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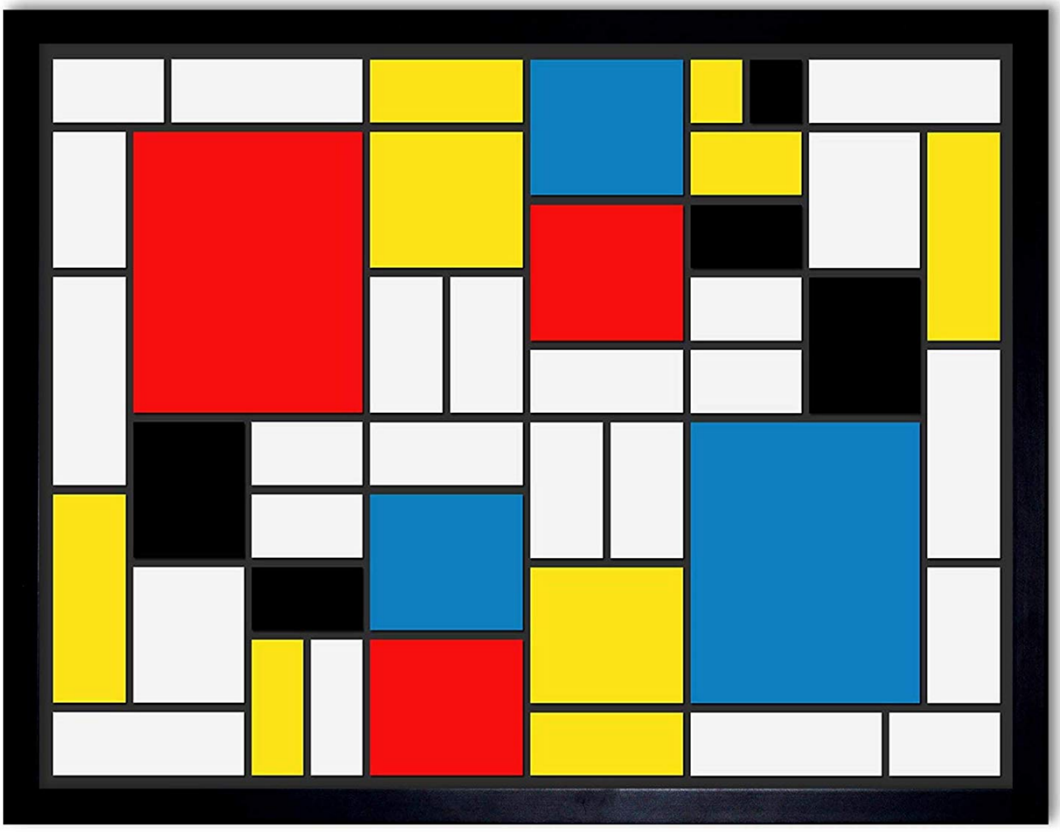
Instituto de Estudos Avançados da Universidade de São Paulo

Life in the Cognitive Era

seminar handbook v2



Introduction

The world has changed. Cognitive technologies (cogtech) are informing life and work, and we need critical understanding of their opportunities and dangers. These include artificial intelligence in general, adaptive systems, augmented reality, automated translation, big data analytics, cognitive computing, collaborative robotics, context-sensitive systems, digital supply chain management, driverless cars, enhanced interfaces (haptic, gestural, multi-sensory, personalised, and predictive), humanoid robotics, intelligent agents, museum and event systems, person recognition (face, eyes, finger, movement), personalising learning systems in education, the semantic web, smart phones, social media, speech recognition and synthesis, surveillance technologies, targeted marketing, ubiquitous computing, virtual personal assistants, virtual reality, wearable systems, etc. These are complemented by innovations in biometrics, nanotechnology, 3D printing, and quantum computing, and by systems such as cryptocurrency and blockchain, producing a different planet.

This is the cognitive era, also termed the 'second machine age' or the 'fourth industrial revolution'. In terms of systems theory, this involves a shift towards more open systems, with attendant opportunities and dangers. We are turning a corner into new forms of life and work, and the social and cultural implications of this change are radical and immanent.

