supervisor**: Prof. Rebecca Montanari
    - **Responsibilities:**
        - Designing spatial and temporal models for extracting insightful knowledge from human/vehicle mobility data
        - Implementing an industry-ready and standard compliant prototype by coding patches and incorporating them transparently with de facto standard big data management frameworks such as Apache Spark, MongoDB and InfluxDB
        - Writing and publishing research papers (as a first lead author or as co-author) and publishing in high-impact venues

Professional experience

- In January 2017, I won a public examination for the position of ***Research Assistant*** at ***Centro Interdipartimentale di Ricerca Industriale ICT (CIRI ICT)***, a prestigious Industrial Research Center of the **University of Bologna, Italy** for information and communication technologies. I covered that position at the University of Bologna starting from ***April 2017*** *until* ***February 2020***.
    - **Project title**: State-of-the-art analysis and design of cloud solutions for smart management of cultural digital data. As part of the SACHER [1] (Smart Architecture for Cultural Heritage in Emilia-Romagna) funded by the POR-FESR 2014-20 (no. J32I16000120009) through CIRI.
    - **Responsibilities:**
        - Designing a distributed NoSQL-based data lake for cultural heritage data in Italy
        - Implementing a standard compliant prototype
        - Writing and publishing research papers (as a first lead author or as co-author) and publishing in high-impact venues
        - Presenting the work in international exhibitions such as Research to Business (R2B) in Bologna Fiere (June 2018) and Salone Internazionale del Restauro, dei Musei e delle Imprese Culturali in Ferrara Fiere (March 2018)

[1] http://www.sacherproject.com/

Experience in academic teaching

- In February 2018, I won a public call for the position of ***educational tutor*** **(teaching assistant)** at **Scuola di Ingegneria e Architettura** - **University of Bologna**. I covered that position at the University of Bologna during the **2018 – 2019** academic year
    - **Responsibilities:**
        - Teaching the lab session of a master's degree level course entitled the "***principles, models and applications for distributed systems m***" Laurea Magistrale in scuola di ingegneria e architettura of the University of Bologna
        - Preparing teaching materials for the lab, which was focusing on advanced programming concepts in distributed systems and their applications in Java, such as multithreading and networking
        - Preparing and conducting lab exams for the course, in addition to marking the exams
- In December 2008, I have won a public examination for the position of ***Lecturer*** at **University of Business and Technology (UBT)**, a leading private higher education provider in the Kingdom of Saudi Arabia. I covered that position from ***February 2009 until February 2016*****.**
    - **Responsibilities:**
        - Teaching various Information Technology courses at bachelor's degree level, including, for example, object-oriented programming in Java, databases, and advanced data warehousing
            - ✓ object-oriented computer programming (3 credit hours)
            - ✓ data structure and algorithms (3 credit hours)
            - ✓ databases (3 credit hours)
            - ✓ software engineering (3 credit hours)
            - ✓ software design patterns (3 credit hours)
            - ✓ human - computer interaction (3 credit hours)
            - ✓ advanced programming (3 credit hours)
            - ✓ IT issues & management (3 credit hours)
            - ✓ introduction to software project management (3 credit hours)
            - ✓ needs assessment and technology evaluation (3 credit hours)
        - Preparing teaching materials including syllabus, lab, and term exam papers, in addition to marking student's exams
        - Supervising student's graduation projects (bachelor's level thesis) to the highest quality standards that conform to *Capstone*.
        - Preparing course files for the national and international (e.g., ABET) accreditation programs
        - Conducting high-quality research and publishing in high-impact venues with a focus on "data warehousing" and ETL design at the time.

Other academic responsibilities

- I have ***supervised & co-supervised student's thesis*** and graduation projects at the ***bachelor's*** degree level, at University of Business and Technology (UBT)
- At University of Bologna, I have assisted my team leaders in *co-supervising* the *bachelor thesis* of their students
- I have actively participated in ***preparing*** and ***supervised the preparation*** of annual course reports for the university accreditation programs at ***UBT***, at a national level (***NCAAA***) and international level (***ABET***).
- I have assisted my team leaders in writing fund-requesting research proposals for projects, in a national level (Italy) and International level (EU).

