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## Keynote speech



**The Metaverse: Paradigm, technologies, quantum strategies, intelligent smart avatar and digital clone and consumer behaviour, AI digital cloning & clones, Metaverse analytics, Metaverse memory recalling, and cyber security & survivability**

**By Shuliang Li, University of Westminster, I&I&I, England, UK**

**The 10th International Conference on Information Management (ICIM 2024), Robinson College, the University of Cambridge, Cambridge, England, United Kingdom, 8-10 March, 2024.**



# The 10th International Conference on Information Management (ICIM 2024), Robinson College, the University of Cambridge, Cambridge, England, UK, 8-10 March, 2024.





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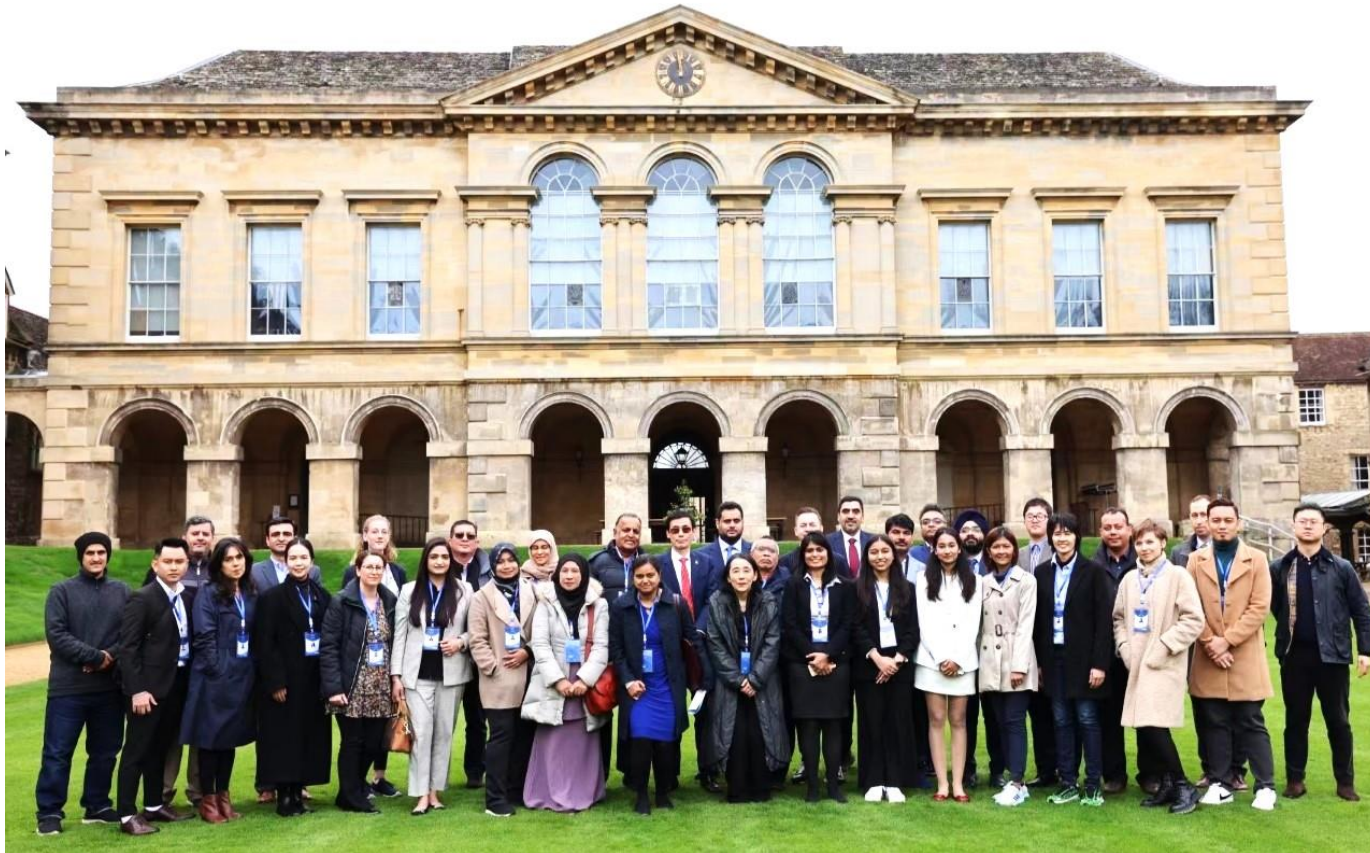
**Fellow (Life member) of the British Computer Society**

**Reader, University of Westminster, London, England, UK**

**Sichuan 100 Talents Scheme Expert, China**

**Director of Information & Innovation & Inspiration Ltd (UK)**

**He has published about 100 items**




# Overview



- Framework/paradigm & applications of the Metaverse
- Supporting technologies
- Avatars, digital clones and cloning
- Strategies & quantum strategies
- Consumer behaviour across the worlds of the Metaverse
- Metaverse analytics & examples
- Memory recall, and good & bad memories of the Metaverse
- Metaverse security

The **Metaverse** is an Internet and computer-based, and socially connected networking space of three-dimensional augmented virtual-reality worlds (*Definition by Shulaing Li, University of Westminster, 2022*)





Connection is evolving  
and so are we.



