Rational Self-Doubt

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Judgmental Self-Doubt

Second-guessing your opinion on the basis of evidence about your cognitive skills or circumstances. Example occasions:

1. You are confident in your memory of certain events, and then your trusted friend says you are on mind-altering drugs.

2. You are confident that the murderer is number 3 in the line-up, and then find out that human beings are generally unreliable in eyewitness testimony.

3. You are watching for a tiger and your visual field suddenly goes blank (uniform).

4. You are a woman not fully confident of your argument, and then you read that women are generally underconfident.

Less obviously, more problematically …

The evolutionist admits to the Creationist that our theories *might be wrong*. The latter concludes his view is just as good. Every view is just a hypothesis! (60% of Americans appear to agree.)

You admit that most past scientific theories have been false, and are expected to withdraw confidence in yours. (Pessimistic induction over the history of science.)

You are contemplating marriage and read that the divorce rate is 60%.

Evidence about your beliefs wrt **q** vs. Evidence about **q**

C = The convection currents of the Sun affect solar neutrino rate etc.

e = modeled data.

→ You form a confidence that C on the basis of e.

p = 80% of past claims about unobservables that were supported by apparently good evidence are now known to be false.

e is evidence about the Sun. It is ***1st-order evidence***.

p is not evidence about the Sun, but is evidence apparently relevant to the reliability of your belief about the Sun.

As such ***p*** is ***2nd-order evidence*** wrt C.

2nd –Order Evidence is Irreducible.

q … There is no tiger around.

You are highly confident of q, and then see an orange, furry rustling in the trees.

vs.

You are highly confident of q, and then your visual field goes blank (uniform).

In second case, you gain no evidence *about tigers*, yet intuitively you should drop your confidence in q.

1st – and 2nd- order belief

Let q be any proposition not containing a belief predicate, e.g.:

The murderer used a knife.

You have a ***first-order belief*** in q when you believe q. You express this:

"The murderer used a knife."

You have a ***second-order belief*** (belief about a belief) when you believe *that* you believe q. To express this belief you say:

"I believe that the murderer used a knife."

If I describe you, I use one belief predicate vs. two belief predicates

I say: **"He *believes* q."** vs. **"He *believes* that he *believes* q."**

Degrees of belief as probabilities

q, r, s, …, q’, r’, s’, …, $P_S(q) = x$, $P_S(r) = y$, … propositions

$P_S(q) = x$ … Subject S’s degree of belief in q is x

$P_S(q/r) = z$ … S’s degree of belief in q *given r* is z

$\mathbf{P_T(}$ $P_S(q) = x$**$\mathbf{) = x'}$** … Subject T has degree of belief x’ *that*
subject S has degree of belief x in q.

$\mathbf{P_S(}$ $P_S(q) = x$**$\mathbf{) = x''}$** … Subject S has degree of belief x’’ *that*
subject S has degree of belief x in q.

Second-Order Probabilities: $P(P'(q)=x) = y$

Don't exist: An assertion concerning probability is merely an expression, not true or false, or measurable. (de Finetti – emotive)

A degree of belief is a disposition to act that has a certain strength. (Ramsey) It can be measured by betting behavior. Same for beliefs about *what your beliefs are*: we ask you to bet about how you would bet.

Are trivial: All of them will be 0 or 1. (Self-transparency about beliefs)

Skyrms: We're not infallible about our beliefs.

Better: Bayesian rationality proudly lacks requirements on substantive knowledge. Whether you believe q is a contingent matter of fact.

Skyrms (1980), "Higher-Order Degrees of Belief"

Agenda – Generalizing 1st-order conditionalization

Synchronic bridge principle

Rule for 2nd-order revision

Defense

Applications

More defense

More applications

The Principle that Gets in the Way

$P(q/P(q) = x) = x$ Self-Respect (SR)

The degree of belief you think you have in q is what your degree of belief should be.