Research and scholarships

Awards, grants & professional membership

- ***PhD@ISA fellow***. In September 2016, I won a ***PhD fellowship*** provided by the Institute of the Advanced Studies (ISA), University of Bologna (UniBO). Since September 2016 until September 2020, I was a ***PhD fellow*** *at* ***ISA, UniBO***. ISA UniBO promotes and organizes international and interdisciplinary research activities enriching and simplifying the acquisition of research knowledge for researchers and PhDs.
- I have been awarded a ***funded mobility grant (Marco Polo)*** from UniBO to conduct a research project for three months. I spent that period at the **Universidad de Extremadura**, with a supervision from Prof. Javier Berrocal. ***Marco Polo*** fund is based on merit. In Spain I have successfully completed a project entitled: Deep learning-based recommender systems.
- ***University of Business and Technology (UBT) Award***. I have been awarded a ***30000 SAR (equivalent to $8000)*** for designing a DW model for student academic data at UBT, Saudi Arabia.

Research Topics

My general research theme focuses on several aspects of big data management and data-intensive applications, with a particular emphasis on geo-referenced and temporal (including time-series) big data management. Specifically, I currently work extensively with the following:

- Highly dynamic and scalable applications in parallel computing environments:
    - Middleware for dynamic and adaptive services in big data management scenarios. Specifically, I am interested in working with spatiotemporal and time-series IoT data. Applications span many aspects of smart cities, urban computing and Industrial Internet of Things (IIoT)

    - Processing of highly burst data streaming workloads with guarantees of Quality of Service. Specifically, for spatially-tagged and temporal big datasets.
    - Context-aware computing. For example, context-aware recommender systems based on latest trending Deep Learning models.
- Active data warehousing
    - Stream-static join processing for dynamic big data scenarios including smart cities, Industry 4.0 and industrial IoT (IIoT).
    - Distributed Extract, Transform and Load (ETL) processing.

Scientific production and indicators

Isam Al Jawarneh, is a Postdoctoral Fellow who has been recently awarded the degree of Ph.D. in Computer Science and Engineering from University of Bologna in Italy. His research interests span from big data management in general to adaptive data stream processing, from active data warehousing to scalable online stream processing for smart cities and Industry 4.0.
From the point of view of his publication record (Google Scholar data – July 2020: h-index=4; i10-index: 2, citations=40), he has authored several ***international journal*** articles (in publication venues that are considered the excellent ones in his research field, such as Journal of Information Development, SAGE & IEEE Access) and co-authored (mostly as a first author) more than 10 additional works published in ***flagship conferences*** (such as IEEE GLOBECOM and ICC) in addition to one ***book chapter***.

Participation in research projects & research visits

- **Project title**: Design of scalable processing system for cultural heritage data. As part of the PON "RESEARCH AND INNOVATION" 2014 - 2020- IDEHA, CUP J46C18000440008.
    - ***Role: Research Fellow (postdoc.)***. **Coordinator** & **supervisor**: Prof. Rebecca Montanari ***(March 2020-current).***
    - A **brief**: I am responsible for designing highly-available and standard compliant prototype for efficiently managing geo-referenced human and vehicle mobility time-series data. I am designing novel indexing, partitioning and query processing algorithms that are aware of the multidimensional nature and shape of mobility data (three dimensions, spatial, temporal, and contextual). The novel contribution is the design of Cloud-based algorithms that operate on the confluence between spatial and time-series data. Most methods of the relevant art are operating in one of the two modes (either spatial or time-series) but applications of both together remain humble. Methods that I am developing will be able to achieve both spatial and temporal awareness synergistically. A probable scenario would be modelling how my support can be used to distribute tourist people around

archeological sites in a proper manner to avoid crowd and to maintain safety.

