



Research on cryptocurrencies and blockchain at the Agile Group

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Agile Group and Blockchain

- Agile Group is the software engineering research group of the University of Cagliari
- We started to study Bitcoin and Blockchain since 2014
- We were among the very first research groups to publish on international reviews on the subject (not considering cryptography)
- Strong collaboration with our spinoff FlossLab srl and other firms, on applied research projects
- Collaborations with foreign Universities and research institutions:
 - Univ. of Hartfield and Brunel Univ. (UK)
 - INRIA Lille (F)
 - Univ. Politecnica di Madrid (E)

Cited on Coindesk

The image is a screenshot of a Coindesk article. At the top, the Coindesk logo is on the left, and navigation links for 'Blockchain 101', 'Technology', 'Markets', 'Business', 'Data & Research', and 'Consensus' are on the right. A yellow banner below the navigation says 'Vote for CoinDesk's Most Influential People in Blockchain 2017'. The main article header features a blurred background image of a person's face and the Google logo. The title is 'Study: Google Searches Can Predict Bitcoin Trading Volume'. Below the title are buttons for 'Google Search' and 'I'm Feeling Lucky'. The author information reads 'Oct 2, 2015 at 10:15 UTC by Grace Caffyn'. At the bottom of the article header, there are links for 'Advertising Programs', 'Business Solutions', 'About Google', and 'Go to Google US'. Below the article header is a blue advertisement for 'MEDIBLOC Healthcare on Blockchain' with the text 'Take you back your healthcare data' and a 'Join ICO Now!' button. Underneath the ad is a 'News' section with a row of social media sharing icons: Twitter, Facebook, Google+, LinkedIn (with '128' next to it), Reddit, and Email. The article text begins with 'Google search data can predict the price of bitcoin, new research has found.' and continues with 'Academics from the University of Cagliari, Italy, compared USD trading volume with data from Google Trends in the 12 months leading up to July 2015.' and 'The results, detailed in their new paper, indicated that search volumes for the keyword 'bitcoin' correlated with – and sometimes predicted – the currency's market volumes.'

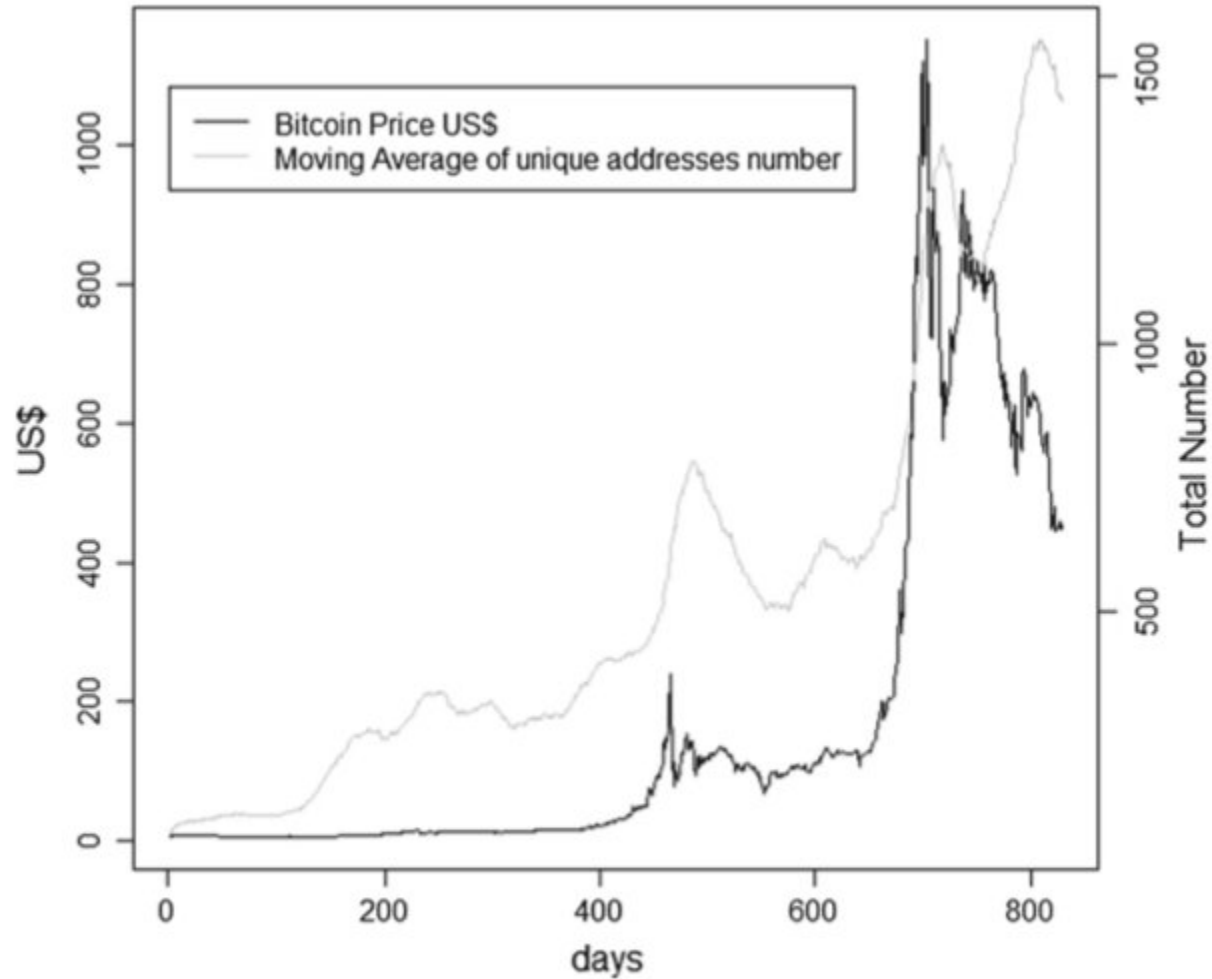
Research topics - 1

- Modeling and simulation of cryptocurrency markets
- Modeling and simulation of miners business model
- Using an object-oriented event-driven stochastic simulator and heterogeneous agents approach
- Analysis of energetic implications of mining
- Use of Blockchain in electric market of renewable power sources
- Study of ICO (Initial Coin Offering) features, success factors and impact on public blockchains

