# Logical Foundations of Strategic Reasoning
Daejeon, South Korea, November 3-4, 2016

Miro BRADA, "Logical model of Personality and Cognition with possible Applications"
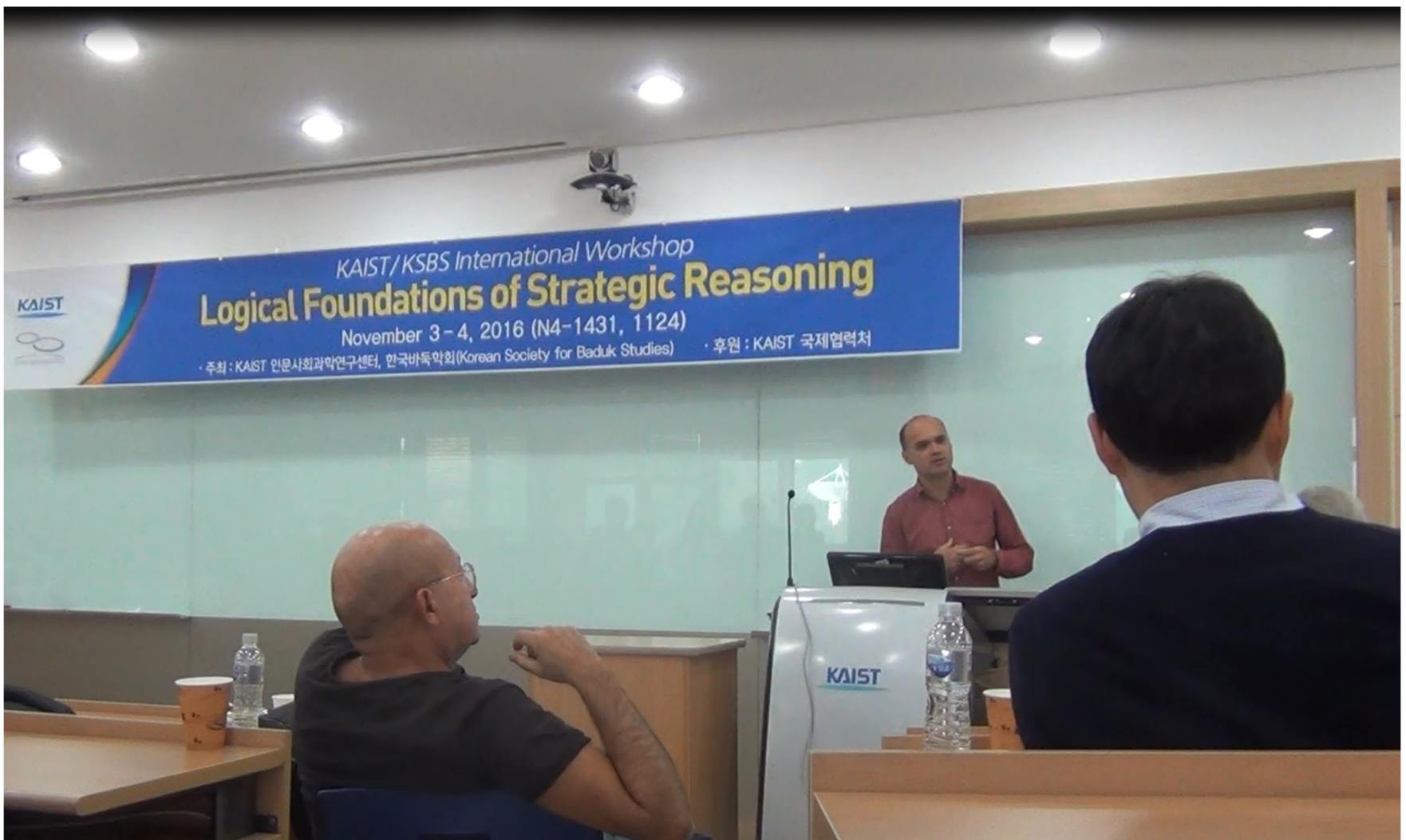
Abstract

Although the cognition is significant in strategic reasoning, its role has been weakly analyzed, because only the average intelligence is usually considered. For example, prisoner's dilemma in game theory, would have different outcomes for persons with different intelligence. I show how various levels of intelligence influence the quality of reasoning, decision, or the probability of psychosis. I explain my original methodology developed for my MA thesis in clinical psychology in 1998, and grant research in 1999, demonstrating the bias of the classic IQ method, and how the intelligence limits thinking. Based on that I defined Personality Model, providing insight into understanding of psychosis (schizophrenia, bi-polar), which has not been explained yet by psychology or psychiatry. In addition, it enables to analyze and assess non-linear problems, utilizable in computer programming, visualization (animation) or other fields including Baduk game. I've already applied some principles in complex information system www.each.co.uk, and video-animations exhibited in London, Germany (next year in Tokyo). I need to mention my experience in chess composition between 1994 and 2000, winning a few international prizes and inventing a special class of fairy rules redefining the mate. The chess composition principles or patterns show the way to organize logical series to higher advanced mechanisms (like calculus), applicable to other fields. One of such principles is a logical aesthetic innovation: new strategy, defined by Italian composers. Finally I show how the simple redefinition of the classic utility concept links economics and psychology to explain irrational / destructive behavior. All presented results (from the research) can be repeated.

Bias of Classic IQ method

Classic IQ tests often contain analogies. Graduate Record Examinations test (1994) has this task:

Choose one of the five options: to expresses the same relation as the pair:
a) geyser : water   **volcano : lava**
b) fault : tremor
c) glacier : fissure
d) avalanche : snow   The right answer is:
e) cavern : limestone   **a) geyser : water**

In fact, there are more correct answers...
E.g. e) cavern : limestone, could be solution, based on the formal analogy,
when cavern has one v (as volcano), and limestone has one l (like lava)

volcano : lava e) cavern : limestone

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The higher intelligence, the more options discovered. It leads to the uncertainty, which one is right. The IQ method, with only one right solution, reflects intelligence (to find out the correct answer), but it excludes solutions with more sophisticated justifications. In my research (1999), I confirmed this bias, asking 600 people to write (not solve) more analogies as is: **life : death = laugh : cry**
for: **fire : .... = darkness : ....**

There were 2 types of analogies:

a) analogy of the meaning: b) formal analogy
fire : red = darkness : black   fire : fire = darkness : darkness
fire : water = darkens : light   fire : darkness = darkness : fire
fire : pleasure = darkness : melancholy   fire : fired = darkness : dark
                                           fire : erif = darkness : ssenkrad

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All wrote an analogy with the meaning, while only 5% discovered the formal analogy. And just these 5% had statistically higher intelligence. The less frequent analogy (sign) discovered, the higher intelligence. And so the classic IQ methods excluding rarer signs, don't reliably assess high intellect. It was also confirmed by another task to write more signs, which would exclude just one of the three words.

