Critique of Kahneman & Prospect Theory

Selmer Bringsjord

Are Humans Rational?

10/5/15

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Test 1; Resurrection problems …
Elements of the Critique

• Explaining/Predicting the Linda Case
• Overconfidence & Stock Picking
• Betting & Prospect Theory
• Auction for $100
• Paradigm:
  – Logicist Agent-Based Economics (LABE)
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What’s really going on with Linda …
“Narratological” Probability
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During college, math major Bruno was a stellar athlete, graduating Phi Beta Kappa from Princeton, where he received the Most Dedicated Athlete in his graduating class.
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Which is more probable [ ]? A alone or A and B together?
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A: Bruno is a trauma surgeon.

B: In leisure time, to relax, Bruno plays competitive tennis.

Which is more probable [as a heading-toward-3D-picture of a person]? A alone or A and B together?
LABE Formalization

\[
S \vdash_{c.} \phi, S \vdash_p L, L \cup \{\beta\} \vdash_{\sigma \geq c.} \phi
\]

\[
S \vdash_{\sigma \geq c.} \phi \land \beta
\]
Overconfidence & Stock Picking …
help a stranger suffering a seizure. They certainly believed the statistics they were shown, but the base rates did not influence their judgment of whether an individual they saw on the video would or would not help a stranger. Just as Nisbett and Borgida showed, people are often reluctant to infer the particular from the general.

Subjective confidence in a judgment is not a reasoned evaluation of the probability that this judgment is correct. Confidence is a feeling, which reflects the coherence of the information and the cognitive ease of processing it. It is wise to take admissions of uncertainty seriously, but declarations of high confidence mainly tell you that an individual has constructed a coherent story in his mind, not necessarily that the story is true.

The Illusion of Stock-Picking Skill

In 1984, Amos and I and our friend Richard Thaler visited a Wall Street firm. Our host, a senior investment manager, had invited us to discuss the role of judgment biases in investing. I knew so little about finance that I did not even know what to ask him, but I remember one exchange. “When you sell a stock,” I asked, “who buys it?” He answered with a wave in the vague direction of the window, indicating that he expected the buyer to be someone else very much like him. That was odd: What made one person buy and the other sell? What did the sellers think they knew that the buyers did not?

Since then, my questions about the stock market have hardened into a larger puzzle: a major industry appears to be built largely on an illusion of skill. Billions of shares are traded every day, with many people buying each stock and others selling it to them. It is not unusual for more than 100 million shares of a single stock to change hands in one day. Most of the buyers and sellers know that they have
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Overconfidence of Stock Pickers

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Market can itself be (partially) controlled.
On the Contrary Supremely Rational:

It’s common knowledge that confidence has great utility.

System makes money.

Market can itself be (partially) controlled.

Simple as that.
$100 Auction …
LABE applied to? …
Logicist Agent-based Economics: Foci ...
Logicist Agent-based Economics: Foci …

• Formal Science of Science: Economics
Logicist Agent-based Economics: Foci …

- Formal Science of Science: Economics
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Formulae for Normal Auction

AA1. "It is common knowledge that at all times $t$, agents $a$, and bid amounts $x$, agent $a$ bids $x+1$ at time $t+1$ only if the current high bid is $x$ at time $t$ and $a$ is not the current high bidder."

\[
\forall t, a, x \ (\text{happens}(\text{action}(a, \text{bids}(x+1)), t+1) \rightarrow (\text{holds}(\text{high_bid}(x), t) \land \neg \text{holds}(\text{high_bidder}(a), t)))
\]

AA2. "It is common knowledge that at all times $t$, agents $a$, and bid amounts $x$, $a$ is the high bidder at time $t$ if and only if $a$ successfully bids $x$ at time $t$."

\[
\forall t, a, x \ (\text{holds}(\text{high_bidder}(a), t) \leftrightarrow \text{happens}(\text{action}(a, \text{bids}(x)), t))
\]

AA3. "It is common knowledge that at all times $t$, agents $a$, and bid amounts $x$, $x$ is the high bid at time $t$ if and only if $a$ successfully bids $x$ at time $t$."

