A Startup Assessment Approach based on Multi-Agent and Blockchain Technologies

Davide Calvaresi[1][0000−0001−9816−7439], Ekaterina Voronova[2], Jean-Paul Calbimonte[1], Valerio Mattioli[1], and Michael Schumacher[1]

[1] University of Applied Sciences and Arts Western Switzerland, Sierre, Switzerland
[2] Innovare Digital s.a.r.l., Lausanne, Switzerland
{name.surname}@hevs.ch, k.voronova@innmind.com,

Abstract. The dynamic nature of startups is linked to both high risks in investments as well as potentially important financial benefits. A key aspect to manage interactions among investors, experts, and startups, is the establishment of trust guarantees. This paper presents the formalization and implementation of a system enforcing trust in the startup assessment domain. To do so, an existing architecture has been extended, incorporating a multi-agent community and related interactions via private blockchain technology. The developed system enables a trust-based community, immutably storing, tracking, and monitoring the agents' interactions and reputations.

Keywords: Multi-Agent Systems, Blockchain, Startup assessment

1 Introduction

Startups have become a driving force fostering innovation in several fields. An intense competition pushes entrepreneurs to strive in creating new opportunities and solutions for existing problems, employing new or combining existing technologies. Startups are demanded to provide disruptive technological solutions able to challenge big corporations, which are less flexible and fast-reacting due to their size and complex decision-making processes. Both novelty and potential flexibility to quickly adapt to new market conditions are favorable for startups to *(i)* create additional value for possible consumers, and to *(ii)* increase financial benefits for investors and technological contributions for all players in the market. In fact, this value has shown continuous growth in the latest years. Between $(2015-2017)$ the global startup economy generated a worth of about 2.3 trillion USD (value growing steadily), according to the Global Startup Ecosystem Report [17]. However, although the startup ecosystem attracts massive investment (i.e., more than 207 billion USD of funds have been raised in 2018 [18]), it cannot be neglected that startups are highly vulnerable to numerous external and internal factors. Not all startups succeed: according to [16], around three quarters of venture-backed US projects do not return investors' capital. The most common reasons why projects fail are: *(i)* no market need, *(ii)* lack of funds, *(iii)* improper balance of the team's competences, and *(iv)* unsustainable competition [23]. Such concerns make investing in startups potentially highly profitable

and risky at the same time. Besides startups and investors, other players participate in the process of creating innovation, who, at the same time, can benefit and are vulnerable to the high-rate of startup failures. For example, we can mention early adopters, contributors, and *participants* of the startup ecosystem. Such participants contribute to the ecosystem by providing specific services to the startups, such as mentoring, testing new products, and facilitating their communication with investors. Tight collaboration with the startups can increase the potential of success. Hence, conducting an in-depth analysis of the project they consider investing in, investors and other players drastically reduce the risks of failure.

In this domain, which requires dealing with sensitive and classified data (e.g., intellectual property and business plans), the employment of intelligent systems is increasing at a fast pace, and privacy, security, and integrity are becoming outstanding concerns. One possible way to address these challenges is by relying on Multi-Agent Systems (MAS), which have been successfully employed even in data-sensitive domains (e.g., e-health [10], telerehabilitation [6], manufacturing [12], etc.). In particular, the establishment of trust mechanisms and guarantees, constitutes a fundamental step towards the deployment of agent-based systems that can help managing interactions among investors, experts and startups. In this respect, the MAS community has explored the usage of blockchain technology (BCT) [21,22,4], in order to manage agent reputation, while enhancing transparency and trust (even in the case of unknown intentions/nature of the agents), removing the need for conventional *trusted third parties* [5]

In the context of startups assessment and incubation, this paper presents a system enabling dynamics among startups, expert evaluators, and investors based on the computation of their reputation relying on Multi-Agent Systems (MAS) and blockchain technology (BCT). In particular, a Jade-based (MAS) and Hyperledger-based (BCT) system has been implemented, including: two-folded actors and services evaluation, a relational-like world-state DB, policies and mechanisms for disagreement resolution, smart contracts computing, and monitoring agent reputation. Finally, the system has been tested with alpha and beta testers.

The paper is organized as follows: Section 2 describes the state-of-the-art in business assessment, trust and MAS technologies, Section 3 describes a motivating case study, Section 4 provides details about the system design, which is discussed in Section 5 before the conclusions.