Otherside: Everything to Know About  
the BAYC's Metaverse

Visit >



Avatars In The Metaverse World Of The  
Sandbox Land In The Sandbox Through ...

Visit >





Roblox: How the children's game becam...

■■■ BBC



# The Metaverse: Framework/paradigm & applications

- ❑ Mark Zuckerberg Meta
- ❑ Immersive
- ❑ Digital (& future quantum) avatar and/or clone engagement dynamics
- ❑ 3D interactions with haptics
- ❑ Sustainability
- ❑ Entrepreneur
- ❑ Open innovation
- ❑ The Metaverse for business, finance, games, music, events, showcase and more
- ❑ Branding in the Metaverse
- ❑ Brand virality
- ❑ Avatar or clone consumer behaviour, conversion funnel, purchase, shopping, deshopping, unethical returns, etc.
- ❑ The Metaverse for education

**AI digital cloning for the Metaverse for games, e-commerce, business, education medicine, etc.**

**AI digital clones**

**Digital clone behaviour**

**(The digital twins)**



**AI cloning is poised to become the next big thing in the technology sector**  
Credit: Getty

**The source of the picture:**

**<https://www.thesun.co.uk/tech/25087045/metaverse-cloning-tech-ai-virtual-games/>**

A simplified illustration example of random user engagement simulation for a branded content is shown in Figure 1. Persons in green color are engaged across the social networks, while the white ones are the disengaged and the yellow icons are the reached. Netlogo software tool and multiple software agents, called Turtles, are coded and created to produce the illustration and simulation with graphical animation.

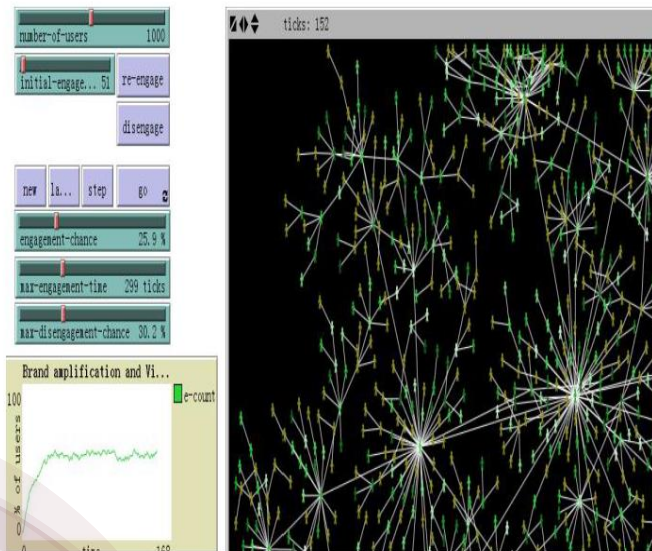
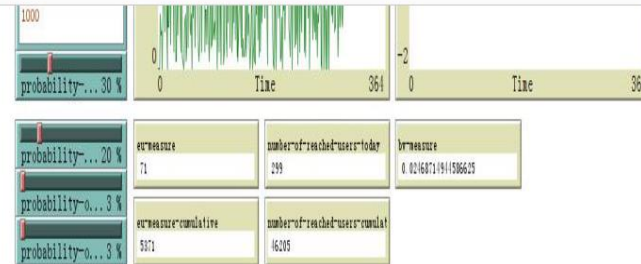


Figure 1. The screenshot for simulation of user engagement with dynamically displayed animation



Brand vitality over social media  
By Jiao Zhang Li & Shuliang Li, United Kingdom

Figure 2. The screenshot for simulation of the brand vitality

## V. THE USE OF FUZZY LOGIC IN ASSESSING THE EFFECTIVENESS AND EFFICIENCY OF BRAND VIRALITY

### A. Fuzzy logic and the space of the variables affecting brand vitality in social media

'A fuzzy set is a class of objects with a continuum of grades of membership' [12, page 338]. Let  $U$  be a universe of discourse, a collection of objects  $\{u\}$ . A fuzzy set  $A$  in  $U$  is characterized by a membership or compatibility function  $\mu_A$  taking values in the interval  $[0, 1]$ .  $A$  in  $U$  is represented as [13, 15]:

$$A = \{ (u, \mu_A(u)) \mid u \in U \} \quad (2)$$

Based upon Fung et al [16]'s work, the set of

**An example of brand virality  
(Li, Shuliang, et al., IEEE conference proceedings, 2015)**

# Supporting technologies

- ✓ Intelligent digital avatars (quantum avatars in the future)
- ✓ Smart bots, AI bots, live person bots, **avatars, digital clones**
- ✓ Augmented virtual reality
- ✓ Machine learning, artificial intelligence
- ✓ AI & technologies for haptics, emotion, etc.
- ✓ VR glasses etc.
- ✓ Blockchain – secured, decentralized, internet-enabled, electronic ledger
- ✓ Cryptocurrency, bitcoin
- ✓ Mark Zuckerberg's meta AI
- ✓ Elon Musk's neuralink chips connected to the Metaverse?
- ✓ Big data, **avatar & digital clones behaviour, analytics & memories**
- ✓ Leading Chips (CPU), e.g. Cambridge ARM Cortex, Intel Core
- ✓ Security support (e.g. Karvinen, Tero & Li, Shuliang: Hidden masters security framework & algorithms for client-server computer network architecture dealing with hacking & attacks)