Another task was to invent categories. For 1. swam 2. chop 3. cut
category 'past tense' links 'swam', 'cut' to exclude 'chop'
category 'work with wood' links 'chop', 'cut', to exclude 'swam'
etc...
Then I asked people to invent such categories (grouping just 2 words) for:
1. rifles 2. revolver 3. pebble chopper   a) gun (1+2, 3)
                                           b) singular (2+3, -1)
                                           c) letter r at the beginning (1+2, -3)
Some answers were: d) letter o (2+3, -1)
                                           e) more than six letters (2+3, -1)
                                           f) one word (1+2, -3)
                                           g) metal, iron, steel (1+2, 3)
                                           h) modern era, prehistoric tools (1+2, 3)

intelligence / originality vs frequency of invented signs

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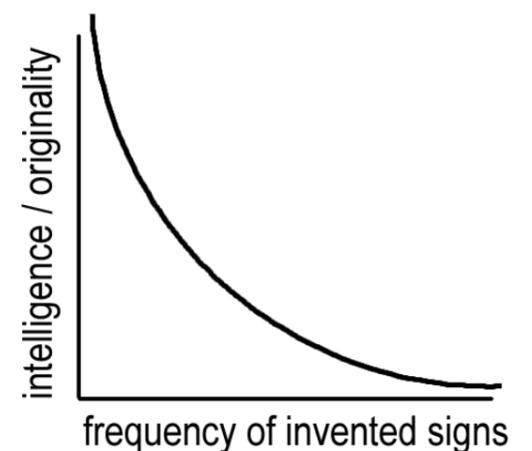
Expectation and cognition

In every game (incl. Baduk, chess) is crucial to accurately guess the guess of other player. Psychology, sociology, economics assume average intelligence in their models. Bounded rationality (in economics) imposes cognitive limits, but doesn't differentiate between levels of intelligence. The asymmetrical models focus on information (its access), rather than the differences in intelligence to assess information. I asked tested persons to fill four patterns with 0-16 circles in 2 ways:
The best strategy of Task A, is the worst of Task B, and vice-verse. For Task A, the optimal strategy is to fill 8 circles randomly having the most different options. The random 8 filled circles, really occurred with the higher intelligence. The breaking rules' strategies: 'cheating' (e.g. adding something extra or semi-fill circle), or 'meaning' (e.g. drawing a face), also occurred with higher intelligence. But they are

Example **Task A** **Task B**

Nobody would do Everybody would do
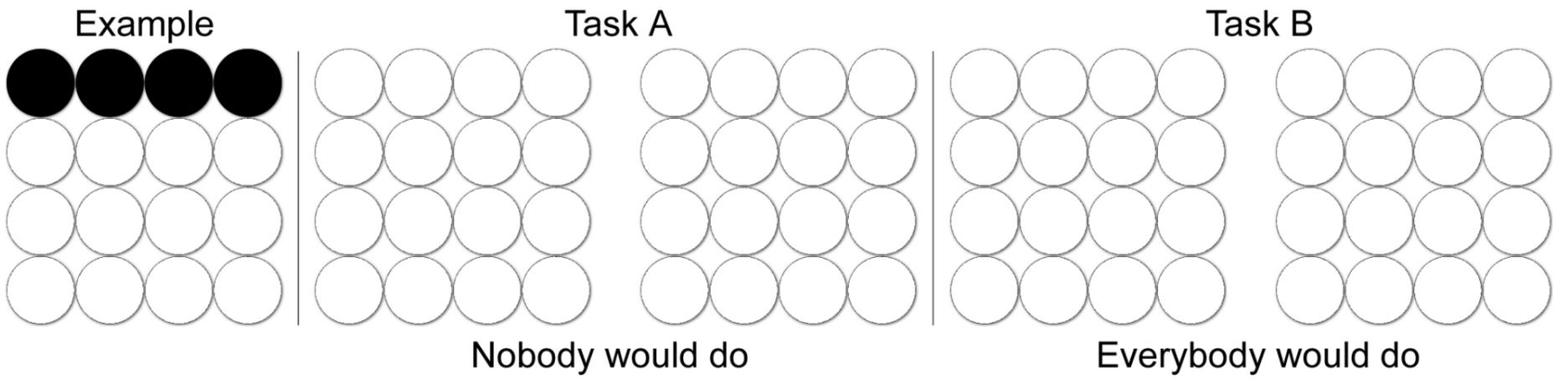
less optimal than 8 random circles. Although cheating can easily lead to a unique shape, 'incentive to cheat' is already less unique (9% cases of cheating).

Task A, 568 tested people   frequency / intelligence (scores from creation of logical series)

optimal strategy   worst strategy

example of 8 random circles — 3.8% / 127

16 circles — 3.7% / 99   Nothing — 6.3% / 100

repeating intro example — 0.9% / 73

example of 1 circle — 8.5% / 93

8 circles symmetry — 1.2% / 55

LT diagonal — 0.9% / 75

4 inside — 0.9% / 109

cheating — 9% / 122

meaning — 1.9% / 114

15 circles' example — 1.1% / 135

symmetry — 0.9% / 100

hidden symmetry — 8% / 104

example of logic between patterns — 8% / 104
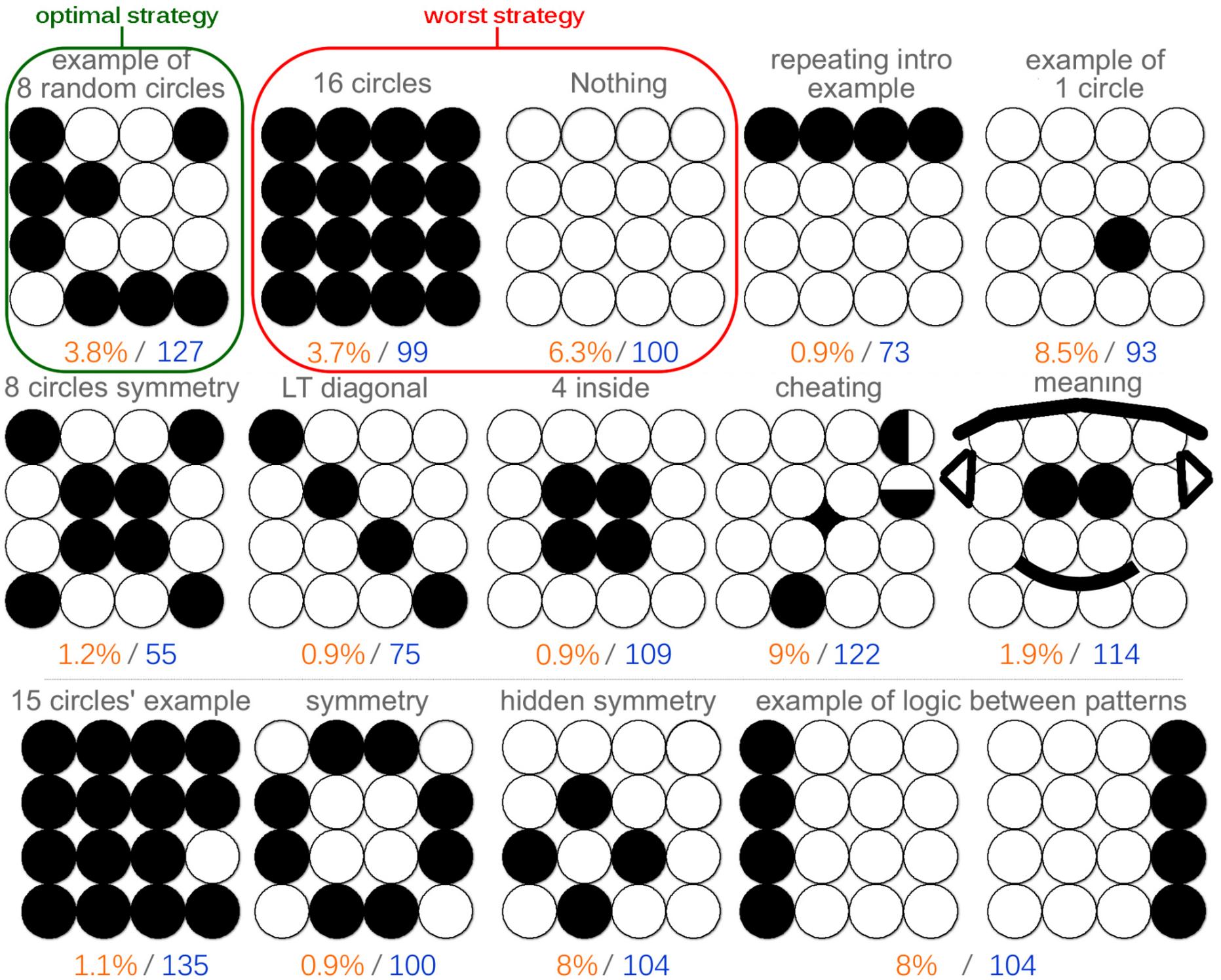
In task B, the most repeated patterns occur with the average intelligence. The objectively optimal strategy (0 or 16 circles) correlates with higher intelligence, but was chosen by merely 4% or 2%. So average intelligence leads to the better real guess than the higher intelligence. On the other hand, the worst strategy (asymmetry) occurs with the low intelligence. So the most popular choices are not optimal, but at least partially rational (=not worst).