Don't disapprove of your own degrees of belief.

(Instance of traditional "Miller's Principle.")

Restricted Self-Respect (RSR)

$P(q/P(q) = x) = x$ (where defined)

provided there is no statement of probability for which P *has a value which when combined with* "P(q) = x" *is relevant to q*.

This says: The mere fact that you have a degree of belief is not by itself a reason for it to be different.

Restricted Self-Respect (RSR)

$P(q/P(q) = x) = x$ (where defined)

provided there is no statement of probability for which P *has a value which when combined with* “$P(q) = x$” *is probabilistically relevant to q*.

This says: The mere fact that you have a degree of belief is not by itself a reason for it to be different.

✓

Unrestricted Self-Respect (USR)

$P(q/P(q) = x \,.\, r) = x$ (where defined)

for any r for which* P *has a value*

I.e., roughly, no matter what else the subject believes.

*r a statement of probability

Expressing Reliability

$$y = \boldsymbol{PR}(q/P(q) = x)$$

This is what your confidence x indicates is the objective probability of q.

This is what you get when you ask to what degree the subject's confidence x in q *confirms* q and combine it with a prior on q or P(q) = x. Equals how far x tells you q is true.

"***PR***" means objective probability, whatever kind you like.

With e: P(q) = x, h: q,

$$\textbf{\textit{PR}}(\textbf{q}/\textbf{P}(\textbf{q}) = \textbf{x}) = \frac{\textbf{\textit{PR}}(P(q) = x/q)\textbf{\textit{PR}}(q)}{\textbf{\textit{PR}}(P(q) = x)} = \frac{\textbf{\textit{PR}}(e/h)\textbf{\textit{PR}}(h)}{\textbf{\textit{PR}}(e)}$$

and

$\textbf{\textit{PR}}(\textbf{q}/\textbf{P}(\textbf{q}) = \textbf{x})$ = [LR – RM]/(LR-1) (leverage equation, *TT*, Ch. 5)

LR = ***PR***(P(q)=x/q)/***PR***(P(q)=x/-q)

LR = ***PR***(e/h)/***PR***(e/-h) ← **likelihood ratio measure**

RM = **PR**(P(P(q)=**x/q)PR**(P(q)=x)]

RM = **PR**(e/h)/P(e)) ← **ratio measure**

With e: P(q) = x, h: q,

safety

$$\boldsymbol{PR}(q/P(q) = x) = \frac{\boldsymbol{PR}(P(q) = x/q)\boldsymbol{PR}(q)}{\boldsymbol{PR}(P(q) = x)} = \frac{\boldsymbol{PR}(e/h)\boldsymbol{PR}(h)}{\boldsymbol{PR}(e)}$$

