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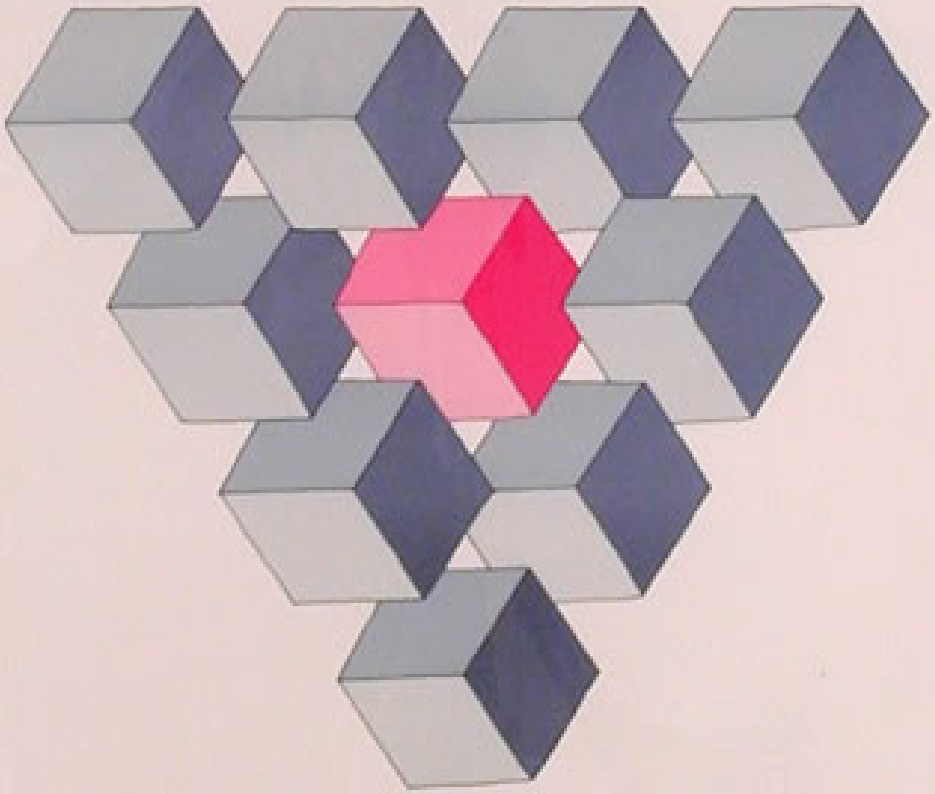

Adaptive Intelligence and Integrative Thinking

by MIHNEA MOLDOVEANU

Transcendental Pragmatism and Adaptive Intelligence:
Sources and Foundations for Integrative Thinking

by Mihnea Moldoveanu

Precis

I develop foundations and guideposts for identifying, mapping, selecting, and training *adaptive intelligence* – intelligence that is at once autonomous in its use and practice and responsive in its deployment to solve *real* problems. Such intelligence must cut across the styles, models and patterns of thinking of the various *professions* and *fields of practice* as well as those of *disciplines* of academia and higher education – the humanities and the natural and social sciences – and successfully embody the most successful modes of inquiry, reasoning and inference in a way that is *adaptive* to the demands of problems and contexts that do not fit neatly into any *single* discipline or mode of thinking. For this reason, such adaptive intelligence by nature will be *transcendental*. It will transcend any particular forms of thought and discourse associated with a single discipline or profession. It will also be *pragmatic* – or, oriented towards the *adaptive* and discerning use of the most successful patterns, modes and styles of thought to solve *practical problems* – as opposed to the stylized, formalized and de-contextualized problems that form the basic canon of academic disciplines.

This work is structured in three parts. In the first part, I introduce a series of 10 distinctions, corresponding to some 20 different 'modes and patterns of thinking' – which collectively span the purposive uses of the mind to solve problems across domains of expertise and areas of inquiry. Together, these modes, patterns and styles of thinking, reasoning and inferring form an 'option set' for the transcendentally pragmatic thinker and allow the thinker to *choose* his or her style of thinking in ways that are responsive and adaptive to the situation, the purpose and the context of problem solving. In the second part, I introduce three additional distinctions among different *functions* of thinking – the aims that an adaptively intelligent being could choose to harness the different styles, patterns and model of thinking that he or she can choose from. In the third part, I explain *integrative thinking* as the competence and propensity to *adaptively and responsively choose from among aims and patterns of thinking in ways that are productive of all things considered superior outcomes*, and thus establish the link between integrative thinking, transcendentalist pragmatism, and successful intelligence.

