

Life in the Cognitive Era

Proposal for an Interdisciplinary Research Project

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30.09.2018



“When the wind changes, so must the sails of the ship.”

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 (with its private and public ledgers), 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. The associated conditions include mass data, fast change, global connectivity, and cyborg interdependence of humans and machines. 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.

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 actions can have opposite effects in different contexts (which may be simultaneous). Many thinkers have advocated a middle way between opposites. In the words of Confucius (6th-5th C BC, book 6, verse 29), 'The virtue embodied in the doctrine of the mean is of the highest order'. Accordingly, in the cognitive era, our basic task is not to classify cogtech as inherently good or bad, but to steer its utilisation to good effect. In the contemporary study of *Life in the Cognitive Era*, we examine the opportunities, dangers, methods, and issues associated with digital technologies and with cogtech in particular.

The field is naturally and necessarily multidisciplinary, it involves both critical and technical understanding, and it is both theoretical and practical. It is theoretical in that it calls on frameworks such as systems theory and context-modulated reasoning (cf Activity 2 below). It is practical in that its issues will increasingly impact graduate employment, mental health, education, work, communication, and quality of life.

The present project addresses *Life in the Cognitive Era* through four integrated activities.

Activity 1. Seminar

I propose to run a seminar on the following topics.

1. Life and the Cognitive Era --- AI, cognitive technologies, the fourth industrial revolution, ditropism and steerage, graduate employment
2. Modern Conditions and Augmentation --- modern conditions (mass data, fast change, global connectivity, cyborgia), augmented intelligence and the cognitive loop, opportunities and dangers
3. Work and Robotics --- the Luddites, mechanisation, the philosophy of technology, the advance of robotics, the future of work, new forms of work
4. Privacy and Surveillance --- the ethics of privacy, the security/access dilemma, snooping and hacking, data harvesting and data hawking, Facebook *et al* and the data market, state surveillance, cybercrime, Tim Berners Lee and SOLID
5. Communication and Superficiality --- relationships, mental simulation, context, understanding or *Verstehen* (Weber 1984 ff) and positivism, community, body language, robot cold calling, the new disenchantment or *Entzauberung* (Weber *ibid*)
6. Health and Information Pollution --- fragmentation, de-contextualisation, fake news, internet addiction, digital detox, cyber-recluse syndrome, heterogeneous interfaces, social media, executive function overload. Support for executive function (diet, meditation, exercises, art, dance, music, intelligent agents)
7. Education and Cybersense --- Aristotle (4th C BC) on *phrónēsis*, the Stoics (3rd C BC - 3rd C AD) on self control, Peirce (1997) on pragmatism, the good life, the cybersense agenda, methods, curriculum, and monitoring
8. Decision Making and Augmented Intelligence --- IBM Watson, the internet of things (IoT), Watson architecture, UIMA, the candidate-generation-selection-pipeline, unstructured and heterogeneous data
9. Agility and Volatility --- agility and volatility in business, epiduction and adaptivity, laws of adaptivity
10. Lifestyle and AI --- the smart home, interoperability, wearable technologies, ubiquitous computing, the smart car, intelligent agents, social media, connectivity, the proximal-distal paradox, virtual life (gaming, avatars, proxy relationships), the digital divide
11. Industry and AI --- oil and gas, sustainable energy, finance, banking, agriculture, fashion, marketing, health, insurance, domestic technology. AI and robotics in Brazil (BH-tec *et al*), India (Bangalore), China (Beijing), Russia (Moscow), USA (Silicon Valley, MIT).
12. Modernity, Postmodernity, and Situationism --- three mindsets, three eras, schemas as absolute/negotiable/programmable, systems theory, epiduction, situationism, executive function, volatility, ditropism and steerage, the digital future, contemporary values.

This involves 12 sessions of 1 or 2 hours. Each session consists of a presentation, a short break, then group discussion. Each session considers a social issue, the possibility of a two-sided (ditropic) relationship with cognitive technology, and the possibility of beneficial steerage. It is hoped that participants will introduce examples and issues from contemporary Brazil.

Activity 2. Research

The cognitive era prioritises adaptivity. My analysis of adaptivity is 'epiduction', a form of practical reason. The general form of epiduction is:

S ergo D, but C co-ergo M

That is: **S ∴ D, C ∴ M**

Where: S = schema, D = default action, C = context, M = morph action.

Our basic unit of analysis is the situation. A situation Z is a 4-tuple <schema, default, context, morph>. Thus **Z = <S, D, C, M>**. The task of epiduction is to adjust the enactment-details of the schema S's default output D in response to a context C so as to produce the modulated action M.

We identify 10 basic laws and 20 basic factors in epiduction. Laws 1-3 give the basic situational pattern, 4-6 describe two mechanisms of adjustment of action to context, and 7-10 address life under volatility.