The broad categories considered here are:

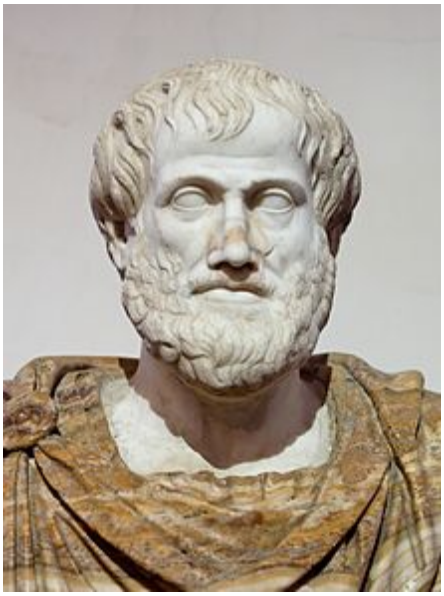
- Technologies --- CAR (connectivity, AI, robotics)
- Conditions --- MVIFC (mass data, volatile, immediate, fragmented, cyborg)
- Life Issues --- EWHW (Education, Work, Health, Wellbeing).

Cognitive technologies and the conditions they create are two-sided (or 'ditropic'): they can turn to benefit, to harm, or to both. In the words of Lǎozǐ (6th C BC, chapter 2), 'High and low rest on each other'. In the words of Heraclitus (6th-5th C BC, fragment 60), 'The way up and the way down are one and the same'. That is: individual things have differing effects according to use and context (which may be multiple). Accordingly, our task is not to classify technologies as inherently good or bad, but to steer their utilisation to good effect.

The field is naturally and necessarily multidisciplinary, it involves both critical and technical understanding, and it is both theoretical (calling on many perspectives) and practical (impacting life and work). Here we need theory in the service of practice in order to plan for the opportunities and dangers of the near future.

In times of volatility, adaptivity is prioritized. We start with three models of adaptivity --- phronesis, executive function, and epiduction.

1 phronesis



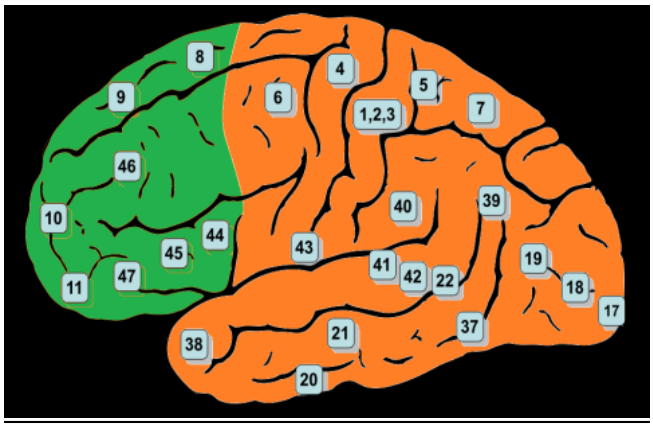
Adaptivity is achieved through phronesis. --- In Aristotle (Nichomachean Ethics, book 6), phronesis is practical wisdom, or the ability to adjust action to situations or contexts. What is best in one context may not be best in another. The idea is linked to public speaking (rhetoric) since the speaker adjusts the delivery of content according to the audience, the situation, the purpose of the speech etc. That is: content is one thing, but its enactment is situated. In general, we may have something to do, but where we do it, when we do it, and how we do it are situation-dependent. Phronesis, then, is a type of situation-processing.

The modern era involves situational volatility, and in response we need situational adaptivity. In business studies this is put by saying that volatility requires agility of response, and it is recognised that agility is survival-critical. If situations change gradually or occasionally, then we need situation-processing, but this is not overly pressurised. However if, as in modern times of fast change, situations change rapidly and unpredictably, then our situation-processing is under pressure. It is prioritised in importance, and challenged in capacity.

In the cognitive era we need cyber-phronesis. This is the capacity for situation-processing in conditions which are MVIFC (mass data, volatile, immediate, fragmented, cyborg). Thus if AI is to provide augmented intelligence, then it must, among other things, provide augmented phronesis. This involves a good fit between what technology provides and the way the human mind works.

The twofold relationship between new technology and phronesis is that new technologies help to create conditions (such as fast change or volatility) which pressurise phronesis, and optimally are also employed to support our natural phronesis.