and

$\boldsymbol{PR}(q/P(q) = x) = [LR – RM]/(LR-1)$

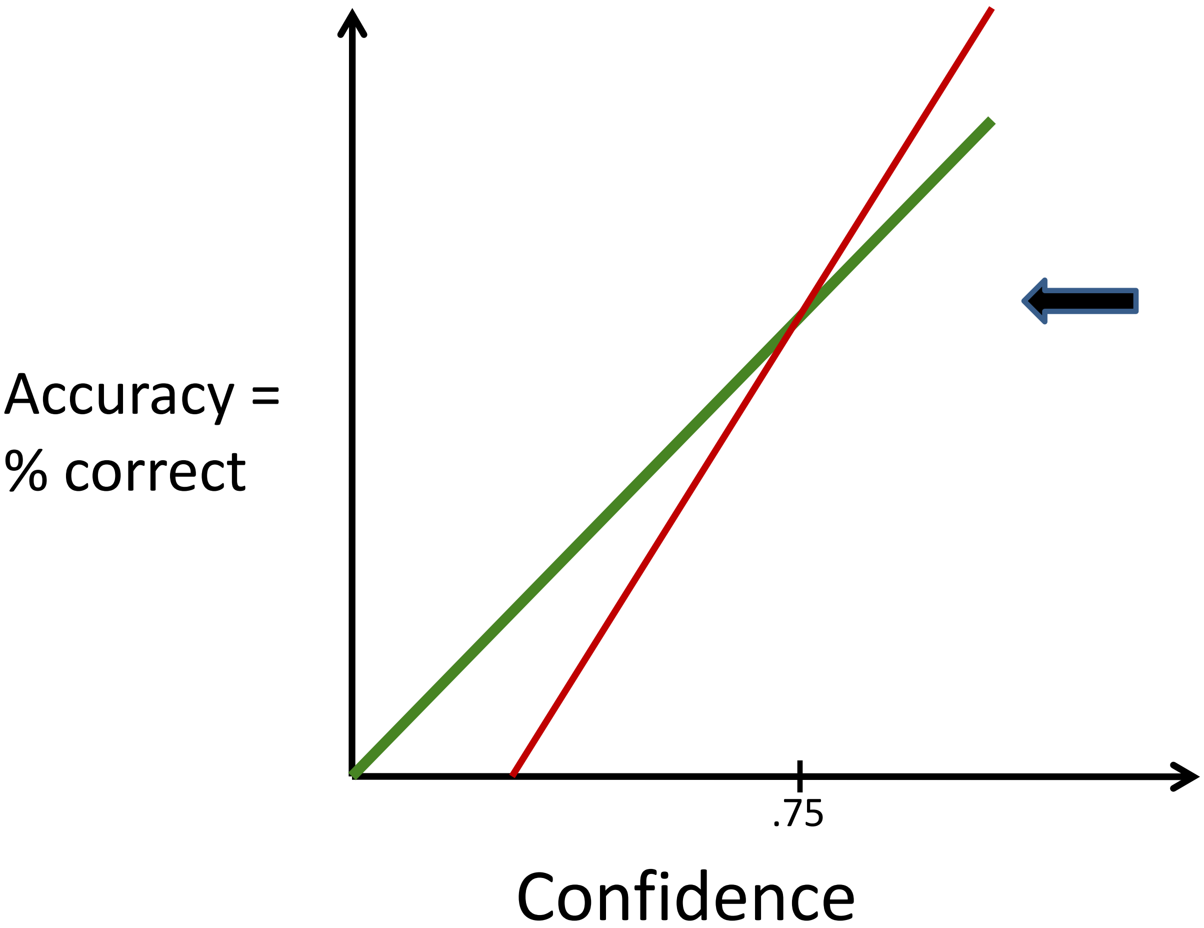
LR = $\boldsymbol{PR}(P(q)=x/q)/\boldsymbol{PR}(P(q)=x/-q)$

LR = $\boldsymbol{PR}(e/h)/\boldsymbol{PR}(e/-h)$ ← **tracking (adherence/variation)**

RM = $\boldsymbol{PR}(P(P(q)=\mathbf{x/q})\boldsymbol{PR}(P(q)=x)]$

RM = $\boldsymbol{PR}(e/h)/\mathbf{PR}(e))$

Common Empirical Finding



Expressing the Quandary

Explicitly:

$$P(q/[P(q) = x \,.\, \boldsymbol{PR}(q/P(q) = x) = y]) = \,?$$

Expressing the Quandary

Explicitly:

$$P(q/ \qquad\qquad\qquad\qquad) = ?$$

$\uparrow$

Given that: $P(q) = x$. ***PR***$(q/P(q) = x) = y$

What is the Answer?

Explicitly:

$$P(q/[P(q) = x \,.\, \boldsymbol{PR}(q/P(q) = x) = y]) = \,?$$

USR says r doesn't matter:

$$\mathbf{P(q/[P(q) = x \,.\, \underbrace{\boldsymbol{PR}(q/P(q) = x) = y}_{r}]) = x}$$

What is the Answer?