1. **Z = <S, D, C, M>**
2. **P = K_S + A**
3. **A = I + T**
4. **O(D, C, G) = F**
5. **I(S, F) = M**
6. **T(S, F) = M**
7. **U_{T/I} ∝ V_C**
8. **B(V_C) ← R_I = R_T**
9. **T = T_N + T_W**
10. **L(S) & L(I) & L(T_N) → P ∝ T_W.**

Where:

A = agility/adaptivity, B = breakpoint, C = context, D = default action, F = frame, G = goals, I = incorporation, K = knowledge, L = limit, M = morph action, N = natural, O = optimise, P = performance, R = resource-cost, S = schema, T = triangulate, U = utility, V = volatility, W = wired, Z = situation.

A relative of epiduction is defeasible or non-monotonic inference in logic. Here a conclusion may be retracted given additional premises. That is, in some cases $(X \vdash Z) \ \& \ (X + Y \not\vdash Z)$. A difference, however, is that in defeasible reasoning a conclusion is retracted while in epiduction it is modified. A closer relative is paraconsistent logic, as first identified by N.C.A. da Costa (1958, cf da Costa N.C.A. *et al.* 1995), which is concerned to deal with contradiction in a constructive and realistic way.

In Russian thought, related work is to be found in the 'imaginary logic' of N.A. Vasiliev (Bazhanov 2011). More general relatives are M.M Bakhtin's polyglossia/polyphony (Bakhtin 1996–2012), ancient Greek (Protagoras 5th C BC) and other relativism, open systems theory (von Bertalanffy

2015, Ashby 1956, László 1996), configurable frames in artificial intelligence (Minsky 1974), and the complementarity of opposites in Heraclitus, Confucius, Lǎozǐ, and other thinkers. The common theme is that adjustment to conflictive plurality is a necessity rather than an error.

Our data conditions have become inconsistent and otherwise fuzzy (massive, heterogeneous, uncertain, unstructured, volatile, de-contextualised, etc.). Appeal to the principle of explosion in these circumstances is not a form of wisdom, and the show must go on regardless. In contemporary conditions, then, a paraconsistent approach to decision making is imperative.

Regarding the mechanics of epiduction, context C is understood as a factor which is both external to a schema S and relevant to S's enactment in relation to its goals G. The enactment of schemas (algorithms, forms, formulas, frames, *logoi*, programs, systems) in the framework is situated, and agility A is achieved in two ways. We can incorporate I the context C into the schema S thus producing a modified schema S₂ which generates the modified action M, or we can triangulate T the context C against D, thus producing M while leaving S itself intact. The two strategies may have different resource-costs R, incorporation having a one-time cost R_I, and triangulation having an each-time cost R_T. Thus, where context is volatile V (fast changing), and resources are limited L (Simon 1957), as in the cognitive era, balance between the two adaptivity strategies I and T may determine performance P, and wired (machine-enhanced) triangulation T_w may be prioritised. This 'cornering' effect calls on laws 2, 3, 9, and 10 above.

In broad terms, we see a fallacy and a challenge. The fallacy is that performance is simply the result of knowledge of schemas: $P = K_S$. The challenge is that performance is actually the joint result of knowledge of schemas and their adaptive enactment: $P = K_S + A$ (law 2 above). This is not convenient: consistency, completeness, etc. become lost aspirations, but it is a reality in our *Life in the Cognitive Era*. Under conditions of volatility and bounded resources, the fallacy becomes less credible, and the challenge becomes more urgent. This urgency invites machine support, e.g. T_w. In short, A may now be prioritised over K_S.

This is a brief sketch and further explanation will be provided in the seminar series (sessions 9 and 12), in separate talks if requested, and in two papers, 'Epiduction and Executive Function' and 'Epiduction and Agility'. The papers address two enhancement targets for augmented intelligence, the 'supervisory attention system' of executive function in the human brain (Norman and Shallice 1986), and agility in business decision making (Setili 2014). Epiduction has application in other areas of psychology and philosophy (cf Peterson 2015), but its point here is to provide a systematic approach to the complexities of *Life in the Cognitive Era*. My plan is to publish both of the above papers during my time at USP.

Activity 3. Teaching

If teaching is requested, I have slides prepared for an introduction to the IBM Watson system: 110 slides, containing exercises, references, and links, addressing Watson's architecture and its application across several industries. These materials can be used at any level: enrolled students, executive short courses, etc. I suggest to provide students with hands-on use of IBM Watson, e.g. for exercises, which can be arranged through Watson Cloud facilities, in consultation with IBM São Paulo.

