Proactive Identification of Future Cyber Threats

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Abstract

Understanding the new digital world naturally requires a suitable approach for proactive identification of future cyber threats in the new mixed reality of people, technologies and biotope symbiotic joining. The paper outlines a methodology for joint exploration of cyber threats, using both expert and machine intellect. Further, a combined assessment is performed on the accomplished results with a simulated futuristic environment, adding human-in-the-loop biometric response. Finally, a wrap-up discussion is performed for the obtained results.

Keywords

Proactive Cyber Threats Identification, Mixed Reality Approach, Combined Results Assessment, Human-In- The-Loop Biometric Response

1. Introduction

Future security dynamics proper understanding in the new digital age is already a rather comprehensive objective for direct achievement. In fact, the new extended reality, joining virtual, objective, augmented and mixed perspectives of one and the same security landscape have to be studied from multiple perspectives [1]. Within the last several years, the utopian digital society development [2] has been seriously disturbed by several major stressors: COVID-19 pandemic, new wars (both in Syria and in Europe – the Ukrainian ones), resulting refugees' flaws and asylum seekers [3]. Additional social negative dynamics with economics, fossil fuels lacking, and technological microchips deficit, adding also climate changes doom prognosis are building a really not so bright future for the new 21-st century beginning [4]. In this sense, the technological progress of IoTs, AI, robots, avatars, ubiquitous communications and their accompanying new smart services [5] could be considered as a positive moment in the post-information society (by means of a society with implausible stressors significant transformational effect) building and transformation. Though this new extended reality establishment, considered as an innovative metaverse ideas incubator, the role of the human intellect stays dominant [6]. A supportive evidence in this context are the social networks advancing with numerous gadgets (both with Web 3.0 & Web 4.0) but still led and addressing the humans [6]. Evidently, human- machine interawarding is approaching us indispensably in the new era of transhumanization with hybrid physical and mental capacity augmentations [7]. Going even deeper in this reality, naturally opens the question of cyber security from both technological and human perspectives. Whilst new complex APT attacks [8] are combined with the cognitive overload, attention deficit and parallel digital existence for the humans [9], the technological part of this new reality is also challenged with new smart adversaries. Advanced DDoS attacks, intelligent malware, complex ransomware and imperfection gaps from the evolving smart systems are severely threatening the smart infrastructure. The process becomes obviously habitual to the transformed digital lifestyle, especially with the new generations [10, 11]. Soon, it is going to become really difficult to secure the new extended reality without the technological advances that however need adequate smart joining to the human intellect, aiming future digital society resilience. Here however the natural boundary of moral, ethics and regulations appear in the security discussion [12]. As though technological progress is certainly and important moment of our civilization evolution, the human advancing (including DNA engineering, technological implants & assisted knowledge access) and privacy digitalization (memories, emotions, experiences, etc.) stay of vital importance [6]. The situation could become even more complex with machines advancing and deeper emersion in our life [13] (taking not only unpleasant, either dangerous or monotonous jobs [14]), aiming singularity (total domination, starting now with society managing or vital decisions taking) in the not so far future [15]. Trying to foresee properly the future of the post-information age and successfully meeting the utopian and dystopian perspectives of our society transformation in the new digital age is of key importance for studying the security landscape transformation in a proactive and comprehensive manner. Merging both human intellect with machine algorithms, further in the paper a triplet framework approach will be outlined, towards the next 10–15 years, when machines are expected to become smarter but human spices evolutionary change will create a more resilient and sustainable extended re-

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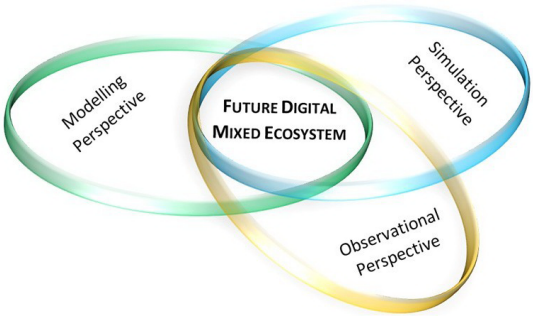

Figure 1: Future Digital Mixed Ecosystem Exploration Framework triplet idea.

