Quantum clouds

http://tph.tuwien.ac.at/~svozil/publ/2019-Svozil-Chile-pres.pdf

Karl Svozil

ITP/Vienna University of Technology, Austria
svozil@tuwien.ac.at

WOE2019, Santiago, Chile, March 7-8, 2019
"Soft" obstacles associated with quantum progress

- Who listens to whom? "Pecking order," "attention economy," Matthew effect in science (funding) [aka compound interest]" (DOI: 10.1126/science.159.3810.56 & 10.1073/pnas.1719557115)

- Reconstruction of (physical) meaning from detector clicks (e.g., controversy about "a posteriori quantum teleportation" [aka Kimble versus Zeilinger] DOI: 10.1038/29678 & 10.1038/29674) yield ambiguous or even unsustainable claims ("science marketing")

- Counterfactuals (Specker DOI 10.1111/j.1746-8361.1960.tb00422.x arXiv:1103.4537): Do "unperformed experiments have no results"? (Peres, DOI 10.1119/1.11393), "how can you measure a proof a [Kochen-Specker] contradiction?" (Clifton, IQSA meeting, personal communication, Prague 1995)

- Mind projection fallacy (Freud 1912, Jaynes 1989)
Methods & ways of exploring value (in)definiteness

- cloud structure of intertwined contexts/cliques/maximal operators/Boolean subalgebras is quantum,
- predictions about what happens within the cloud, and, in particular, at its endpoints Alice & Bob are classical
How is $|\text{Bob}\rangle$ given $|\text{Alice}\rangle$? True? False? Whatever? None?

true-implies-true

true-implies-false

true-implies-whatever

true-implies-none
True (1) implies whatever (quantum 50:50)

\[ |Alice\rangle = (1, 0, 0) \quad |Bob\rangle = \left( \frac{1}{\sqrt{2}}, \frac{1}{2}, \frac{1}{2} \right) \]
True (1) implies false (0)

|Alice⟩ = (1, 0, 0)  | Bob⟩ = \( \left( \frac{1}{\sqrt{2}}, \frac{1}{2}, \frac{1}{2} \right) \)
True (1) implies true (1)

$$\left| \text{Alice} \right\rangle = (1, 0, 0)$$

$$\left| \text{Bob} \right\rangle = \left( \frac{1}{\sqrt{2}}, \frac{1}{2}, \frac{1}{2} \right)$$
True (1) implies value indefinite (Abbott, Calude, KS 2015)

\[
|\text{Alice}\rangle = (1, 0, 0) \\
|\text{Bob}\rangle = \left( \frac{1}{\sqrt{2}}, \frac{1}{2}, \frac{1}{2} \right)
\]
Strategies to obtain value indefiniteness/partiality

The scheme of the construction & proof of partiality of value assignments is as follows:

(i) Find a logic (collection of intertwined contexts of observables) exhibiting a true-implies-false property on the two atoms \(a\) and \(b\).

(ii) Find another logic exhibiting a true-implies-true property on the same two atoms \(a\) and \(b\).

(iii) Then join (paste) these logics into a larger logic, which, given \(a\), neither allows \(b\) to be true nor false. Consequently \(b\) must be value indefinite.
Partiality/value indefiniteness can be extended to any vector $b$ non-collinear and non-orthogonal to $a$: Alastair A. Abbott and Cristian S. Calude and KS, “A variant of the Kochen-Specker theorem localising value indefiniteness”, Journal of Mathematical Physics, 56(10), 102201(1-17), 2015; https://doi.org/10.1063/1.4931658

For a (in some respects weaker) statement relative to global truth assignments, see Itamar Pitowsky’s “Infinite and finite Gleason’s theorems and the logic of indeterminacy”, Journal of Mathematical Physics 39(1), 218-228, 1998; https://doi.org/10.1063/1.532334
### History of contextual sets & elational properties realizable by two-point quantum clouds

<table>
<thead>
<tr>
<th>Condition</th>
<th>Description</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>a is true classical value assignments</td>
<td>anectodal, historic quantum realisation</td>
<td>reference to utility or relational properties</td>
</tr>
<tr>
<td>b is independent (arbitrary)</td>
<td>firefly logic $L_{12}$ eg, Cohen, 1989[pp. 21, 22]</td>
<td></td>
</tr>
<tr>
<td>b is false (TIFS)</td>
<td>Specker bug logic KS, 1965 [Fig. 1, p. 182]</td>
<td>Stairs, 1983 [p. 588-589], Cabello et al, 1995 . . . 2018</td>
</tr>
<tr>
<td>b is true (TITS)</td>
<td>extended Specker bug logic</td>
<td>KS, 1967 [$\Gamma_1$, p. 68], Clifton, 1993 [Sects. II,III, Fig. 1], Belinfante, 73 [Fig. C.I. p. 67], Pitowsky, 1982 [p. 394], Hardy, 1992, 1993, 1997, Cabello et al, 1995 . . . 2018</td>
</tr>
<tr>
<td>b true (nonseparability)</td>
<td>combo of intertwined Specker bugs</td>
<td>KS, 1967 [$\Gamma_3$, p. 70]</td>
</tr>
</tbody>
</table>
Do clouds “exist” merely in our minds?
Do they represent our own subjective imaginations & constructions?
Logic/cloud does not determine the probability

As long as there is a separating set of two-valued states (Kochen-Specker, Theorem 0, DOI: 10.1512/iumj.1968.17.17004) there quasi-classical analogies: partition logics/Wright's generalized urn models/automaton logics; with classical probabilities (convex combinations of 2-valued states): KS arXiv:1810.10423.

Quantum realization in terms of the faithful orthogonal representation (Lovász, Saks and Schrijver DOI 10.1016/0024-3795(89)90475-8) and the Theta-body (Grötschel, Lovász and Schrijver DOI: 10.1016/0095-8956(86)90087-0)
Anecdotal examples of “exotic” probability measures satisfying Kolmogorovian classical probabilities on local contexts

- Wright's (1978) dispersionless measure on the pentagon (or cyclic arrangements of odd contexts $\geq 3$)

Thank you for your attention!