- **Project title**: State-of-the-art analysis and design of Cloud solutions for smart management of cultural digital data, **Funding Area**: ICT for innovative services in cultural heritage. As part of the SACHER (Smart Architecture for Cultural Heritage in Emilia-Romagna) funded by the POR-FESR 2014-20 (no. J32I16000120009) through CIRI.
    - ***Role: Research Fellow***. Coordinator & supervisor: prof. Rebecca Montanari ***(2016-2020).***
    - A **brief**: I was responsible for designing and manipulating a standard-compliant prototype for a NoSQL-based data lake for cultural heritage data in Italy. I have designed a framework and an efficient high-available end-to-end pipeline for ingesting heterogeneous cultural heritage data, (optionally) passing it through purpose-built transformation stages and storing it in distributed NoSQL storage as raw data in a raw zone, transforming what is needed for decision making on-demand , putting raw data into NoSQL-based multidimensional models (such as star schemas) and offering it in a form that is transparently accessible by BI tools. Data was coming from heterogeneous sources including SPARQL, flat files, RDBMSs and JSON.
- Spent three months as a ***research visitor (collaborator)*** at ***Universidad de Extremadura***, Spain. On a work supervised by prof. Javier Berrocal, we have worked on designing a Deep Learning model for incorporating context into DL-based recommender systems. The outcome was a journal paper in IEEE Access. ***(September 2018 – December 2018)***.
- Design of a data warehouse model for decision support at higher education a case study. University of Business and Technology, Jeddah, Kingdom of Saudi Arabia, Project No.[107/E/2015]. ***Role: primary investigator***. Amount: 30000 SAR (equivalent to $8000). ***March 2015 – November 2015***
    - ***Outcome:*** *a journal paper in Information Development (SAGE)****.***

Publications (in publication order)

Peer-reviewed International Journals and Magazines

[j3] * ***I. M. Al Jawarneh***, P. Bellavista, A. Corradi, L. Foschini, and R. Montanari, *"Big Spatial Data Management for the Internet of Things: A Survey"*. Springer's Journal of Network and Systems Management. Accepted (**to Appear**). Expected publication date: July 2020. **DOI**: 10.1007/s10922-020-09549-6

[j2] * ***I. M. Al Jawarneh,*** P. Bellavista, A. Corradi, L. Foschini, R. Montanari, J. Berrocal and J. M. Murillo, *"A Pre-Filtering Approach for Incorporating Contextual Information Into Deep Learning Based Recommender Systems,"* IEEE Access, vol. 8, pp. 40485-40498, 2020. **DOI:** 10.1109/ACCESS.2020.2975167

[j1] ***I. M. Aljawarneh***, *"Design of a data warehouse model for decision support at higher education: A case study,"* Information Development, vol. 32, (5), pp. 1691-1706, 2016. **DOI:** 10.1177/0266666915621105

Peer-reviewed Conferences and Workshops

[C9] * ***I. M. Al Jawarneh***, P. Bellavista, L. Foschini and R. Montanari, *"Spatial-aware approximate big data stream processing,"* in 2019 IEEE Global Communications Conference (GLOBECOM), 2019, pp. 1-6.

[C8] * ***I. M. Al Jawarneh***, P. Bellavista, F. Bosi, L. Foschini, G. Martuscelli, R. Montanari and A. Palopoli, *"Container orchestration engines: A thorough functional and performance comparison,"* in ICC 2019-2019 IEEE International Conference on Communications (ICC), 2019, pp. 1-6.

[C7] ***I. M. Al Jawarneh***, P. Bellavista, L. Foschini, G. Martuscelli, R. Montanari, A. Palopoli and F. Bosi, *"Qos and performance metrics for container-based virtualization in cloud environments,"* in Proceedings of the 20th International Conference on Distributed Computing and Networking, 2019, pp. 178-182.

[C6] * ***I. M. Al Jawarneh***, P. Bellavista, A. Corradi, L. Foschini, R. Montanari and A. Zanotti, *"In-memory spatial-aware framework for processing proximity-alike queries in big spatial data,"* in 2018 IEEE 23rd International Workshop on Computer Aided Modeling and Design of Communication Links and Networks (CAMAD), 2018, pp. 1-6.