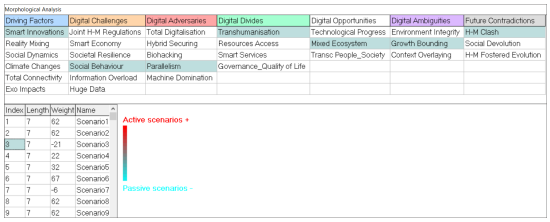

Figure 2: Digital transformation future transcendents cross-consistency matrix towards 2037, following [1].

ality, especially for the new, mixed ecosystem security transcendents successful handling.

2. Triplet Framework Approach

The presented exploration framework (based on the ideas from [1], see Figure 1) is considered as a triplet, giving both forward and backward future assessment, with three different perspectives, but: (i) modelling (using expert and reference data for modelling & analysis), (ii) simulation (implementing machine algorithms towards the future) and (iii) observation (monitoring biometric set with extended realities mix) ones. Finally, some selected results comparison is presented and discussed.

2.1. Modelling Perspective

Initial building of a security landscape, concerning the future digital transformation effects could be achieved by combining morphological & system analysis [16]. The idea is at first implementing the scenario method, with expert and reference data, towards the establishment of a plausible & implausible scenario combinations [17]. The final result is a cross-consistency matrix M, containing three types of scenarios, in accordance with their *Relative Common Weight* – RCW: *Active* (tangible), *Passive* (intangible) & *Neutral* (probably most uncertain).

The total number $N^* = 136080$ ($N^* = 7 \times 6 \times 6 \times 5 \times 4 \times 3 \times 3 \times 3$; plausible – $N1^* = 13420$ & implausible ones – $N2^* = 122660$; from $N1*$ are additionally selected: *Active*, i.e. – "tangible" (11186, $RCW > 0$), Passive, i.e. – "intangible" (2000, $RCW < 0$) & Neutral (234, $RCW = 0$) scenarios) [1].

The identified transcends, constructing a scenario sample of interest are encompassing: "Driving Alternative" -> "Challenge Alternative" -> "Adversary Alternative"-> "Divide Alternative" -> "Opportunity Alternative" -> "Ambiguity Alternative" -> "Contradictions Alternative". Whilst the size of the matrix M is platform limited with the computational power and memory resources allocation, the alternatives with the different dimensions should be mutually exclusive.

The scenario analytical results towards 2037, could be briefly summarized as follows:

The most intangible scenarios for the future will address transhumanization and the resulting future digital society reorganization due to the transformation of smart machines, i.e., moving from AI supportive role, to a potentially dominant one [6, 18]. Additionally, a federated new reality is expected to be created due to general resources access equal limitation, fostered with climate changes and technological availability, providing reality mixing and total connectivity in an uneven manner.

The new social behaviour will be mostly affected by living parallelism and information overload that will certainly require a new hybrid security (joining human & machine intellect) handling with future smart machines and infrastructure significant role [1]. However, AI evolution and IoT deeper immersion in the new ecosystem of humans, machines and biotope will be somewhat bounding the upcoming human-machine clashes and fostered post- information evolution, supporting the establishment of a future smart society and people.

The tangible scenarios will be mainly related to new smart services and technological innovations aiming a peaceful human-machine coexistence with a fostered smart economy and new hybrid (addressing both humans & machines) regulations necessity that is expected to successfully handle the new huge data flow but also challenged with advanced (by means of AI & IoTs) types of human-machines clashes.

Luckily, the total digitalization idea and biohacking are expected to be kept under control, though the ambitious development of AI is already addressing human traits (to note: emotion, creativity, imagination, intuition, etc.) digitalization [7]. The new hybrid senses advancement [13] is already a fact for the future transhumans [19], claiming to support the successful handling of cognitive overload and digital fatigue in the new hyperreality.

Additionally, *neutral scenarios*, concerning the unplanned external impacts could be marked, though quite uncertain, also producing potential new stressors, like

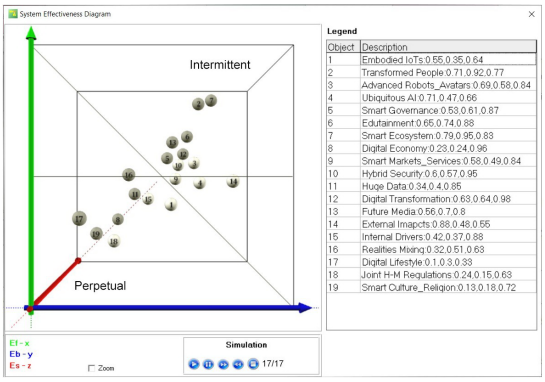

Figure 3: Digital transcendents of a discrete system-of-systems model analytical assessment for the post-information age, towards year 2037.

current

COVID-19 pandemic, either additional other natural or man-made stressors (new wars, refugees' flaws, natural disasters, etc.) that is going to change the normal society cyclic dynamics, or governance order [3, 20].

