we can't prove "DAIS-10 is always better" in an absolute sense, but we **can** show:

- Under realistic AV assumptions,
- For a clear safety objective,
- DAIS-10's **meaning-based rule** has **strictly lower expected harm** than a pure probability threshold rule.

I'll keep it tight and focused on the **calculation logic**.

1. Setup: a minimal safety model

We model a single critical scenario:

- A pedestrian may or may not be behind an occlusion (e.g., truck).
- The AV must choose: **Brake** or **Don't brake**.
- If a pedestrian is there and the car doesn't brake → high harm.
- If no pedestrian is there and the car brakes → minor cost (comfort / time).

Define:

- P: event "pedestrian exists behind obstacle"
- $p = \Pr(P|\text{sensor data})$: AV's estimated probability
- CFN: cost of a **false negative** (pedestrian exists, no brake) — very large
- CFP: cost of a **false positive** (no pedestrian, brake) — small

Assume CFN≫CFP (life vs inconvenience).

2. Baseline AV rule (probability threshold)

Typical AV decision logic:

- Choose a threshold $\theta \in (0,1)$.
- If $p \geq \theta$ → **Brake**
- If $p < \theta$ → **Don't brake**

Expected cost under this rule:

$$E[CAV] = \Pr(P) \cdot E[C|P] + \Pr(\neg P) \cdot E[C|\neg P]$$

Conditioned on the posterior estimate p, the decision is:

- If **Brake**: expected cost ≈CFP (even if P is true, braking is the safe action we want).
- If **Don't brake** and P is true: cost CFN.

So, given a particular p:

- If brake: CAV, brake≈CFP
- If don't brake: CAV, no brake=p·CFN

The **probability-optimal** decision (minimizing expected cost) is:

- Brake if $CFP < p \cdot CFN \Rightarrow p > CFP / CFN$

So the "rational" threshold is:

$\theta \backslash * = CFP / CFN$

If the AV uses a higher threshold (which many do for "comfort" / fewer interventions), it **accepts more risk than cost-optimal**.

3. DAIS-10 rule in the same scenario

DAIS-10 doesn't care only about p. It cares about **meaning** and **recent history**.

Let:

- S: DAIS-10 semantic score for "pedestrian presence" (0–100)
- Previously visible pedestrian → Meaning-Defining → S initially high (e.g., 95)
- Each frame where the pedestrian is not directly observed → apply fading, but **not to zero**

Example fading model (DIFS-10):

- First missing frame: S=95−5=90
- Second missing frame: S=90−10=80
- Third missing frame: S=80−20=60

Define a **semantic critical threshold**:

Scrit=70

DAIS-10 decision rule:

- If attribute is Meaning-Defining and S≥Scrit → **Treat as "still there" → Brake / high-governance action.**
- Only when S < Scrit may you downgrade governance.

So in the same occlusion case:

- AV probability: 0.42→0.31→0.12→0.05
- DAIS-10 meaning score: 95→90→80→60

On frame 2:

- AV might already be below its operational threshold and decide **not to brake**.
- DAIS-10 still has S=80≥70 → **enforce braking / caution**.

4. Numerical comparison under reasonable parameters

Let's pick some realistic numbers:

- CFN=1,000,000 (catastrophic harm)
- CFP=1,000 (hard brake, discomfort, minor cost)

Then:

$\theta*$=CFP / CFN=1,000 / 1,000,000=0.001

A **strictly risk-minimizing** AV should brake if p>0.001. In practice, many AV implementations effectively behave with a **much higher behavior threshold** (e.g., 0.1, 0.2, 0.3) to avoid "over-reacting."

Let's compare behavior at p=0.12:

- Many AV stacks might decide: 0.12 is "low," so **no brake**.
- DAIS-10 still treats the pedestrian as Meaning-Defining with high semantic score (e.g., 80) → **Brake**.

Expected cost if AV chooses **no brake** at p=0.12:

E[CAV |no brake, p=0.12]= p·CFN=0.12·1,000,000=120,000

Expected cost if DAIS-10 chooses **brake**:

E [CDAIS | brake] ≈ CFP=1,000

Comparison at that decision point:

120,000≫1,000

So, **under any situation where a system chooses "no brake" at** p **such that**

p· CFN > CFP

the DAIS-10 rule (which continues to enforce caution because of its high semantic score) has strictly lower expected harm.

This inequality is exactly the condition:

p> CFP / CFN

If an AV behaves as if its effective threshold $\theta_{AV} > \theta\backslash*$, then a DAIS-10-style conservative semantic rule **dominates it in expected safety cost**.

5. Where DAIS-10 is mathematically "better"

We can say this clearly:

If:

1. The cost of a false negative is much larger than the cost of a false positive ($CFN \gg CFP$), **and**

2. The AV behaves as if its action threshold $\theta_{AV} > \theta\backslash* = CFP / CFN$ (i.e., it waits for "high confidence" before braking), **and**

3. DAIS-10 keeps **Meaning-Defining** attributes in a "governed" state (high S) longer than the AV's probability logic would,

then:

*   At the decision points where AV chooses **no brake** and DAIS-10 chooses **brake**,
*   The **expected safety cost of DAIS-10 is strictly lower**:

$E[CDAIS] = CFP < p \cdot CFN = E[CAV]$

That is a **formal inequality**, not hand-waving.

6. What's actually being "proven"

We're not proving "DAIS-10 is universally superior in all possible universes."

We are showing:

*   Given a standard risk-based cost model,
*   Given realistic cost ratios in AV safety,
*   Given current industry behavior (high implicit thresholds),
*   And given DAIS-10's conservative treatment of **Meaning-Defining** attributes,

then **DAIS-10's semantic governance rule yields lower expected catastrophic harm** than a naive or comfort-tuned probability threshold.

That *is* a meaningful mathematical argument.