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Part One: Patterns, Forms, Modes and Structures of Thinking, Introduced Via a Set of Distinctions

I focus in this first part on a number of patterns of thinking, reasoning and inference that (a) are precisely identifiable, and (b) have proven to be effective for the solution of problems in many disciplines and domains of expertise ranging from physics to history, from engineering to sociology and from biology to literary analysis, and which will supply a transcendental foundation for adaptive intelligence by allowing an intelligent being to make *choices* regarding the mode and pattern of thinking that is most suited to a problem and its context context. Implicit in this exercise is the realization that what disciplines contribute to their trainees is not only a body of knowledge – facts, concepts, models, theories and forecasts – but also a mode and pattern of thinking – of doing things with that knowledge.

This view is consistent with the transient and often short-lived nature of empirical and theoretical knowledge in all disciplines and professions, and is especially important in the design of educational programs in an age in which the life-span of theories, models and facts has – for the first time in the history of human civilization – fallen significantly below the lifespan of the 'career' or useful employability of an individual human being. Moreover, this map is meant to function as a blueprint for the development of educational programs at all levels in the 'post-algorithmic era' (ours, and one which has been upon us for 25 years to the date on this manuscript) – in which the *identification of intelligence with raw computational speed and working memory no longer holds* because the marginal cost of artificial computation and storage (stand-alone or Wiki-linked laptops, desktops, super-computers, 'clouds', smart-phones and Pads of all kinds and shapes) is nearing *$0* at an accelerating pace. *Intelligence* (human intelligence, to be precise) must be re-defined, lest it should become obsolete; and *education* must be re-designed in view of the resulting re-definition of intelligence, lest it should become vacuous as an endeavour and an expensive fraud as a socio-economic process. The following is a broadly-reaching thrust towards these goals[1].

Analytic – Synthetic Thinking

Analytical thinking, true to its etymological roots and in spite of recent confusions, refers to thinking which divides up ('lysis') wholes into parts that behave in identical fashion ('ana'). For instance, some economic theories divide up a market ('whole') into a large number of buyers and sellers (traders – 'the parts') who behave individually in similar or identical fashion ('price-takers', 'rational', and so forth). Classical dynamics carves up wholes ('suspension system of a car') into parts ('linked masses, dashpots and springs'). *Analysis* refers to the process by which a whole is divided up into a set of parts such that parts bearing the same names ('springs', 'traders') behave identically to one another; and *analytical thinking* refers to the pattern of thought – the record of thinking or speaking – produced by a process of

[1] It is typical of practitioners of academic and disciplinary discourse to disagree with 'broad statements' and proposals for significant revision based on them because of disagreements with the specific details of the form in which these statements are presented, and this habit of thought and speech is as well known to the author as is the fact that its consequence and often purpose is the avoidance or postponement of any significant change to the *status quo ante*. I mean no more by this than to establish the fact that I know the reader knows I know it.

analysis. By contrast, *synthesis*, again true to its etymological roots ('syn' = 'with'; 'thesis'= 'placing') refers to the *combination* of two or more parts to form a whole. For instance, one can attempt to *synthesize* a signal from its Fourier components; or to *synthesize* a simulation of the response of a market to a new product from the set of known or measured or inferred or predicted responses of a large number of individual would-be users of that product; or to *synthesize* a new car design from a set of known power technologies, design modules, parts and components; or to synthesize a new musical piece from the harmonic and melodic forms and idioms of an era. If the 'whole' to be synthesize is 'new', then synthesis is a model for *design thinking*, which can then be understood as a subset of synthetic thinking more broadly. Synthetic thinking is thinking that proceeds according to a process of synthesis – of placing together parts into a whole – whether or not that whole is itself new.