2 State of the art

Nowadays, communities play a major role in the success of business projects. Many startups defined as unicorns[3] owe a considerable part of their success

[3] "unicorns": startups companies which have market value of 1 billion dollars (or more). This term is widely used in venture investment industry. Highly successful startups. It commonly refers to businesses having valuation higher than a certain amount (e.g., 1 BLN dollars).

to the *relationships* built thanks to their communities. However, communities can provide more than just connecting the players. For example, sharing visions, estimating certain aspects crucial for the evolution of a startup, supporting other players in the decision-making process, and building a solid understanding about product markets. By creating a trustworthy common ground, it is possible to distinguish the most promising and robust ideas, projects, and companies in a faster and more precise manner.

InnMind [14] is an example of a platform establishing a common ground for startups, investors, service providers, and all the relevant professionals. It comprises complex B2B2C solutions that combine *(i)* online database (marketplace) of innovative startups, *(ii)* online hub of investment organizations (VCs, angels, etc), *(iii)* industrial players and service providers, and *(iv)* educational sources with comprehensive information for innovative business owners. InnMind connects providers and suppliers of innovative technologies and startups, providing an efficient multi-functional instrument to help them to be more productive and successful. Platforms such as InnMind, address numerous challenges, e.g. access to promising projects, listings of experienced professionals, potential partners and investors from all around the world. However, currently, there is still the need for providing a profound assessment of given projects in a transparent and comprehensive form. Moreover, it is currently not possible to provide manual communication or deliver in-depth analysis and assessment of a company's current position and future potential.

Although there are many platforms operating as a listing service for the registered projects [13], only a few of them consider the reputation as an important discriminant factor. Some platforms provide assessment conducted by their own team of experts, keeping the ranking private or disclosing only partially the assessment process/methodology [2]. The most popular providing such services are listed below: *StartupRANKING* [19] provides a two-factor ranking system. The first factor is closely linked with search engine optimization (SEO) of the project website (e.g., the number of backlinks to the webpage, traffic on the webpage, and content). The second factor is calculated based on users' engagement on Facebook and Twitter. It is also planned to add analysis of audience engagement in such social media channels as LinkedIn, Pinterest, Youtube, and others. *Crucnchbase* [9] introduced Crunchbase Rank (CB Rank) and Trend Scores. According to [20], CB Rank combines factors such as the number of connections a profile has, the level of community engagement, funding events, news articles, and acquisitions, etc. While CB Rank is linked to the activities of the entity, Trend Score considers changes in the Rank. CB Rank is reflected on the companies' profiles, and Trend Score can be used for building a search filter for users who have paid subscription. *CB Insights* [8] uses a system called Mosaic to assess the startups. There are three key elements at the basis of each score proposed by the platform: market (e.g., competition and saturation on the market), money (financial situation of the company) and momentum (marketing, social sentiment, customers and partnerships).

Moreover, many ratings operate with Initial Coin Offering (ICO) or Security Token Offering (STO) projects. For example, *ICO Bench* delegate the ranking

score to community, evaluating the companies based on three factors: team, vision, and product (marks then averaged by the platform). The lack of transparency in the criteria, mechanisms, and score assignment generate considerable skepticism and mistrust, especially in platforms allowing the users to rank each other.

Aiming at fostering transparency and reliability in ranking platform and firms, several paradigms and approaches from the Artificial Intelligence (AI) field can be employed. For example, MAS are characterized by models and dynamics, emulating human behaviors. Ensuring accountable and trusted interactions between agents is essential, and although not straightforward, many remarkable efforts have been invested in the cause [24,15,11]. Yet, constantly evolving scenarios and technologies demand new, viable, and sustainable solutions. As reported in [4] binding MAS and BCT is a promising approach and represents a new frontier in the AI field. Studies such as [5] and [7] provided early proof of concept and architectures addressing trust and security requirements by combining MAS and BCT.

