

iExec

iExec: Towards Decentralized Cloud Computing

Seminario Ugo Bordoni
Rome, Italia, 23 Mai, 2019

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Agenda

Historical view of distributed/volunteer/Grid computing

Blockchain-based decentralized marketplace

iExec architecture

Use-cases

Conclusion





From **distributed** to **decentralized**
computing

A not so new idea...

*We described a computational model based upon the classic science-fiction film, **The Blob**: a program that started out running in one machine, but as its appetite for computing cycles grew, it could reach out, find unused machines, and grow to encompass those resources. In the middle of the night, such a program could mobilize hundreds of machines in one building; in the morning, as users reclaimed their machines, the “blob” would have to retreat in an orderly manner, gathering up the intermediate results of its computation. (This affinity for night-time exploration led one researcher to describe these as “vampire programs.”)*

(John F. Shoch and Jon A. Hupp, 1982)



Evolution of distributed computing 90's-00's

P2P

Free to join
Anonymous
Unmanaged
Scalable
Resilient
File sharing

Grid Computing

network of clusters/HPC
Managed
Identity/security
High Throughput
Computing

Cloud

Commercial
Virtualization
IaaS/PaaS/SaaS
Web application
Big Data

Desktop Grid: loosely coupled distributed computing infrastructures

- managed, secure, scalable, programmable, efficient, resilient



Blockchain and Dapps

1st generation blockchain (Bitcoin)

- Distributed Ledger: immutable, secure, consensus

2nd generation blockchain (Ethereum)

- programmable: smart contract, tokens

Dapp (decentralized application)

- autonomous, censorship resilient, unstoppable



Decentralized marketplace (DeX)

Emerging solution for implementing decentralized exchange to trade cryptocurrencies

Implemented on top of public blockchain

- direct P2P interactions
- no trusted party: consensus on-chain

Free market: anyone can join, as long as they accept the governance rules





Decentralized cloud computing

Blockchain-based Decentralized Cloud Computing

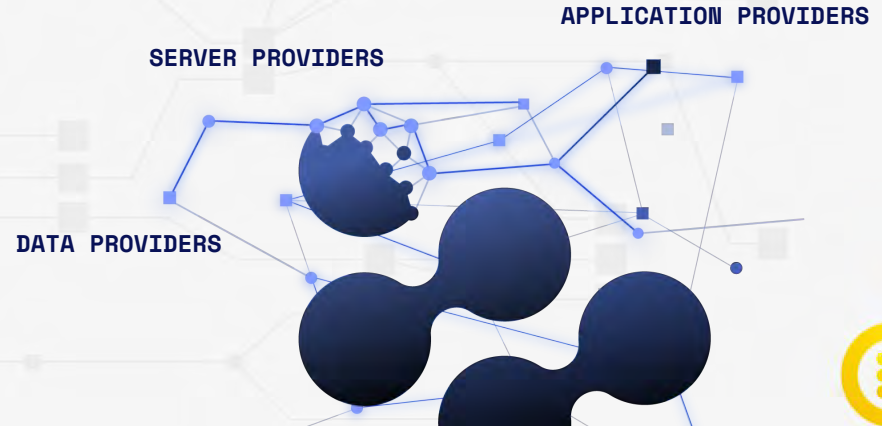


iExec

- **Decentralized marketplace** for computing resources (servers, applications, datasets)
- Use Ethereum to advertise/provision computing resources
- Providers can interact in a P2P way, without central authority

Why Does it Matter ?

- Decentralized applications need an infrastructure
- Cheaper, greener, more efficient than traditional centralized Cloud



For Which Applications ?

- Blockchain-based Distributed Application (Dapps)
 - iExec provides access to off-chain computing resources:
 - servers (CPU & GPU), applications, data-sets
- Legacy applications
 - High Performance Computing (HPC), Big Data
 - Simulations, 3D rendering, bio-medical research, analytics, machine learning, finance, business intelligence scientific computing, etc...
- Emerging distributed applications
 - when the centralized Cloud becomes the bottleneck !
 - IoT + Big Data, Fog/EDGE Computing, micro-services, distributed machine learning, ambient IA, VR,, and more...