Task B, 568 tested people   frequency / intelligence (scores from creation of logical series)

worst strategy   optimal strategy

example of
8 random circles
1.8% / 92

16 circles
4% / 124

Nothing
1.4% / 143

repeating intro
example
6% / 90

example of
1 circle
3% / 106

8 circles symmetry
10% / 100

LT diagonal
11% / 103

4 inside
10% / 103

RT diagonal
8% / 106

L column
4% / 89

D row
1.4% / 27

10 circles symmetry
10% / 100

4 outside
11% / 103

chessboard I
4% / 94

chessboard II
1.1% / 79
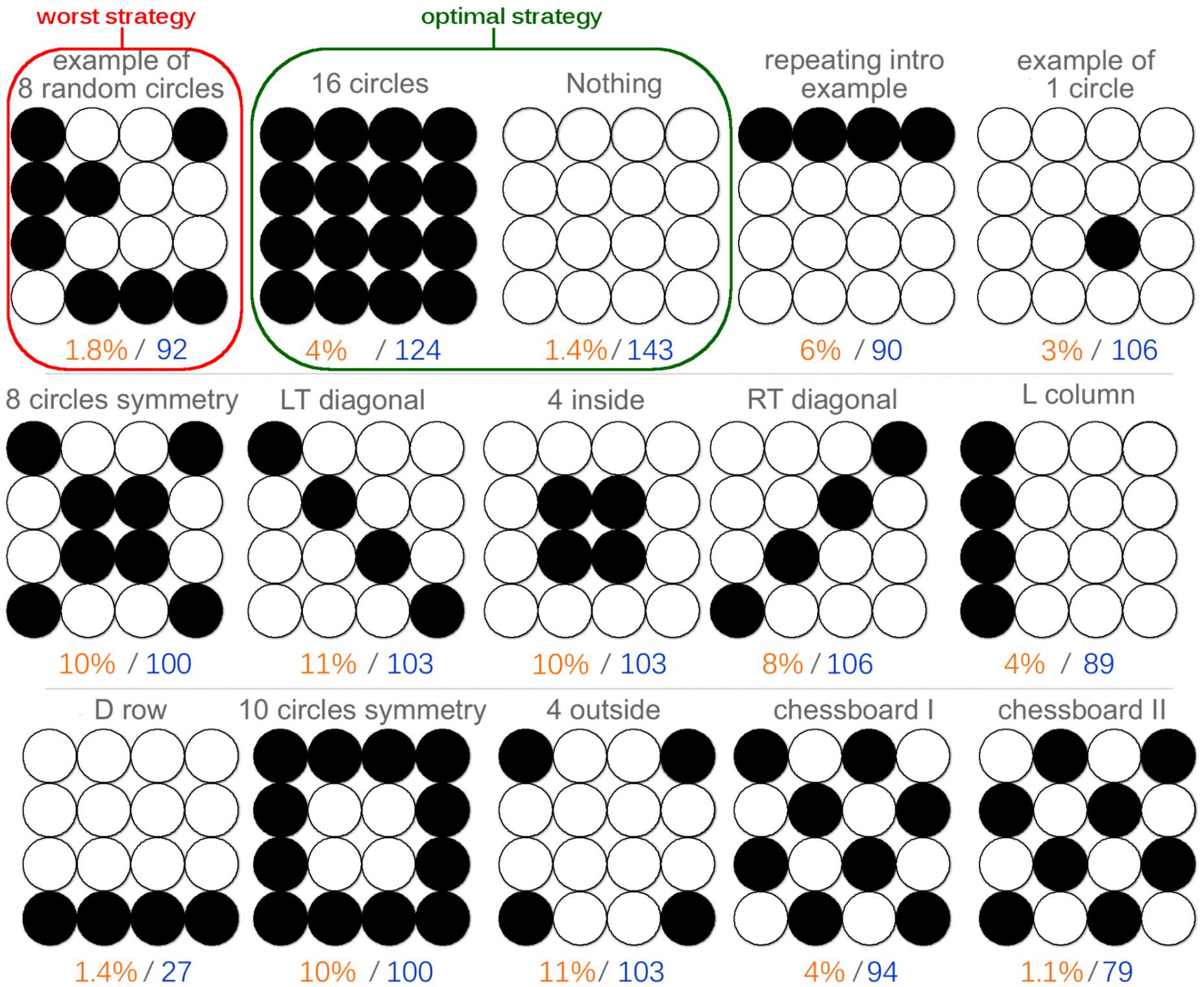
The higher intelligence, the more optimal choice, which however does not need to be 'right' - if its optimality overreaches average intelligence. Theoretically infinity intelligence would adjust to majority's guess... But it can't precisely recognize the majority's non-optimal choice, without objective criteria and so with more equivalent guesses. Zero-sum game (chess, Baduk) limits speculative guesses, because of the criterion to win. That's why computer can easier calculate (using min-max algorithm) the guess of other guess. Non zero-sum games like chess composition (expressing ideas), have no limitation of other guess, and so computers are not able to compose chess problems (they can just check correctness). Non-optimal collective choices could shed some light on inefficiency in societies: crises, wars, as kind of 'collective neurosis' or 'collective psychopathy', outvoting optimal choices because of misunderstanding, or intention to exclude the clever people (as too efficient competitors). I found other correlations too. E.g. the higher intelligence, the higher independence of intro example (and of using 4 circles patterns). Various instructions (guess how less / more smart would guess other's guess, etc..) could be used in testing to differentiate the results further. Classic prisoner's dilemma is 'guess other guess' task too, requiring to guess what other would do, to optimaze decision. If both prisoners (A, B) betray each other they get 2 years, if both are silent they get 1 year. If A betrays and B is silent, A is free, B get 3 years (and vice-verse). The assumption is that game is finite (does not repeat), and no external punishment / reward is possible. The rational result is: they betray, even though the best outcome for both would be if both are silent. But, If both are 'dumb', they may guess the other would be silent, to be silent too. In this special case, lower intelligence, leads to optimal solution.

Intelligence and intricacy: Thinking

Intelligence links unique units of reality to logical series, e.g: 1, 2, 3... defined by the same change +1:
1, 2, 3, 4, or other justifications. Series 1, 2, 3, 4 can result from:

a) $y = x$, returns 1, 2, 3, 4, 5

b) $y = x^4 - 10x^3 + 35x^2 - 49x + 24$, returns 1, 2, 3, 4, 29

c) other logic.

Different justifications can return, for some parameters, same results: 1, 2, 3, 4, but then the results diverge (5 versus 29). Classic IQ method based on 1 correct answer excludes rarer justifications.