\[
\forall t, a, x \ (\text{holds}(\text{high_bid}(x), t) \leftrightarrow \text{happens}(\text{action}(a, \text{bids}(x)), t))
\]

AA4. "It is common knowledge that there is no more than one high bidder at any time $t$."

\[
\forall t, a, y \ (\text{holds}(\text{high_bidder}(a), t) \land y = a) \rightarrow \neg \text{holds}(\text{high_bidder}(y), t))
\]

AA5. "It is common knowledge there is no more than one high bid at any time $t$."

\[
\forall t, x, y \ (\text{holds}(\text{high_bid}(x), t) \land y = x) \rightarrow \neg \text{holds}(\text{high_bid}(y), t))
\]

AA6. "At all times during the auction, if an agent makes a bid, then all agents perceive it: i.e., it's a public auction where all bidding is perceived by everyone."

\[
\forall t, a, x, b \ (\text{happens}(\text{action}(a, \text{bids}(x)), t) \rightarrow \text{Pb, happens}(\text{action}(a, \text{bids}(x)), t))
\]

AA7. "It is common knowledge that for all times $t$, all agents $a$, and all bid amounts $x$, $a$ buys reward at time $t+1$ for price $x$ if and only if $a$ bids $x$ at time $t$ and there does not exist an agent $b$ ($b <> a$) who bids $x+1$ at time $t+1$.

\[
\forall t, a, x, b \ (\text{happens}(\text{action}(a, \text{buys}(\text{price}, x)), t+1) \leftrightarrow (\text{happens}(\text{action}(a, \text{bids}(x)), t) \land \neg \exists b (b <> a \land \text{happens}(\text{action}(b, \text{bids}(x+1)), t+1))))
\]
Beliefs and Intentions (Strategy) for Normal Auction

B1. "Everyone believes the prize value is 20."
   {B1} Assume ✓

B2. ∀ a B(a, reward_value(20))
   {B2} Assume ✓

l1. "For all a, t, x, a makes a bid of x+1 at time t+1 if and only if a believes reward value is 20, a knows high bid is x, a is not high bidder, and a knows x + 1 <= 20."
   {l1} Assume ✓

l1. ∀ a, t, x ((B(a, reward_value(20)) ∧ K(a, holds(high_bid(x), t)) ∧ K(a, ¬holds(high_bidder(a), t)) ∧ K(a, (x + 1 <= 20))) ⟺ happens(action(a, bids(x + 1), t + 1))
   {l1} Assume ✓
Bi-Pay Auction Formulae

in addition to those of the normal auction…

AA8. "It is common knowledge that for all t and all agents a, a is second high bidder at time t+1 if and only if a was high bidder at time t and there exists b bids x+1 at t+1 (b <> a)."

\[ C(\forall t, a \, (\text{holds(second\_high\_bidder}(a), t + 1) \leftrightarrow (\text{holds(high\_bidder}(a), t) \land \exists b \, (\text{happens(action(bids(b,x + 1),t + 1)) \land b <> a)))) \]

AA9. "It is common knowledge that for all t, bid amounts x, x is second high bid at time t+1 if and only if x was high bid at time t and there exists agent a that bids x+1 at t+1."

\[ C(\forall t, x \, (\text{holds(second\_high\_bid(x), t + 1) \leftrightarrow (\text{holds(high\_bid(x), t) \land \exists a \, (\text{happens(action(bids(a,x + 1),t + 1))}))}) \)

AA10. "It is common knowledge that for all times t, all agents a, and all bids x, a pays x at t+1 iff a is second high bidder at t and there is not an agent b (b <> a) who bids x+1 at t+1."

\[ C(\forall t, a, x \, (\text{happens(action(a,pays(x)), t + 1) \leftrightarrow (\text{holds(second\_high\_bidder}(a), t) \land \neg \exists b \, (b <> a \land \text{happens(action(b,bids(x + 1),t + 1))}))}) \]
Beliefs and Intentions (Strategy) for Bi-Pay Auction

B1. "Everyone believes the prize value is 20."
   \( \text{[B1] Assume } \checkmark \)