Further, adding causality in the modelling perspective, a holistic outlook to the digital transcendents future evolution with the next 10-15 years has been obtained with system-of-systems holistic idea [21].

By implementing *Entity-Relationship* $(E - R)$ representation and probabilistic Bayesian assessment of the relations weights for effectiveness (studying causality feed-forward effectiveness – E_f and feed-backward – E_b ratio usage), following [9] a resulting *3D System Effectiveness Diagram* is giving a resulting model classification towards year 2037 in I-SCIP-EA environment [1].

Two main types of model entities resulting classification, with different roles are produced as follows:

Perpetual: "Embodied IoTs" – 1, "Internal Drivers" – 15, "Joint H-M Regulations" – 18, all three expected to be active; "Digital Economy" – 8; "Huge Data" – 11; "Realities Mixing" – 16, "Digital Lifestyle" – 17, "Smart Culture_Religion" – 19, all five expected to be passive;

Intermittent: "Advance Robots_Avatars" – 3, "Ubiquitous AI" – 4, "Smart Markets_Services" – 9, "Hybrid Security"– 10, "External Impacts"– 14, all five expected to be active; "Transformed People" – 2, "Smart Governance" – 5, "Edutainment" – 6, "Smart Ecosystem" – 7, "Digital Transformation" – 12, "Future Media" – 13, all six expected to be passive.

Obviously, the transcending effects of digital change to transformed people, smart governance, edutainment, new smart ecosystem (joining people, technologies & biotope) and future smart media will be quite uncertain and intermittent – thus rather complicated for effective securing due to multiple social and technical profound changes.

Additionally, ubiquitous AI embedded in new advanced robots and avatars will be quite active, together with smart markets and services, that also require effective hybrid securing (merging human and machine smart efforts towards a more resilient digital future). Their role is also expected to be out of direct control (due to deeper technological emersion in future jobs, infrastructure, economics and lifestyle in general), jointly with external impacts having natural or man-made origin [3, 22].

The process has also been challenged by present COVID-19 pandemic [20] and new hybrid wars (by means of technologies & people smart involvement [23]), mostly federating with new divides for the new digital society with different resources and smart infrastructure services availability.

However, the future transformational landscape is also positive as the new digital lifestyle with joint human- machine regulations is expected to keep stability [24]. The result is produced due to system internal drivers' active role affecting digital economy, while mixing technologies, people and biotope with IoTs for both humans and objective reality digital embodiment. This naturally generates huge data with different dynamics and origin that could be successfully used for new security landscape resilient handling.

Adding smart elements in the new digital culture and religion could be quite helpful in this sense, as objective and digital realities mixing naturally generates also numerous social ambiguities that could be somewhat clarified in the dynamic context, joining both scenarios and holistic systems evolution towards the future.

2.2. Simulation Perspective

As holistic systems complexity is somewhat conditional to the transformational context, better understanding of the models on the future transcendents role, naturally requires a joint consideration of system and morphological analysis results in a dynamic sense.

What however needs to be stated here are the objectives for future transformational changes (e.g.: technological domination on humans, resource federated world, climate changes technological handling) that need to be stated and evaluated for a feasibility within both scenario context and system-of-systems models joining.

So, using both human objective beliefs and machine simulations for the future could be fused as follows:

(i) system models dynamics probabilistic distribution approximation fitting, based on their relations in the E-R sense (taking into account the Forrester's simplifications [25]) with a certain time horizon;

(ii) extending results from (i) with multiple time horizons in the Kondratiev sense [26], using a four-cycle stage