3 Case Study

In the scenario of startup assessment, we aim at implementing a two-folded evaluation to foster the computation of reputation of the actors operating in the InnMind Platform in a system combining MAS and BCT. Following the agent-based approach, let us define the set of high-level behaviors (autonomous or user-dependent):

- B0: *actor profiling:* filling the user profile with personal/professional information according to his/her role.
- B1 *startup self-assessment:* evaluation of the startup features;
- B2: *request of assessment:* demand for an evaluation of the startup features;
- B3: *request visualization:* demand for a visualization of profile and expert(s) assessment(s) (data on/off-chain under evaluation);
- B4: *expert assessment:* assessment of an expert's skills and past startups assessments (executed on a voluntary basis);
- B5: *assessment response:* if the request is accepted, B11 follows. If the request for B11 is rejected, a motivation has to be provided;
- B6: *suggestion:* recommending a project as promising investment;
- B7: *success rate:* assessment of the percentage of successful deals of an investor;
- B8: *demand for an expert assessment:* request a startup to get some features assessed by one or more experts with particular expertise and competence;
- B9: *demand for assessing a startup:* request an expert to assess a startup or to evaluate an assessment produced by another expert about a given startup;
- B10: *assessment negotiation:* negotiation of cost/delivery time of a given evaluation. It can be delegated to the agent representing the user, which according to a customizable cost function, can negotiate autonomously;
- B11: *startup evaluation:* evaluation of the startup and its products/services. Such a value impacts on the computation of the agent reputation;
- B12: *assessment proposal:* proposal to perform B11 for a given cost and deadline;

Table 1 provides the association agent - behaviors. The diagonal elements (cells in blue) indicate the behaviors involving a single agent. The others, reading the table rows to columns indicate the initiator and the recipient of a given behavior. It is worth to recall that the primary objective of creating such a system for startup assessment is to ensure transparency and achieve trust in the community. According to the evidence provided in Section 2, the current practices of fundraising, expanding to new markets, and finding new partners/projects are eager of resources and time. A trustworthy assessment system can play a crucial role during preliminary screenings, semi-automating the process of pre-selecting promising projects/partners in the early stage.

	STUP	EXP	INV
STUP	B0, B1	B2, B5, B10, B11	B3, B11
EXP	B5, B10, B11, B12	B0, B4*	B6, B11
INV	B8, B11	B9, B10, B11	B0, B7

* indicates behaviors among actors of the same category.

Table 1. high-level agent behaviors; STUP: startup, EXP: expert, and INV: investor.

4 System design and implementation

Regardless of the scale, startup assessment systems are classified as private distributed systems composed of both collaborative and/or competitive actors (i.e., agents). Such entities aim at *(i)* maximizing their interests (e.g., earning money for a given evaluation, credits, expertise, knowledge, and reputation) and *(ii)* having freedom of joining, serving, and leaving the platform at any time. However, besides the high-level behaviors presented in Table 1, the agents can show/evolve malicious behaviors such as *(iii)* organize coalitions and *(iv)* foster selfish interests manipulating and exploiting other actors or some dynamics in the platform. To reduce such risks and to enable the agents' autonomous interactions on behalf of the human actors, it is necessary to understand and monitor agent reliability. The high-level behaviors introduced in Section 3 have been modeled as simple and composite behaviors. Moreover, a set of low-level behaviors such as send/receive messages, search agents in the platform, registration, and identification, has been developed extending the architecture in [7].

Acknowledging the risk of not having *fully* trustworthy agents, there is the need for computing the reputation with uniform and unbiased techniques. In the underlying architecture (see Figure 1) the reputation management is handled by smart contracts, thus enforcing the main BCT properties (e.g., data transparency, immutability, integrity). Moreover, a given reputation threshold can be set to discriminate whether to suspend or expel an agent from the community. The agents operating in the system respect the loosely coupled, interconnected, and organized networks of the human actors of the InnMind Platform [14]. The mapping actors - agents have been realized at the JADE level (the underlying agent framework [1]). Considering the InnMind community as "restricted", we have employed the *Certification Authority* of Fabric Hyperledger (v1.2) [3].

4.1 System Architecture, Agent Identity, and Certificates Management

The underlying architecture supports the implementation of two cases of agents.

- CA-A: it handles registration, interacts with the certification authority component of Hyperledger, and can define rules and conditions for enrollment.
- BC-A: regular agent operating in the community. All its interactions/behaviors are stored on the blockchain;

The *administrator* of the InnMind platform is an instance of CA-A. The actors *startup, expert, investor, business angel, freelancer, consultant, mentor*, and *advisor* are instances of BC-A. To operate in the community (and on the ledger(s)), the BC-A(s) have to be registered by CA-A (obtaining credentials and certificates of the corresponding public keys) and to operate according to rules and policies of the platform (see Section 4.2).