2 different justification of logical series: 1, 2, 3, 4   Miro.Brada.1998
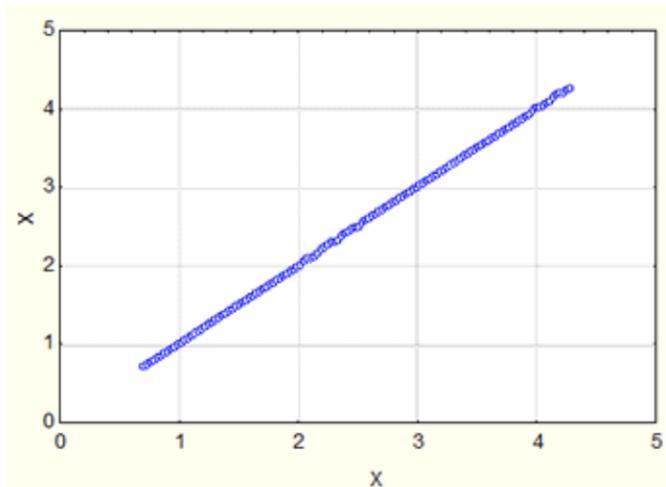
$y = x$
justifies 1, 2, 3, 4, 5, etc
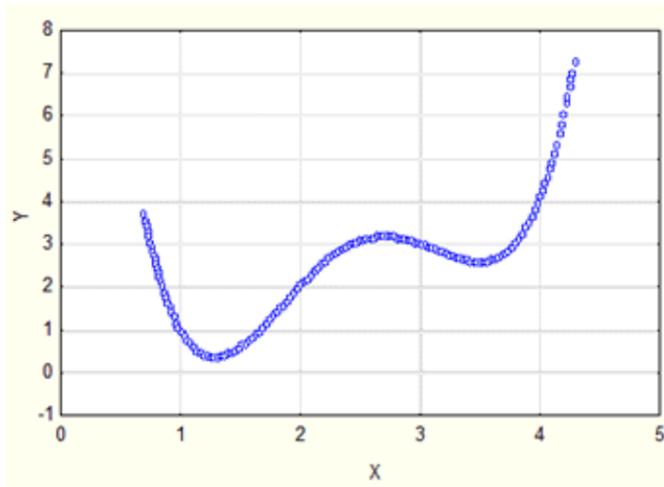
$y = x^4 - 10x^3 + 35x^2 - 49x + 24$
justifies 1, 2, 3, 4, 29, etc

The identity doesn't exist: 'p' differs from next 'p' by its position, time: p != p (Heraclitus Panta rhei 525-475 BCE). If 1/a is probability of occurrence of 'p', probability of next 'p' is $1/a^2$. Like likelihood to throw 6 with dice is 1/6, to throw 6 again is 1/36. Intelligence linking 'identical' changes to logical series, can be defined by probability: the lower probability of logical series per unit of time in given environment, the higher intelligence. The intelligence is inverted probability of logical series having discrete intricacies (combined logics): 1, 2, 3, ... 'Intricacy 1' has 1 logic e.g: adding, 'intricacy 2' combines 2 logics e.g. adding & rotating, 'intricacy 3' e.g. adding & rotating & sum, etc. The intelligence (as inverted probability) of series with 'intricacy 1' = 1, 'intricacy 2' = 2 * 2, 'intricacy 3' = 3 * 3, etc. So intelligence of every series = intricacy ^{2}, and thinking is a sum of every intricacy ^{2} of all series per unit of time. At glance thinking look as a linear process. In fact all elements building a logic, are linked exponentially - through multiplication of their probabilities. In general, assumptions of linearity - e.g. economic growth or political ideologies, don't capture the underlying dynamics (multiplication of probabilities), which may result to unpredicted outcomes (e.g. bombing of Hiroshima, collapse of Soviet Union...).

Thinking: $a_1^2 + a_2^2 + a_3^2 + a_4^2 + a_n^2$
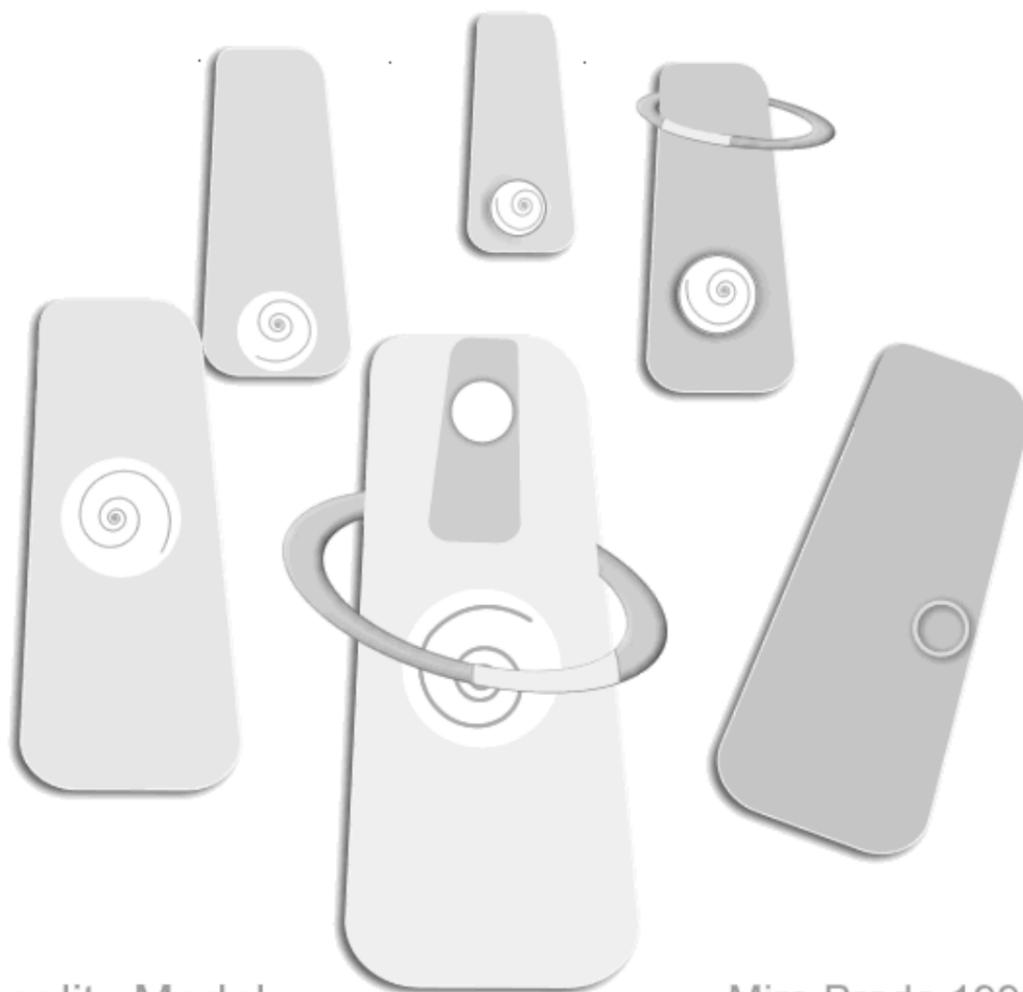
Personality Model   Miro.Brada.1996

Test of Intelligence and Creativity (TIC)