Consider:

$$P(q/\mathbf{P(q) = x}\ .\ \boldsymbol{PR}\mathbf{(q/P(q) = x) = y}) = \ ?$$

The LHS is an instance of the LHS of the Conditional Principle:

$$P(q/\ B\ .\ \mathbf{Ch}(q/B) = y) =$$

with B as P(q) = x, if we take credences as probabilities, and ***PR*** as chance.

Conditional Principle

$$Cr(q/\ B\ .\ \mathbf{Ch}(q/B) = y) = y$$

(Skyrms 1988, van Fraassen 1989, Vranas 2004)

What is the Answer?

$$P(q/\mathbf{P(q) = x} \,.\, \boldsymbol{\mathit{PR}}\mathbf{(q/P(q) = x) =} \mathbf{y}) = \mathbf{y}$$

This is an instance of the Conditional Principle:

$$P(q/\ B\ .\ \mathbf{Ch}(q/B) = \mathbf{y}) = \mathbf{y}$$

with B as P(q) = x, if we take credences as probabilities, and take ***PR*** as chance.

Forced Choice

$$P(q/(P(q) = x \,.\, \boldsymbol{PR}(q/P(q) = x) = y)) = \textbf{?}$$

USR:

$$P(q/(P(q) = \mathbf{x} \,.\, \boldsymbol{PR}(q/P(q) = x) = y)) = \mathbf{x}$$

Conditional Principle*:

$$P(q/(P(q) = x \,.\, \boldsymbol{PR}(q/P(q) = x) = \mathbf{y})) = \mathbf{y}$$

Symmetry Argument

Our respect for the judgment of others is not unconditional (and CP agrees):

$$P_T(q/P_S(q) = x \,.\, \boldsymbol{PR}(q/P_S(q) = x) = y) = y$$

Why should it be for ourselves?

$$P_T(q/P_T(q) = x \,.\, \boldsymbol{PR}(q/P_T(q) = x) = \mathbf{y}) = \mathbf{y}$$

(special case where S = T)

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Calibration and Re-calibration

Cal (synchronic constraint)

$$P(q/P(q) = x\ .\ \mathit{PR}(q/P(q) = x) = y) = y$$

Re-Cal (diachronic constraint)

$$P_f(q) = P_i(q/P_i(q) = x\ .\ \mathit{PR}(q/P_i(q) = x) = y) = y$$

To be *calibrated* (here) is for one's confidence to match one's rationally believed reliability. ($x = y$)

To *re-calibrate* is to update one's confidence in light of information about one's reliability. ($x \rightarrow y$)

Calibration and Re-calibration

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Re-Cal (diachronic constraint)

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To be *calibrated* (here) is for one's confidence to match one's *rationally believed* reliability. (x = y) **(not objective!)**

To *re-calibrate* is to update one's confidence in light of *information about* one's reliability. (x → y)

Applications

Eyewitness case: ***PR***(q/P(q) = .99) = .70

Tiger case: ***PR***(q/P(q) = high) = .5

Creationist case: ***PR***(q/P(q) = .99) < 1

Pessimistic Induction: ***PR***(q/P(q) = .8) < .5

(But see: "Optimism about the Pessimistic Induction" and "The Rationality of Science in Relation to its History")

Woman: ***PR***(q/P(q) = .75) = .95

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Creationist case: ***PR***(q/P(q) = .99) < 1

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Woman: ***PR***(q/P(q) = .75) = .95

Marriage: Hopefully you have more specific evidence.

Taking Stock

Supposed reasons to ignore 2^{nd}-order evidence:

-- If you start second-guessing, how do you stop? Arbitrarily?

-- 2^{nd}-order probabilities ~~don't exist~~, are ~~trivial~~, **are incoherent**.

-- ~~Miller's Principle (a.k.a. Self-Respect)~~

-- 2^{nd} order revision could be distorting

-- Is there any added value?

Incoherence?