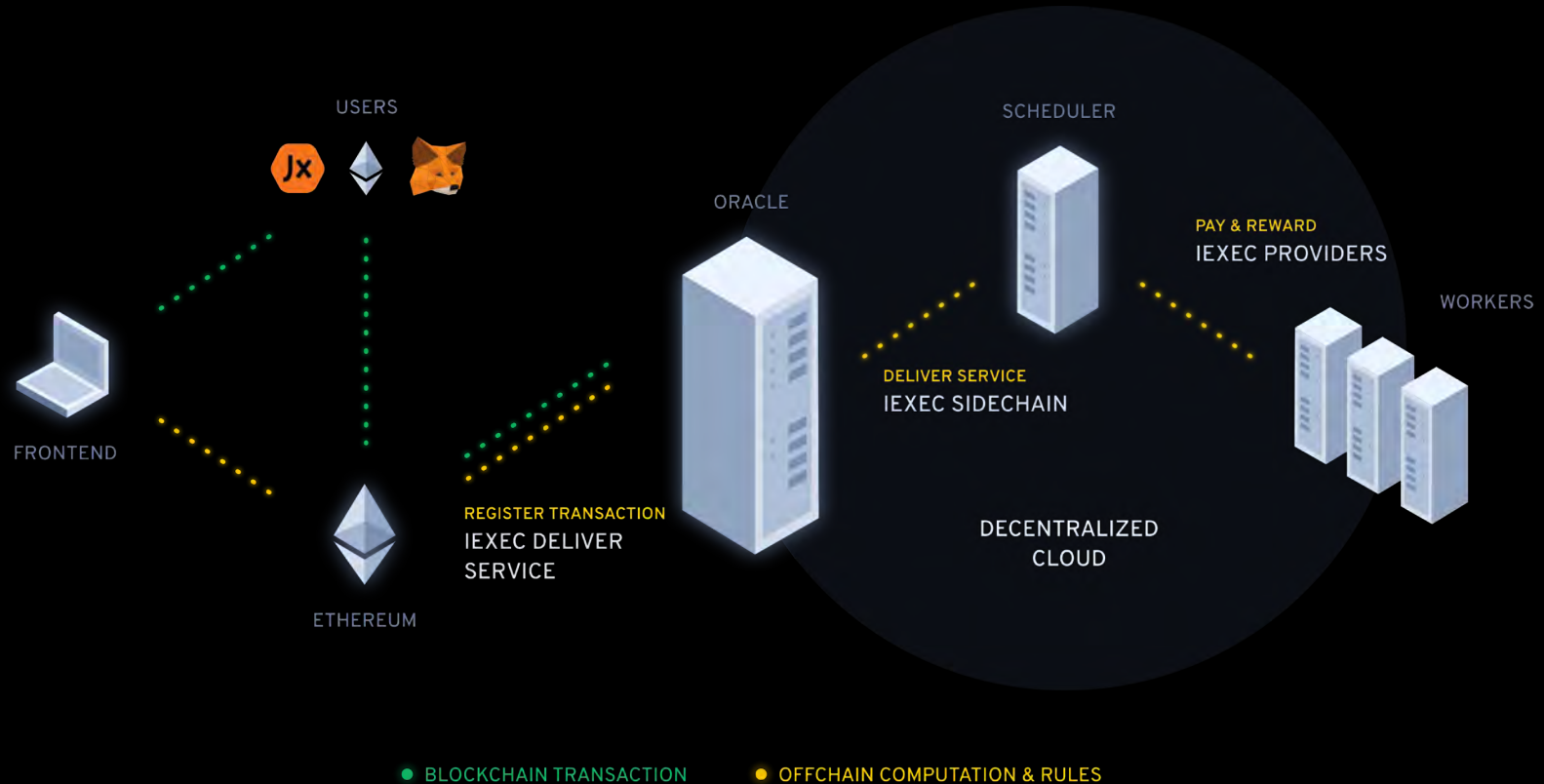
The iExec Token: RLC

Token usage

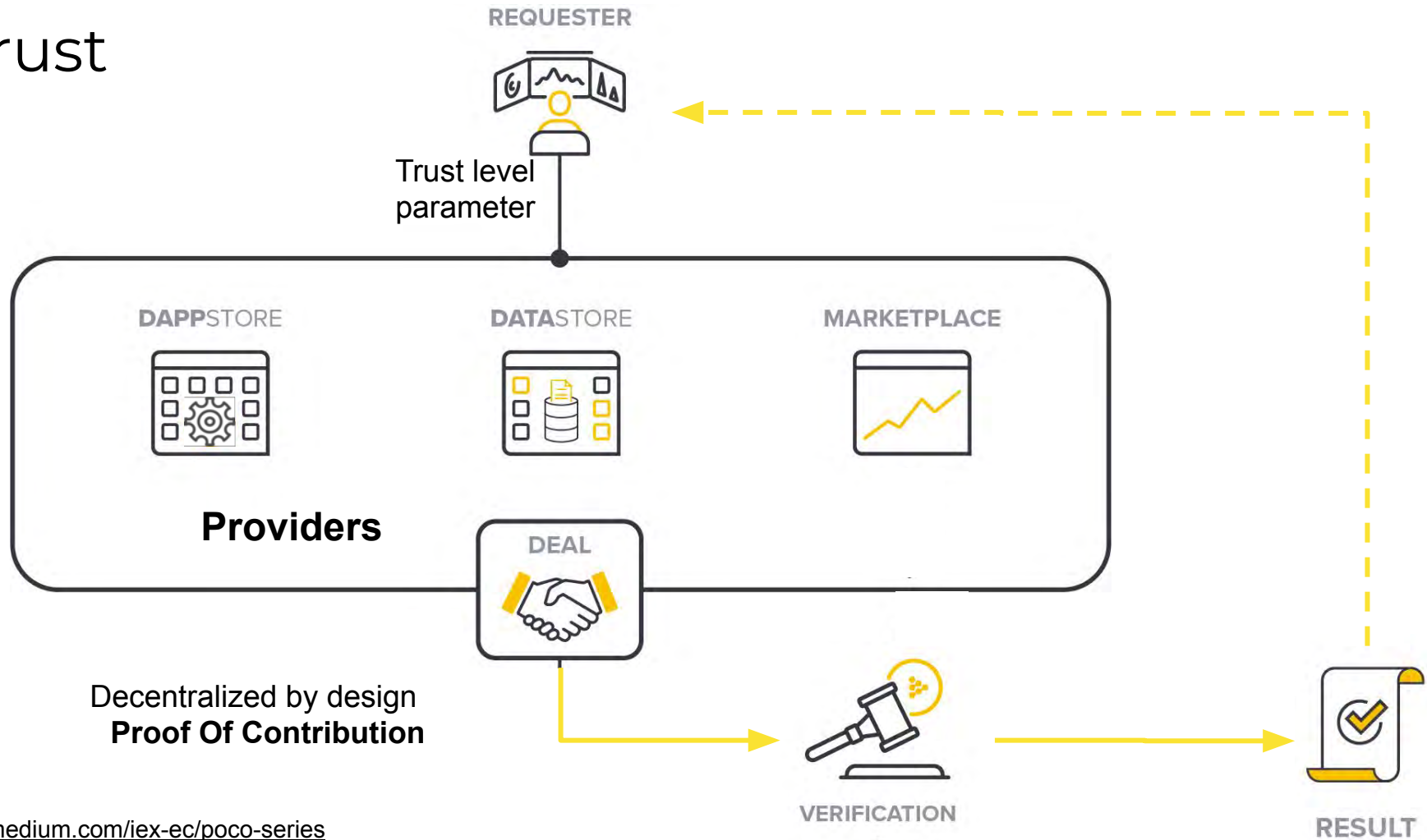
- The RLC Token is the only way to access the iExec decentralized cloud
 - Providers are paid with RLC
 - Allows to build incentives in the network.
-
- Issued on main net on April 2017