In 1996 I developed TIC to asses intelligence, flexibility, originality from drawn logical series on printed patterns, which was a synthesis of [Torrance Test of Creativity](#) (1984) and IQ tests like [Amthauer](#) (1953), [Raven](#) (1936), [Wechsler](#) (1955). TIC and theory of intelligence was my Master thesis in 1998 highly appreciated by [O. Kondáš](#) - expert in clinic psychology. TIC consists of 4 different patterns, and every pattern repeated 4 times in one row. Every row of the same pattern repeats 4 times, so there are 16 rows, where tested persons can create logical series. Instruction is 'draw a logical series on 4 printed patterns':
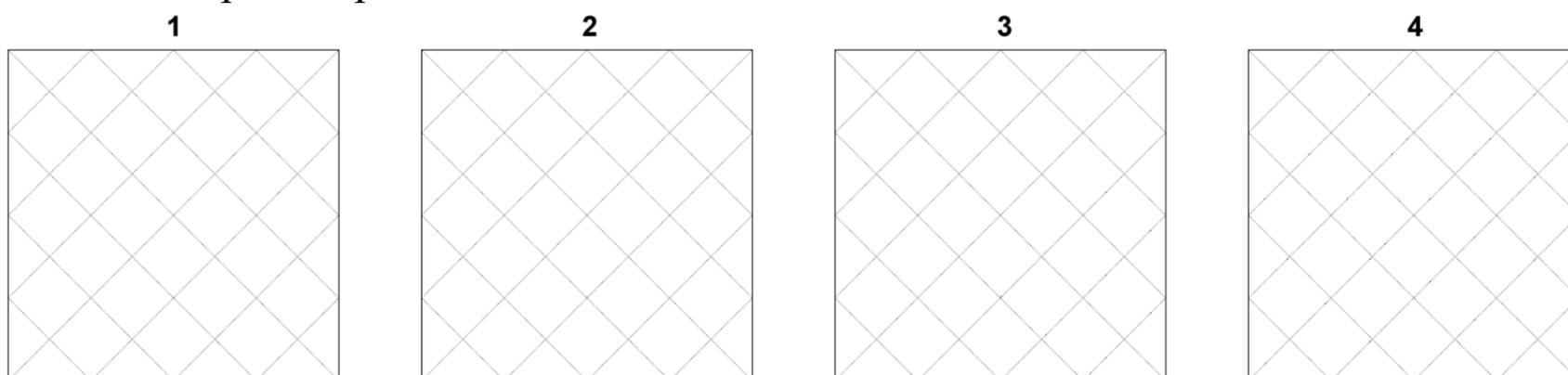
To find solution (classic IQ test) is much easier than creating logic. It requires certain intelligence, and so some created nothing (it does not mean 0 IQ). Before starting the test, I showed 2 examples: adding and alternation, with practice pattern, to explain what tested person should do.


Practice pattern

Example A - Addition of a rectangle

Example B - Alternation of a rectangle
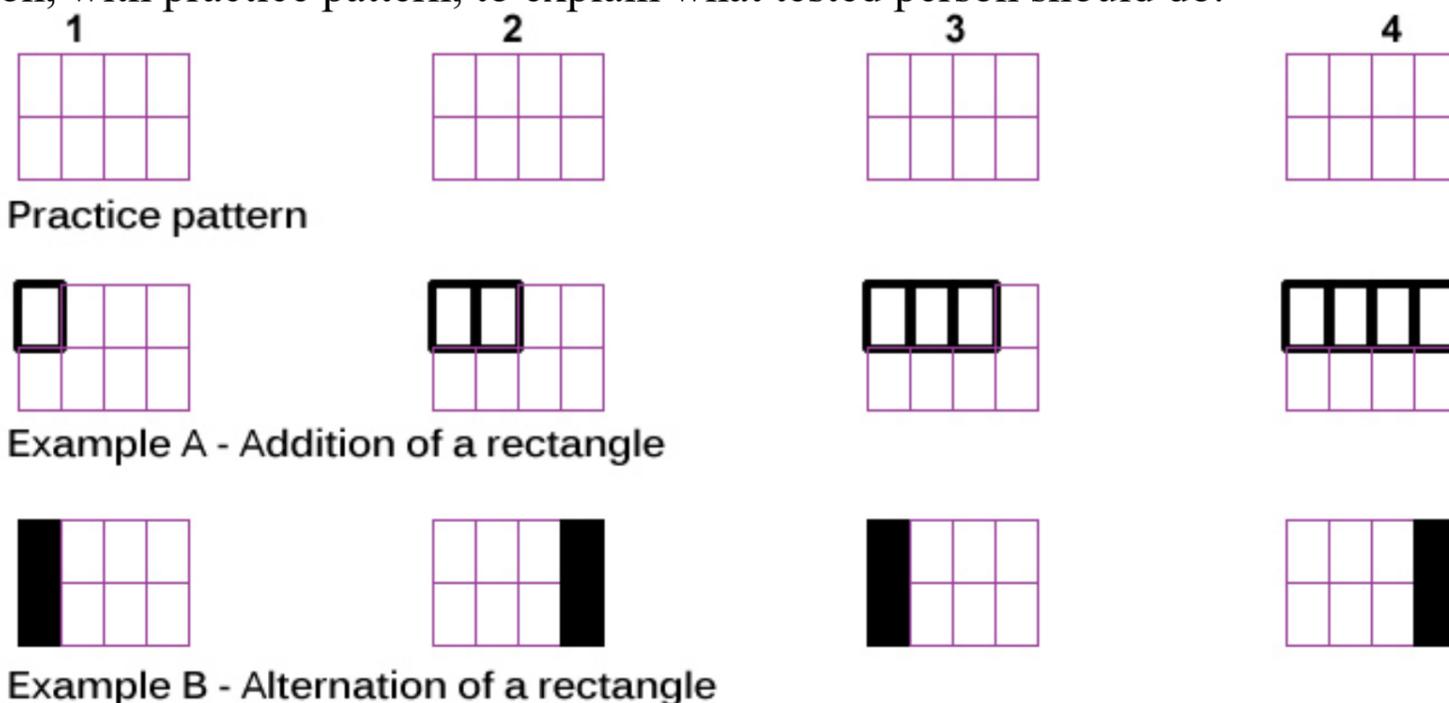
Testing 600 people, I found 24 types of logic - some were combined.
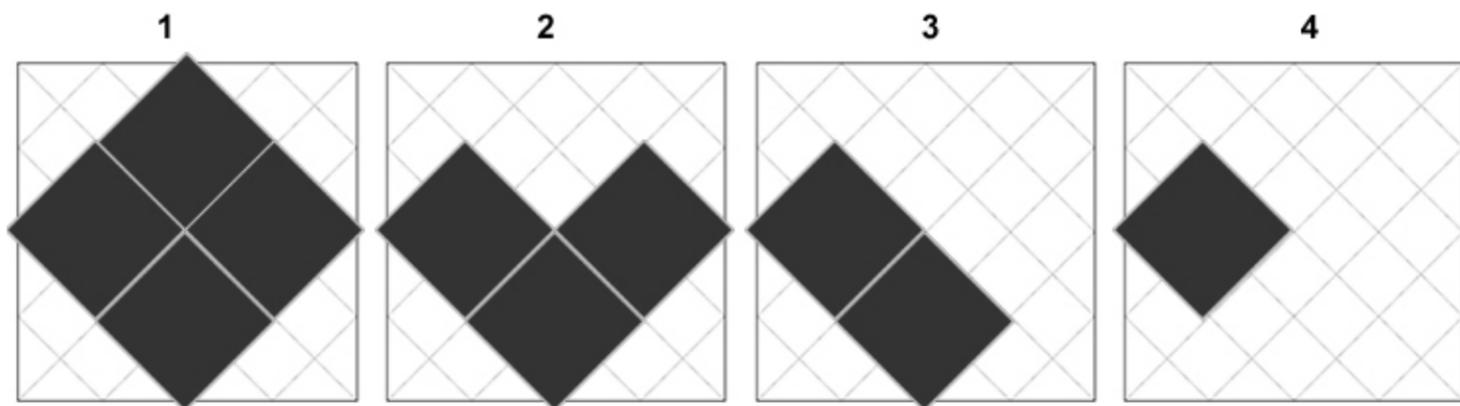
Subtration (-1) polygon ◆   P(subtraction) = probability (occurrence) of subtraction = $1/a_s$
Intricacy = 1, Intelligence = 1 * 1 = 1, Flexibility = 1, Originality = a_s
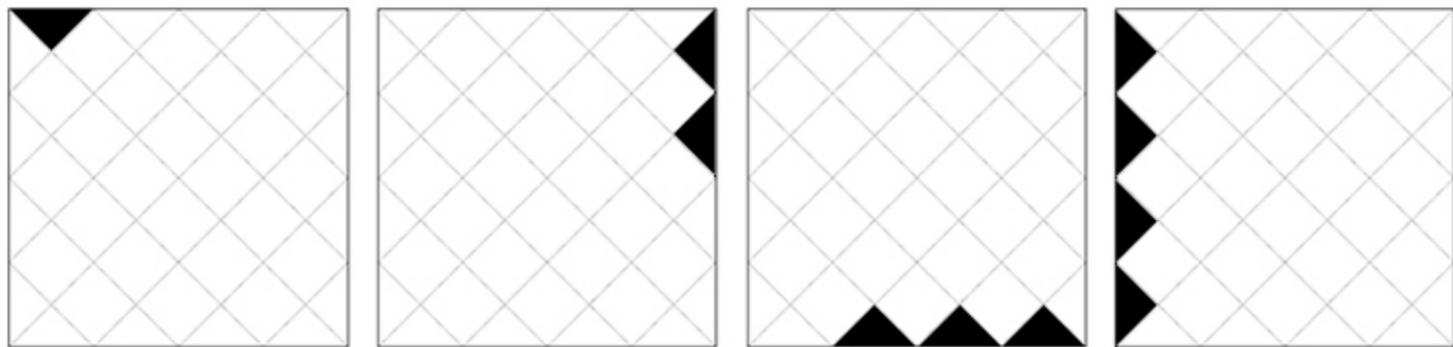
Adding (+1) & rotating (CW) triangle ▼   P(adding) = $1/a_a$, P(rotating) = $1/a_r$
Intricacy = 2, Intelligence = 2 * 2 = 4, Flexibility = 2, Originality = $a_a * a_r$