B1. \( \forall a \ B(a, \text{reward_value}(20)) \)
   \( \text{[B1] Assume } \checkmark \)

B2. "Every agent believes that every other agent would never bid any more than 20 at any time \( t \)."
   \( \text{[B2] Assume } \checkmark \)

\( \forall x,a,t,b \ (a \neq b \rightarrow B(a,(\text{happens}(b,a,\text{bids}(x + 1)),t + 1) \rightarrow (x + 1 \leq 20))) \)
   \( \text{[B2] Assume } \checkmark \)

I1. "For all \( a, t, x \), if \( a \) believes reward value is 20, \( a \) knows high bid is \( x \), \( a \) is not high bidder, and \( a \) knows \( x \leq 20 \), then \( a \) makes a bid of \( x+1 \) at time \( t+1 \)."
   \( \text{[I1] Assume } \checkmark \)

\( \forall a,t,x \ ((B(a, \text{reward_value}(20)) \land K(a, \text{holds}(\text{high_bid}(x),t)) \land K(a, \neg \text{holds}(\text{high_bidder}(a),t)) \land K(a,(x \leq 20))) \rightarrow \text{happens}(a,\text{bids}(x + 1),t + 1)) \)
   \( \text{[I1] Assume } \checkmark \)

I2. "For all \( t \), agents \( a \), agents \( b \) (\( b \neq a \)), and bids \( x \), if, at time \( t \), \( a \) is 2nd high bidder and high bid is \( x \) and \( a \) does not believe \( b \) will bid \( x+2 \) at \( t+2 \), then \( a \) will bid \( x+1 \) at \( t+1 \)."
   \( \text{[I2] Assume } \checkmark \)

\( \forall a,t,x,b \ ((K(a, \text{holds}(\text{second_high_bidder}(a),t)) \land K(a, \text{holds}(\text{high_bid}(x),t)) \land \neg B(a, \text{happens}(b,a,\text{bids}(x + 2),t + 2))) \land b \neq a) \rightarrow \text{happens}(a,\text{bids}(y,x + 1),t + 1)) \)
   \( \text{[I2] Assume } \checkmark \)
Bi-Pay Auction Proof Assertion

C8: a bid over $20 occurs.
Conclusions

• How will human-level agents behave in the deviant bi-pay auction?

• Two cases:

  • If naïve:

    • Lacking the time to thoroughly determine the answer to the question of whether to participate in the bi-pay auction, they substitute the easier question of whether to participate in a normal auction ... and the answer is YES!

  • If sophisticated:

    • Gamble that others won’t participate and win auction with early (low) bid.
Implementation of These Conclusions
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- Hypercomputation: Economics/Innovation
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Initial “Toddler Steps” for Roscas in the LABE Paradigm …
Start of “Sound” 4-Agent Rosca
Start of “Sound” 4-Agent Rosca
Start of “Sound” 4-Agent Rosca
Start of “Sound” 4-Agent Rosca

$  $  $  $  $  $  $  $  $  $
Start of “Sound” 4-Agents Rosca
Start of “Sound” 4-Agent Rosca
Start of “Sound” 4-Agent Rosca
Start of “Sound” 4-Agent Rosca

But:
How do we predict agents that won’t default?
How do we encourage agents not to default?
Syntax

\[ S ::= \]
Object | Agent | Self □ Agent | ActionType | Action □ Event |
Moment | Boolean | Fluent | Numeric

\[ action : Agent × ActionType → Action \]
\[ initially : Fluent → Boolean \]
\[ holds : Fluent × Moment → Boolean \]
\[ happens : Event × Moment → Boolean \]
\[ clipped : Moment × Fluent × Moment → Boolean \]
\[ f ::= initiates : Event × Fluent × Moment → Boolean \]
\[ terminates : Event × Fluent × Moment → Boolean \]
\[ prior : Moment × Moment → Boolean \]
\[ interval : Moment × Boolean \]
\[ * : Agent → Self \]
\[ payoff : Agent × ActionType × Moment → Numeric \]

\[ t ::= x : S | c : S | f(t_1, \ldots , t_n) \]

\[ t : Boolean | \neg \phi | \phi ∧ \psi | \phi ∨ \psi | \]
\[ P(a,t,\phi) | K(a,t,\phi) | C(t,\phi) | S(a,b,t,\phi) | S(a,t,\phi) \]
\[ \phi ::= \]
\[ B(a,t,\phi) | D(a,t,holds(f,t')) | I(a,t,happens(action(a*,\alpha),t')) \]
\[ O(a,t,\phi,happens(action(a*,\alpha),t')) \]