[C5] * ***I. M. Al Jawarneh***, P. Bellavista, F. Casimiro, A. Corradi and L. Foschini*, "Cost-effective strategies for provisioning NoSQL storage services in support for industry 4.0,"* in 2018 IEEE Symposium on Computers and Communications (ISCC), 2018, pp. 1227.

[C4] *S. Bertacchi*, **I. M. Al Jawarneh**, F. I. Apollonio, G. Bertacchi, M. Cancilla, L. Foschini, C. Grana, G. Martuscelli and R. Montanari, *"SACHER project: A cloud platform and integrated services for cultural heritage and for restoration,"* in Proceedings of the 4th EAI International Conference on Smart Objects and Technologies for Social Good, 2018, pp. 283-288.

[C3] ***I. M. Al Jawarneh***, P. Bellavista, L. Foschini, R. Montanari, J. Berrocal and J. M. Murillo, *"Toward privacy-aware healthcare data fusion systems,"* in International Workshop on Gerontechnology, 2018, pp. 26-37.

[C2] ***I. M. Aljawarneh***, P. Bellavista, C. R. De Rolt and L. Foschini, *"Dynamic identification of participatory mobile health communities,"* in Cloud Infrastructures, Services, and IoT Systems for Smart CitiesAnonymous Springer, 2017, pp. 208-217.

[C1] ***I. M. Aljawarneh***, P. Bellavista, A. Corradi, R. Montanari, L. Foschini and A. Zanotti, *"Efficient spark-based framework for big geospatial data query processing and*

analysis," in 2017 IEEE Symposium on Computers and Communications (ISCC), 2017, pp. 851-856.

Peer-reviewed Book Chapters

[B1] *P. Bellavista*, J. Berrocal, A. Corradi, S. K. Das, L. Foschini, **I. M. Al Jawarneh** and A. Zanni, *"How Fog Computing Can Support Latency/Reliability sensitive IoT Applications: An Overview and a Taxonomy of State of the art Solutions,"* Fog Computing: Theory and Practice, pp. 139-213, 2020.

Further data

Posters

[P1] ***I. M. Aljawarneh***, P. Bellavista, A. Corradi, R. Montanari, L. Foschini. *"QoS-Aware Big Geospatial Data Processing"*. Seventh European Business Intelligence & Big Data Summer School (eBISS 2017), 2017, Brussels, Belgium.

Participation in exhibitions

[E2] ***I. M. Aljawarneh*. "***Multidimensional Search Engine for Cultural Heritage service (SACHER MuSE CH)". Research to Business (R2B). Bologna Fiere, Bologna, Italy. June 2018.*

[E1] ***I. M. Aljawarneh.*** *"Smart Architecture for Cultural Heritage in Emilia Romagna: Data Processing". Salone Internazionale del Restauro, dei Musei e delle Imprese Culturali.* Ferrara Fiere, Ferrara, Italy. March 2018.

Potential publications under review

Three conference papers and two journal papers have been recently submitted (I am the lead and first author for all of them) to high impact venues. Now they are having full consideration (under review), and my expectation that they all will be accepted.

Recent reviewing activities

- **Reviewer** for the international journals/magazines:
    - Mobile Information Systems, Hindawi,2020
    - IEEE Communications Magazine,2020
    - Wireless Networks, Springer,2020
    - International Journal of Distributed Sensor Networks (IJDSN), since 2018
    - Concurrency and computation: practice and experience, since 2018
    - Information Development – SAGE – since 2015
- **P.S.** Information available through publons: https://publons.com/researcher/1547696/isam-mashhour-al-jawarneh/
- **Reviewer** for the international conferences/workshops:
    - 25th IEEE Symposium on Computers and Communications (**ISCC**), 2020

- 6th International Conference on Cloud and Big Data Computing, 2020
- IEEE Wireless Communications and Networking Conference (IEEE **WCNC** 2020)
- **CASPer'18**, 5th International Workshop on Crowd Assisted Sensing, Pervasive Systems and Communications (2018)
- IEEE 30th Annual International Symposium on Personal, Indoor and Mobile Radio Communications (**PIMRC**) (2019)
- IEEE Wireless Communications and Networking Conference (**WCNC**), 2019.