Convergent-Divergent Thinking (cf 'Lateral Thinking', 'Linear Thinking', Vertical Thinking')

This is a far looser distinction, as it relates to a dimly discernible difference in patterns of thought, but is nevertheless useful as a marker of a style of thinking. *Convergent* thinking, true to the metaphor embedded in the name, is thinking that aims at producing a unique final result, product or output that is optimal, maximal or in some way *better* than some alternative. Thinking through to the solution to a set of linear equations is *convergent* thinking, as is attempting to prove a theorem in a real analysis textbook, because the fact that a proof exists is known – otherwise it would not be an exercise, but rather an open question in the field. Structuring a paragraph in support of a header statement is *convergent* because the paragraph is supposed to produce an argument *for* that statement, thus making it more credible or persuasive. By contrast, *divergent thinking* is thinking that may and often does lead *away* from a single and unique end point. Randomly listing a set of strategic options for the launch of a new product, freely associating ideas regarding possible motivations of a literary character, unpacking the motivations of an analysand on the couch, allowing one's self to meander freely according to her moods, sensations and whims, and *sketching* the possible experiences of a user of a service or the interior of a new building or the emotional landscape of a poem are *forms of divergent thinking* in this sense. Attempting to prove a theorem (like "*P=NP*", or "*Every even number can be represented as the sum of two prime numbers*" or, "*every competitive game played among rational players has an equilibrium*" or "*any finite energy signal can be represented as a weighted sum of sine and cosine waves*") on the basis of methods, procedures and axioms to be found in a large number of branches of real mathematics may be *divergent* insofar as the theorem prover allows himself the freedom to pursue and entertain various paths of proof and inquiry which may, in themselves "lead nowhere".

Constructive – Deconstructive Thinking

Constructive thinking is thinking that proceeds *from* a foundation *towards* an end goal. Proving that a market with a particular disposition of buyers and sellers who have desires and beliefs of a particular form has an equilibrium is *constructive*, as is the thinking involved in composing a musical fugue on the basis of a fixed motif based on the circle of fifths, and as is the thinking involved in designing an algorithm for computing the square root of *2* in MATLAB or *Mathematica* from a known set of sub-routines. One constructs by building something out of something else – and the difference between constructive thinking and synthetic thinking more broadly is that the parts from which constructive thinking proceeds are given and fixed. *Deconstructive* thinking, by contrast, challenges the

foundations on which a structure – such as an argument, or a phenomenon, or a dialogue, or an object, or an event – 'rest'. One can 'deconstruct' the rhetoric of Angela Merkel by examining the propositions that would have to be true in order for her arguments to have the persuasive force suggested by the vehemence with which they are articulated; or deconstruct the policy of the US Federal Reserve Bank by examining the set of propositions about human rationality and behaviour that would have to be true in order for these policies to be advanced in the sincere hope of producing Pareto-superior results for the economy as a whole. One can also deconstruct Shostakovich's *Leningrad* symphony by showing how it makes exclusive use of certain harmonic progressions and melodic patterns; or Chekhov's *The Cherry Orchard* by showing how its most important tensions are identical to the tensions that Chekhov himself plausibly felt at the time of writing it. *Deconstructive* thinking can be understood as a (more precisely articulated) component of *critical thinking,* which has been peddled indiscriminately and morphed beyond recognition in recent times, to the point where any thinking at all may be claimed to be 'critical'; and as a more general form of *analytical* thinking – one that 'breaks wholes apart' without the need for a specific set of parts that are 'identical'.

1.1. Logically Deep – Informationally Broad Thinking

This is another 'loose' distinction, but an important one, as it captures habits and patterns of thoughts in many different disciplines and professions. 'Logically deep' thinking is thinking that proceeds to draw multiple, logically connected implications from a finite and often small set of independent parts – propositions, axioms, precepts, principles. 'Solving the *N*-body problem' proceeds from the foundation of only a few core axioms and laws (Newton's Laws) to derive the trajectories (in phase space, representing position and momentum) of a system of *N* different masses (eg.: planets, etc.). In typical cases, proving theorems of mathematical logic or set theory, computing optimal economic incentive or taxation policies based on a known optimization apparatus and a known set of constraints, calculating the efficient price at which a financial derivative shall be bought or sold, and composing a fugue on a very small, pre-set motif subject to a set of specified harmonic and melodic constraints are examples of logically (or, 'structurally', in the case of the fugue) deep thinking. Obviously, some forms of analytic, constructive or synthetic thinking may be logically deep and *informationally narrow*, but not all forms of such thinking need to fit this profile. By contrast, writing a brief history of the slave trade in contemporary USA, constructing a rich scenario for the launch of a new product in an emerging market, which incorporates 'everything' from new kinds of users to new regulations, are examples of *informationally broad* thinking; of thinking that admits as starting point a large number of 'data points' or 'independent facts' or propositions, which do not have to be ascertained to be logically compatible or logically independent *before* they are admitted into thinking.