Simulation of Bitcoin market and of mining business

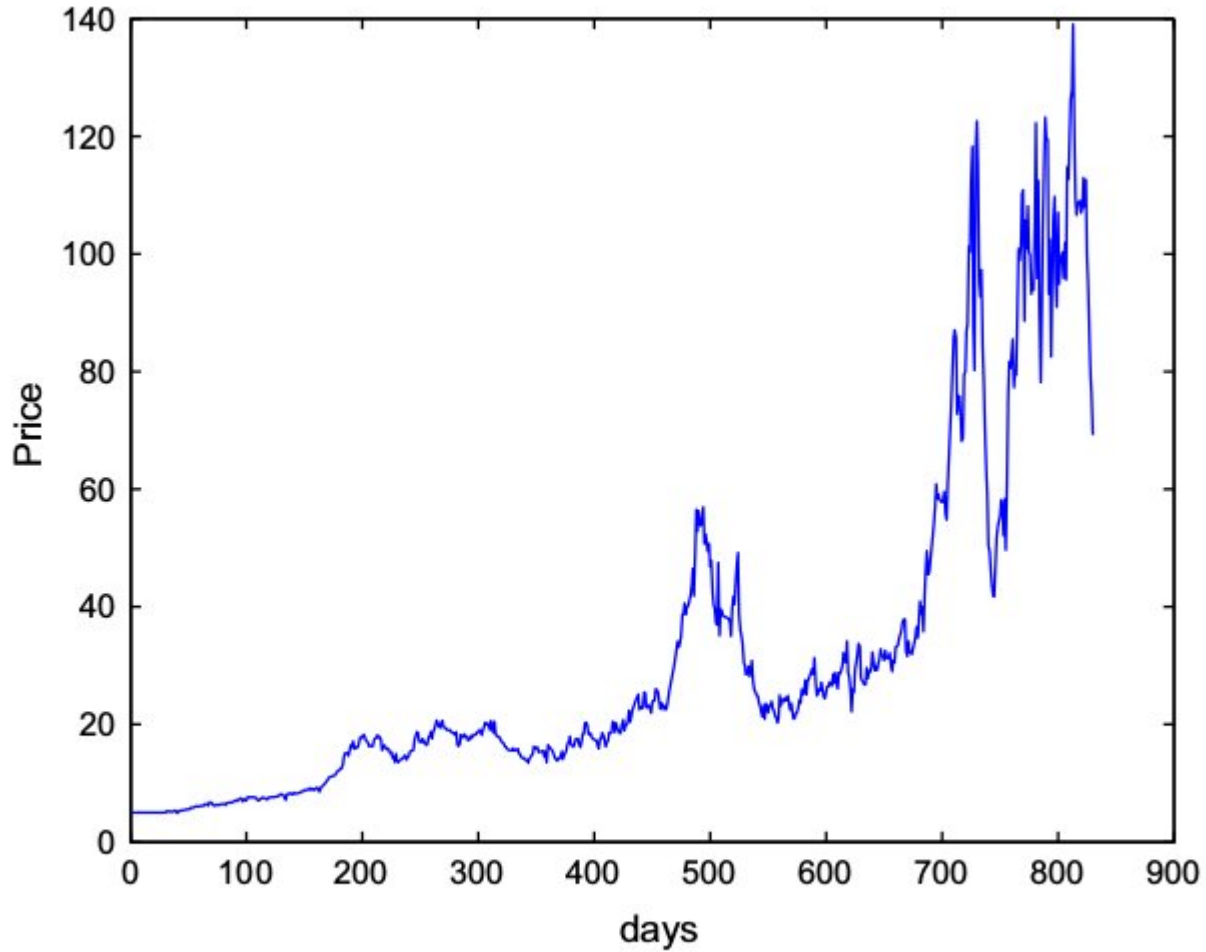
- A model based on heterogeneous agents
- 3 kinds of traders:
 - random traders
 - chartists
 - (miners)
- Features of the model:
 - inflow of new traders
 - order clearing through a book
 - analysis of prices trend and statistical properties
 - analysis of the survivability of the various strategies in the long term