# Strategies

- ❖ Mintzberg: Innovation perspective
- ❖ Porter: Differentiation, uniqueness
- ❖ Social networking strategies
- ❖ Metaverse 4Ps marketing strategies
- ❖ Branding strategies
- ❖ Sustainability strategies
- ❖ Big data strategies
- ❖ Quantum entanglement strategies
- ❖ Quantum superposition strategies
- ❖ Quantum computing strategies

# Superposed quantum strategies

By Shuliang Li, University of Westminster

## Examples



# Quantum entanglement strategies for Metaverse interactions



By Shuliang Li, University of Westminster





## Calculate the initial state

The quantum formulation evolves by assigning the output of the classical strategies  $D$  and  $C$  to two vectors,  $|C\rangle = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$ ,  $|D\rangle = \begin{pmatrix} 0 \\ 1 \end{pmatrix}$ , where  $|C\rangle$  and  $|D\rangle$  are in the Hilbert space. In each case, the state of the game is denoted by a vector in tensor product space that is crossed by the classical game basis  $|CC\rangle$ ,  $|CD\rangle$ ,  $|DC\rangle$ ,  $|DD\rangle$ . Here it is supposed that suppliers and beneficiaries started with  $|CC\rangle$ . Consequently, qubits  $|C\rangle \otimes |C\rangle$  go through an entangling gate  $\hat{J} = \exp(i\gamma \hat{D} \otimes \hat{D} / 2)$ , which is a reversible two-bit gate with  $\gamma \in [0, \pi/2]$ .

# Quantum entanglement & entangling gate

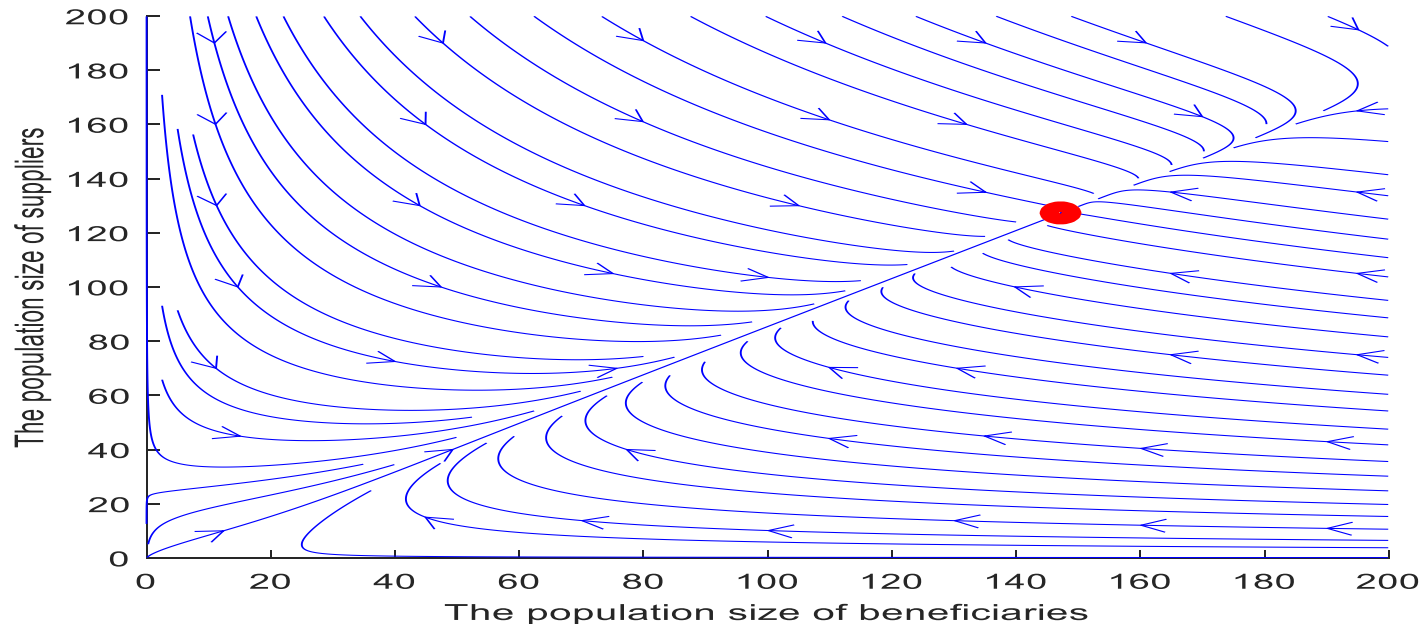
$$\hat{J} = \exp(i\gamma \hat{D} \otimes \hat{D} / 2) = \exp\left(i\gamma/2 \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix} \otimes \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}\right) = \begin{pmatrix} \cos\left(\gamma/2\right) & 0 & 0 & i\sin\left(\gamma/2\right) \\ 0 & \cos\left(\gamma/2\right) & -i\sin\left(\gamma/2\right) & 0 \\ 0 & -i\sin\left(\gamma/2\right) & \cos\left(\gamma/2\right) & 0 \\ i\sin\left(\gamma/2\right) & 0 & 0 & \cos\left(\gamma/2\right) \end{pmatrix}$$