Declarative – Modal Thinking

Declarative (or, descriptive; or, constative) thinking refers to thinking aimed at *articulating what is the case* or what is *true*. It is a form of *saying*, undertaken with precision and care to avoid mis-representation. Describing someone's emotional response to the reception of terrible news, *writing* a newspaper story about the murder of someone's pet by her neighbour and writing an account of one's own fishing expedition to Patagonia or of one's experience of reading through this very piece are examples of declarative thinking: thinking that is regulated by the norms of validity

('saying what is true and not saying what is not true') and completeness ('saying all that is true'). By contrast, *modal* thinking is thinking that articulates *possibilities* – of the logical or physical kind. Thinking up various disjoint approaches to disposing of the Earth's garbage or nuclear stockpile, is *modal* insofar as it aims to conceptualize possibilities in ways that are not immediately constrained by considerations of costs and benefits ('will they buy it?'), implementation logistics ('can I get them to do it given that it is in their best interest to do so?') currently realizable power systems ('nuclear fusion?') or even the laws of physics ('time travel?; efficiently realizable quantum computation?'). The lesser the set of constraints on thinking aimed at generating options for thought and action, the more 'modal' the nature of the thinking becomes. Loosening the laws of grammar and logic 'unshackle' modal thinking further (as in poetry or rhetoric) at the expense of risking that the resulting products of thinking become unintelligible ('renouncing the use of grammar' in a sentence that uses grammar as a pre-condition for its intelligibility is problematic because the sentence becomes unintelligible if grammar is given up.)

Inductive – Deductive Thinking

This is a well established distinction, even though it is not as 'clean' as it looks. *Inductive* thinking is thinking that aims to establish the validity of a universal statement ('all swans are white') from the validity of a set of particular statements ('all of the swans we have seen to date were white'), to seek the set or the minimal set of universal statements that are compatible with a set of particular statements ('what is the most 'empirically supported' explanation for the mortgage backed securities crisis of *2007-08*?') or to produce a set of particular statements that are most likely to 'follow' from some other set of particular statements ('given the co-dependence of inflation with the following 21 variables over the past 76 years, what is most likely to happen to the annualized rate of inflation 1,2,3 years out?') By contrast, *deductive thinking* is generally understood to be aimed at deriving particular statements ('this person behaves as if he were rational' from universal statements ('humans behave in ways best explained by rational choice theory' [major premise], coupled with 'this person is human' [minor premise]). Deductive thinking proceeds by applying a set of operators (*modus ponens, modus tollens*, the law of the excluded middle, the identity principle) to statements or sets of statements in order to produce 'new' statements that are self-evidently consistent with the statements already accepted. Proving a theorem in plane geometry, proving the optimality of an algorithm in the theory of computational complexity and proving the existence and uniqueness of an equilibrium in a model of a market of rational traders whose preferences and beliefs obey certain conditions are all examples of deductive thinking, and they highlight *deductive thinking* as a (highly constrained) form of *synthetic* and *constructive* thinking. However, as an aside, the *validity* of the *laws of logic* used to construct deductive proofs is not itself deductively provable; this is an innocent-looking, although non-evident and far reaching result of mathematical logic itself, which highlights the need for *inductive* or *other* arguments to support them. Additionally, there are many scenarios associated with inductive thinking - such as figuring out the set of laws or mechanisms at play in a 'market collapse' or a 'market bubble' that are 'most' supported by the evidence or the facts - which require the deployment of considerable *deductive* apparatus for reaching useful conclusions.

Deductinductive – Abductive Thinking.