Provides Dapp an Infrastructure for Off-chain Execution



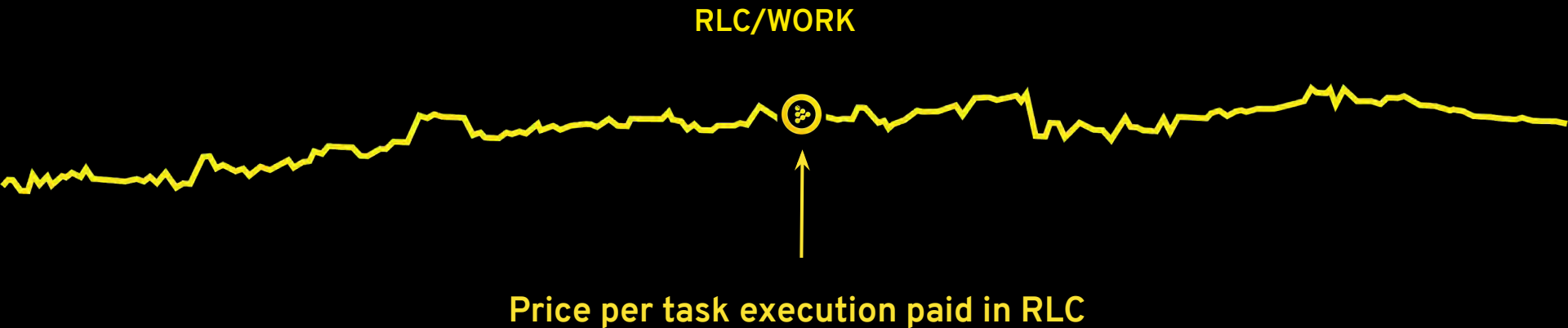
Trust



Marketplace for Computing Power

Allows to trade **computing power as a commodity**

Allows companies and individuals to **monetize their servers/PCs**



XS

S

M

L

XL

TEE ☐CUDA ☐Trust ☐

nRLC/Task

80

75

70

65

60

55

50

45

40

35

30

25

20

15

10

5

Order Book

Hash	Price	Worker...	Trust	Volume
0xd3ed3...	13	0xCa7c0...	1	
0x85df95...	13	0xCa7c0...	1	
0x2f28a8...	10	0xCa7c0...	1	
0xef885f...	10	0xCa7c0...	1	
0xe26e5...	10	0xCa7c0...	1	
0xeb079...	10	0xCa7c0...	1	
0x8b1fdb...	10	0x9B919...	1	
0x9e4da...	10	0xCa7c0...	1	
0x0828a...	10	0xCa7c0...	1	
Last price: 33 nRLC ↑				
0x3ce83...	7	0xF048e...	0	1

Recent Trades

ID	Price	Time	Worke...	Volume
0x5c17...	33	10:11:40	0x9B9...	1
0x153b...	11	10:08:52	0xCa7...	1
0x862d...	28	09:42:24	0x9B9...	1
0xf8f8d...	16	09:40:20	0xCa7...	1
0x87f5...	10	09:14:12	0x9B9...	1
0x67c2...	18	09:12:16	0xCa7...	1
0xd056...	27	08:47:52	0x9B9...	1
0x0979...	18	08:44:28	0xCa7...	1
0x8285...	12	08:21:52	0x9B9...	1
0x5c05...	19	08:19:52	0xCa7...	1
0xbede...	37	08:00:44	0x9B9...	1
0x8ba4...	15	07:57:32	0xCa7...	1
0xfa04...	37	07:30:24	0x9B9...	1
0x4f2e...	11	07:27:20	0xCa7...	1
0xdaab...	25	07:05:24	0x9B9...	1
0x8ab9...	17	07:01:20	0xCa7...	1
0xa7a4...	13	06:39:28	0x9B9...	1
0xf580...	14	06:37:32	0xCa7...	1
0x2b91...	25	06:15:16	0x9B9...	1
0x444e...	17	06:10:44	0xCa7...	1

My Trades

My Open Request Orders

My Open Workerpool Orders

ID	Price	Time	Workerpool	Volume
0xd18f64e536df9cfee4c85ae2b790fbc...	10	14:18:00	0xCa7c0e9a96666bC3636f3d3E8480...	1
0xd71b06b8ea058192a78036b2cab9...	10	17:45:48	0xCa7c0e9a96666bC3636f3d3E8480...	1
0xf155166a1e7f2c06965ec0c001010...	10	17:27:24	0xCa7c0e9a96666bC3636f3d3E8480...	1
0xdd4b1ca055a547a46530a0ccec524...	10	07:37:04	0xCa7c0e9a96666bC3636f3d3E8480...	1
0x9c6c4214c7ce1a498e1a51fbc828...	10	00:32:44	0x9B919d74f8E149C33343AD305695...	1
0x1a5c8181672ba73c08f94313399c9...	10	00:27:04	0xCa7c0e9a96666bC3636f3d3E8480...	1