Bitcoin price between 1/12012 and 10/4/2014



Price of Bitcoins in US\$, and number of unique addresses of the Blockchain

Simulated Bitcoin price



Price of the Bitcoin in the simulated market

Simulated Bitcoin price CCDF

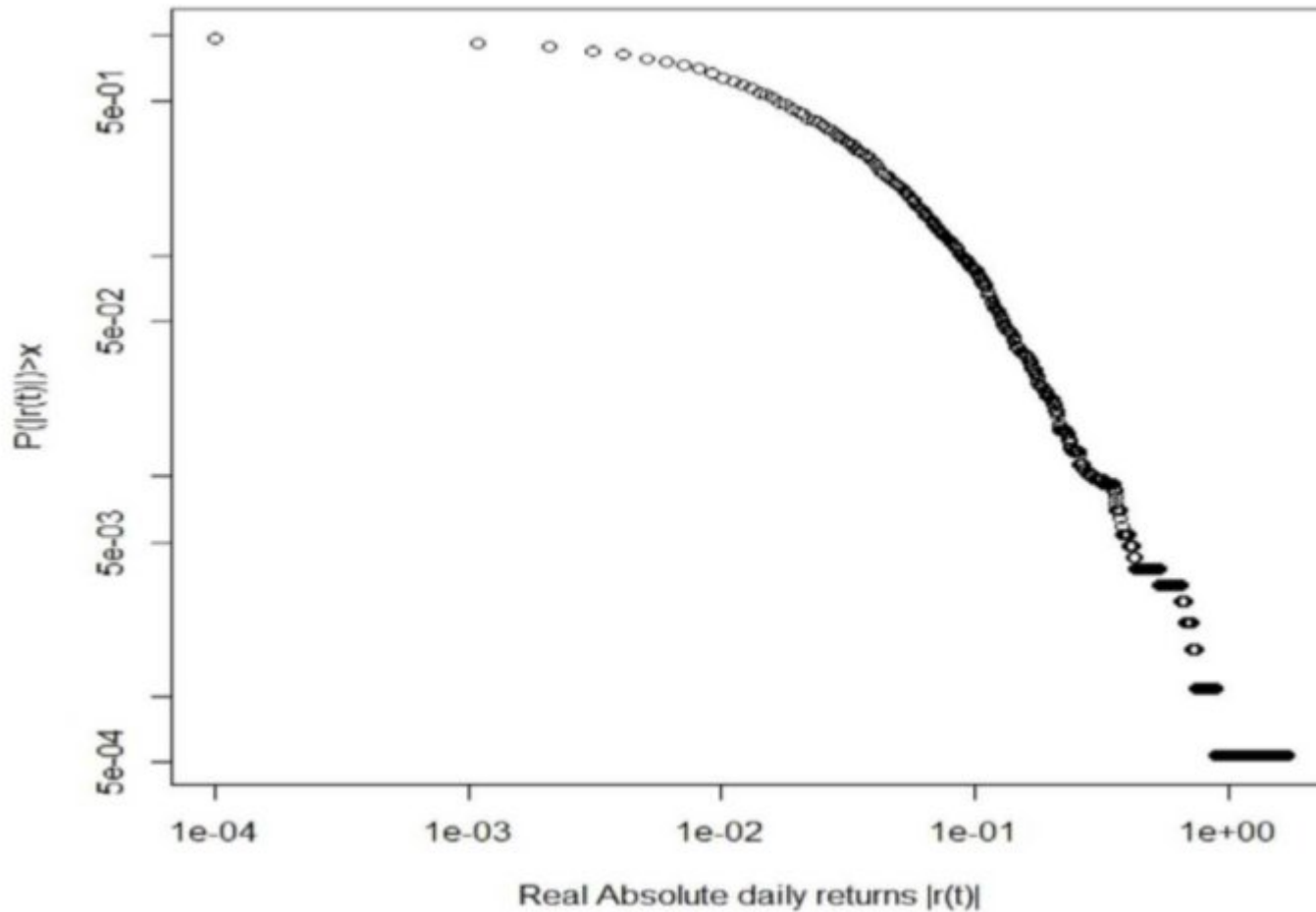
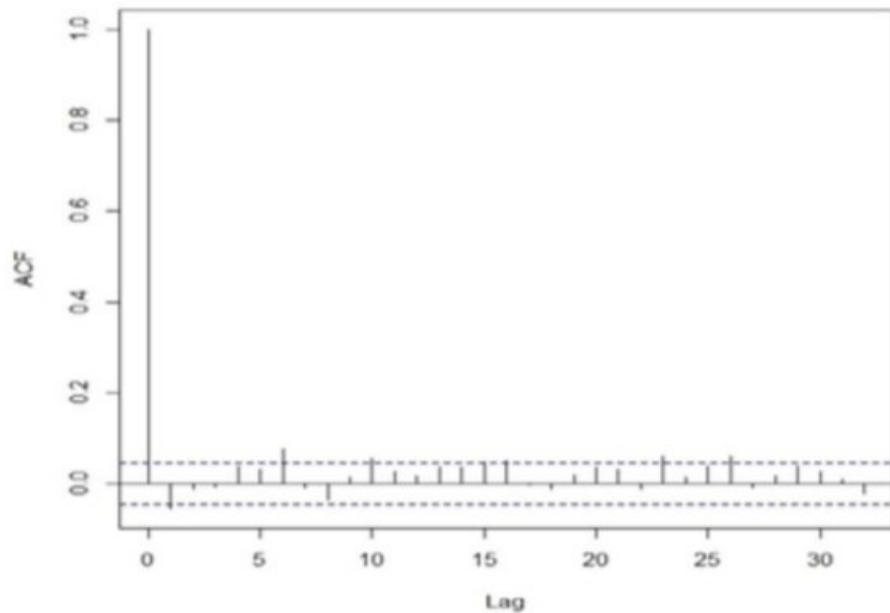
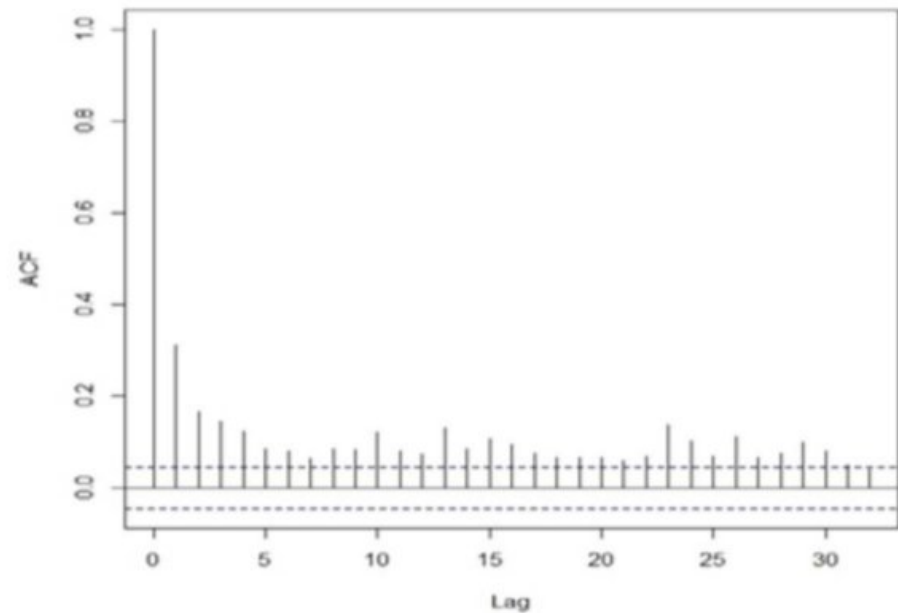


Fig 5. The decumulative distribution function of the absolute returns.