Intuitively, it is puzzling how a person can doubt her own judgment, and remain consistent and one subject.

Coherence concerns

1) Against Cal and Re-Cal in particular.

2) Against applying the function P to P-statements.

3) Doesn’t probabilistic coherence already imply calibration?

Incoherence of Cal?

1. $P(P(q) = x) = 1$, Perfect Confidence
2. $P(q) = x$, Accuracy
3. $P(\mathit{PR}(q/P(q) = x) = y) = 1$ Certainty about your reliability
4. $x \neq y$ You are not calibrated

Cal says:

$P(q/(P(q) = x \,.\, \mathit{PR}(q/P(q) = x) = y)) = y$

From 1. , 3., and Cal, we get $P(q) = y$.

But by assumption 2., $P(q) = x$. By 4, **contradiction**.

Incoherence of Cal? *Nah*.

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Incoherence of Second-order Probability?

Power Set problem:

Let domain, D, of probability function P be all propositions of form q, r, etc., P(q) = x, P(r) = y, etc., P(P(q) = x) = z, etc., etc., $q \in S$, etc., and all Boolean combinations thereof.

Let S_1, S_2, S_3, … be the subsets of D. For each one, we can construct a distinct proposition in D:

P(q) = z if and only if $q \in S_1$.

P(q) = z if and only if $q \in S_2$. etc. …

These propositions fulfill the requirements for being in D.

→ This gives a 1-1 mapping of the set of subsets of D into D.

Impossible.

Solutions?

Typed theory?

Not P’(P’(q) = x) = y, but only P”(P’(q) = x) = y

Re-Cal becomes:

P_f“(q) = P_i“(q/ **P_i‘(q) = x . *PR*(q/P_i‘(q) = x) = y**) = y

Solutions

Typed theory?

$$P''(P'(q) = x) = y \text{ but not } P'(P'(q) = x) = y$$

Re-Cal becomes:

$$P_f``(q) = P_i``(q/P_i`(q) = \sout{x \cdot PR}(q/P_i`(q) = x) = y) = y$$

not self-correcting or determinate

Solution

The class of propositions is not a set.

But then probability must be definable on proper classes.

It is:

Rubin, Herman, A new approach to the foundations of probability. 1969 *Foundations of Mathematics (Symposium Commemorating Kurt Gödel, Columbus, Ohio, 1966)* pp. 46--50 *Springer, New York*.

Doesn’t probabilistic coherence imply calibration?

Does probabilistic coherence imply calibration?

1. No, it implies that it is *not a priori impossible* for you to be calibrated. (van Fraassen)

   Note: My purpose here is not to defend adherence to the axioms.

Does probabilistic coherence imply calibration?

1. No, it implies that it is not a priori impossible for you to be calibrated. (van Fraassen)

2. It implies that the subjective Bayesian must regard himself as someone who will be calibrated in the long run.

The coherent agent must regard himself as someone who will be vindicated in the long run with regard to calibration.

He may be someone whose concern with calibration doesn’t extend beyond the long run.

He may be someone for whom it extends to the short run.

The Well-calibrated Bayesian

Dawid (1980): "The *coherent* sequential forecaster believes that he *will* be empirically well-calibrated. … Considering the wide variety of admissible selections that might be used to test the calibration property, it seems doubtful, ***though not impossible***, that such a coherent self-recalibrating distribution could exist." (my emphasis)

The Well-calibrated Bayesian

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"although I cannot perceive any clear logical assumptions that might govern its [finite re-calibration’s] detailed application, ***I find its general message unavoidable***." (my emphasis)

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-- ~~Miller's Principle~~

-- 2nd order revision could be distorting

-- Is there any added value?

Regress and Pathology?

Re-Cal

$$P_f(q) = P_i(q/P_i(q) = x \,.\, PR(q/P_i(q) = x) = y) = y$$

This yields a new first-order degree of belief in q, so it looks like Re-Cal is applicable again.