Creation of logic always enables to add new logic to series to increase its intricacy. E.g. subtraction of a polygon can be enriched by weakening colour (it is very original logic), and diminishing size. Alternating (empty, full) triangle can enrich adding and rotating triangle, plus summing the first 3 patterns to the 4, adds 'sum' logic. Then the triangle could be moving, diminishing etc... Theoretically infinity logics may be mutally combined. The results of TIC allows higher differences than classic IQ tests. In my research the highest score (of one musicologist) corrensponded to 250 IQ, while some achieved 0 (unable to produce any logic).
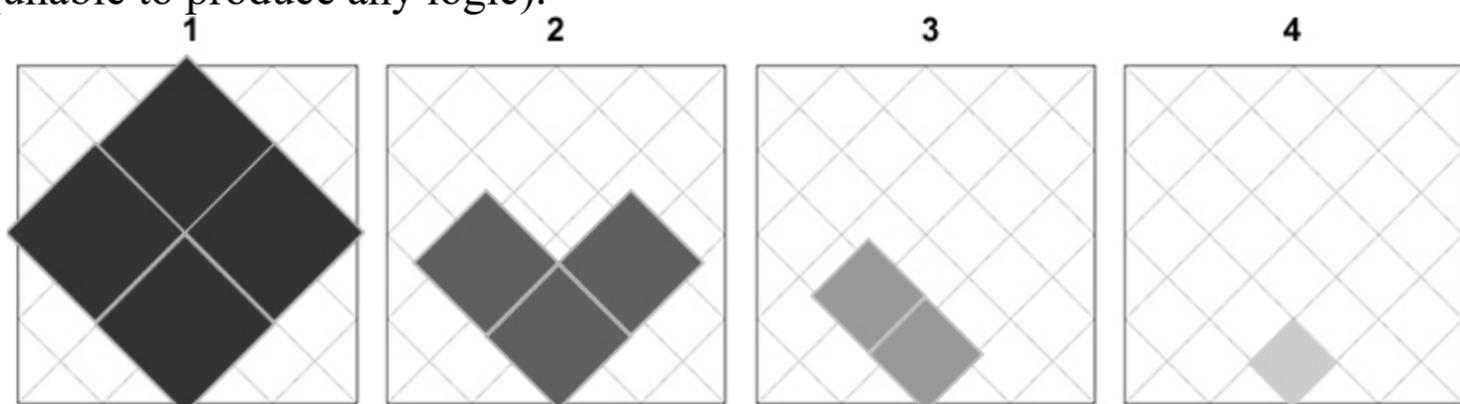
Substration (-1) & Diminishing & Weakening (color)
Intricacy = 3, Intelligence = 3 * 3 = 9, Flexibility = 3, Originality = $a_s * a_d * a_w$
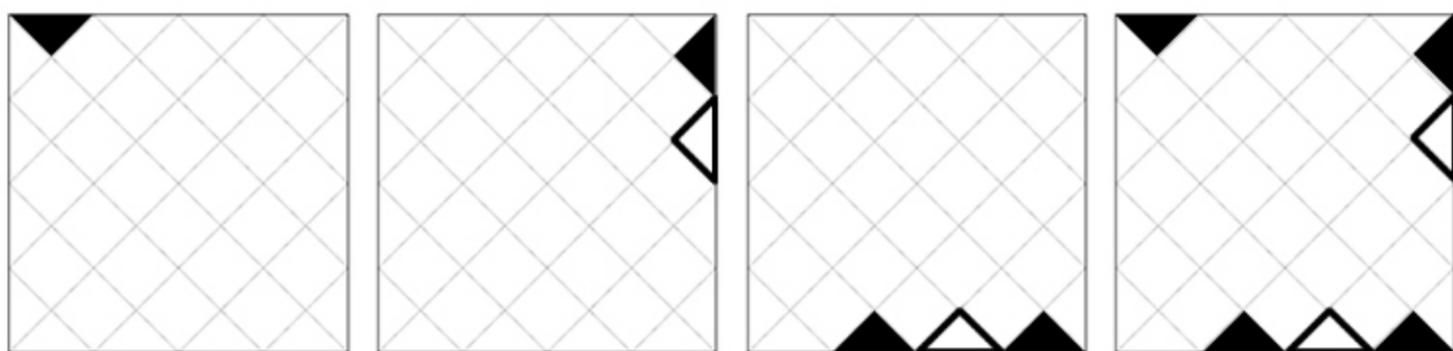
Adding (+1) & rotating (CW) & alternating (empty, full) & sum (1,2,3 = 4)
**Intricacy = 4, Intelligence = 4 * 4 = 16, Flexibility = 4, Originality = $a_a * a_r * a_{alt} * a_{sum}$**

Intelligence (of series) is intricacy², which was explained before, and should be now clearer from examples of logical series. Total intelligence is sum of intelligence of all N logical series in given time:

$$\text{Intelligence} = \Sigma_i^N \text{intricacy}_i^2$$

Flexibility = Σ_i^N different $logic_i$

Originality is inverted probability of logic, if probability of rotating is $1/a_r$, its originality is a_r.

Probabilities of intricate series are multiplied, originality of rotating & adding = $a_r * a_a$.

Originality = $\Sigma_i^N O_i$

where originality of series $O_i = \Pi_x^{intricacy} a_x$, where a_x is inverted probability of logic x

Environment influences originality - logic original for most people, can be banal for a special group, e.g. technicians overuse 'decomposing', because in technical fields the problems are broken down to be resolved like integration by parts: [Riemann–Stieltjes integral](.).