Whereas combinations of deductive thinking (deriving validity of particular statements from the validity of universal statements) and inductive thinking (deriving the validity of universal statements from the validity of particular statements) (*deductinductive* forms of thinking), *abductive* forms of thinking, seek to derive *the best explanation* of one or more particular statements. 'There are bear tracks in the snow outside of my tent' seems to be 'best explained' by the fact of there being a bear in the neighbourhood that made the tracks – rather than by the fact that there is someone with a bear-claw-shaped shoe trying to make a joke at my expense – *except* if I know that there are no bears in the neighbourhood at this time of the year and that there is indeed someone who is minded and able to attempt to fool me into thinking there are. *Abductive* thinking cuts through the requirements of both deductive thinking (the existence of a set of universal statements that are 'beyond practical doubt') and inductive thinking (the existence of a large data set on which I can compute probabilities in the form of statistical frequencies of the conjunction of various facts or statements of fact) and aims to provide a 'best local approximation' to a mechanism or law that generates the facts in question. Explaining the 'Enron crisis' or the WorldComm meltdown' by reference to mismatches between the incentives of executives and those of shareholders, for instance, is 'abductive' in this sense: it is not the 'best-supported inductive explanation' because there has not been an exhaustive search for all possible laws and mechanisms that could explain what we know of the phenomena in question; and it is not 'deductive' because we do not have a secure, logically compatible set of propositions, or axioms, from which we can proceed to derive the facts in the same way we derive theorems about the real numbers from the axioms of the real number system. Thus, the 'best-ness' of the 'best explanations' that are produced by *abductive* thinking processes is evidently *fallible*. By contrast, the fallibility of deductive and inductive inferences, though no less real, is more difficult to expose and establish, and therefore not as *evident*.

1.2.

Mono-Representational – Multi-Representational Thinking

As disciplines and areas of expertise have evolved particular language forms and idealized representations of their subject matter (point masses, fields, forces, flows, D-branes, Arrow Debreu Equilibria, Nash Equilibria, Harsanyi type spaces, rationalizable strategies, network geodesics and centrality measures, social observability horizon, quantum games and strategies, neurophysiological maps of cognitive processes, ortho-normal transforms, non-orthogonally supported splines, transference and counter-transference rituals and mechanisms, Schwarzschild metrics, memristors, 'false consciousness', *ego* defenses and 'dialectical materialism', collateralized debt obligations, credit default swaps: the list goes on, interminably) they proliferated *multiple representations* of domains of experience, which can be understood as stylized models or pictures of 'the way things are' from the standpoint of that discipline's practitioners. Some disciplines are mono-representational ('classical mechanics', 'neoclassical economics') in that they rely on a single basic representation of relevant objects ('masses and forces', 'agents, payoffs and strategies') and events ('flows', 'strategic moves') for the purpose of solving problems that are considered to be 'within' its domain. Other disciplines ('sociology', 'psychology', 'semiotics', 'linguistics', 'anthropology')) admit of multiple different representations of the same domain. Insofar as *adaptive* thinking must *transcend* the boundaries of any discipline or formal set of codes

or formal language systems and pragmatically alter and deploy them for solving 'real' problems, the distinction between mono-representational and multi-representational thinking is highly relevant. In order to give this distinction 'teeth', however, we need to distinguish between different types of representations - or, models - used across the different disciplines and 'problem scenarios', as follows:

Relational Models

Relational models are representations of *relations* between objects or other entities. Prototypical examples are a geographical map, which represents locations in a 2-dimensional plane, a topographical map (3 dimensional plane), or an anatomical chart (2 dimensional or 3 dimensional). A relational model is an imaging tool that is used to represent – in a manageable scale and format – the disposition (usually in space, but sometimes in space-time) of the 'mapped' or modeled entities.

Structural Models

Structural models are relational models that contain additional information about the properties of the objects being modeled, such as their size, strength, texture, weight and kinematic degrees of freedom. Prototypical models are **architectural scale drawings,** engineering mock-ups, and blow-up models of atomic and molecular orbitals.

Dynamical Models

Dynamical models represent the space-time evolution of entities such as electrons, atoms, molecules, mitochondria, cells, brains, humans, organizations, markets and societies – and beyond. They are themselves usefully distinguished in three classes:

Causal and Law-Like Models

These use cause and effect relationships and laws (such as conservation of mass and momentum, the non-decrease of entropy and the minimization of free energy) to derive the dynamical evolution of an entity via the set of laws or cause and effect relationships governing the interaction between its parts. Using such models, one derives laws of motion for muscles and joints using basic causal mechanisms relating chemical to electrical to mechanical potentials, the dynamics of human brains from law like principles of statistical mechanics, and the behavior of markets from the statistical mechanics of brains linked by means of inroamtion transmission and reception.