**Source:**

**Li, S. and Huang, D., 2017. Hybrid Quantum Games. Working paper, the University of Westminster, London, UK. October 2017. Westminster Research Repository.**

**Huang, D., Delang, C.O., Wu, Y. and Li, S., 2021. An Improved Lotka–Volterra Model Using Quantum Game Theory. *Mathematics*, 9(18), p.2217.**

# Interactions and the equilibrium point

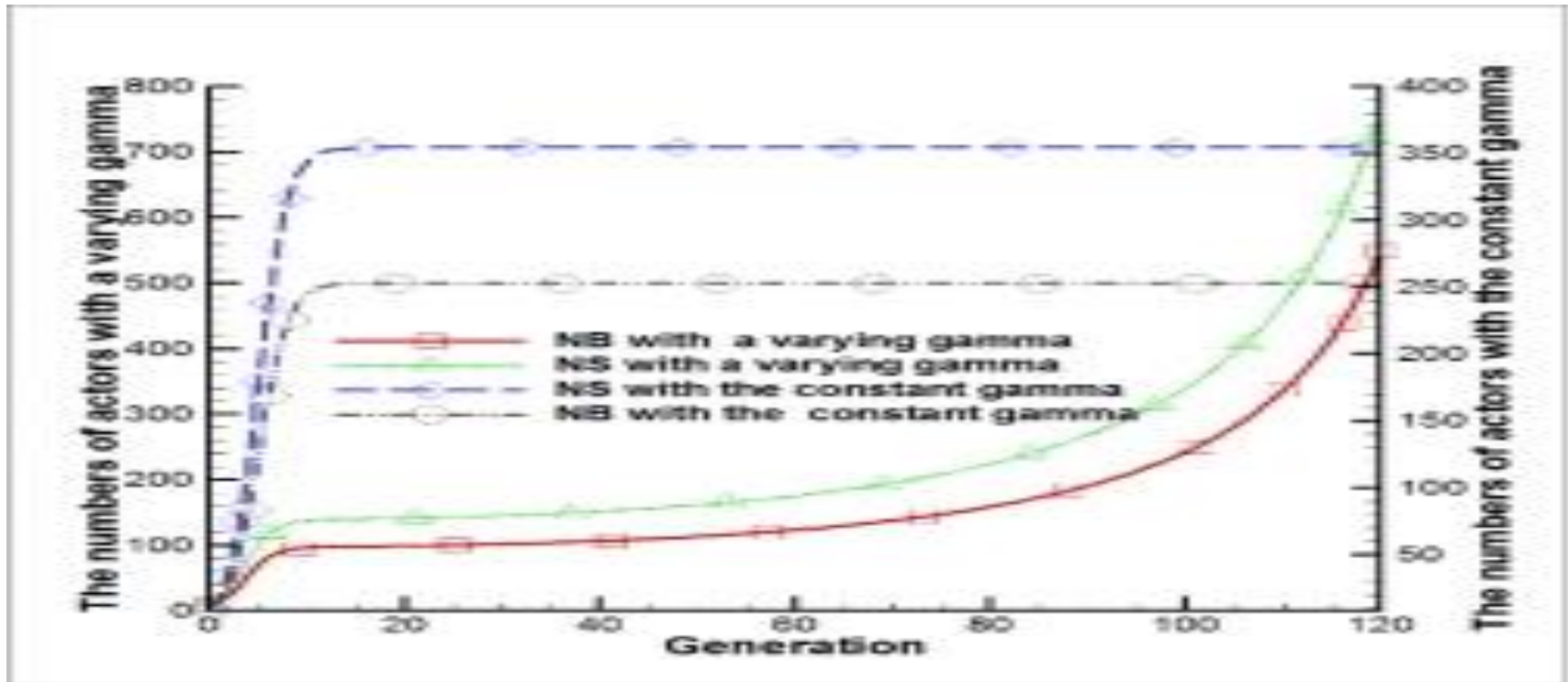


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**The numbers of different actors in the scenario with a constant or varying gamma between the suppliers/vendors and the beneficiaries/digital avatars/customers**



**Source:**

**Li, S. and Huang, D., 2017. Hybrid Quantum Games. Working paper, the University of Westminster, London, UK. October 2017. Westminster Research Repository.**

**Huang, D., Delang, C.O., Wu, Y. and Li, S., 2021. An Improved Lotka–Volterra Model Using Quantum Game Theory. *Mathematics*, 9(18), p.2217.**

**The Otherside, Sandbox,  
Decentraland, Roblox, etc.**  
encourage and give the freedom,  
flexibility, the power of  
customisation and creativity to the  
players, the consumers. Examples:  
The user's creation of her/his own  
avatars, digital assets, etc.

# **Consumer behaviour across the worlds of the Metaverse**

**(By Shawkat Rahman & Shuliangn Li, U. Westminster)**

**For example:**

**Multi-Agent-Based Modeling  
of Deshopping Behavior  
Considering Two or More  
Shops/stores or sites or  
worlds**

# Consumer behaviour in the Metaverse: Shopping & deshopping

## Multi-Agent-Based Modeling of Deshopping Behavior Considering Two or More Shops or worlds of the Metaverse

By **Shawkat Rahman & Shuliang Li, University of Westminster**

Rahman, Shawkat & Li, Shuliang (2023). Multi-Agent-Based Modeling of Deshopping Behavior Considering Two or More Shops or Web Sites. *The 9th International Conference on Information Management (ICIM2023)*. The University of Oxford, Oxford, England, UK 17 - 19 Mar 2023 IEEE conference proceedings.