Fill Market Order

Place Limit Order

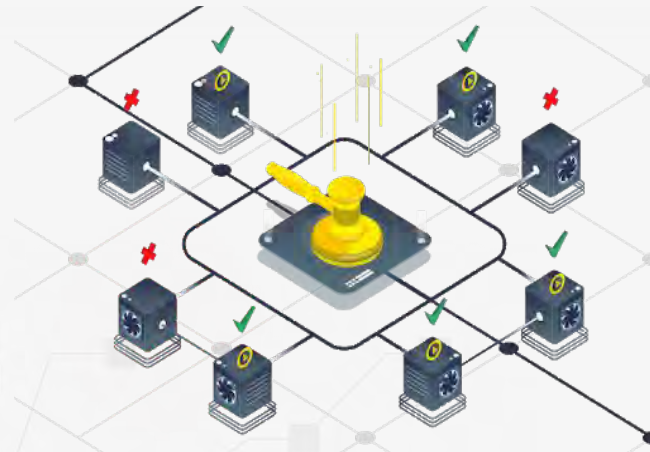
Order Hash: *	<input type="text" value="0x0828aa3c7446f21464d4219da7c2f"/>	Request Order Hash:	<input type="text" value="0x3ce83e3afc62ba48d42703d48"/>
Dapp Address: *	<input type="text" value="or name..."/>	Volume: *	<input type="text" value="1"/>
Dataset Address: *	<input type="text" value="or name..."/>	Workerpool address:	<input type="text"/>
Work Params: *	<input 0\":\"\"}"="" type="text" value="{\"/>	<input type="button" value="Sell computation at market price"/>	

Advanced parameters

Proof-of-Contribution

staking + reputation + result certification:

- A confidence threshold is associated with each requested execution
- Workers have a reputation
- Before executing a task, workers commit a security deposit (stake)
- The execution confidence threshold is computed by comparing results and computing a function of the credibility and stake
- Task is duplicated as long as the confidence threshold is not met
- Workers who computed an erroneous results loose their stake
- Workers who correctly compute gains the payments + the losers' stake
- Reputation is adjusted



iExec End-to-End Trusted Execution with Intel SGX



Enclaves: Confines execution and data within a encrypted environment: no one can access/tamper the execution

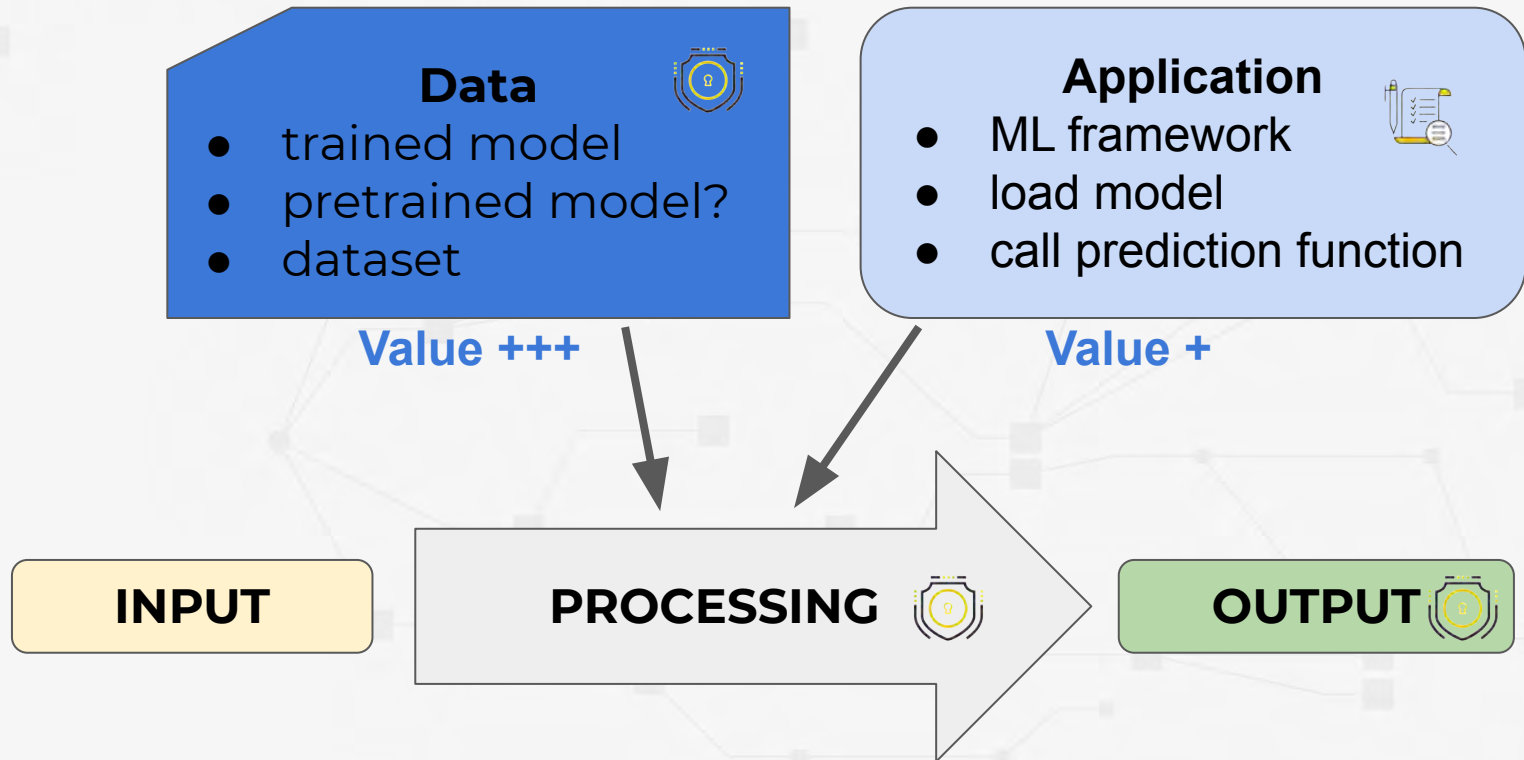
- SDK that provides full end-to-end privacy preserving computation
 - for application/input/results
 - guarantee execution integrity
 - provide on-chain enclave execution attestation