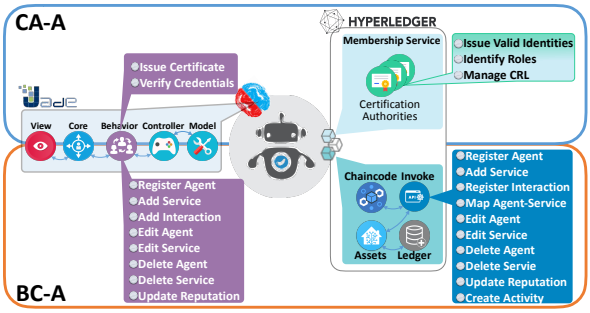

Fig. 1. Conceptual design of the system components.

In the current implementation, the blockchain network is composed of one ledger with three peers running on different machines. This configuration is contrasting with the policy of the underlying architecture assigning a peer to every $(BC - A_i)$. Such a strategical choice is due to legal and privacy obligations over the shared data. The World State database (maintaining the current state of the ledger state) used in the presented systems is shown in Figure 2 (where it is also possible to notice the handcrafted relational properties).

The structure of the world-state (Level-DB) respects the composite keys-indexes mechanism offered by the underlying architecture. However, it has been introduced the concept of *composite service* which allows a hierarchical aggregation of services. Such a choice has been demanded by the dynamical nature of some services. For example, a startup can operate in diverse domains, therefore the fields composing the self-assessment can be different and must be configurable dynamically. By doing so, it is possible to track the reputation of a given agent (startup or expert) down to the single instance and then aggregating it up to the composite service.

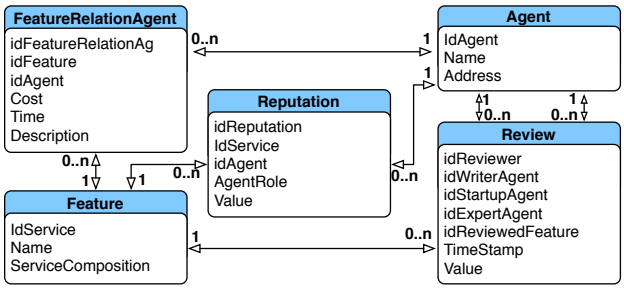

Fig. 2. Basic structure of the InnMind WSDB

Concerning Figure 2, *Agent* contains the details of the agent. *FeatureRelationAgent* relates the services to the agent. *Review* defines the registration of the feature evaluation, tracking service, actors, and *WriterAgent* (e.g., STUP or EXP) for implementing the two-folded reputation evaluation mechanism. Moreover, there is the *timestamp* field which serves to purpose of tracking the evolution over the time of the reputation values (see Figure 3). *Reputation* relates a given agent, service, and reputation. Finally, *Feature* details the service and its possible composition.

Fig. 3. getHistory function for tracking the reputation evolution

The correctness of structures and functionalities have been tested following the Test Driven Development (TDD) approach. By doing so, it has been possible to avoid setting up the network (e.g., download and install the docker images of Hyperledger) when not strictly required. Moreover, the TDD approach allows to verify if the latest functionalities have compromised the existing and stable functionalities. Finally, the TDD has been employed to execute a predetermined set of scenarios.

4.2 System Dynamics

Being a permissioned community, the first step is to register and get the certificates enabling interactions with other actors/agent via the underlying blockchain. To do so, the current implementation demands proof of identity of the registering actor and code (in the future proof of payment). Focusing on the two main actors, after the registration, and profile completion (B0), a given startup (STUP)

must provide the *self-assessment* (B1)[4]. Hence, if a STUP has not completed B0 and B1, it is not allowed to operate in the community (Figure 4 (b)).

Viceversa, STUP can proceed according to the natural flow of actions demanding to be assessed (B2) by an expert (EXP) who, on the other hand, must have already filled his/her profile and expertise (B12)[5] to be visible and eligible (Figure 4 (a)). In particular, STUP can read the ledger screening the EXP possibly eligible to perform B11. At this point, a human-based or agent-based (autonomous) negotiation (B10) can take place (e.g., based on cost and delivery time). When B11 is completed, STUP can check the assessment received and release a mark based on its quality. In case no EXP is available to evaluate a STUP, B11 need by a given STUP remains pending. If an EXP registers and becomes eligible to perform it, he/she will send an assessment proposal (B12), possibly triggering acceptance, rejection, or a negotiation (Figure 4 (c)).