Interface Info Code

Edit Delete Add  || normal speed ||  view updates on ticks || Settings...

ticks: 0

Setup Go

These are the Global Settings

shopperz - How many shoppers  
deshopperz - How many deshoppers  
max-group-size - Max number in a social group

These are the variables for the individual shops  
Need has to be more than their corresponding min values

Return Parameter  
refund-lenency score is a weighted score of return policy  
lenency  
return-ratio % of items returned to retailer  
recovery value - Product value recovered

These are the sliders for individual stores Strategy

- churn-limit: Amount of return related loss to force a shopper away
- refuse-count: Deshop attempt rebuffed

return-lenency-score1 3    return-lenency-score2 3

churn-limit 3

refuse-count 7

Shop A

Shop B

money 1586

$$\text{Deshopping Intention} = \beta_0 + \beta_1 q + \beta_2 B + \beta_3 (qB) - \beta_4 p - \beta_5 C - \beta_6 (pC) - \beta_7 N + \varepsilon..(2)$$

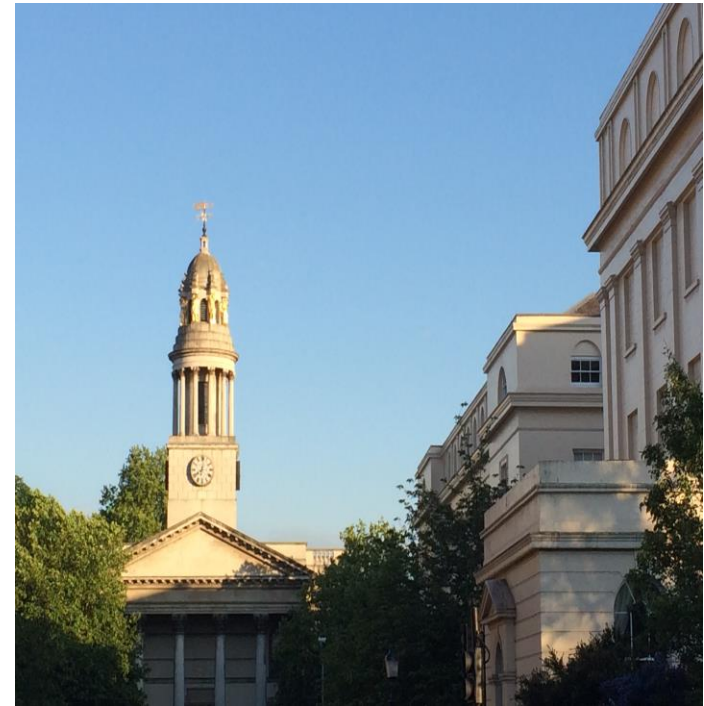
These are the models we will be testing. There are even more complete and sophisticated versions of this equation available which solve the problem of treating costs and benefits as independent of each other. (Shawkat & Li, 2023, ICIM, Oxford U.)



# Analytics

**Shuliang Li (2022)'s definition on Metaverse:  
Aiming at analysing what occurred, what is occurring and what will or may occur or happen in the future, Metaverse Analytics is about the use of relevant strategies, procedures, methods and software tools for tracking, gathering, reporting, visualising, interpreting, mining, exploring and reviewing the users and digital avatars' behaviour, digital clones, activities, interactions and associated data in a computer-generated and socially connected networking space of three-dimensional virtual-reality worlds, called Metaverse or meta universe. Metaverse analytics transforms data into information, knowledge, success and decisions. (Shuliang Li, University of Westminster, 2022).  
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# Metaverse analytics