Regress and Pathology? *No.*

Re-Cal

$$P_f(q) = P_i(q/\mathbf{P_i(q) = x\ .\ \mathit{PR}(q/P_i(q) = x) = y}) = y$$

This yields a new first-order degree of belief in q, so Re-Cal is applicable again?

1. Yes, but only provided you have new evidence about your reliability.

2. Yes, that's how conditionalization works.

Regress and Pathology? *No.*

Re-Cal

$$P_f(q) = P_i(q/\mathbf{P_i(q) = x\ .\ \mathit{PR}(q/P_i(q) = x) = y}) = y$$

This yields a new first-order degree of belief in q, so Re-Cal is applicable again?

1. Yes, but only provided you have new evidence, evidence about your reliability **at y after a re-cal at x**.
2. Yes, that's how conditionalization works.

Is Recalibration distorting?

Seidenfeld, Teddy, 1985. "Calibration, Coherence, and Scoring Rules." *Philosophy of Science* 52(2): 274-94.

Problem: You can be calibrated in your confidence about rain by knowing that 20% of the days in the year it rains in your locale and announcing 20% chance of rain every day.

You have no discrimination. You could hedge your bets this way.

→ Calibration is an improper scoring rule.

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→ Calibration is an improper scoring rule.

Re-Cal is not a scoring rule, but a principle of conditionalization.

Distorting in the short run?

Teddy:

Say you have *one* data point about your reliability. Are you seriously saying it is rational to update on that basis?

Distorting in the short run?

Teddy:

Say you have *one* data point about your reliability. Are you seriously saying it is rational to update on that basis?

Say you flip a coin once. Are you seriously saying that it's rational to update your belief that it's fair on that basis?

All conditionalizing can be distorting in the short run. Deal with it at second order as you do at first order.

Jeffrey Re-Calibration

$P_f(q) =$

$P_i(q/(B.\mathit{PR}(q/B)=y))P_f(B.\mathit{PR}(q/B)=y) +$

$P_i(q/-(B.\mathit{PR}(q/B)=y))P_f(-(B.\mathit{PR}(q/B)=y))$

If B is $P(q) = x$

Jeffrey Re-Calibration

$P_f(q) =$

From CP

How confident are you in your judgments of your belief and reliability?

$\mathbf{P_i(q/(B.\mathit{PR}(q/B)=y))P_f(B.\mathit{PR}(q/B)=y)}$ +

$\mathbf{P_i(q/-(B.\mathit{PR}(q/B)=y))}P_f(-(B.\mathit{PR}(q/B)=y))$

Together (via LR) these measure *degree* to which B.***PR****(*q/B)=y) confirms q.

If B is P(q) = x

Distorting in the long run?

The inference embedded in Re-Cal goes like this, for day i, and q_i = It will rain on e.g. May 9, 2013:

$P[q_i / P(q_j)=x_j$. $\mathbf{Ch(q_v/P(q_v)=x)=y(q,v,x)}$] = $y(q,i,x_i)$

You will end up with the right degree of belief in q if you have the right chance hypothesis (function), i.e., the correct y(q,v,x).

So, the issue is whether in the long run we can converge on the correct chance function, **y(q,v,x)**, which gives the chance of rain on a given day (q_v) on which the subject believes to degree x that it will rain.

The evidence stream is ordered pairs, day by day:

<degrees of belief in rain, rain or not>.

Likelihood Ratio Convergence Theorem (LRCT)

Hawthorne, James, "Inductive Logic," *Stanford Encyclopedia of Philosophy*.

Likelihood Ratio: P(e/h)/P(e/-h)

Suppose you will be fed *separating evidence*, that is h, -h predict at least some different outcomes in the stream of evidence you're going to get. (Modulo Hume and brains in vats, we have that.)