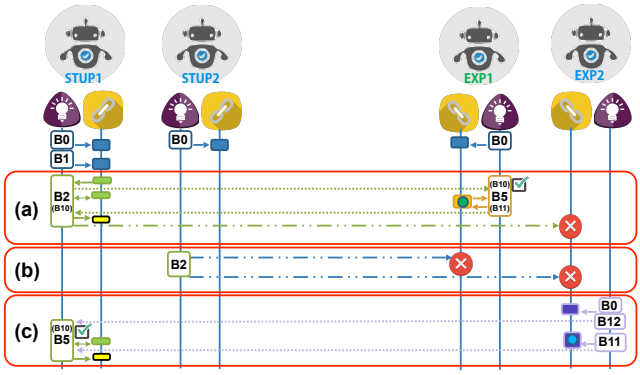

Fig. 4. Agents interactions

4.3 Actors Reputation: Misalignment and conflict resolution

The agent reputation is computed averaging and weighing the marks received on previous and current behaviors (e.g., self-assessment and service evaluation). To maintain a high level of trust and quality services in the platform, the system administrator can regularly trigger smart contracts monitoring the evolution of the reputation of the various actors (in terms of both single behaviors and trends). By doing so, it is possible to monitor if given behaviors can lead to malicious trends, systematic errors, or just to a single (involuntary fault).

However, the assessments can be subject to personal biases and therefore showing relatively diverging marks. If the marks given by two actors about the evaluation of a given content differ more than a customizable threshold, the actors are required to revise their judgment. In turn, if either one accepts to revise his/her mark and the difference goes below the threshold, the new reputation is computed, and the ledger is updated. Viceversa, if the difference persists, the

[4] The features implemented in the ledger are listed in Appendix A
[5] The features implemented in ledger are listed in Appendix B

system or the administrator identifies a third actor (e.g., an expert) to provide a third evaluation and review the two disagreeing assessments.

Another risk concerning the reputation and existing solutions is that once deleted a profile and abandoned the platform, in many cases, it is possible to come back with new registration and a *clean* profile. To study the robustness of the developed systems with respect to such a possibility, we tested the following scenario: An expert newly registered in the platform is given a fair reputation of 6 out of 10. Performing "arguable" behaviors, his reputation assumes an almost monotonic negative trend. Reaching the minimum value of 4, the expert decides to leave the platform and delete his account. After a given period the expert registers himself again in the platform. In turn, we tested two different approaches:

(i) we handcrafted the possibility of bypassing the certification authority mechanisms (e.g., providing fake Id and codes). In such a case, the expert gains again the initial reputation value of 6. This time, we performed positive behaviors gaining quickly reliability (Figure 5 - red line).

(ii) we registered using the actual id and a new code (received after the simulation of a new payment). Even if its profile has been previously deleted (from the WD-Database), exploring the ledger his history and reputation have been restored. Performing the same positive behaviors of the scenario *(i)*, however, generate a different outcome (Figure 5 - blue line).

The development of smart contracts to compute and monitor the reputation trends is still in its early stage. In the upcoming implementation, factors such as *(i)* how long a given value is kept), *(ii)* the number evaluated behaviors, and *(iii)* the derivative of the reputation curve will play a crucial role.

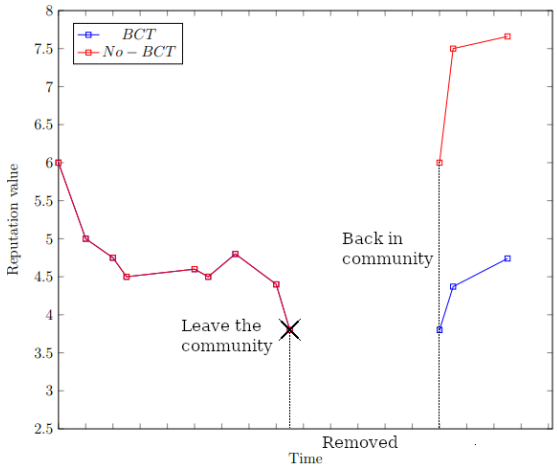

Fig. 5. Possible evolution of agent reputation.