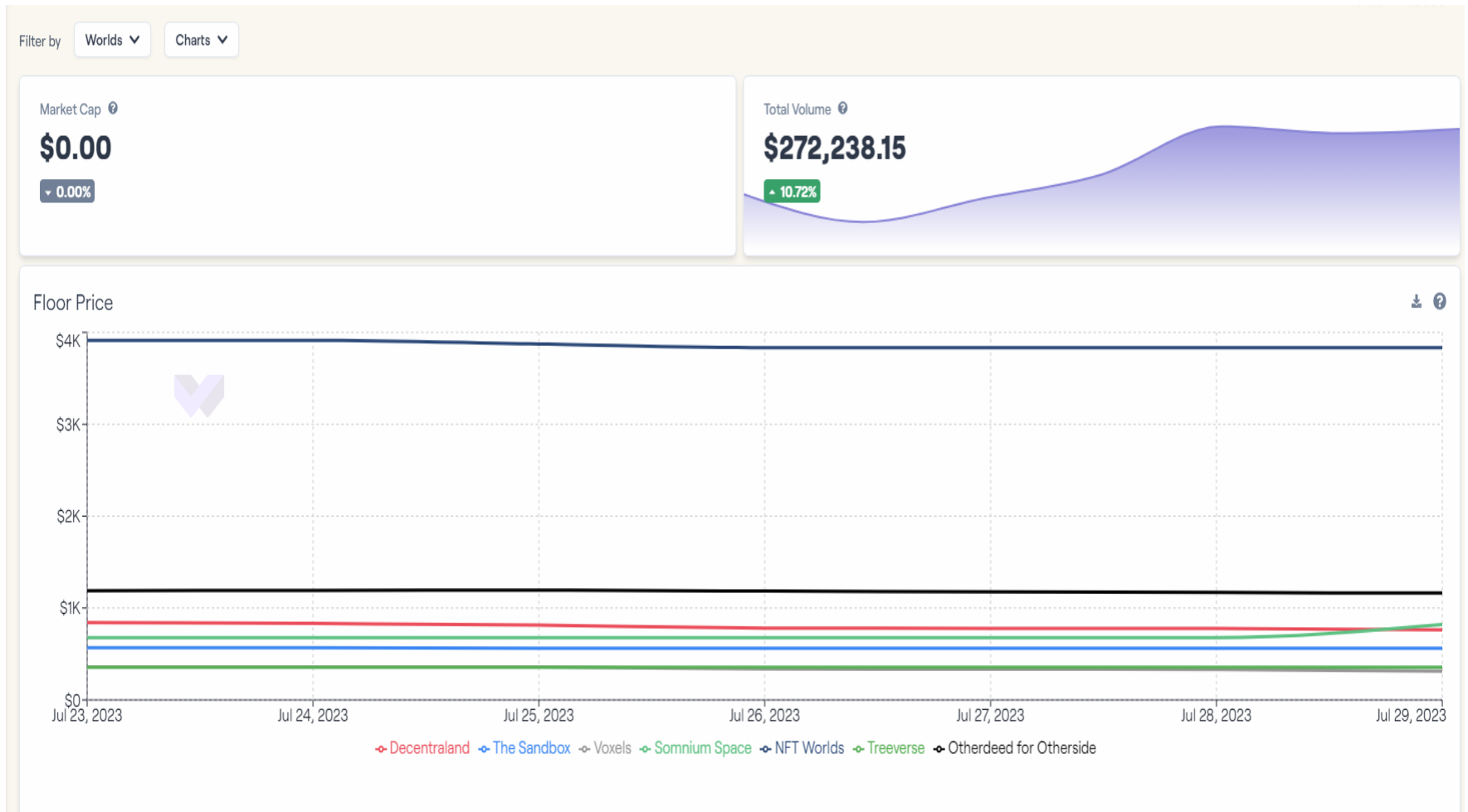
# Metaverse analytics for business (Extended by Shuliang Li)

Element	Function	Software tools for Metaverse analytics
Metaverse SN space	Answers: reach, communication, interactions, engagement, etc.	Software tools, e.g. WeMeta, for Metaverse analytics for the elements; Artificial intelligence; Machine learning.
Avatar behaviour, clickstream or touch stream & metrics	Answers the what: Intelligent/smart digital avatars' behaviour, online visitor behaviour, traffic, bounce rate, referrals, conversions ...	
Multiple outcomes	Answers the how much: Sales, revenue, profit margin, costs, avatar/customer retention & loyalty, ...	
Customer churn; Digital avatar churn	Contribute to the why: comments, feedback from customers and intelligent or smart digital avatars	
Competitive intelligence	Answers the what else: Digital avatars' behaviour, monitoring competitors, ...	
Insights	Help achieve understanding, identifying, discovering new opportunities, useful patterns, hidden relationships ...	
Strategies, decisions, innovation, competition	Aims/goals to achieve; the means; courses of actions, different types & levels of decision making; digital innovation; open innovation; analysis of competitors	

*Adapted, extended and modified by Shuliang Li on the basis of Avinash Kaul (2010)'s basic work*