Rules of Inference

\[ C(t,P(a,t,\phi) → K(a,t,\phi)) \]
\[ [R_1] \]
\[ C(t,K(a,t,\phi) → B(a,t,\phi)) \]
\[ [R_2] \]

\[ C(t,\phi) t ≤ t_1 \ldots t_n \]
\[ K(a_1,t_1,\ldots K(a_n,t_n,\phi)) \]
\[ [R_3] \]
\[ C(t,\phi) \]
\[ [R_4] \]

\[ C(t,K(a,t_1,\phi_1 → \phi_2)) → K(a,t_2,\phi_1) → K(a,t_3,\phi_2) \]
\[ [R_5] \]

\[ C(t,B(a,t_1,\phi_1 → \phi_2)) → B(a,t_2,\phi_1) → B(a,t_3,\phi_2) \]
\[ [R_6] \]

\[ C(t,C(t_1,\phi_1 → \phi_2)) → C(t_2,\phi_1) → C(t_3,\phi_2) \]
\[ [R_7] \]

\[ C(t,∀x. \phi → \phi[x → t]) \]
\[ [R_8] \]
\[ C(t,\phi_1 ↔ \phi_2 → \neg \phi_2 → \neg \phi_1) \]
\[ [R_9] \]

\[ C(t,\phi_1 ∧ \ldots ∧ \phi_n → \phi) → [\phi_1 → \ldots → \phi_n → \psi] \]
\[ [R_{10}] \]

\[ B(a,t,\phi) \phi → \psi \]
\[ [R_{11a}] \]
\[ B(a,t,\phi) \]
\[ B(a,t,\phi ∧ \psi) \]
\[ [R_{11b}] \]

\[ S(s,h,t,\phi) \]
\[ B(h,t,B(s,t,\phi)) \]
\[ [R_{12}] \]

\[ I(a,t,happens(action(a*,\alpha),t')) \]
\[ [R_{13}] \]

\[ P(a,t,happens(action(a*,\alpha),t)) \]
\[ [R_{14}] \]

\[ B(a,t,\phi) \]
\[ B(a,t,O(a*,t,\phi,happens(action(a*,\alpha),t'))) \]
\[ [R_{15}] \]

\[ O(a,t,\phi,happens(action(a*,\alpha),t')) \]
\[ K(a,t,I(a*,t,happens(action(a*,\alpha),t'))) \]
\[ [R_{16}] \]

\[ \phi ↔ \psi \]
\[ O(a,t,\phi,\gamma) ↔ O(a,t,\psi,\gamma) \]

“Ethics” Added …
Syntax

S ::= Object | Agent | Self ⊕ Agent | ActionType | Action ⊕ Event | Moment | Boolean | Fluent | Numeric

action : Agent × ActionType → Action

initially : Fluent → Boolean

holds : Fluent × Moment → Boolean

happens : Event × Moment → Boolean

clipped : Moment × Fluent × Moment → Boolean

f ::= initiates : Event × Fluent × Moment → Boolean

terminates : Event × Fluent × Moment → Boolean

prior : Moment × Moment → Boolean

interval : Moment × Boolean

*: Agent → Self

payoff : Agent × ActionType × Moment → Numeric

t ::= x : S | c : S | f(t₁, ..., tₙ)

t : Boolean | ¬φ | φ ∧ ψ | φ ∨ ψ |
P(a,t,φ) | K(a,t,φ) | C(t,φ) | S(a,b,t,φ) | S(a,t,φ)

