UOIF: Proof-Driven Recompute of $\Psi(x)$ with Confidence and Live-Artifact Verification

UOIF Working Note

August 08, 2025

1 Model and Proof Logic

We evaluate

$$\Psi(x) \;=\; \underbrace{[\alpha\, S(x) + (1-\alpha)\, N(x)]}_{\text{hybrid linearity}} \cdot \underbrace{\exp(-[\lambda_1 R_a + \lambda_2 R_v])}_{\text{exponential penalty}} \cdot \underbrace{P(H \mid E, \beta)}_{\text{Bayesian posterior}} \;, \quad \lambda_1{=}0.85,\ \lambda_2{=}0.15,\ S(x){=}0.60.$$

Proof logic:

- **Hybrid linearity**: $O(\alpha) = \alpha S(x) + (1-\alpha)N(x)$ is affine in α, so $\partial O/\partial\alpha = S(x) - N(x) < 0$ when $N(x) > S(x)$. Hence decreasing α (more external) increases O, and thus $\Psi(x)$ (holding penalty/posterior fixed).
- **Exponential boundedness**: With $R_a, R_v \geq 0$, Penalty $= \exp(-[\lambda_1 R_a + \lambda_2 R_v]) \in (0, 1]$, preventing overconfidence and giving Lipschitz damping.
- **Posterior calibration**: We use $P(H \mid E, \beta) = \min\{\beta\, P(H \mid E),\, 1\}$ to encode expert/canonical uplift while capping at certainty.

2 Parameters (shared unless noted)

- 2025 **results** (canonical live): $\alpha \in [0.12, 0.15]$, $N(x) = 0.97$, $\beta = 1.15$.
- 2025 **problems** (pending canonical): $\alpha \in [0.15, 0.20]$, $N(x) \in [0.88, 0.90]$, $\beta = 1.05$.
- 2024 (DeepMind P1/P2/P4 enhanced): $\alpha \in [0.10, 0.15]$, $N(x) = 0.96$, $\beta = 1.05$.

3 Recompute: IMO 2025 Results (Canonical Live)

Stepwise derivation with confidence

- **Sources**: Official results + DeepMind 2025 + Evan + AoPS. Confidence: 0.98.
- **Hybrid**: $O(\alpha) = 0.97 - 0.37\alpha$ for $\alpha \in [0.12, 0.15]$. Confidence: 0.96.
- **Penalty (conservative mixed state)**: $R_a{=}0.15, R_v{=}0.05 \Rightarrow$ Penalty $= \exp(-0.135) = 0.8737$. Confidence: 0.85.
- **Posterior (conservative)**: $P(H \mid E) \in [0.85, 0.90]$, $\beta{=}1.15 \Rightarrow P(H \mid E, \beta) \approx 0.913$. Confidence: 0.85.
- **Value (conservative)**: $\alpha{=}0.12 \Rightarrow O{=}0.9256$, $\Psi(x) \approx 0.9256 \cdot 0.8737 \cdot 0.913 \approx \mathbf{0.738}$; $\alpha{=}0.15 \Rightarrow \Psi(x) \approx 0.726$. Label: Empirically Grounded. Confidence: 0.90.

- **Penalty (canonical-eased)**: R_a=0.12, R_v=0.04 ⇒ Penalty = $\exp(-0.108) = 0.8977$. Confidence: 0.85.
- **Posterior (capped)**: $P(H \mid E, \beta) = 1.0$. Confidence: 0.88.
- **Value (eased)**: α=0.12 ⇒ $\Psi(x) \approx 0.9256 \cdot 0.8977 \cdot 1.0 \approx \mathbf{0.831}$; α=0.15 ⇒ $\Psi(x) \approx \mathbf{0.821}$. Label: Primitive/Empirically Grounded (results primitives). Confidence: 0.90.
- **Sensitivity**: $\partial\Psi(x)/\partial\alpha < 0$ (proof above). Confidence: 0.92.

4 Recompute: IMO 2025 Problems (Pending Canonical)

- **Hybrid (midpoint)**: α=0.17, $N(x)$=0.89 ⇒ $O = 0.17 \cdot 0.60 + 0.83 \cdot 0.89 = 0.8417$.
- **Penalty**: R_a=0.25, R_v=0.10 ⇒ Penalty = $\exp(-0.235) \approx 0.7965$.
- **Posterior**: $P(H \mid E, \beta) = 0.90 \cdot 1.05 = 0.945$.
- **Value**: $\Psi(x) \approx 0.8417 \cdot 0.7965 \cdot 0.945 \approx \mathbf{0.633}$; range over $\alpha \in [0.15, 0.20]$, $N(x) \in [0.88, 0.90]$: **0.60**–**0.65**. Label: Interpretive/Contextual (pending canonical). Confidence: 0.85.

5 Recompute: IMO 2024 (DeepMind P1/P2/P4)

- **Hybrid**: $O(\alpha) = 0.96 - 0.36\alpha$, $\alpha \in [0.10, 0.15]$.
- **Penalty**: R_a=0.10, R_v=0.05 ⇒ Penalty = $\exp(-0.0925) \approx 0.9117$.
- **Posterior**: $P(H \mid E, \beta) = 0.90 \cdot 1.05 = 0.945$.
- **Value**: α=0.10 ⇒ $\Psi(x) \approx 0.9240 \cdot 0.9117 \cdot 0.945 \approx \mathbf{0.796}$; α=0.15 ⇒ $\Psi(x) \approx \mathbf{0.781}$. Label: Primitive/Empirically Grounded. Confidence: 0.88.

6 Keystone Reflections

- $\Psi(x)$ **as evidential synthesizer**: aligns source authority (canonical vs. expert vs. community) with verifiability and Bayesian calibration, producing robust, monotone responses to allocation α.
- **AI-driven mathematics**: the framework cleanly upgrades claims when official artifacts arrive (results), while maintaining caution for pending primitives (problems), supporting transparent promotion in AI-assisted solution corpora.

7 Verification (Real-Time, Aug 08, 2025)

- Official 2025 **results** pages are live (year info, country/individual, statistics): year info, country, individual, statistics.
- **Problems page pending**: no 2025 content found yet on the official problems/shortlist pages.

Condensed Citations

- Official IMO 2025 (results): year info, country, individual, statistics (links above).
- DeepMind 2025 (gold; solutions PDF): https://deepmind.google/discover/blog/advanced-version-of- https://storage.googleapis.com/deepmind-media/gemini/IMO_2025.pdf
- DeepMind 2024 (silver; P1/P2/P4 pages): https://deepmind.google/discover/blog/ai-solves-imo-problems-at-silver-medal-level/, https://storage.googleapis.com/deepmind-media/DeepMind.com/Blog/imo-2024-solutions/index.html
- Evan Chen: https://web.evanchen.cc/, 2025 PDF https://web.evanchen.cc/exams/IMO-2025-notes.pdf
- AoPS 2025: P1–P6 threads (IDs as in prior exchanges).