# Metaverse analytics examples: WeMeta

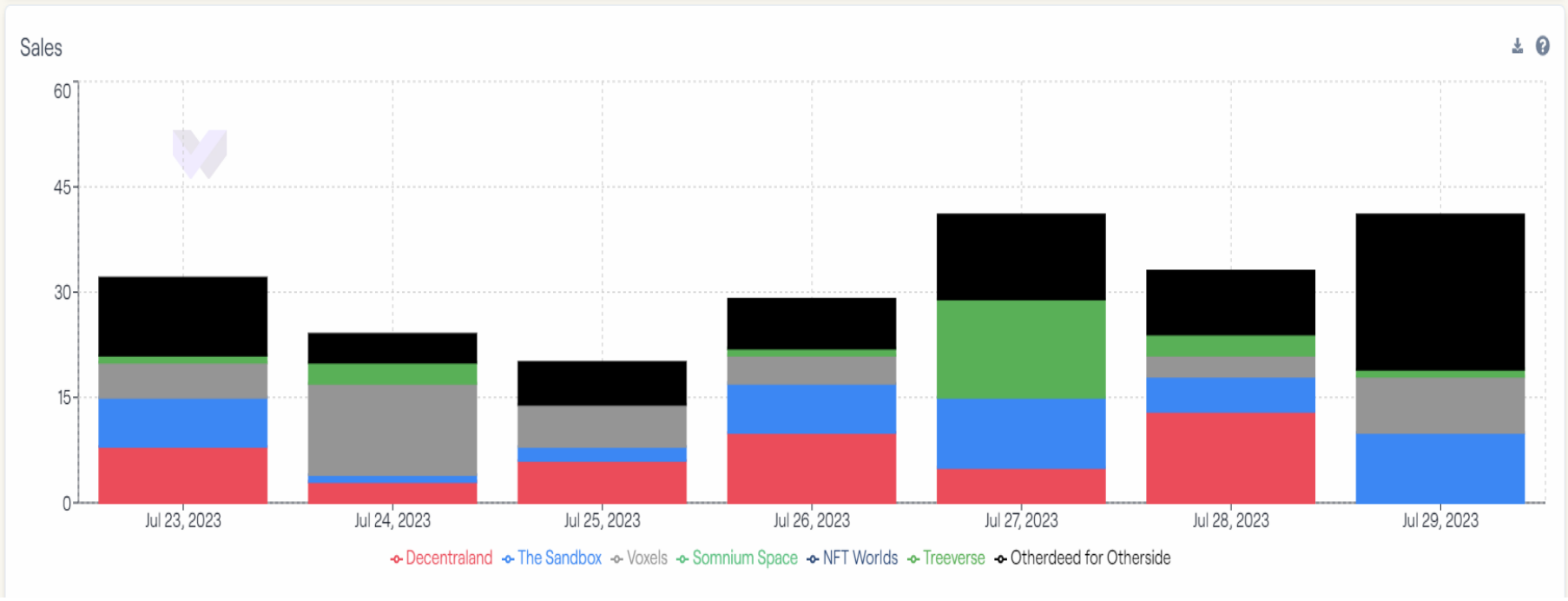
Source: <https://analytics.wemeta.world>



Breaking changes with builder tag V1.0.0! Update your analytics tag to avoid disruptions in your data. [Read more](#)

Jul 23, 2023 Jul 24, 2023 Jul 25, 2023 Jul 26, 2023 Jul 27, 2023 Jul 28, 2023 Jul 29, 2023

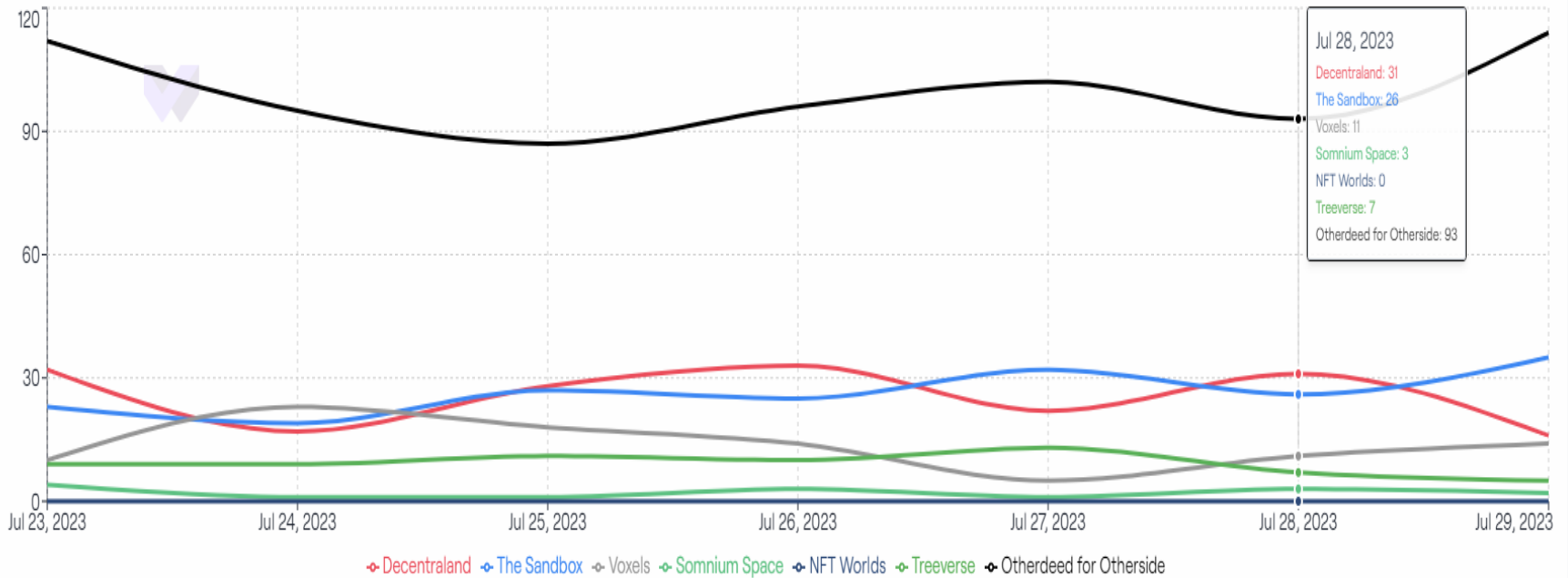
Decentraland The Sandbox Voxels Somnium Space NFT Worlds Treeverse Otherdeed for Otherside



Breaking changes with builder tag V1.0.0! Update your analytics tag to avoid disruptions in your data.