Professional training

Attended and actively participated in the following prestigious and top-level summer schools

- 3rd International **Summer School on Deep Learning** (DeepLearn 2019). Warsaw, Poland, July 2019.
- Seventh European **Business Intelligence & Big Data Summer School** (eBISS 2017), Brussels, Belgium. July 2017. Presented a poster [2] entitled "*QoS-Aware Big Geospatial Data Processing* "explaining the outcomes of my research through my first year at Ph.D.

PhD courses attended & passed

As part of the PhD program at DISI, UniBO, I have attended and passed PhD courses during my PhD.

- Blockchain Technologies and Cryptocurrencies, 2 ECTS[3]
- Models and Algorithms for Matching and Assignment Problems, 4 ECTS
- Advances and challenges in Business Intelligence & big data, 4 ECTS
- Spatial Multiagent Systems and Aggregate Computing: New Directions for Spatial Computing, 2 ECTS
- Introduction to deep learning, 3 ECTS
- An Introduction to parallel programming, 2 ECTS
- Learning-Based dense Depth Estimation from Stereo and Monocular Images, 4 ECTS

Technical Skills

- Apache Spark, Spark Streaming, Spark Structured Streaming, Kafka, MongoDB
- Amazon Elastic MapReduce (EMR), Microsoft Azure, Amazon Web Services (AWS)
- Ubuntu, Windows
- Apache Zeppelin, Jupyter notebooks

[2] https://cs.ulb.ac.be/conferences/ebiss2017/files/posters/aljawarneh_ebiss2017_poster.pdf
[3] European Credit Transfer and Accumulation System

- BigDL
- Endnote, RefWorks
- JAVA, C#, Python, Scala, C++, R
- HTML, CSS and ASP.NET
- MySQL, MS SQL server
- SQL Server Integration Services (SSIS), Talend open studio
- SQL Server Reporting Services (SSRS)
- Time-series: InfluxDB, Prometheus

Experience in the implementation of software prototypes

- I have successfully implemented software prototypes and benchmarked them as the following:
    - ***SpatialSPE*** [4]. A spatiotemporal Approximate Query Processing (AQP) engine. In short, SpatialSPE incorporates a spatial online sampling method (dubbed SAOS) that is spatial-aware in the sense that it interactively selects spatially-proportional counts of spatial objects from a survey area. The prototype is engineered atop an emerging best-in-class Cloud-based in-memory stream processing framework that is the first in providing SQL-alike API for stream processing in distributed environments (Spark Structured Streaming, SpSS hereafter for short). The prototype that I have developed efficiently extends SpSS by providing spatiotemporal support and awareness.
        - ***Relevant publications:***
            - [C1] ***I. M. Al Jawarneh***, P. Bellavista, L. Foschini and R. Montanari, "Spatial-aware approximate big data stream processing," in 2019 IEEE Global Communications Conference (GLOBECOM), 2019, pp. 1-6.
            - Another conference paper has been submitted recently and is now having full considerations (under review)

    - ***SpatialSSJP*** [5]: Adaptive Stream-Static Spatial Join Processing. A QoS-aware adaptive stream-static join processor that exploits SpatialSPE (and specifically SAOS) in adaptively selecting proportionate sampling fraction through the application of an embedded rate controller and serve it to SAOS using a feedback loop mechanism. SpatialSSJP is an approximation framework that is designed to efficiently tradeoff miniscule error-bounded accuracy for low-latency, thereby assisting Spatial data stream management systems (DSMS) to survive during brutal burst spikes in data arrival rates. SpatialSSJP achieves that in a circadian rhythm without compromising the overall stability of spatial DSMS. I have implemented

[4] https://github.com/IsamAljawarneh/SpatialSPE
[5] https://github.com/IsamAljawarneh/SpatialSSJP

SpatialSSJP on top of Spark Structured Streaming to complement SpatialSPE for approximate query processing of fast arriving spatial big data loads. Our evaluations with real-world scenarios and big spatial benchmarks and data loads prove that SpatialSSJP is able to survive even the most striking burst workloads while keeping accuracy loss in check (i.e., under a statistically desirable margin).