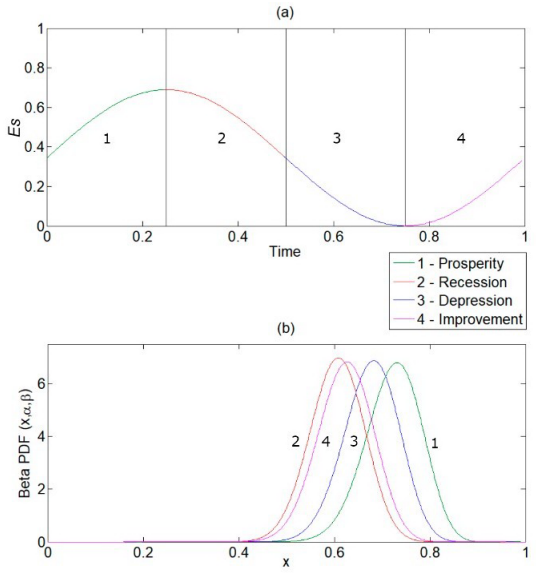

Figure 4: System effectiveness – Es a priori dynamics idea (a) and resulting a posteriori stochastic validation (b), [27].

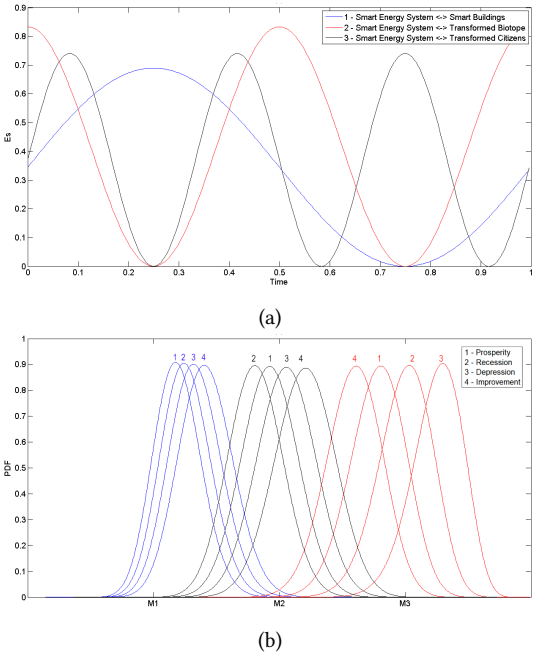

Figure 5: Dynamic representations, concerning the ideas from Figure 4 on a multilateral relations base [30].

interpretation: Prosperity, Recession, Depression, Improvement [9]. The dynamic stochastic assessment with the multiple time horizons could be explored both with base oscillators concept [27] or quantum tunnelling simulation [28], in case of preliminary order S-wave phases change due to external stressors (like: COVID-19 pandemic, either additional other natural or man-made stressors).

As it was already stated before, multiple system characteristics, could be studied with this approach (sensitivity, utility, risk, effectiveness, etc.), using different probabilistic representations [29], whilst the idea here is to consider the system effectiveness – E_s (see Figure 7), following the model from Figure 3.

Some Illustrative examples, concerning selected entities with holistic system model results from Figure 3 are given below:

As properly assessing future holistic model evolution is somewhat uncertain, a supplementary entity "Other" has been added in order to omit unfeasible subsystem heuristic solutions, because the complete system evolution could be unstable, either contradictory one.

Next, in order to get more comprehensive results future assessment from deductive perspective (whilst so far, the framework is working only inductively, assuming a certain future scenario context definition both in static and dynamic sense) an observation with multiple biometrics responses and contexts have been added, producing an experimental results future proactive verification perspective.

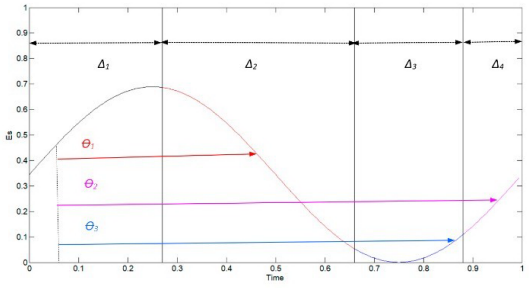

Figure 6: Dynamic quantum tunnelling idea with different phases duration Δ_i & switching thresholds Θ_j between phases, caused with implausible stressors.

2.3. Observational Perspective

The implementation of this perspective could be arranged with different viewpoints [1] but in practice the idea requires an interactive human factor observations in a futuristic environment, with resulting key outlines. In this sense, recently two kinds of experimental observations have been performed and will be further described.

2.3.1. Simulated Exploration

Based on imaginary future reality recreation, either building still non-existing simulated realities, following the

"simulacra" concept [30]. Virtual, augmented and mixed realities are combined, providing possibility for multimodal extended reality interacting (using special gadgets, like: glasses, helmets, joysticks, clothes, biometric controllers). User multiple observations are performed with different human-in-the-loop biometric responses, trying to better understand this new futuristic reality transformational perspectives.