5 Discussion

Independently from the application domain, unveiled or merging new technologies can generate a valuable breakthrough, as well as rising even more questions and challenges. Currently, the InnMind platform operates connecting startups, experts, and investors. The developed system enriches the value of the platform by adding a reliable social assessment (reputation/trust assessment) based on MAS and BCT. Such technologies and transparent mechanisms promote more trustworthy interactions and investments among the actors. The system is still in its early stage, and dynamics such as conflict resolution and arbitrage still need a fine-tuning. In a later stage, a considerable number of dynamics will be directly delegated to automated behaviors and predefined smart contracts. Further, InnMind plans to integrate machine learning and AI algorithms within the MAS aiming at delivering predictions based on the collected historical data (e.g., company's development and founders' reputation).

However, several concerns from the real world still need to be assessed. For example, a legal basis for the data on/off-chain need to be developed, as well as policies for cross-border distributed peers. Currently, no comprehensive legal base explains and regulates integration of the blockchain into the business sector. There is a need for clear laws connected to the privacy, and personal data use, that will help further to develop "healthy" markets. Moreover, a low level of trust in the virtual world could be considered relevant for undertaking legal actions in the real world. From the technological point of view, besides their tamper-proof mechanism once already in the system, verifying the correctness of the smart contracts remains an open challenge, as well as how to verify the identity and intentions of who is in charge of updating or developing new ones.

6 Conclusions

This paper presented the formalization and implementation of a system enforcing trust in the startup assessment domain. To do so, it has been extended an existing architecture presented in [7] by implementing a multi-agent community and related interactions via private blockchain technology. The developed system enables a trust-based community, immutably storing, tracking, and monitoring the agents' interactions and reputations.

The observations show promising directions to undertake. Although the benefits of combining MAS and BCT are justified by several studies and the acceptance of the developed prototype satisfied the InnMind managers, the employed technologies are not fully framed by standards nor been widely adopted yet.
The planned future works are: *(i)* extending B10 (given the shared benefits, we aim at involving startups in sharing the assessment costs in the negotiation, adapting the behavior accordingly.), *(ii)* implementing smart contracts to infer possible future behaviors reasoning on historical data (e.g., reputation), *(iii)* implement autonomous behaviors and smart contracts to timely spot malicious behaviors, and *(iv)* implement behaviors regulating lack of commitment (both startups and experts side).

A Startup self-evaluation features

- **Product:** technology/product, value proposition, scalability, and IP rights;
- **Customer:** customer development, targeted market, and regional coverage;
- **Market competition:** competition, current partnerships, need in the market, marketing, and PR Strategy
- **Finance:** business model/tokenomics, current financial situation, pace of ROI, and exit Strategy.
- **Team and administrative:** components, team experience, company registration, and legal aspects;

B Startup assessment features for expert evaluation

- **Team:** experience, roles covered, traditional Media, and social media proof (in regards to the team and their connection to the project), blockchain knowledge and experience, and advisory board;
- **Product/Service development:** stage of development, proof of stage of development, speed of development, roadmap, correlation between, plans and capacities, innovativeness of the product/service, sufficiency of resources/assets for creation of the product, specialised conferences participation, and comments;
- **Technology chosen:** technology fits the goals of the product/service, technology helps to create the value added in the best way, the level of internal risk wrt. the use of the technology, coding activity, blockchain added value, and comments;
- **Added value and problem solved:** product/market fit, relevance added value, solved problem, difficulty in creating value, and comments;
- **Market research:** differentiation, Economies of scale, competition analysis and understanding, real competition, and comments
- **Customer development:** target audience (analysis), market size, market fit, market share potential, and comments;
- **Marketing strategy:** marketing documentation, channels of distribution, clear positioning, partners, media coverage, online marketing activities, offline marketing activities, power of buyer, and comments;
- **Business model and tokenomics:** financial planning, business model validity, tokenomics margin, power of buyer and supplier, access to finance, and comment;
- **Risks:** political, economic, social, technological, environmental, legal, and internal;