Simulated Bitcoin price returns autocorrelation



A



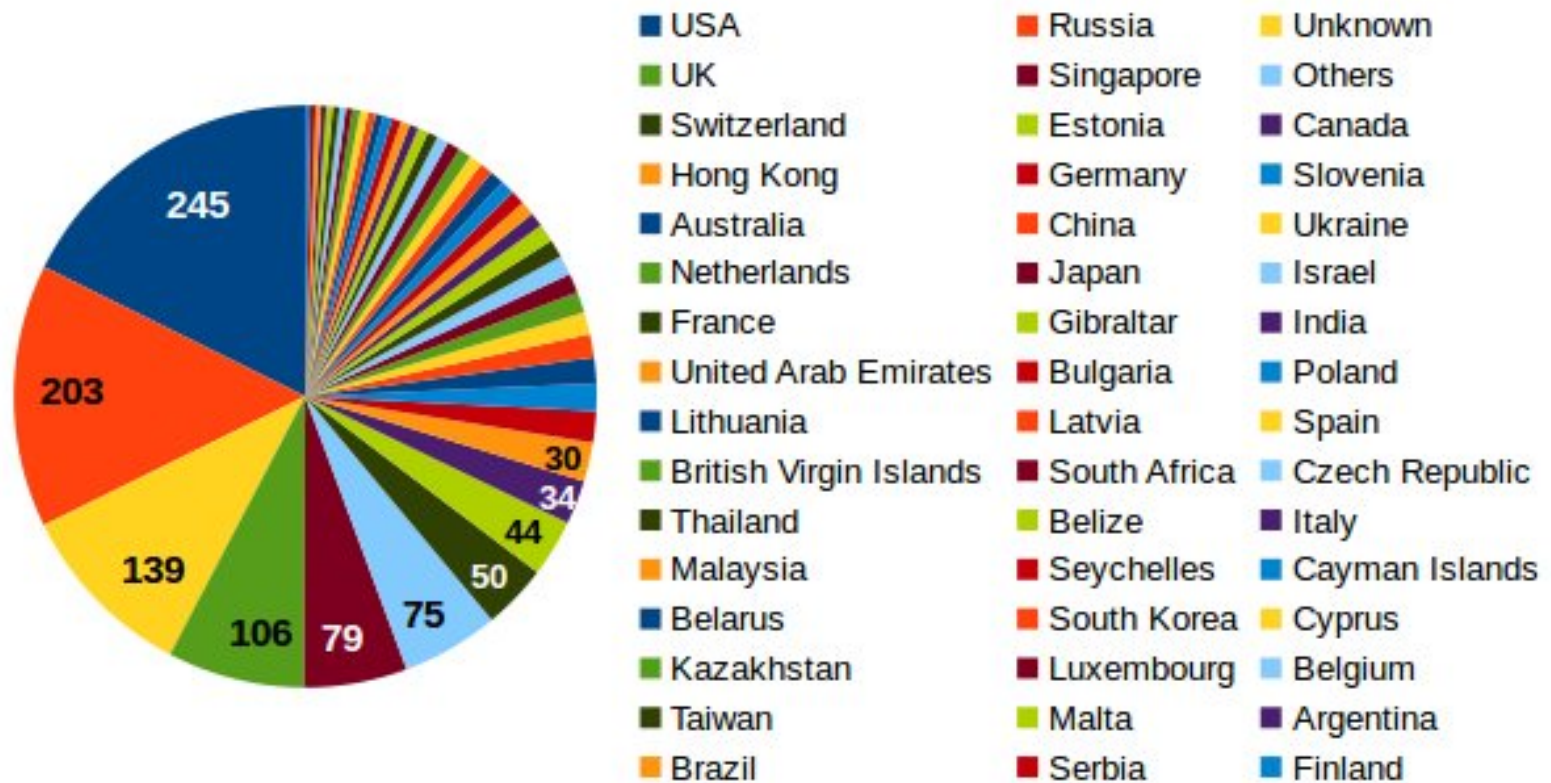
B

Fig 6. Autocorrelation of (A) raw returns, and (B) absolute returns of Bitcoin prices.