2 executive function



Adaptivity is achieved through executive function. --- The brain´s executive function (EF) is associated primarily with the pre-frontal cerebral cortex (the green part above).

The general function of EF concerns planning, decision making, and moment-to-moment control of behaviour. It is a manager function, rather like air traffic control. In particular, it enables us to respond to situations or context. --- We may have a standard way of doing something, or an impulse to do something, but EF will select what is to be done, when it is done, and how it is done.

A good model of this brain function is provided by Norman and Shallice (1986). In this model, knowledge consists of schemas, and the enactment of these schemas is controlled by EF. EF determines which schemas are prioritised (working memory or mental set), when they are activated (´contention scheduling´), and the handling of unexpected situations (´supervisory attention system´, SAS).

There is a correspondence, at least, between the demands of phronesis and the provisions of executive function and the pre-frontal cerebral cortex of the brain. E.g. a result of damage to this area of the brain is diminished adaptivity to situations: standard responses are not inhibited, and opportunities are not grasped.

Adaptivity, or situation-processing, is prioritised in the cognitive era, and executive function provides a model of the brain´s contribution to this.

3 epiduction

Adaptivity is achieved through epiduction. --- I define epiduction as a form of context-reactive practical reason as below. (I also call it ´transduction´, see Peterson 2015.) The general form of epiduction is:

> **S ergo D, but C co-ergo R**
> That is: **S ∴ D, C :: R**
>
> Where: S = schema, D = default action, C = context, R = reset action.

Our basic unit of analysis is the situation. A situation Z is a 4-tuple <schema, default, context, reset>. Thus **Z = <S, D, C, R>**. This is a closed situation $\mathbf{Z_{CL}}$ where R is determined. Where R is unspecified, we have an open situation $\mathbf{Z_{OP}}$ **= <S, D, C, _>**. Epiduction converts $\mathbf{Z_{OP}}$ to $\mathbf{Z_{CL}}$ by a 2-step process which generates D, then adjusts its enactment details in response to C to produce R, while leaving S intact.

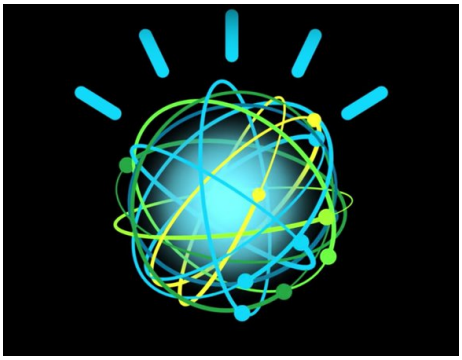
We identify 12 basic laws and 23 basic factors in epiduction. Laws 1-3 give the basic situational pattern, 4-6 describe two mechanisms of adjustment of action to context, 7-10 concern context processing under the pressure of situational volatility, and 11-12 define hypothetical and multiplex situations.

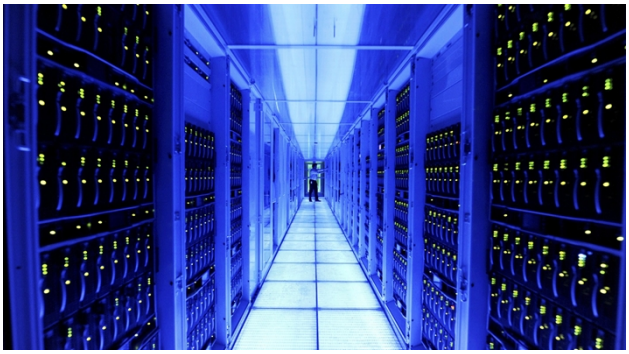
> **1. Z = <S, D, C, R>**
> **2. O = K_S + A**
> **3. A = I + T**
> **4. P(D, C, G) = F**
> **5. I(S, F) = R**
> **6. T(S, F) = R**
> **7. $U_{T/I}$ α V_C**
> **8. $B_{T/I}$ (Q_C) ← E_I = E_T**
> **9. T = T_N + T_W**
> **10. L(S) & L(I) & L(T_N) → O α T_W**
> **11. Z_H = <S, D, C_H, R_H>**
> **12. Z_M = <S, D, C_{++}, R_{++}>.**

Where: A = adaptivity, B = breakpoint, C = context, D = default action, E = expense, F = frame, G = goals, H = hypothetical, I = incorporation, K = knowledge, L = limit, M = multiplex, N = natural, O = output, P = pragmatise, Q = quantity, R = reset action, S = schema, T = triangulation, U = utility, V = volatility, W = wired, Z = situation.