- **Relevant publications**:
  [J1] **I. M. Al Jawarneh**, P. Bellavista, L. Foschini and R. Montanari. *"SpatialSSJP: QoS-Aware Adaptive Approximate Stream-Static Spatial Join Processor"*. Submitted to one of the IEEE transactions journals. 2020.

- ***SpatialBPE*** and ***SpatialNoSQL*** [6]: Scalable Distributed Spatial Batch Query Processing and Storage. As part of my PhD I have designed two QoS-aware custom data partitioning methods and their associated query optimizers for scalable storage and batch processing of big spatiotemporal data. We dub those systems as SpatialNoSQL and SpatialBPE, respectively. Spatial data partitioning is a mean-to-an-end, where the goal is achieving quality goals; lowering latency and maximizing resource utilization while keeping accuracy levels high. To achieve those, we have designed Geospatial Sharding Scheme (GSS), a custom spatial partitioning method for a NoSQL scalable distributed storage emerging framework, MongoDB , together with a query optimizer that exploits GSS for improving the quality of service, both constituting SpatialNoSQL. I also have designed a custom spatially-attuned adaptive partitioning method that we dub as SCAP, which adequately trade-off three contradicting spatial partitioning goals (i.e., boundary spatial objects - a.k.a. edge cases, spatial co-locality preservation and load balancing) in an emerging batch processing framework (i.e., Apache Spark). I further have retrofitted a density-based clustering algorithm so that it exploits SCAP, both the SCAP and the associated query optimizer form SpatialBPE. I have evaluated SpatialNoSQL and SpatialBPE using real-world geospatial big data loads. Our results show that SpatialBPE and SpatialNoSQL outperform state-of-art counterparts by significant magnitudes. Also, they were able to meet QoS goals specified as latency/throughput and resource utilization. SpatialNoSQL is geared toward scalable distributed storage, whereas SpatialBPE is designed for distributed batch processing.
  - **Relevant publications:** Several published and few more have been submitted. See my publications list section.
- ***CA-NCF*** [7]**:** A Deep-learning based recommender system. As part of a collaborative project with **Universidad de Extremadura,** I have designed

[6] https://github.com/IsamAljawarneh/SpatialNoSQL
[7] https://github.com/IsamAljawarneh/CA-NCF

and implemented a prototype for a context-aware deep learning-based recommender system that operates over a cloud-based deep-learning framework (BigDL[8]). I have termed the new system as CA-NCF (short for context-aware neural collaborative filtering), which is a hybridization between retrofitted versions of a pre-filtering context incorporation method known as item-splitting and a novel recommender system deep learning based method known as neural collaborative filtering (NCF). The stock version of NCF is unaware of contextual features. I have transparently incorporated context-awareness within NCF so that we have the benefits of both the incorporation method (item-splitting) and NCF without their limitations.

- **Relevant publications**:

  [J1] ***I. M. Al Jawarneh***, P. Bellavista, A. Corradi, L. Foschini, R. Montanari, J. Berrocal and J. M. Murillo, "A Pre-Filtering Approach for Incorporating Contextual Information Into Deep Learning Based Recommender Systems," IEEE Access, vol. 8, pp. 40485-40498, 2020.

- ***GitHub account:***
  - I have open sourced the implementations of the SpatialSPE (written in Scala and engineered atop Apache Spark) and CA-NCF (written in python and engineered atop BigDL, which by itself is a DL framework operating over Apache Spark). You can find them in my account, at the following link:
    - https://github.com/IsamAljawarneh
  - SpatialNoSQL, SpatialBPE & SpatialSSJP are ready (standard-compliant prototypes) but currently only available for collaborators. I will open source them as soon as the related papers (underway) are officially published.

Language competence

Arabic, English, and Italian

Arabic: Native proficiency

English: full professional proficiency (Level: C1)

Italian: limited working proficiency (Level: A2)

[8] https://bigdl-project.github.io/0.10.0/