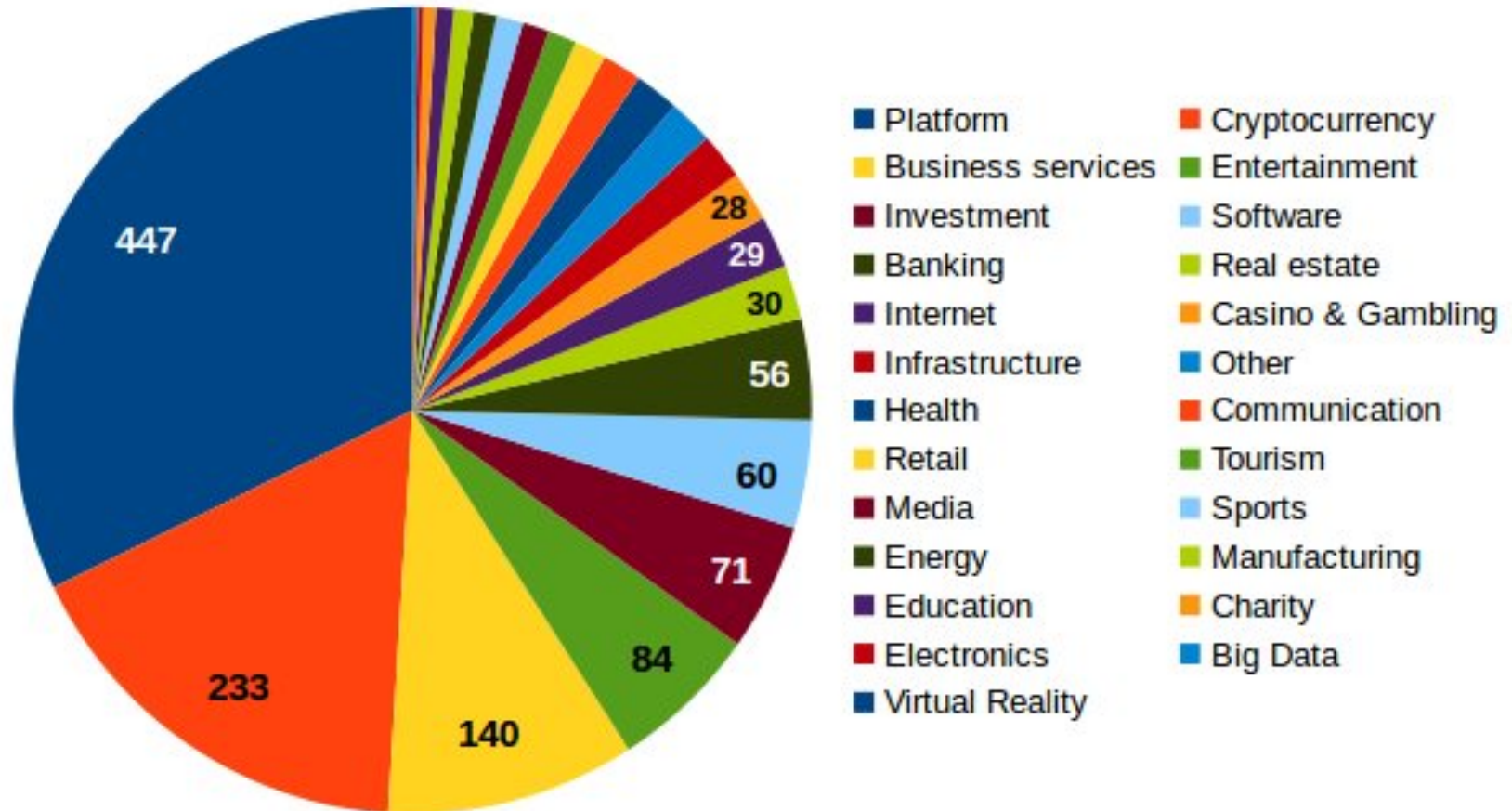
Analysis of ICO features and success factors

- We analyzed 1387 ICOs, gathered on 31/12/2017 from icobench.com Web site
- We added info from coinmarketcap.com (financial data) and from ethplorer.io (Ethereum blockchain data)
- We performed an analysis of the features of the ICOs
- We defined as success factor having gathered more than 200.000 US\$ for ICOs ended within November 2017
- We analyzed the significance of ICO features with respect to the ICO success