φ ::= B(a,t,φ) | D(a,t,holds(f,t')) | I(a,t,happens(action(a*,α),t'))

O(a,t,φ,happens(action(a*,α),t'))

Rules of Inference

---

\[ C(t, P(a,t,φ) \rightarrow K(a,t,φ)) \] \([R₁]\)

\[ C(t, K(a,t,φ) \rightarrow B(a,t,φ)) \] \([R₂]\)

\[ C(t, φ) \leq t₁ \ldots tₙ \] \([R₃]\)

\[ K(a₁,t₁, ..., K(aₙ,tₙ,φ)) \] \([R₄]\)

\[ C(t, K(a,t₁,φ₁) \rightarrow φ₂) \rightarrow K(a,t₂,φ₁) \rightarrow K(a,t₃,φ₂) \] \([R₅]\)

\[ C(t, B(a,t₁,φ₁) \rightarrow φ₂) \rightarrow B(a,t₂,φ₁) \rightarrow B(a,t₃,φ₂) \] \([R₆]\)

\[ C(t, C(t₁,φ₁) \rightarrow φ₂) \rightarrow C(t₂,φ₁) \rightarrow C(t₃,φ₂) \] \([R₇]\)

\[ C(t, \forall x. φ → φ[x \mapsto t]) \] \([R₈]\)

\[ C(t, φ_₁ \rightarrow φ₂ \rightarrow φ₂ \rightarrow ¬φ₁) \] \([R₉]\)

\[ C(t, [φ₁ \land \ldots \land φₙ \rightarrow φ] \rightarrow [φ₁ \rightarrow \ldots \rightarrow φₙ \rightarrow ψ]) \] \([R_{10}]\)

\[ B(a,t,φ) \rightarrow ψ \] \([R_{11a}]\)

\[ B(a,t,ψ) \] \([R_{11b}]\)

\[ S(s,h,t,φ) \] \([R_{12}]\)

\[ B(h,t,B(s,t,φ)) \] \([R_{13}]\)

\[ I(a,t,happens(action(a*,α),t')) \] \([R_{14}]\)

\[ P(a,t,happens(action(a*,α),t)) \] \([R_{15}]\)

\[ B(a,t,φ) \rightarrow B(a,t,O(a*,t,φ,happens(action(a*,α),t')))) \] \([R_{16}]\)

\[ O(a,t,φ,happens(action(a*,α),t')) \] \([R_{17}]\)

\[ K(a,t,I(a*,t,happens(action(a*,α),t')))) \] \([R_{18}]\)

\[ φ \leftrightarrow ψ \] \([R_{19}]\)

\[ O(a,t,φ,γ) \leftrightarrow O(a,t,ψ,γ) \] \([R_{20}]\)
“Ethics” Added …

Syntax

\[ S ::= \]

Object | Agent | Self □ Agent | ActionType | Action □ Event |

Moment | Boolean | Fluent | Numeric

\[ action : Agent \times \text{ActionType} \rightarrow \text{Action} \]

\[ initially : \text{Fluent} \rightarrow \text{Boolean} \]

\[ holds : \text{Fluent} \times \text{Moment} \rightarrow \text{Boolean} \]

\[ happens : \text{Event} \times \text{Moment} \rightarrow \text{Boolean} \]

\[ clipped : \text{Moment} \times \text{Fluent} \times \text{Moment} \rightarrow \text{Boolean} \]

\[ f ::= \text{initiates} : \text{Event} \times \text{Fluent} \times \text{Moment} \rightarrow \text{Boolean} \]

\[ \text{terminates} : \text{Event} \times \text{Fluent} \times \text{Moment} \rightarrow \text{Boolean} \]

\[ prior : \text{Moment} \times \text{Moment} \rightarrow \text{Boolean} \]

\[ interval : \text{Moment} \times \text{Boolean} \]

\[ * : \text{Agent} \rightarrow \text{Self} \]

\[ payoff : \text{Agent} \times \text{ActionType} \times \text{Moment} \rightarrow \text{Numeric} \]

\[ t ::= x : S | c : S | f(t_1, \ldots, t_n) \]

\[ t : \text{Boolean} | \neg \phi | \phi \wedge \psi | \phi \vee \psi | \]

\[ P(a,t,\phi) | K(a,t,\phi) | C(t,\phi) | S(a,b,t,\phi) | S(a,t,\phi) \]

\[ \phi ::= \]

\[ B(a,t,\phi) | D(a,t,\text{holds}(f,t')) | I(a,t,\text{happens}(\text{action}(a^*,\alpha),t')) \]

\[ O(a,t,\phi,\text{happens}(\text{action}(a^*,\alpha),t')) \]