If PhD supervision is requested, here are some relevant topics:

1. Education PhD. To 'accentuate the positive' in the cognitive era, we need to live and work with cogtech in a beneficial way, without fragmented attention, addiction, superficiality, and information pollution. The UK's Royal Society for Public Health (2017) report an association between mental problems (depression, anxiety, attention deficit, literacy deficit) and indiscriminate use of media such as Facebook, Instagram, and Twitter. There may also be an association with gabbling and asynchronous interrupting in oral communication. There is therefore a place for 'cybersense': the judicious, deliberate, stoical, pragmatic, and organised use of digital technology. PhD topic: 'A school curriculum on 'cybersense' with both theoretical and empirical justification'.
2. Business PhD. The conditions of the cognitive era require decisions which are both open (agile, adaptive) and robust, a tradeoff which is recognised in systems theory (von Bertalanffy 2015). A primary issue in machine-supported decision making (e.g. in finance or oil & gas) is the optimisation of this tradeoff under conditions of volatility and data which is probabilistic, heterogeneous, unstable, inconsistent, and de-contextualised. PhD topic: 'Agility, stability, and decision support'.
3. Philosophy PhD. Cognitive technologies are in many cases context-sensitive. The significance of context has been recognised by Protagoras (5th C BC) and other early Greek Sophists, Giambattista Vico (1725/2002), Max Weber (1984 ff), in work on mental simulation in developmental psychology, in law (Hart 1949 and the rebuttable presumption), and now in context-sensitive technology. The significance of context and situation is recognised by Aristotle (*phrónēsis*) and is pronounced in 'high context' cultures (Hall 1976). What then is context, and why does it matter? PhD topic: 'Context, situated cognition, and cognitive technology'.
4. Logic PhD. A question for the cognitive era is whether cognitive technologies 'think like a brain'. IBM Watson uses a candidate-generation-selection-pipeline (CGSP). Processing in the CGSP is inherently paraconsistent (da Costa 1958, da Costa N.C.A. *et al.* 1995), requiring judgement, prioritisation, and selection in relation to a rich but inconsistent set of candidate hypotheses. It also has affinity with (forward chaining) abduction (Peirce

1997, Kowalski 2011), and with executive function in brain science, as mediated by the pre-frontal cerebral cortex (Norman and Shallice 1986). PhD topic: 'What logic does IBM Watson follow, and does it think like a brain?'.

5. Computing PhD. An issue in the cognitive era is whether personalised assistance is needed in using cognitive technologies. Abductive logic programming (Kowalski 2011) extends logic programming by allowing some predicates ('open predicates') to be incompletely defined. We therefore envisage a meta-query-engine for IBM Watson where an open predicate triggers a strategic query evolution utilising query permutation, the Watson query ontology, and storage of previous queries and answers in personal connection graphs. PhD topic: 'Creation and evaluation of a personalising abductive query engine for IBM Watson'.

These PhD topics address *Life in the Cognitive Era* from different angles, and all should enhance graduate careers and social value. PhD students could be encouraged to form a reading and discussion group under this rubric.

Activity 4. Book

I suggest to produce an edited book entitled *Life in the Cognitive Era* on topics similar to those in the seminar series. This should be multidisciplinary in content, readable in style, alert to ditropism and steerage, and collaborative in inception. The authors should have the chance to meet, discuss, and develop their ideas in a collaborative manner, thus producing a network of researchers and a good result. If possible a mini-conference should be included. Dissemination is important, since the deliverable documents from research projects often disappear from public view. To enhance dissemination the book should be available in both paper and electronic forms, the electronic form preferably being a downloadable file. This will be a world first: as far as I know, no other book with this title or format exists yet.

Objectives and Deliverables

Activity 1. Seminar

Objective: to establish *Life in the Cognitive Era* as a significant contemporary theme

Deliverable: a series of 12 seminars

Activity 2. Research

Objective: to establish epiduction as a systematic explanatory framework for issues of adaptivity, volatility, and machine-augmentation in *Life in the Cognitive Era*

Deliverable: 2 or more published papers on epiduction

Activity 3. Teaching

Objectives: to create understanding of *Life in the Cognitive Era*, increasing graduate employment and social value

Deliverable: talks, short courses, PhD supervision

Activity 4. Book

Objective: development of ideas, expertise, networking, and dissemination in the area of *Life in the Cognitive Era*

Deliverable: an edited book on *Life in the Cognitive Era*.

The amount which can be done will depend on the time available. In a shorter time, activities 1-2 should be realistic, and in a longer time activities 1-4 should be realistic.

I would hope to interact with interested people in the IEA/USP research groups 'Humanities and the Contemporary World' and 'Philosophy, History, and Sociology of Science and Technology', with people in other departments at USP (e.g. Philosophy, Computer Science, Economics), at other universities in Brazil, and in industry in Brazil.

Conclusion

The ship of cogtech is already at sea and needs steerage to good waters, away from rocks, stress, and chaos. This steerage needs the telescope, compass, and wind vane of understanding. This understanding needs new concepts and analyses, since the ship and its weather are new. The present project aims to contribute to and disseminate such understanding.

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