In hypothetical situations $\mathbf{Z_H}$, the context C is a hypothesis for purposes of simulation. In multiplex situations $\mathbf{Z_M}$, there are multiple alternative and co-occurring contexts C and hence multiple alternative resets R. Expanding understanding of a multiplex is a form of learning.

4 big data & cognitive computing





situation. Basic digital literacy should now include understanding of big data and cognitive computing. Current curriculum, however, usually does not.

details. IBM Watson. Jeopardy! Architecture: natural language processing + intelligent data-mining + probabilistic reasoning + parallel hardware. DeepQA. UIMA. The candidate-generation-selection-pipeline (CGSP). Scoring and ranking. Correspondence with human brain architecture (schemas + executive function). Unstructured and heterogeneous data. Data from the internet of things (IoT). Industrial applications for cognitive computing: agriculture, energy (grid operation, oil and gas, renewable energy), banking, fashion, hospitality, insurance, marketing, medicine, security, traffic flow.

5 business & agility

situation. Agility in business is the ability to respond to changing circumstances. As the volatility of situations and circumstances rises, as change accelerates, agility is prioritised.

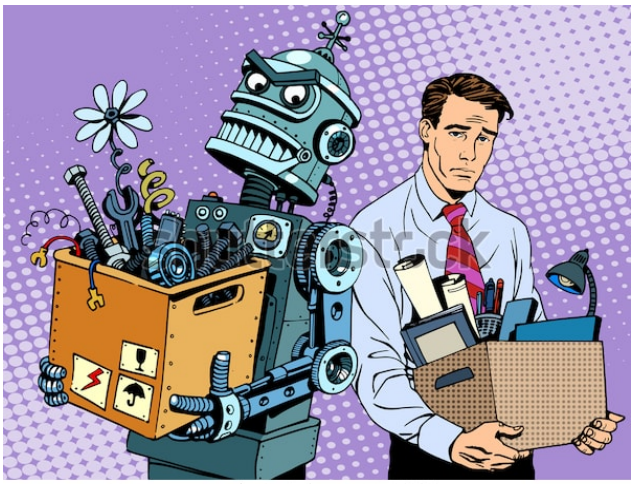
details. An example is Nokia who “saw the heat coming round the corner” and changed from photocopiers to cellphones. Agility in response to volatility is a generic issue: for businesses, individuals, leaders, institutions, etc. In terms of systems theory, we gain and we lose through the required openness. In terms of brain science, agility is associated with “set shifting” in working memory in executive function. In terms of epiduction, some laws are relevant to fast change in circumstances. In terms of training there exist games for “mental agility”, and rudimentary instruments for measuring AQ (agility quotient).

6 education & cyber-sense

situation. We increasingly need cyber-sense --- practical understanding of how to live in a world of information overload, fragmented delivery, compromised privacy, multiple and changing interfaces, software upgrades, multiple passwords, etc.

details. A key skill is how to navigate this maelstrom. When do we attend to something and when not? Do we use our cellphone at the meal table? We face a dilemma of attention --- if we attend to everything we die, if we ignore anything we may lose out. Aristotle advocated practical wisdom (phronesis), the Stoics advocated a type of rational detachment, and in any case we need nowadays to be methodical in cyberspace. We need cyber-stoicism. We need both agility and focus. For this we need curriculum which teaches habits and methods of cyber-sense, as virtues of the New Stoic.