Rules of Inference

\[ \frac{C(t,P(a,t,\phi) \rightarrow K(a,t,\phi))}{[R_1]} \]

\[ \frac{C(t,K(a,t,\phi) \rightarrow B(a,t,\phi))}{[R_2]} \]

\[ \frac{C(t,\phi) t \leq t_1 \ldots t_1 \leq t_n}{[R_3]} \]

\[ \frac{K(a_1, t_1, \ldots, K(a_n, t_n, \phi))}{[R_4]} \]

\[ \frac{C(t, K(a, t_1, \phi_1 \rightarrow \phi_2)) \rightarrow K(a, t_2, \phi_1) \rightarrow K(a, t_3, \phi_2)}{[R_5]} \]

\[ \frac{C(t, B(a, t_1, \phi_1 \rightarrow \phi_2)) \rightarrow B(a, t_2, \phi_1) \rightarrow B(a, t_3, \phi_2)}{[R_6]} \]

\[ \frac{C(t, C(t_1, \phi_1 \rightarrow \phi_2)) \rightarrow C(t_2, \phi_1) \rightarrow C(t_3, \phi_2)}{[R_7]} \]

\[ \frac{C(t, \forall x. \phi \rightarrow \phi[x \mapsto t])}{[R_8]} \]

\[ \frac{C(t, \phi_1 \wedge \ldots \wedge \phi_n \rightarrow \phi) \rightarrow [\phi_1 \rightarrow \ldots \rightarrow \phi_n \rightarrow \psi]}{[R_9]} \]

\[ \frac{B(a, t, \phi) \rightarrow \psi}{[R_{11a}]} \]

\[ \frac{B(a, t, \phi) \rightarrow B(a, t, \psi \wedge \phi)}{[R_{11b}]} \]

\[ \frac{S(s, h, t, \phi)}{B(h, t, B(s, t, \phi))} \]

\[ \frac{I(a, t, \text{happens}(\text{action}(a^*, \alpha), t'))}{[R_{12}]} \]

\[ \frac{P(a, t, \text{happens}(\text{action}(a^*, \alpha), t))}{[R_{13}]} \]

\[ \frac{B(a, t, \phi) \rightarrow B(a, t, \text{O}(a^*, t, \phi, \text{happens}(\text{action}(a^*, \alpha), t')))}{[R_{14}]} \]

\[ \frac{O(a, t, \phi, \text{happens}(\text{action}(a^*, \alpha), t'))}{[R_{15}]} \]

\[ \frac{\phi \leftrightarrow \psi}{O(a, t, \phi, \gamma) \leftrightarrow O(a, t, \psi, \gamma)} \]
One Proof from Two POVs

One of the four agents who wins the pot early knows that he will not refuse to ante up in subsequent periods, because he knows that he is obligated to refrain from dropping out, and intends to meet all obligations.

The system knows that one of the four agents who wins the pot early knows that he will not refuse to ante up in subsequent periods, because the system knows that that agents knows that he is obligated to refrain from dropping out …
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The Meaning of Life …

- Kahneman Chapter 38: “Thinking About Life”
- Seligman Chapter 14: “Meaning & Purpose”
- SEP entry:
  - [http://plato.stanford.edu/entries/life-meaning](http://plato.stanford.edu/entries/life-meaning)
  - Nozick’s Argument
  - Camus: *The Myth of Sisyphus; Ecclesiastes*
- *The Brain & the Meaning of Life* by Thagard, reviewed by Bringsjord & Bringsjord