The background is a dark gray to black gradient, overlaid with a complex, abstract network of thin, light gray lines. These lines connect numerous small, semi-transparent gray circular nodes, creating a web-like structure that fills the entire frame. The density of the connections is higher in some areas, particularly towards the top and right, while other areas are more sparse. The overall effect is one of a dynamic, interconnected system.

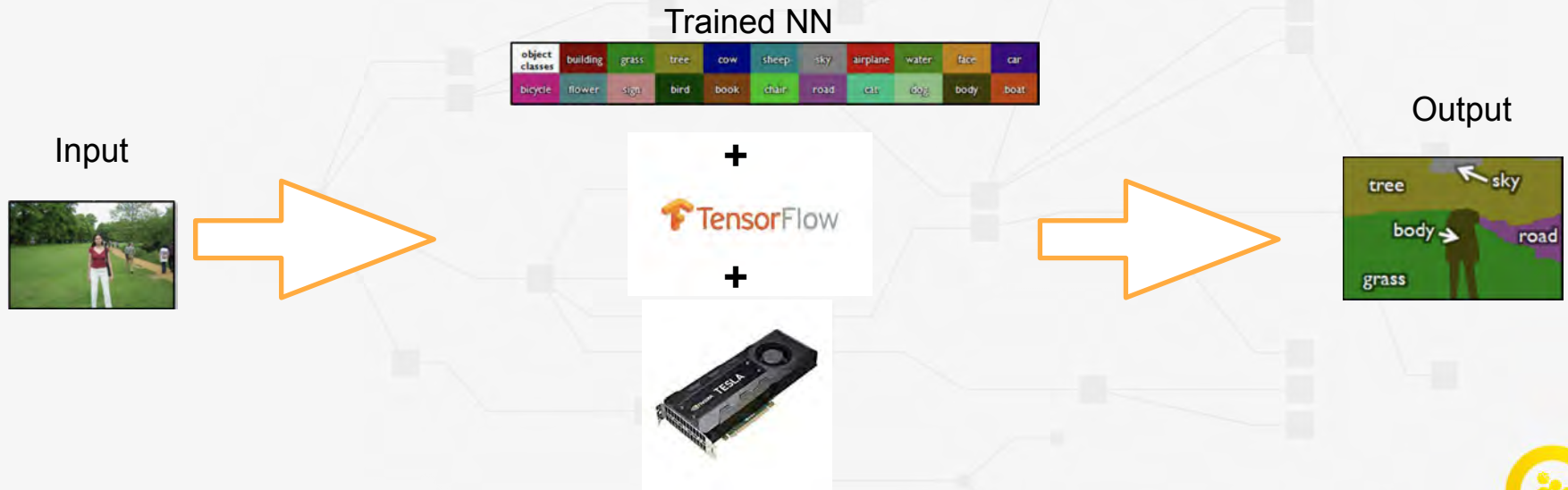
Use Cases

The data renting concept



Data Wallet: Monetize AI model

Possible thanks to Trusted Execution



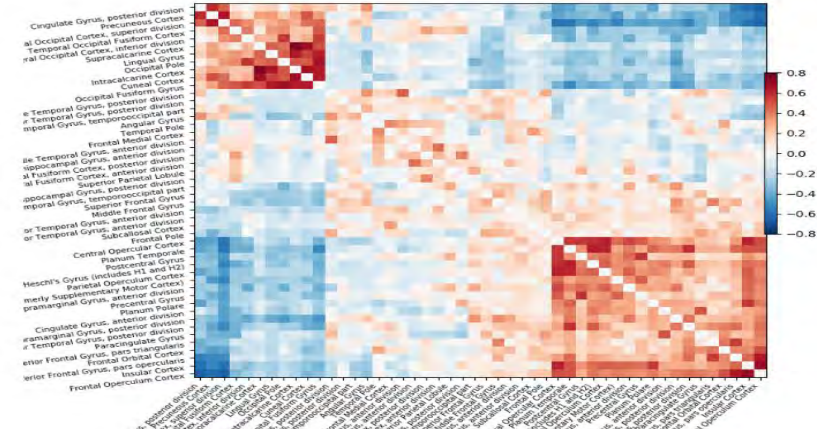
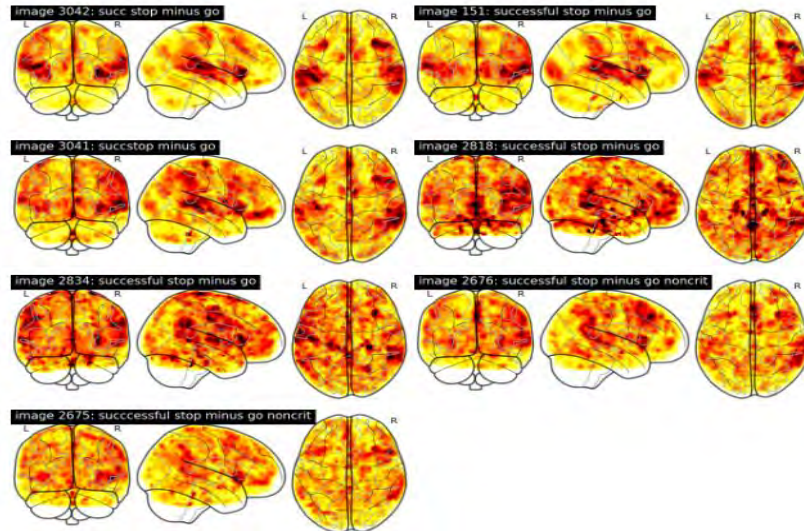
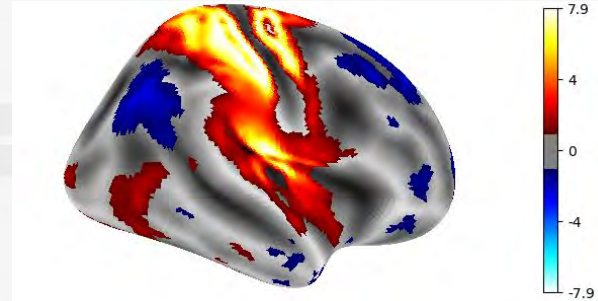
Use-case: Semantic Image Segmentation with Convolutional Neural Net



Nilearn: a framework from Neuro imaging

Demo RSAConference 2019: brain scans with diagnostics.

Privacy preservation for data and **requester**.



The background is a dark gray field filled with a complex, interconnected network of thin white lines. These lines connect numerous small, semi-transparent white circular nodes. The nodes are distributed across the frame, with some appearing as isolated points and others as part of larger, more dense clusters. The overall effect is one of a digital or molecular structure, possibly representing a data network or a complex system. The word "Conclusion" is centered in the middle of the image, rendered in a clean, white, sans-serif font.

Conclusion

Decentralized Cloud Computing

iExec:

- Stack of decentralized technologies to trade computing resources
- Tokeneconomics

Perspective:

- Fog/Edge infrastructure