7 work & meta-robotics

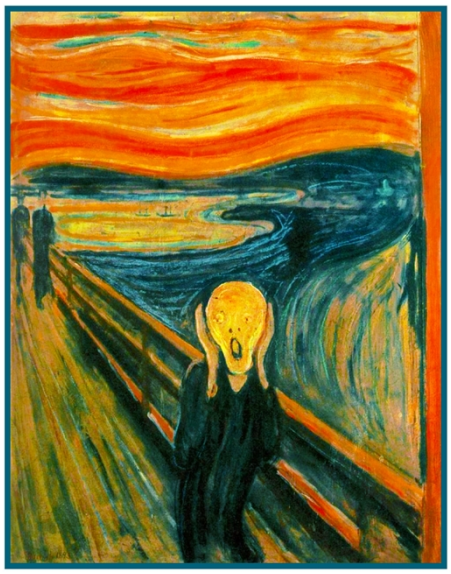


situation. The robots are coming, and we need to prioritise meta-robotics --- human work in design, manufacture, maintenance, use, management, installation, marketing, repair, regulation, legislation, etc. for robots.

details. This involves expertise in several fields, it requires education, including short courses, and should lead to employment, consultancy, training, teaching, etc. It involves both software and hardware robots, intelligent agents, medical robotics, geriatric carer robots, agricultural robots, personal robotics, robot tailoring, humanoid robotics, and robots in every industry. It requires expertise in HRI (human-robot interaction) and RRI (robot-robot interaction).

The Luddites were concerned that machines would take human jobs, and the same seems inevitable in the case of robots. It is imperative therefore that we anticipate this with re-education, re-skilling, and re-definition of human roles at work. A particular danger is that there will be a selective effect on the less skilled parts of the workforce: people who are already on low income could then become unemployed.

8 health & cyber-stress



situation. Cyber-stress is a growing problem for mental health --- it is a response to MVIFC conditions, global connectivity, fast change, complexity, overload.

details. Cogtech is a threat to mental health. Some factors are information bombardment, multiple passwords and interfaces, endless upgrades, always-on reception, mobile devices, fake news, the need for attention, obligation to be available, expectations of fast response. We have cyber-recluse syndrome, digital detox, internet addiction, social media addiction, de-contextualised communication. France has recently legislated the right to disconnect outside working hours and also restrictions on use of social media at school. Some ameliorative forces are cyber-sense, health practices, art, and the development of intelligent agents to act as buffers (DPAs, digital PAs).

9 privacy and surveillance

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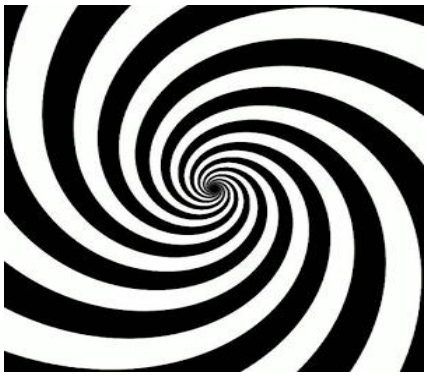
situation. New technology is infringing old standards of privacy.

details. The ethics of privacy, the security/access dilemma, snooping and hacking, data harvesting, data hawking, Facebook *et al,* the data market, state surveillance, cybercrime, fraud, Tim Berners Lee and SOLID.

This is an attack on the good life (bem estar, wellbeing, flourishing, prosperity, blessedness) as in Aristotle (eudaimonia). However, if we were denied the connectivity which makes intrusion possible, this would also be an attack on the good life.

10 summary



We have considered some of the benefits and harms which technologies can bring under the following broad categories:

- Technologies --- CAR (connectivity, AI, robotics)
- Conditions --- MVIFC (mass data, volatile, immediate, fragmented, cyborg)
- Life Issues --- EWHW (Education, Work, Health, Wellbeing).

Some guiding concepts used are:

- adaptivity (agility)
- cyber-phronesis
- cyber-sense
- cyber-stoicism
- cyber-stress
- ditropic
- epiduction
- meta-robotics
- phronesis
- situation, situation-processing, situationism
- volatility (fast change).

We have considered the IBM Watson system as an example case of AI in industry.

We have emphasised the issue of adaptivity, its increasing priority, and three models (phronesis, executive function, and epiduction). On the present analysis, the primary unit in capability, knowledge, and learning is the situation **Z = <S, D, C, R>** (including the hypothetical and multiplex cases $\mathbf{Z_H}$ and $\mathbf{Z_M}$), and a primary issue is growing pressure on the natural cognitive function of situation-processing, We call this situationism. This differs from the paradigms of atomism and absolutism, it concerns human cognitive architecture under pressure in a new era, and it identifies a 2-step logical function which is essential to adaptivity.

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