Then if h is the true hypothesis it is probable that you will see outcomes that rule out all the –h hypotheses within a certain number of trials. (Law of Large Numbers)

Likelihood Ratio Convergence Theorem (LRCT)

Hawthorne, James, "Inductive Logic," *Stanford Encyclopedia of Philosophy*.

Likelihood Ratio: P(e/h)/P(e/-h)

An LRCT theorem can be proven for the chance hypothesis (calibration function) in Re-Cal*, i.e., where h =

$$\mathbf{Ch(q_v, P(q_v)=x)=y(q,v,c,x)}$$

→ Adding 2nd-order conditioning to 1st-order conditioning is not distorting in the long run.

Pointless?

Teddy (1985):

1st-order conditionalization alone gets you to the true probability of q (and to subjective calibration) in the long run. Why bother with the re-calibration rule?

THEOREM: (Schervish 1983): If a forecaster is not well calibrated over a given (finite) sequence of events, then his well-calibrated counterpart *outperforms* him in similar decisions taken over this sequence.

Does Re-Cal make you actually more calibrated over finite sequences? Well, depends how long.

What’s the Point?

Seidenfeld: Why bother with re-calibration?

-- If you think CP is a synchronic rationality constraint, then you should follow Re-Cal.

-- Adherence to PP is not preserved under Jeffrey conditionalization. Re-Cal at least gets you back to CP.

-- Re-Cal can endogenously change extreme degrees of belief, to the other extreme or to non-extreme values.

-- Speculation: the bad predictive consequences of biasing assumptions in the model governing first-order conditionalization can be corrected by using Re-Cal, without knowing what those assumptions are (or re-training model).

Revising extreme probabilities

$P_f(q) = P_i(q/P_i(q) = x \,.\, \mathit{PR}(q/P_i(q) = x) = y) = y$

If q is an empirical proposition, and x is 1,
y may still be < 1.

You are certain of q and read in a reputable journal that people who are certain are sometimes wrong.

Bayesianism

How far is this account restricted to a bayesian approach?

1) Consistency is a big intuitive problem with self-doubt. Best to use a system that puts a premium on global consistency.

2) The fact that Re-Cal is a conditionalization rule allowed it to escape the objection that re-calibration is improper, etc.

3) I'd be happy if there were 25 different ways to formulate the ideas and see added value. That's what you do in implementation.

-- There's a connection between higher-order evidence questions and re-calibration.

and a connection between these and discussion of the Principal Principle (or rather CP).

-- A second-order, Bayesian, re-calibration rule can be formulated and defended by the independently appealing Conditional Principle.

-- Does it preserve coherence?

-- What is the added value short term?

end

THEOREM: (Schervish 1983): If a forecaster is not well calibrated over a given (finite) sequence of events, then his well-calibrated counterpart *outperforms* him in similar decisions taken over this sequence.

Does Re-Cal make you actually more calibrated over finite sequences? Well, depends how long.

$$P(q / \mathbf{P(q) = x} \,.\, r) = x = \frac{P(q \,.\, \mathbf{P(q) = x} \,.\, r)}{P(\mathbf{P(q) = x} \,.\, r)}$$

Your degree of belief in q doesn't occur in the condition. What's relevant is what you *take* P(q) to be, i.e., your degree of belief in "P(q) =x)". See denominator.

A nice rule if you can use it

Teddy (1985):

1. One does not *know* one's calibration curve – the real relation between one's reliability and confidence in q:

   y = ***PR***(q/P(q) = x)

2. If one knew that one would know the true probability of q and wouldn't need to re-calibrate!

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$$y = \boldsymbol{PR}(q/P(q) = x)$$

2. If one knew that one would know the true probability of q and wouldn't need to re-calibrate!

1, 2 are true. But we can have evidence about $y = \boldsymbol{PR}(q/P(q) = x)$.

A nice rule if you can use it

$$P_f(h) = P_i(h/e)P_f(e) + P_i(h/-e)P_f(-e)$$

We may not know the true probability of any e when we update on our best information about it.