Read more

### Active Traders



Breaking changes with builder tag V1.0.0! Update your analytics tag to avoid disruptions in your data. [Read more](#)

4



2440  
Otherdeed for Otherside

0xa1c2...8035

### Coins

	COIN	PRICE	HOURLY DELTA
1	<b>Bitcoin</b> BTC	\$29,314.00	-0.15%
2	<b>Ethereum</b> ETH	\$1,875.80	-0.22%
3	<b>Ape Coin</b> APE	\$1.98	-0.51%
4	<b>The Sandbox</b> SAND	\$0.39	-0.51%

Source: <https://analytics.wemeta.world>

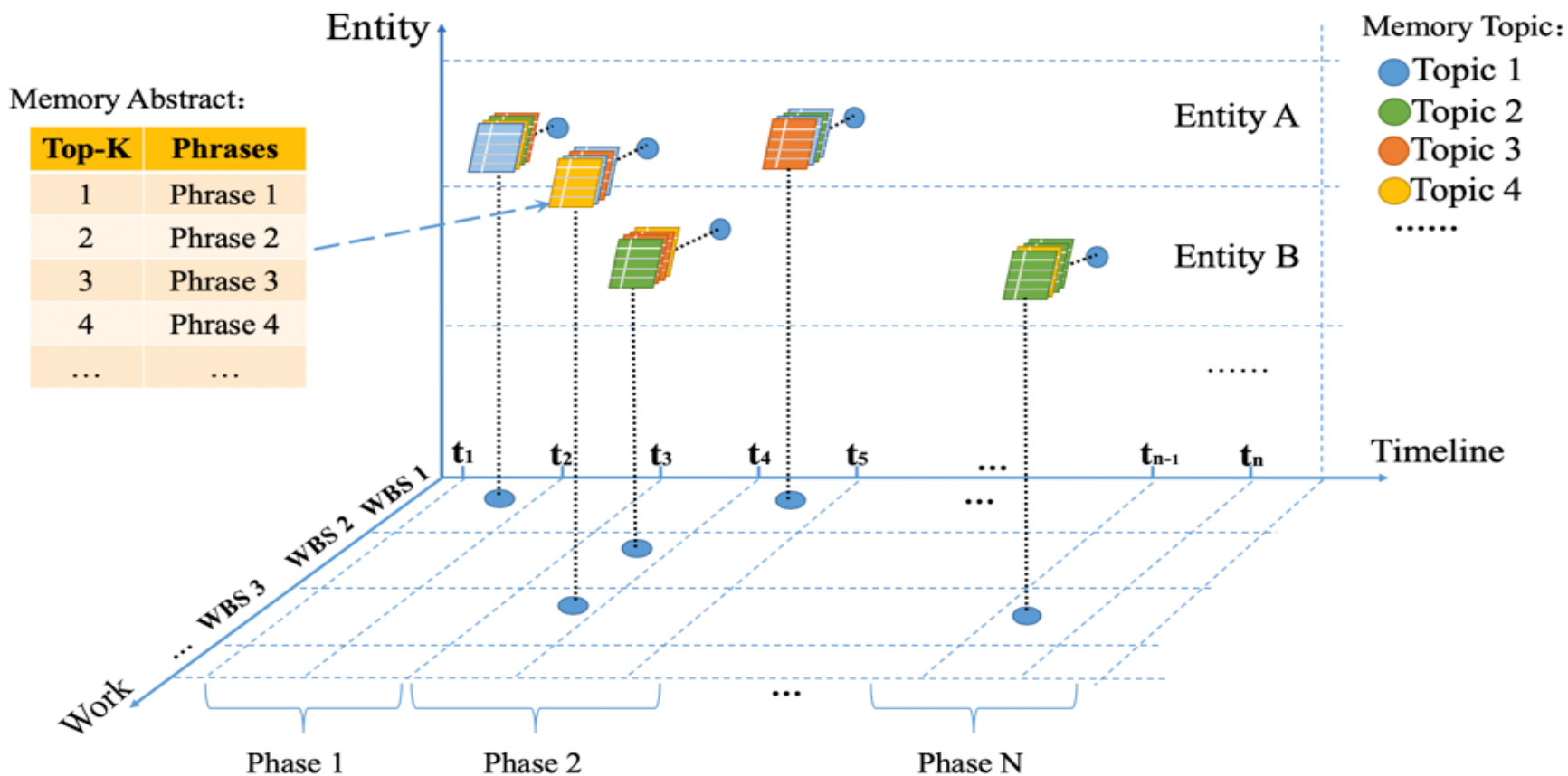
# Memory recall, and good & bad memories in the Metaverse

J. XU and S. Li (2019 & 2023 & 2024)

- Dimensions
  - T: Timeline
  - W: Work, job, shopping process, banking process, game playing process, or others, breakdown structure
  - E: Entity (avatar, clone, store, bank, product/service, digital currency, etc.)
  - Tc: Memory Topics
  - Ab: Memory Abstracts



# Memory recall , and good & bad memories in the Metaverse



XU, Zhu and S. Li (2019 & 2023 & 2024)

# Metaverse security

- ❖ Security issues
- ❖ Our hidden master client-server architecture for the recovery and survivability when the computer network hosting the **Metaverse worlds** getting hacked and attacked (T. Karvinen and S. Li, 2017 & 2023)





Thank you 谢谢 Questions?