References

1. Bellifemine, F.L., Caire, G., Greenwood, D.: Developing multi-agent systems with JADE, vol. 7. John Wiley & Sons (2007)
2. Bv4: Certified expert evaluation. `https://www.bv4.ch/startup-rating` (2018), [Accessed 24/03/'19]
3. Cachin, C.: Architecture of the hyperledger blockchain fabric (2016)
4. Calvaresi, D., Dubovitskaya, A., Calbimonte, J.P., Taveter, K., Schumacher, M.: Multi-agent systems and blockchain: Results from a systematic literature review. In: International Conference on Practical Applications of Agents and Multi-Agent Systems. pp. 110–126. Springer (2018)
5. Calvaresi, D., Dubovitskaya, A., Retaggi, D., Dragoni, A.F., Schumacher, M.: Trusted registration, negotiation, and service evaluation in multi-agent systems throughout the blockchain technology. In: 2018 IEEE/WIC/ACM International Conference on Web Intelligence (WI). pp. 56–63. IEEE (2018)

6. Calvaresi, D., Marinoni, M., Dragoni, A.F., Hilfiker, R., Schumacher, M.: Real-time multi-agent systems for telerehabilitation scenarios. Artificial Intelligence in Medicine (2019)
7. Calvaresi, D., Mattioli, V., Dubovitskaya, A., Dragoni, A.F., Schumacher, M.: Reputation management in multi-agent systems using permissioned blockchain technology. In: 2018 IEEE/WIC/ACM International Conference on Web Intelligence (WI). pp. 719–725. IEEE (2018)
8. cbinsights: Understanding the health of tech startups. https://www.cbinsights.com/company-mosaic (2018), [Accessed 24/03/'19]
9. crunchbase: crunchbase web startup ranking platform. https://about.crunchbase.com/blog/influential-companies/ (2018), [Accessed 24/03/'19]
10. Dubovitskaya, A., Urovi, V., Barba, I., Aberer, K., Schumacher, M.I.: A multiagent system for dynamic data aggregation in medical research. BioMed Research International (2016)
11. Hedin, Y., Moradian, E.: Security in multi-agent systems. Procedia Computer Science **60**, 1604 – 1612 (2015). https://doi.org/https://doi.org/10.1016/j.procs.2015.08.270, http://www.sciencedirect.com/science/article/pii/S1877050915023972, knowledge-Based and Intelligent Information and Engineering Systems 19th Annual Conference, KES-2015, Singapore, September 2015 Proceedings
12. Hsieh, F.S.: Modeling and control of holonic manufacturing systems based on extended contract net protocol. In: American Control Conference, 2002. Proceedings of the 2002. vol. 6, pp. 5037–5042 (2002)
13. InnMind: 62 top listings to promote your startup. https://innmind.com/articles/1816 (2018), [Accessed 24/03/'19]
14. InnMind: Global sturtup community for supporting innovation. https://innmind.com/ (2018), [Accessed 24/03/'19]
15. RAMCHURN, S.D., HUYNH, D., JENNINGS, N.R.: Trust in multi-agent systems. The Knowledge Engineering Review **19**(1), 1–25 (2004). https://doi.org/10.1017/S0269888904000116
16. School, H.B.: The venture capital secret. https://www.hbs.edu/news/Pages/item.aspx?num=487 (2018), [Accessed 24/03/'19]
17. startupgenome: Global startup ecosystem report 2018: Succeeding in the new era of technology. https://startupgenome.com/all-report-thank-you/?file=2018 (2018), [Accessed 24/03/'19]
18. startupgenome: Pwc q4 2018 evaluation. https://www.pwc.com/us/en/industries/technology/moneytree.html (2018), [Accessed 24/03/'19]
19. StartupRANKING: Sr web startup ranking platform. https://www.startupranking.com/how-it-works (2018), [Accessed 24/03/'19]
20. Stephan, D.: Crunchbase rank and trend score. https://about.crunchbase.com/blog/crunchbase-rank-trend-score (2018), [Accessed 24/03/'19]
21. Swan, M.: Blockchain: Blueprint for a new economy (2015)
22. Tapscott, D., Tapscott, A.: Blockchain Revolution: How the technology behind Bitcoin is changing money, business, and the world. Penguin (2016)
23. TILab: cbinsights research. https://www.cbinsights.com/research/startup-failure-reasons-top/ (2018), [Accessed 24/03/'19]
24. Yu, B., Singh, M.P.: An evidential model of distributed reputation management. In: Proceedings of the first international joint conference on Autonomous Agents and Multiagent Systems: Part 1. pp. 294–301. ACM (2002)