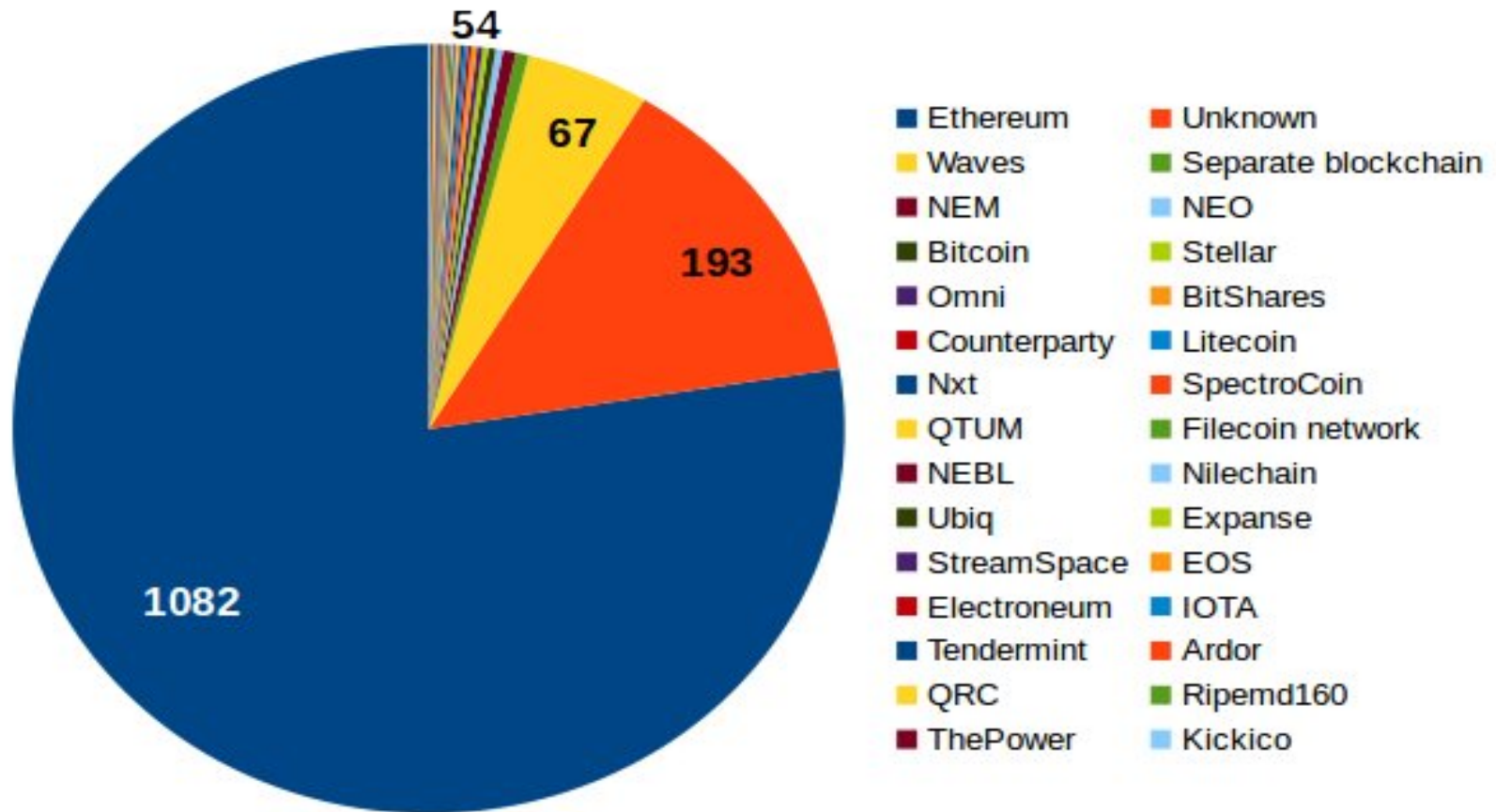
ICO features: countries



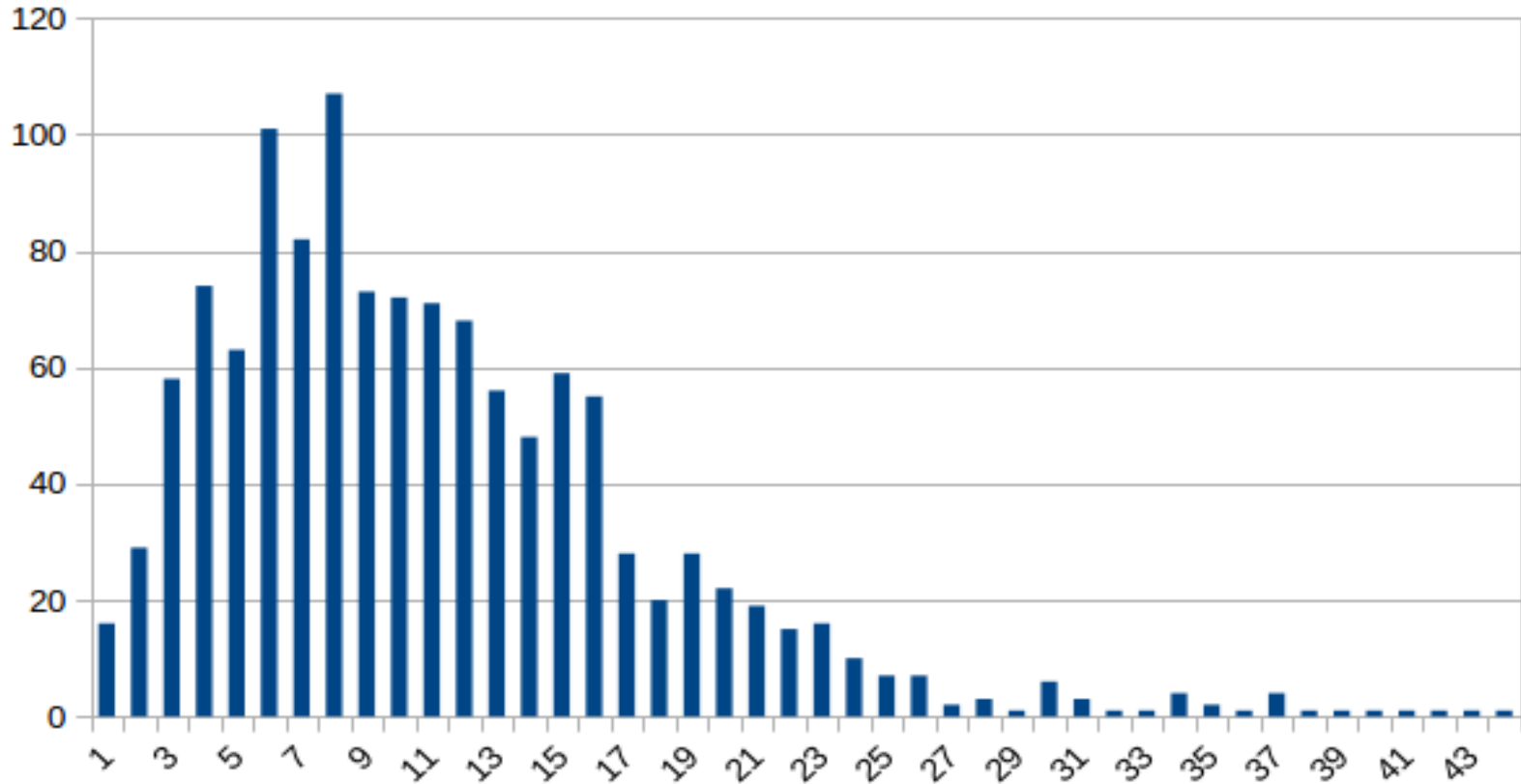
ICO features: main categories



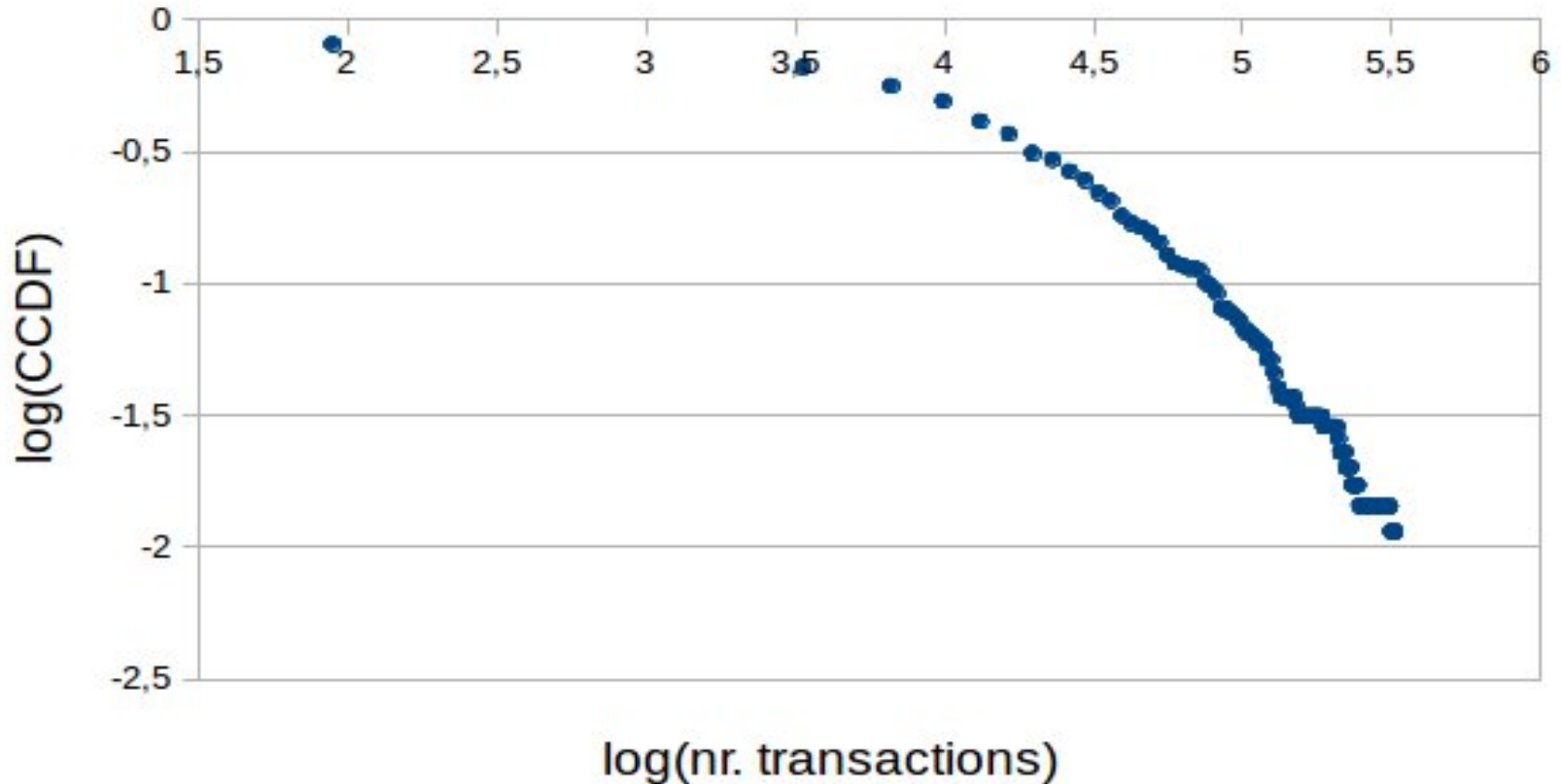
ICO features: platforms



ICO features: team size



ICO features: CCDF of token transfers (ERC-20 on Ethereum blockchain)



Research topics - 2

- Analysis of Blockchain transaction graph using complex network techniques
- Prediction of Bitcoin (and of other digital currencies) price and volume using Sentiment Analysis on social networks
- Prediction of time series, including cryptocurrencies price and volume using:
 - neural networks
 - wavelets

Research topics - 3

- Blockchain-oriented software engineering:
 - applications of software engineering to the issues of analysis, design, development and testing of Blockchain-based systems