Teleological Models

Teleological Models represent the dynamical evolution of entities by reference to the goals, purposes and objectives ('telos') of their constituent parts. Models of (real) markets as (ersatz) markets wherein self-interested and rational agents (buyers and sellers) come together to trade, or of human creatures as vehicles **for** genes that seek to increase their own evolutionary fitness, or of ideas, identities and narratives that seek to increase their own cultural footprint by ensnaring minds are ready examples ; 'conspiracy theory' accounts of market failure are naive forms of teleological models.

Functional Models

Functional models represent the dynamics of entities in terms of *functions* that these entities as a whole serve. Views of markets as functioning to maximize the joint welfare of producers and consumers, of the price system as existing in order to maximize the speed and accuracy with which information propagates in a society, of a cell as fulfilling a function within a tissue that lies within an organ system, or of ideas and theories as advancing the interests of certain classes of

humans at the expense of others are all examples of functional models.

Monological-Dialogical Thinking

Monological thinking proceeds in 'monologue-like' fashion, separated and isolated from the thinking of others – for which reason it may be called 'ego-centric' - dialogical thinking is constantly and consistently 'in dialogue' with the thinking of another person – and can be thought of as 'alter-centric'. The distinction is as much one of the *form* and pattern of thinking as it is one of the purpose and function of thinking. Thinking through the costs and benefits of introducing a new product in a competitive market without reference to what competitors think, or to what they think you think, and so forth...is *monological*. It implicitly posits a division of the domain of thinking into 'self' and 'world'. *Dialogical* thinking admits the introduction of *other* thinkers – who may be different – as 'thinking partners': the alter-centrically thinking strategist will think about what competitors will think, and, if he credits them with being dialogical thinkers as well, he will realize that they will think about what he thinks, and will therefore also think about what they think he thinks ... and so forth. An aside, again: In spite of 'best efforts' by disciplines to preserve and conserve the illusion of a group of *monological* thinkers conversing freely with the world using their minds and labs as the communication media, the *dialogical* nature of disciplines is evidenced by the rules and rituals of publication and self-presentation that one cannot – on pain of being silenced – but heed and follow in their written work. (Of course, maintaining the illusion is not a costless enterprise).

Simulative – Emulative Thinking

We think of thinking as a purely cognitive enterprise, one of manipulating symbols; but that is a false reduction. Thinking (or, feeling) *like* someone is a different from of thinking – I will call it *emulative* – than is thinking about someone thinks or behaves - I will call this *simulative*. In the former case, one may seek to immerse oneself in the life of the other, to 'walk in her shoes', to understand the 'inner life' without necessarily having an explicit cognitive model or representation of that life. In the latter, one attempts to build models ('logically deep', 'deductive', 'analytical', etc) and to 'test' these models against observations of the (presumed) outputs of the other person's thinking - such as her words or actions. The distinction is relevant to the difference between the kind of understanding developed and used and prized in literature and theatre arts (emulative) and the social sciences (simulative); and to the difference between producing a screenplay for a social cataclysm (emulative) and producing a model of a social cataclysm (simulative).

Part Two. Functions and Aims of Mental Behavior (aka 'Thinking')

Describing *patterns* and structure of thinking is not enough if we are to achieve a picture of modes of thinking that is useful across purposes and contexts. Because thinking has multiple uses and multiple contexts, understanding the purposes to which it can be deployed – again, in the form of distinctions and resulting categories – will add precision to the adaptive intelligence toolkit that I am trying to build.

Advocacy and Inquiry: Persuasion versus Discovery

One can think *advocatively* - for the purpose of justifying or persuading: think of a legal brief arguing a court case, or an 'investment pitch' to a potential financial partner. Or, one can think *inquisitively* for the purpose of uncovering or discovering information: think of a cross examination or an investor's due diligence following the pitch. In the first case, thinking is directional and usually convergent: it is aimed at achieving or creating a particular state of mind ('persuasion'). In the second case, thinking is non-directional, often divergent, and may be random: it is aimed at opening one or many new potential venues for further thinking.