Decomposing   P(decomposing) = $1/a_{dc}$

Intricacy = 1, Intelligence = 1, Flexibility = 1, Originality ≈ a_{dc}
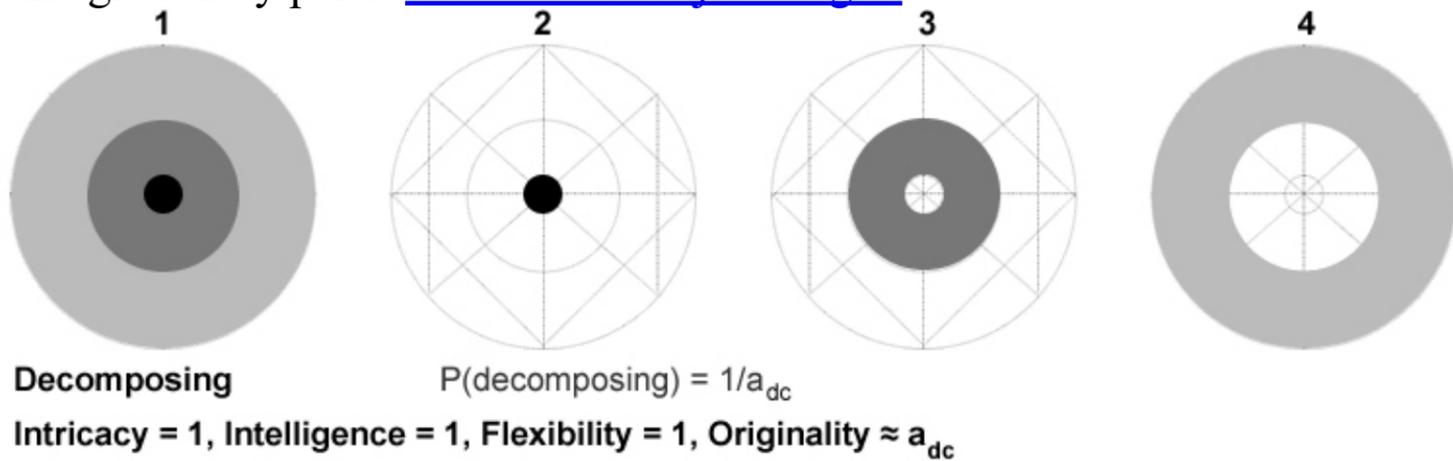
From the above definitions it is clear that intelligence, originality, creativity are statistically correlated. Together with logic, there were sometimes various effects: drawing meanings e.g. rotating umbrella, moving square bouncing or reappearing, etc. These effects increase intricacy, flexibility, originality, so each one has 0.5 point. Crucial is to classify the intention, which is not always easy, because logic can be drawn imperfectly, mistaken, or psychologist can see non-existing intention. Also interpretation may be ambiguous e.g. alternating left / right may be rotation of 180. Or are rotations CW, CCW, 45, 90 equivalent? Assessment could be more elaborated e.g. people could explain their logic to better understand their intention.

Alternating (full, empty) & Moving (right) + effect 'eternal': moving square reappears in the beginning

P(alternating) = $1/a_l$, P(moving) = $1/a_m$, P(effect eternal) = $1/a_{ee}$

Intricacy = 2 + 0.5 (effect), Intelligence = $2.5^2 = 6.25$, Flexibility = 2.5, Originality = $a_l * a_m * a_{ee}$


Repeating & Analogy + effect 'meaning': umbrella

P(repeating) = $1/a_p$, P(analogy) = $1/a_n$, P(effect meaning) = $1/a_{em}$

Intricacy = 2 + 0.5 (effect), Intelligence = $2.5^2 = 6.25$, Flexibility = 2.5, Originality = $a_p * a_n * a_{em}$

Theoretically, Rotating & Rotating should have smaller originality $a_r * a_r$, than e.g. Rotating & Summing because Summing is rarer than Rotating. Unlike machines, for humans repeating the same logic in one series is less likely i.e. Rotating & Rotating has higher originality than $a_r * a_r$ So the probability of the combined series does not need to be exactly same as expected. Humans don't tend to combine same logic e.g. adding & adding & adding & adding. The exception is paranoia, or psychosis

(they spy me, and I know they spy me, and they know that I know...). New concept of intelligence can so explain the psychosis, as one series of combined same logic, absorbing the whole intelligence.

Rotation ◖ & Rotation ◤   P(rotation) = $1/a_r$
Intricacy = 2, Intelligence = 4, Flexibility = 1, Originality > $a_r * a_r$
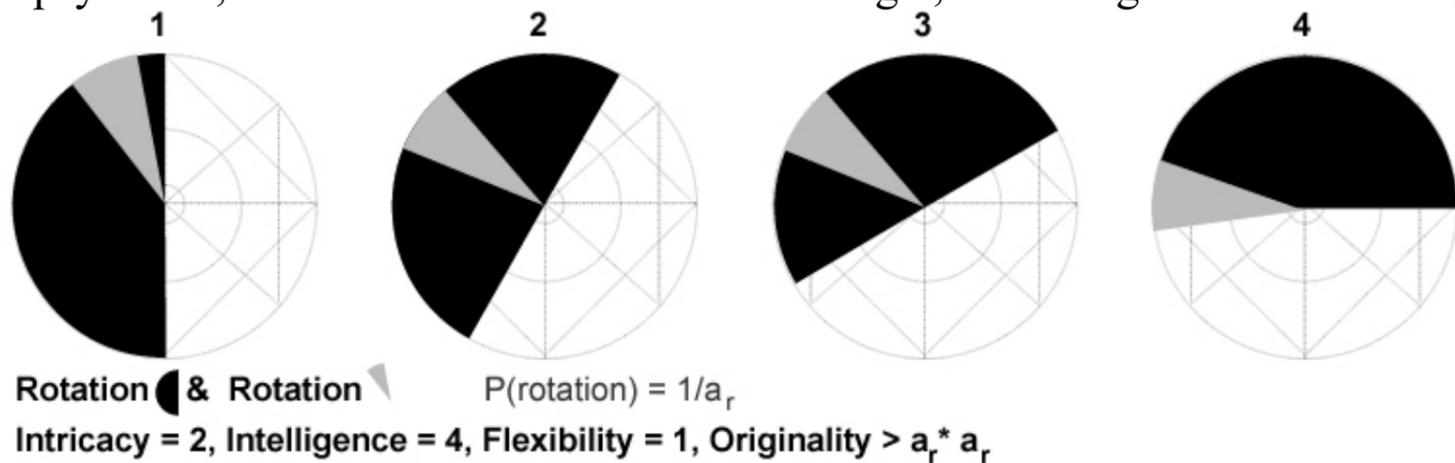
Psychosis

Personality is determined by certain level of intelligence a^2 distributed in various logical series, with core self-identity series.

Psychoses are of 2 types: a) schizophrenia with 1 logic, b) bipolar disorders (manic-depression) with 2 logics (bipolar can be understood as 'weak' psychosis).

Example of 1 logic in schizophrenia is: they know 'what I know', but I know that 'they know 'what I know'', but they know that 'I know that 'they know 'what I know'''... etc It can continue infinitely till absorbing the whole intelligence, capturing the 'self-identity'. The higher intelligence, the more repetition (higher intricacy) of the same logic. For personality with intelligence a^2, the intricacy of one logic is 'a'. For 2 logics in manic-depression, one logic's intricacy is: '$a/\sqrt{2}$' (because $(a/\sqrt{2})^2 + (a/\sqrt{2})^2 = a^2$)

Let's assume each number of a dice represents one logic (opportunity), so there are 6 logics: 1, 2, 3, 4, 5, 6 Then intelligence is a number of throws M: the higher intelligence, the more throws (M).