- Use of Smart Contracts for data exchange among Public Bodies, using Blockchain and/or specific APIs
- Use of public Blockchains for document notarization, supply chain management and Internet of Things

Blockchain-oriented software engineering

- Challenges
 - New professional roles
 - Security and reliability
 - Software architecture
 - Modeling languages
 - Testing and debugging
 - Tools aiding the modeling and development of Smart Contracts

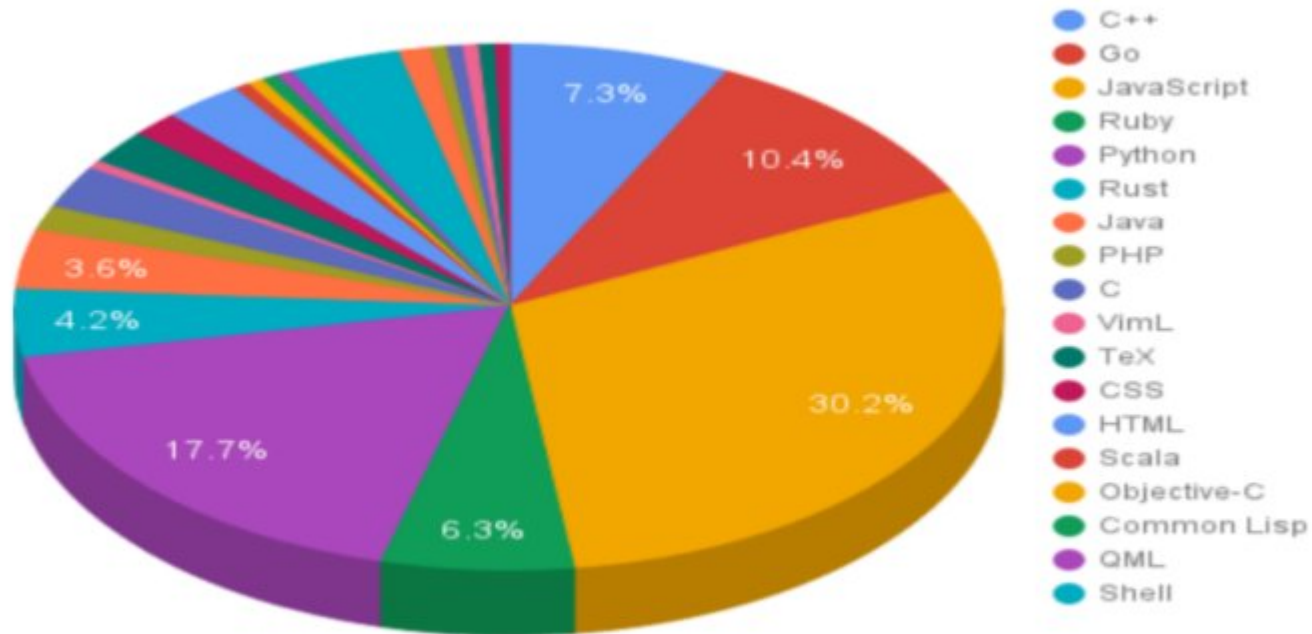
Blockchain-oriented software engineering

In order to define new research directions for the BOSE on the basis of the state-of-practice of blockchain-oriented software, we conducted an exploratory study on a corpus comprising 1184 GitHub software repositories, which were identified with the use of the Moody's Blockchain Report.