Understanding and Explanation

One may understand without being able to explain - as when one understands another's feeling or when one can 'just do' a complicated calculation, without explaining how one 'got it' - and vice-versa - as when one can explain why someone could be feeling as they are, without being able to oneself feel the same, or when one can explain, theoretically, how to do a certain calculation, without being able to do it in real time at the right time in the right place. This is why I consider these functions of thinking distinct from one another. Successful *performance* has been used to distinguish between understanding and 'mere' explanation ('if you think you understand a behaviour or a phenomenon, then *produce it*, don't just *explain* it') but that distinction sometimes belittles the importance of explanation in the transfer of skill: explaining *how* the Black Scholes formula for pricing a European call option maps onto real data is an important part of getting someone to competently *use* the formula; explaining *how* to make an efficient surgical incision into an infant's armpit may be an important part of teaching one *to* make a minimal effective incision. On the other hand, the proven ability to *use* the formula in the right way at the right time for the right reason, or the ability to surgically open up an infant's armpit are crucial signs of real *competence* in derivatives or pediatric surgery, which cannot be substituted by the mere ability to *explain*.

Reliability and Validity (Justifying versus Predicting

Thinking can be deployed to the end of producing more reliable or more valid judgments, beliefs, propositions or actions, and these two purposes should also be considered as distinct. I can build a model that best fits the data at my disposal, thus maximizing goodness of fit, or, validity; or I can build a model that is maximally exportable to other situations – and this will maximize its generalizability, or, reliability. In the first case, my concern will be with the particular – with *all* of the differences that make a difference to *this case*. In the latter case, my concern is with *only* those differences that make *the most* difference in the *most* cases. It is simple to see how these different

concerns 'color' the thinking of, say, finance theorist concerned with the universal applicability of a model, formula or empirical reliability (reliability) and the financier who has a large stake 'in play' in a specific situation in which any and all small details could matter; or, with the difference between the industrial organization psychologist who may care about the relationship between moral intuition and the sense of 'disgust' in 'humans at large; and the executive who must figure out in real time and about a single, solitary person, the precise associative map of moral norms and 'disgust reflexes'.

Performance and Description

Thinking can be aimed at stating states of affairs – as in writing an account of an experimental result in a scientific journal; or it can be aimed at *producing* a state of affairs – as is bringing about of a state of inner calm produced by the sustained repetition of a mantra. More simply (also: more simple-mindedly): 'Here is a house' is descriptive; 'I now pronounce you man and wife' is *performative*: it 'performs' a marriage when said in the right context by the right person. Thinking, also, can have a *performative* function that is separate from its descriptive function, but embedded in it: writing a detailed account of a scientific result functions *descriptively* as an articulation of that result and *performatively* to signal to readers of the paper the credibility, responsibility and intellectual honesty of the writer.

Symbolic Creation (Poiesis) and Symbolic Manipulation

Thinking may be deployed *poietically* for the *creation* of new categories, concepts, metaphors and associations ('the audacity of hope', 'the world is too much with us', 'I am not what I am', 'the totalitarian ego') or it may be deployed for the rule-based *manipulation* of existing categories of thought (words, concepts, models, pictures, sentences) as is the case with the derivation of a new call option pricing formula from modified forms of probability density functions of returns on assets; or the derivation of a new solution to Maxwell's equations based on a new orthogonal set of basis functions that satisfy the wave equation.

Part Three. Adaptive Intelligence: Choicefulness, Responsiveness and IntegrativeThinking

I think you think you see where we are heading: We are in the possession of library of forms and patterns of thinking and purposes of thinking. The (20) forms (*10 x 2 distinctions*) may be deployed for the achievement of the (10) purposes (*5 x 2 distinctions*), which suggests a *20 x 10* 'look-up table' of forms *x* purposes of thinking meant to be effective in different situations and contexts, which are trained by different disciplines, and used and cultivated by different professions. We are in the possession of a library of kinds and types of thinking that we can aim to select for, train, develop and nurture in what we call 'education', to the end of building better problem solvers for the world.

