Let us suppose that our agent is equipped with a confidence ordering \( \succeq \) over propositions. So that \( p \succeq q \) iff \( S \) is at least as confident in the truth of \( p \) as in the truth of \( q \).

And, \( p > q \) iff \( S \) is strictly more confident in \( p \) than in \( q \).

- **Correctness Requirements** (for comparative confidence)
  - If \( p \) is false and \( q \) is true, then \( p > q \) is incorrect.
  - Heuristically, correctness requirements involve agreement with the attitudes of an omniscient agent [17, 14, 23].

- **Rational Requirements** (for comparative confidence)
  - Intransitive \( \succeq \) relations are structurally irrational. E.g., the combination of attitudes \( \{p > q, q > r, r > p\} \) is incoherent.
  - If one’s total evidence \( K \) supports \( p \) strictly more strongly than \( K \) supports \( q \), then \( q \succeq p \) is substantively irrational.

Bayesians also like to talk about numerical degrees of confidence (credences). Indeed, this will be our main focus today...
The Fourth Pillar of Structural Bayesianism follows from (1)–(3).

4. **Learning & Supposing.** \( \text{cr}_{t_1}(\cdot) \) should equal \( \text{cr}_{t_0}(\cdot \mid E) \).

de Finetti [3] gave Dutch Book Arguments for both (1) and (2). Accuracy-dominance arguments for (1) are now popular [23]. One can also give an accuracy-dominance argument for (2) [11].

Lewis and others have aimed to adapt de Finetti’s argument for (2) into a “diachronic Dutch Book” argument for (3) [24].

Like de Finetti, I view (1) and (2) as the fundamental Bayesian principles governing the (structural) rationality of credences.

I have always been more skeptical about the existence and nature of “diachronic coherence requirements.” Indeed, there seem to be many reasons to worry about (3) & (4) [12, 35, 28].

I will focus, primarily, on the synchronic requirements (1) & (2), and how they (allegedly) interact with Explanationism.

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As Douven [5] explains, there have been various historical views regarding the proper formulation of Explanationism.

Rather than rehearsing Douven’s list of historical explications in detail, I will remain at a higher level of abstraction.

The idea behind Explanationism is that some “epistemic credit” should accrue to a hypothesis \( H \) in virtue of its being the best (or only) explanation of \( E \) (among the available alternatives \( \{H_k\} \)).

The question in which I am interested is: What is the best way to accommodate this basic Explanationist idea — of “credit” accruing to \( E \)’s best explanation — within a Bayesian framework?

van Fraassen [30] and Douven [5] maintain that a Bayesian should incorporate Explanationism by revising some of the basic requirements of Structural Bayesianism: (1)–(3).

Before we delve into that dialectic, I must digress, briefly, to discuss an important argument that’s in the background here.

There are also substantive Bayesian requirements. In general, these are of the following generic form: If one’s total evidence at time \( t \) (\( K_t \)) is such and so, then \( \text{cr}_t(\cdot) \) should be thus and such.

Let \( \{H_1, \ldots, H_n\} \) be some partition of alternative hypotheses (putative explanations of \( E \) entertained by an agent (at time \( t \)).

**Substantive Bayesianism** (some example requirements)

- **The Principle of Indifference** [8]. If \( K_t \) does not favor any \( H_i \) over any \( H_j \), then \( \text{cr}_t(H_i) \) should equal \( \text{cr}_t(H_j) \), \( \forall \ i,j \).

- **The Principal Principle** [20]. If \( K_t \) entails the objective chance of \( H_i \) is \( c \) (and \( K_t \) doesn’t contain/imply any inadmissible evidence), then \( \text{cr}_t(H_i) \) should equal \( c \).

- **The Requirement of Total Evidence** [18, 1, 33]. \( \text{cr}_t(H_i) \) should be equal to the evidential probability \( \text{Pr}(H_i \mid K_t) \).


Some authors [21, 22] argue that explanatory considerations (to the extent they are epistemically relevant) are automatically taken into account by Bayesianism, which requires that, for all \( t \),

**Bayes’ Theorem.** \( \text{cr}_t(H \mid E) \propto \text{cr}_t(E \mid H) \times \text{cr}_t(H) \)

Some terminology: \( \text{cr}_t(H \mid E) \) is called the posterior probability of \( H \) (relative to \( E \)), \( \text{cr}_t(E \mid H) \) is called the likelihood of \( H \) (relative to \( E \)), and \( \text{cr}_t(H) \) is called the prior probability of \( H \).

So, to the extent that explanatory considerations are relevant to the determination of the posterior, they must already be captured either by the likelihood or by the prior (or both).