Some illustrative results, regarding the set-up process and simulated exploration are presented in Figure 8 & Figure 9. The idea is accomplishing short multimedia stimulations (about 3 min each, with 5 min resting pause between the series) in a virtual reality (using HTC VIVE Pro system), concerning four scenario combinations (*Future Habitat*, *Future Cooking*, *Digital Fashion* & *Smart Cinema*). About 25 healthy volunteers (18 men & 7 women, average age 43 ± 7; reporting a normal healthy status and tested for side effects, like: vertigo, disorientation, dizziness or headache exclusion on the environment set-up) *EEG Relative Power Spectrum* – RPS (resulting of six leads after Jasper 10/20 placement scheme: F3, F4, C3, C4, P3, P4, [31]) changes, by using a 3D monitor with active glasses (because of montage physical limitations of the head electrodes, not possible to be combined with VR glasses), after [32] and GSR (from dominant hand D3 & D4 fingers) adapted H*iguchi Fractal Dynamics* – HFD [16] measuring has been taken and synchronized in a reasonable interval with stimuli. All experimental recordings have been taken while the volunteers were sitting calm in a comfortable position. No particular voluntary movements or other expressive responses were requested.

The experimental set-ups are trying to identify biometric correlations with futuristic multimedia tailored background stimuli. A supplementary psychology evaluation based on Eysenck's personality (assuming: extrovert, introvert & ambivert tuple of classification) and Lüscher color motivation assessment have been compared with self- reporting of key entities (resulting from multimedia stimulations, remembered about 10 min after the experiments), trying to achieve context comprehensive understanding (see [33] for some more details).

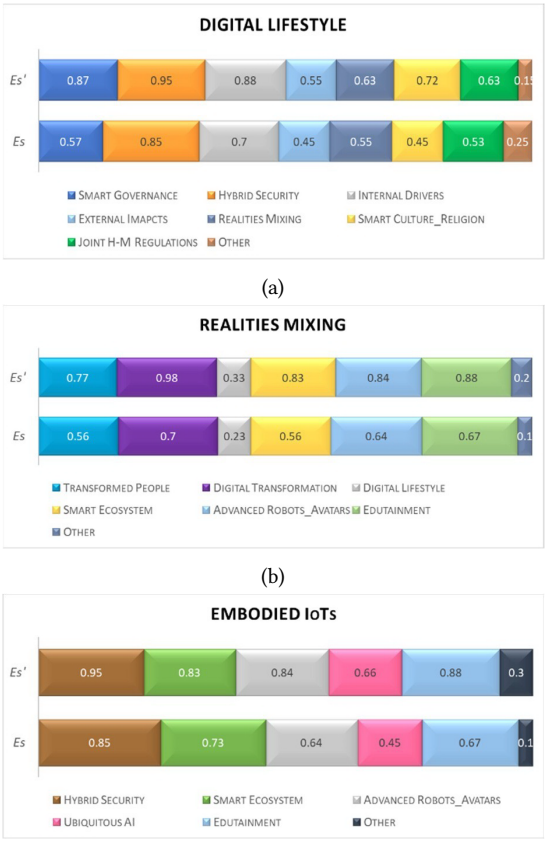

Figure 7: Machine stochastic assessment of present E_s & future E'_s effectiveness of selected entities of Figure 3.

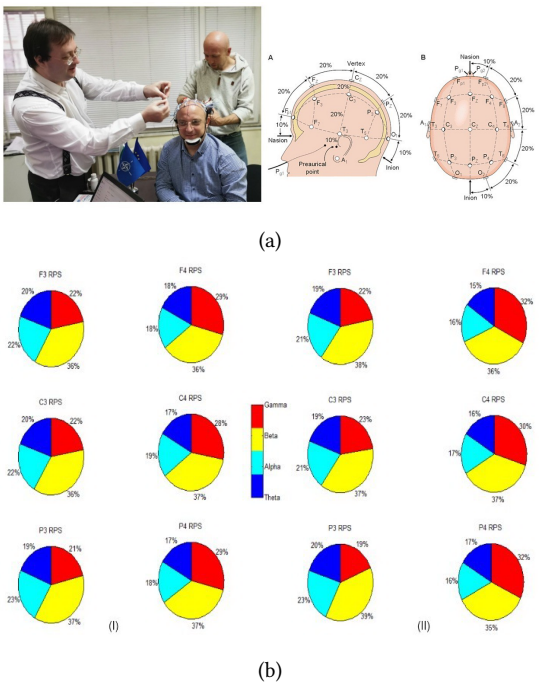

Figure 8: Selected examples of EEG experimental set up & resulting EEG RPS with difference of 2D vs 3D stimuli in an extended futuristic reality of smart cities, after [32]