Possible personalities = N^M, where N = number of opportunities, and M is intelligence, in our example it is: 6^M
Possible Schizophrenia(s) = N, in our example it is: 6
Possible bipolar disorders = N * (N-1) / 2, in our example it is: 15

While number of personalities exponentially raises with M (intelligence), for 6 logics there are still just 6 possible schizophrenias, and 15 possible bipolars. So:
The higher intelligence, the lower probability of psychosis and bipolars - probability decreases geometrically.
The more opportunities, the lower probability of psychosis and bipolars - probability decreases arithmetically.
The more opportunities, the higher ratio of bipolars to schizophrenia - the ratio increases arithmetically.

To minimize a chance of psychosis, intelligence is more important than opportunities, but at least some opportunities are necessary (extreme situations may trigger psychosis regardless of intelligence, as one logic always results in a repetition of the same: psychosis). The importance of intelligence was documented by many studies, e.g here is a study from The American Journal of Psychiatry, 2015, by Dr. Kendler.
Ratio of bipolar to schizophrenia is (N - 1) / 2, does not depend on intelligence. According to WHO, there are 21 millions of schizophrenia, and 60 millions of bipolar disorders. Ratio of bipolar disorders to schizophrenia (N - 1) / 2 suggests: the more developed societies (more opportunities), the higher ratio of bipolar to schizophrenia. E.g. some studies show that bipolar disorders in USA is 4.4%, while in India only 0.1%. And according to WHO's 2000 statistics, there are 1.45 times higher rate of schizophrenia in India than USA. The environment (opportunities) influences the number of psychoses / bipolar disorders, as well as their ratio. So genetics can't explain everything.

The reality is more complex than a dice, with possible heterogeneity in logics (e.g. some logics cannot be for some reason always combined), and the accessibility of logics may differ by time. However the formula for possible distributions (personalities) across logics (opportunities) in dependence on intelligence, remains true, which opens a possibility to study Personality mathematically.

Maximization of Uniqueness

I developed the concept of maximization uniqueness - a synthesis of economics and psychology - as a student of PhD in economics in 2000, redefining the classic utility concept. I published a few articles about that and other related concepts: Edison's economics, Redirection of talent, Convergence and Divergence of economics, Pay as you go system.

The richer you are the less equally rich or richer people.
The richest person is only one (= unique).
Maximization of richness or leisure (=the classic utility concept), maximizes the originality (uniqueness).
Doing an extreme sport, striptease, having tattoo, can have the same function as maximizing richness / leisure.
So maximization of originality can relate any activity / motivation.
Seemingly to be the richest is unique as to be the poorest... But the rich can easily become poor, while the poor can hardly become the rich. So there is an asymmetry in what is maximized, reflecting intelligence and opportunity... Without opportunity even the brilliant person maximize irrationally (=destructive behavior). So irrational behavior doesn't necessarily indicate insufficient intellect.
John Stuart Mill in Principles of Political Economy (1848) wrote that a commodity must be useful and scarce: the scarcer (= more original), the more precious. The evaluation of scarcity depends on opportunity and intelligence, determining time spent on affordable value:
$a + b + c ... = $ Time, where a, b, c, ...are affordable values / activities
The utility can be defined as: Umax $= a * b * c * ...$
Utility multiplies the values because they are independent (in terms of occurrence), and their overall occurrence (=probability) is then equal to multiplication of all their probabilities. So maximizing utility minimizes overall probabilities of all values. It is opposite to entropy.
If there is only 1 possible value, it consumes all time, regardless of intelligence…
For 2 values, we have this equation:
$a + b = T$
Umax $= a * b$
By mathematical substitution: Umax $= a*(T-a) = a * T – a^2$ And derivation gives: $T = 2*a$, so: $a = T/2$...
In case of two affordable values, rational agents halve their time between value 'a' and 'b'. To illustrate, it is better to have 2 children equally healthy, than 1 child very healthy and another very sick.
It results from fact that a^2 is bigger than $(a - x) * (a + x) = a^2 - x^2$:
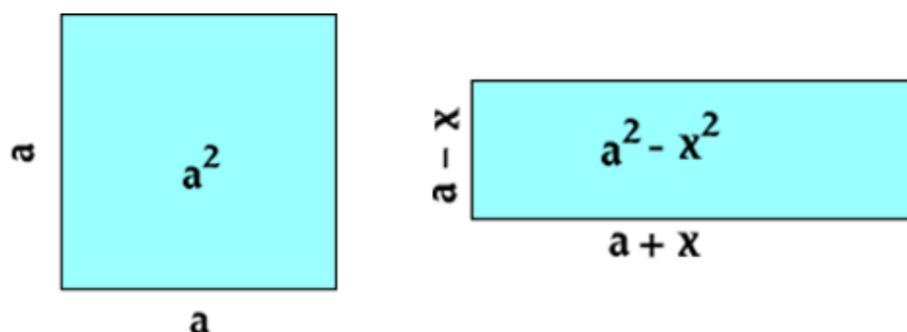
Maximization of uniqueness: the law of values' equity. Irrational e.g. drunk person may break law of values' equity... To maximize originality the drunk person can make a striptease in front of public (= a+x) to pay a price at police station (= a-x).

Possible applications

Naomi Campbell is a pop-art animation (below are just 4 shots from the animation). Warhol repeated the same object (celebrity) differentiating just by color, which is a special logical series. I applied various logical series and their combinations: rotation, increasing, moving, etc to create more advanced result. Applying chess composition patterns would enable to create the unique mechanisms of logical series.

2nd Prize in the British Problemist for Mate in 2, shows one of my new-strategic compositions, with so called Kiss theme: cyclic change of key and 2 mates, between try and solution. To appreciate its hidden beauty, it is necessary to understand the changes between the phases. Transferring new-strategy principles into visual art, has a potential to establish a new kind of Mamnerism (game in game).

Miroslav Brada

2nd Prize *The Problemist*, 1997

Mate in two

Dutch juror Henk Prins wrote:
A problem with a modern scheme. The composer
shows the Kiss theme with just 13 pieces - nearly a
Meredith. Did you notice that the threat of the try
reappears post-key after 1...Bg1?

Many (if not most) programming projects are developed, but not used at the end. There is a problem to accurately estimate time of tasks, preventing projects to be planned and finished on time. At glance, logic / functionality created by all objects / elements (containers, controls), looks linear, but it is non-linear. It means that states of the all independent elements are multiplied, not summed. So the overall intricacy of e.g. the 3 elements: a, b, c, isn't a + b + c, but a * b * c (set of states is from 1 to N). That's why the crucial is a reduction of the logic to only necessary elements, otherwise complexity and development time rises exponentially. The organization of elements matters too, when reusing the functionality (with different parameters) reduces the states. The reduction may be prevented by the power structure, when manager(s) has a temptation to fragment (divide and conquer) the project for various persons. Resulting competition leads to duplicated logic of different persons, exponentially rising complexity of development. Since 2008 I've applied the elements reduction and functionality programming to minimize the code and metadata structures, for a complex information system www.each.co.uk, with a simplified logic reusing the same functionality for various purposes and different devices, sites.

Links to some of my works:
ISSC, 2016[Personality Model](#)
Problem Paradise, 1999[Intelligence and Special Problems](#)
Foucault News, 2015[Film Discontinuity](#)
Respekt, 2003[Redirection of Talent (Interview with William Baumol)](#)
Chelsea Town Hall, 2015[Naomi Campbell - pop art](#)
Inzine 2004[Maximization of Originality](#)
Chess Problems and Puzzles, 2016[Chess Composition as an Art](#)