Typically, it is said that the likelihood captures relational explanatory virtues of \( H \), vis-à-vis \( E \) (e.g., how well \( H \) accounts for/fits \( E \)), while the prior captures non-relational (or intrinsic) explanatory/theoretical virtues of \( H \) (e.g., simplicity).

The **Double-Counting Argument** (DCA) argues that giving “epistemic credit” to best explanations is double-counting.
Douven recommends that Bayesians revise the Ratio Formula (2) in such a way that the following alternative to Bayes’s Theorem is adopted (for hypotheses $H_i \in \{H_1, \ldots, H_n\}$ and evidence $E$).

$$\text{EXPL. } cr_t(H_i | E) = \frac{cr_t(H_i) \cdot cr_t(E | H_i) + c(H_i, E)}{\sum_{k=1}^n [cr_t(H_k) \cdot cr_t(E | H_k) + c(H_k, E)]},$$

where $c(H, E) \in [0, 1)$ is $H$’s “$E$-abductive credit score.”

And, $c(H, E) > 0$ iff $H$ best explains $E$ (o.w. $c(H, E) = 0$).\footnote{This definition can’t be quite right, since $c(H, E)$ will need to be $\gg 1$ for some Bayesian updates. But, this is a minor, fixable technical problem.}

Note that if there is no best explanation of $E$ among the $\{H_k\}$, then EXPL reduces to Bayes’s Theorem (since all of the credit scores $c(H_k, E)$ will be equal to zero in such a case).

Because EXPL leads to violations of Structural Bayesianism [viz., (2)], Douven discusses various ways a defender of EXPL might respond to de Finetti’s [3] Dutch Book argument for (2).

I’m not the first one to propose something like ERA.

Climenhaga, Hartmann et. al., Lange, and Weisberg have all argued convincingly for similar principles [2, 19, 31, 4, 15, 9].

Roche & Sober [25] agree that ERA is the right formulation of Explanationism; but, they argue that ERA is false — viz., that $A_j$ is never relevant to $H_j$ (on the supposition of the evidence $E$).


The main thing I would add to Climenhaga’s and Lange’s trenchant responses Roche & Sober is the following point.

In order to refute R&S’s skepticism, all that is required is a single example in which $A_j$ is relevant to $H_j$ (given $E$).

I will close by discussing just such an example (involving Newton, Einstein, and the motion of Mercury), which is a well-known instance of The Problem of Old Evidence [6, 13, 16].
Let $E$ be the precession of the perihelion of Mercury $\approx 574''$/cy. Note that $E$ had long been known by $t_1 = 1914$. \footnote{For simplicity, I will assume that $t_0 = 1913$ in my reconstruction of the case. But, in fact, $E$ was already known in 1882, when Newcomb calculated the Newtonian discrepancy in Mercury’s perihelion precession precisely [29].}

Let $H_1 \equiv$ Newton’s theory of planetary motion, and $H_2 \equiv$ Einstein’s theory of general relativity. This yields the following 3-element partition of hypotheses: $\{H_1, H_2, H_3 = \lnot H_1 \land \lnot H_2\}$.

If ERA applies in this case, then our agent should be such that

$$cr_{t_0}(H_2 \mid E \land A_2) > cr_{t_0}(H_2 \mid E \land \lnot A_2).$$

Thus, after $E$ was learned (between $t_0$ and $t_1$), we should have

$$cr_{t_1}(H_2 \mid A_2) > cr_{t_1}(H_2 \mid \lnot A_2).$$

When $A_2$ was subsequently learned in $t_2 = 1915$ [29, 7], it — and not $E$, which was old evidence — provided a boost to $H_2$ [15, 9].

How would EXPL$_1$ handle this Old Evidence Problem?

Let us suppose that our agent became certain of $A_2$ in $t_2 = 1915$. Then, according to EXPL$_1$, $H_2$ receives a “positive credit score” $c(H_2, E) > 0$ and a boost in credence (at $t_2$) — over and above what Bayes’s Thm would recommend. Hence, EXPL$_1$ yields

$$cr_{t_2}(H_2 \mid E) > cr_{t_2}(H_2).$$

In this sense, according to EXPL$_1$, $E$ confirms $H_2$ in 1915.

I see (at least) two problems with this application of EXPL$_1$.

- It is misleading to say that $E$ is what confirms $H_2$ in 1915. It is $A_2$ — by ensuring $c(H_2, E) > 0$ — that is doing the work.
- In addition to the machinery of probability theory [modulo (2)], Douven also needs a “theory of credit scores.” In this sense, the (Bayesian) ERA approach is more parsimonious.