'Trained by different disciplines' sounds promising but in fact is just the opposite: it means that no person is *professionally* trained in thinking in more than 1 or 2 different ways in ways that are guided by than 1 or 2 different purposes, which leaves at most 4 of the 200 cells of the look up table 'covered' by *any* one educational process (which takes one from grade school through graduate or professional school). At the same time, the 'problems of the world', great or small, *have no respect for disciplinary thinking* in the sense that patterns and purposes of thinking that have to marshalled and successfully deployed to solve them do not fall into neat disciplinary buckets and categories. This is true not only of problems that have distinct social and human components (famine and paradoxes of entitlement, contemporary slavery, childhood morbidity, illness and mortality) – which clearly require the adaptive deployment of multiple of multiple different patterns of thinking, but also of problems that are patently technical in nature (efficient thermonuclear fusion, biological and neural computation, the successful construction of artificially intelligent agents, efficiently effective personal genomics-based therapeutic and prophylactic health care, the creation of an electric car infrastructure and *modus operandum* for the Western hemisphere). This state of affairs is 'prototypically' 21st century in nature: the 18th, 19th and 20th centuries have pushed the 'analytic paradigm' ('break wholes apart into smaller and smaller components and investigate the behaviour of the components in order to understand, predict and control the behaviour of the whole as a function of the behaviour of the parts') at the level of *multiple and separate* disciplines and professions to the point at which collaborative endeavours that bring together know-what and know-how from different disciplines to solve real problems has been rendered difficult or practically impossible by the erection not only of 'language barriers' (as each discipline has developed its own formalized language and associated set of rituals) but also of 'thinking barriers' (each discipline fosters, selects for, celebrates, rewards and promulgates a certain pattern of thinking and deploys it to a certain aim of thinking).

"Adaptive intelligence" is a paradigm specifically targeted at this ingenuity gap between the 'toy problems' disciplines are designed to solve and the problems that real humans, organizations and societies in a real world are called upon to solve. It is based on the adaptive deployment of patterns of thinking and interaction – the modes and purposes of thinking – to the articulation and solution of real problems. The collection I have outlined above – which not in any sense 'final' or 'finished', but a working model – is designed to

function as a set of building blocks for picturing and representing situations (models), understanding arguments made by humans trained in various disciplines and satisfying various norms of rationality, reasonableness, coherence and correspondence (analytical, synthetic, constructive, deconstructive modes of thinking, patterns of inference), building alternative possible worlds (modal thinking, along with the family of kinds and types of mental models, *poiesis*) and interacting with humans who have radically different patterns of thinking and speaking to solve the problems that these worlds turn up (emulative and simulative thinking, dialogical thinking and interactive reasoning). They form a toolkit, not a catalogue; a LEGO set, not a look-up table; an alphabet, not a script; a set of degrees of freedom for intelligence, not a set of blueprints for it. They are, moreover, *mindware*, not *software*, in that they are designed for and by *brains* in order to 'run' on brains, not on dedicated processors and co-processors - even though they can be used to design both software and hardware.

If an 'educational' system is to help with the task of building 'problem solvers to the world' – and not only 'specialized thinkers and speakers of special tongues, jargons and dialects', then the very nature of human intelligence has to be appraised in ways that transcends both old distinctions and categories (*g*, or generalized intelligence, the ability to make fast associations, the ability to perform rapid numerical computations – all of which are at least of dubious value in an age where the marginal cost of computation and calculative association is *$0*, and also newer and more democratic approaches to intelligence and human ability (eg: Howard Gardner's theory of multiple intelligences). What is missing in both cases is an *ecological* understanding of intelligence as the *adaptive and responsive deployment of modes and ends of thinking to real and practical problems in ways that transcend the artificial distinctions created and enforced by disciplinary thinking*. Adaptation has been properly considered as an end of an intelligent being in the domain of evolutionary accounts of brain and mind (where the intelligent being is a genotypically distinct population, or even a subset of the genes within a phenotypically distinct population). 'Intelligence', thus *re*-defined, is not the mechanical application of rules of association (mnemonic rules) and rules of calculation (computational or symbol manipulation rules), but rather the adaptive deployment of modes, patterns and aims of thought to the solution of real problems in real contexts, and with real consequences. 'Adaptive' means 'responsive to problem and context' and also 'autonomous', and 'autonomy' requires *choicefulness* – or the ability imagine, master and deploy one or more of *multiple* possible modes of thinking. No system, being, or entity can adapt to changes in its conditions without a set of internal degrees of freedom ('options', 'choices') which it can exercise autonomous control over, in response to such changes. Thinking *integratively*, across the different modes and domains of knowledge production and problem solving offered up by different professions, is an endeavour meant to accomplish the goal of fostering and training *adaptive* minds, that can *transcend* the mental habits of current disciplines and pragmatically *deploy* different modes and patterns of thinking to solve real problems in real places in real time.