2.3.2. Real-World Social Experiments

The experiments have been performed relying on human personality traits and skills transformation changes observation, while clashing with smart technologies both in short and longer time frames with group events, like: table top exercises, round tables, training workshop exercises and summer schools (see Figure 10).

The presented idea is a rather useful one but somewhat resource consuming, requiring: human, technologies, time, economic and knowledge sustainable investments.

Here, it should be noted that digital transformation in itself and COVID-19 pandemic effects to the post-information age, together with recent climate crisis and wars could be also considered as live real-world experiments on modern

society adaptation and response to dynamic external stressors [20, 24].

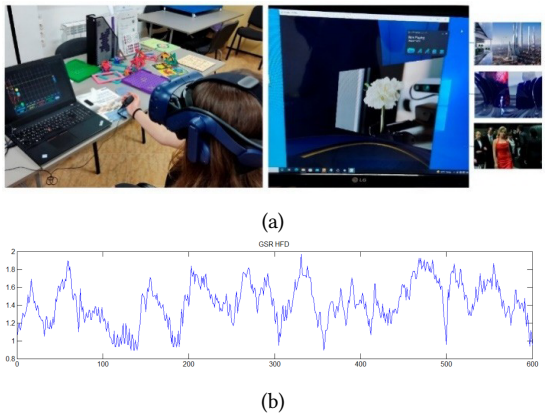

Figure 9: VR experimental set up (top) and responsive GSR HFD dynamics (bottom) illustration.

Figure 10: Real-world experiments for digital transformation transcendents multiple verifications: SRS' 22, EURO CC Twining meeting & HEMUS 2022.

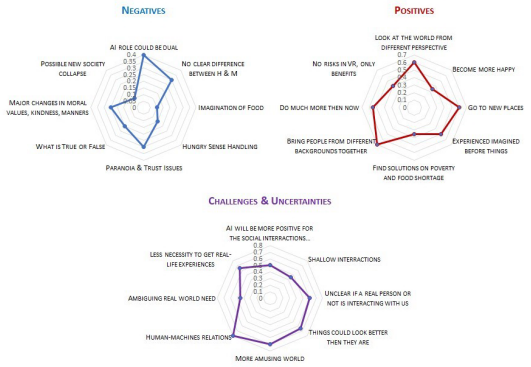

Figure 11: Generalized results on imaginary reality & AI role assessments with SRS'2022, towards 2037, [34].

2.4. Discussion

Innovative technologies progress, transhumanization and intelligent biotope closer and advanced interawaring with smart elements, added due to AI evolutionary algorithms and ultraconnected IoTs are obviously establishing a new transcended and already preferred hyperreality mix. The future transhuman cyber traits will certainly attack our extended senses, skills and capabilities in this new hyperreality, joining also smart machines' advanced knowledge and dual role (attack & defense) to the new digital mixed ecosystem securing. In this sense, the transformed digital society lifestyle will definitely look quite different from now, especially with extended role of AI in multiple smart gadgets, robots and avatars, assisting and securing the society with multiple areas. Due to the extended ultraspeeded and deeply emersed with future humans hyperreality the new generations consciousness, behaviour and other personal traits are going to be dramatically transformed, providing new digital people (also marked as "transhumans") with extended capacity and understandings but adding also different mental and cognitive disorders. Finally, it should be noted that this hyperreality mix and digital people (resulting from the transformation) should be taken with the understanding for a new living advanced digital ecosystem. While, assuming naturally mistakes, uncertainties and transcendents appearance that need to be properly handled and studied in the dynamic context of the future post-information age, resulting currently mostly of pandemic but also and collaborating with other new stressors' turbulent role. The process becomes even more complicated with proactive exploration necessity that obviously need to merge both human advanced capabilities with general AI algorithms towards singularity or at least successful coping of new unprecedented natural and machine system stressors.

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