GitHub Repository	stargazers	contributors	open issues	age (days)	watchers	forks	first language
bitcoin/bitcoin	9966	396	547	2105	1211	4266	C++
ethereum/go-ethereum	2160	78	285	1002	367	695	Go
ledger/ledger	1813	108	14	3055	103	255	C++
digitalbazaar/forge	1584	41	137	2260	103	241	JavaScript
ripple/ripple-client	1244	51	21	1437	968	486	JavaScript
ethereum/mist	1168	35	198	471	210	299	JavaScript
dogecoin/dogecoin	1153	300	52	1022	149	505	C++
ripple/rippled	1144	53	118	1782	246	338	C++
coinbase/toshi	839	18	97	749	98	187	Ruby
ethereum/cpp-ethereum	723	89	212	1001	196	270	C++

Blockchain-oriented software engineering

Extracted statistics across the top 10 blockchain repositories



Languages across 193 repositories

Publications

- *[Cocco 2015] L Cocco, G Concas, M Marchesi (2015). Using an Artificial Financial Market for studying a Cryptocurrency Market. Journal of Economic Interaction and Coordination, online 16/10/2015, Springer.*
- *[Matta 2016a] Matta, M., Lunesu, I., Marchesi, M. (2015). Is Bitcoin's Market Predictable? Analysis of Web Search and Social Media. International Joint Conference on Knowledge Discovery, Knowledge Engineering, and Knowledge Management, pp. 155-172, CCIS vol. 631, Springer.*
- *[Matta 2015b] Matta, M., Lunesu, I., Marchesi, M. (2015). The predictor impact of Web search media on Bitcoin trading volumes, Knowledge Discovery, Knowledge Engineering and Knowledge Management (IC3K), 7th International Joint Conference, pp. 620-626, IEEE.*
- *[Matta 2015c] M Matta, I Lunesu, M Marchesi (2015). Bitcoin Spread Prediction Using Social And Web Search Media. Proceedings of DeCAT 2015 - 1st Workshop on Deep Content Analytics Techniques for Personalized and Intelligent Services, co-located with UMAP 2015, Dublin.*
- *[Cocco 2016] L Cocco, M Marchesi (2016). Modeling and Simulation of the Economics of Mining in the Bitcoin Market. PLOS ONE 11(10): e0164603. doi: 10.1371/journal.pone.0164603*

Publicazioni

- [Stocchi 2017] *M Stocchi, M Marchesi (2017). Fast wavelet transform assisted predictors of streaming time series. Digital Signal Processing, Elsevier.*
- [Mannaro 2017] *K Mannaro, A Pinna, M Marchesi (2017). Crypto-Trading: blockchain-oriented energy market. 2017 AEIT International Annual Conference, Cagliari, Italy - September 20-22, 2017.*
- [Cocco 2017] *L Cocco, A Pinna, M Marchesi (2017). Banking on Blockchain: Costs Savings Thanks to the Blockchain Technology. Future Internet 9 (3), 25. doi: 10.3390/fi9030025.*
- [Porru 2017] *Porru, S., Pinna, A., Marchesi, M., Tonelli, R. (2017). Blockchain-oriented software engineering: challenges and new directions, Proc. 39th International Conference on Software Engineering Companion, pp. 169-171, IEEE Press.*
- [Pinna 2018] *Pinna, A., Tonelli, R., Orrù M., Marchesi, M. (2018). A Petri Nets Model for Blockchain Analysis. The Computer Journal, 1-15, January 2018, The British Computer Society.*

Organized Events

- *1st International Workshop on Blockchain Oriented Software Engineering, 20 March 2018, Campobasso. Evento di SANER 2018 - 25th IEEE International Conference on Software Analysis, Evolution and Reengineering*
<http://www.agilegroup.eu/iwbose2018/>
- *WETSEB 2018, 1st International Workshop on Emerging Trends in Software Engineering for Blockchain. 27 May 2018 – Gothenburg, Sweden. Evento di ICSE 2018 – 40th Int. Conf. on Software Engineering*
<http://www.agilegroup.eu/wetseb2018/>
- *Vari seminari su Blockchain a Cagliari*

Research projects ongoing, funded or proposed

- *AIND: Amministrazioni e Imprese Native Digitali, con FlossLab srl, DISSI e DSEA – PIA financed by Regione Sardegna*
- *SardCoin: a token for tourism in Sardinia, financed by Sardegna Ricerche*
- *Innovation projects financed by Sardegna Ricerche:*
 - *Easy Wallet, with TrustMyPhone srl*
 - *CAFCHA, with FlossLab srl*
 - *CryptoTrading, with SelfieWealth srl*
 - *Bertulas, with Strateghia srl*
- *Various projects on call PON of MIUR, deadline 11/2017*

Teaching

Courses of Computer Science Master degree

- 2 courses with Blockchain and Smart Contracts in their program:
 - Cybersecurity: 6 CFU
 - Advanced Programming Techniques: 6 CFU
- Reading courses: 6 CFU each
 - Cryptocurrencies and smart contracts
 - Advanced software engineering (Blockchain-Oriented Software Engineering)