A Mathematical Model of Academical Sabotage

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1) Sets and Elements

- **SS**: set of High-Performing Students (the universe under study)
- **TT** $\subseteq$ **SS**: set of Talented Students
- **EE** $\subseteq$ **TT**: set of Exceptional Students
- **OO** $\subseteq$ **EE**: set of Olympiad Students

Subset chain:

$$\mathrm{OO} \subseteq \mathrm{EE} \subseteq \mathrm{TT} \subseteq \mathrm{SS}$$

Fix an individual student $s \in \mathrm{SS}$. All performance/impact functions below refer to this s.

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2) Baseline Performance Model

A student's performance depends on innate talent T, hard work W, and focus F.

For student s:

$$P_s(t) = k \cdot T_s \cdot W_s(t) \cdot F_s(t)$$

where:

- $k > 0$ is a proportionality constant.
- T_s is (relatively) time-invariant intrinsic talent.
- $W_s(t), F_s(t)$ are time-dependent effort and focus.

Ideal assumption: $W_s(t)$ and $F_s(t)$ are self-regulated and contribute positively to $P_s(t)$.

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3) Hypothesis: External De-optimization

There exists a **Competitor** C_B guided by a **Manipulator** F_C aiming to reduce $P_s(t)$ indirectly by suppressing $W_s(t)$ and $F_s(t)$ (not by improving $T_{C_B}, W_{C_B}(t), F_{C_B}(t)$).

Let:

- $P_{\text{target}}(t)$: target performance metric (e.g., score/rank).
- $P_{C_B}(t)$: competitor's performance.

Core aim:

$$\lim_{t\to\infty} P_s(t) < P_{C_B}(t) \quad \text{via decreases in } W_s(t), F_s(t).$$

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4) Two-Phase Attack Model

Phase 1 — Distraction (Soft Attack)

Let the distraction set be:

$\mathcal{D} = \{\text{Fame } (D_F), \text{ Money } (D_M), \text{ Entertainment } (D_E), \text{ Romantic Flattery } (D_R)\}.$

For each $d \in \mathcal{D}$, define a distraction impact function $\delta(s, d, t) \geq 0$.

Effective work and focus:

$$W'_s(t) = W_s(t) \; - \sum_{d\in\mathcal{D}} \alpha_d \, \delta(s, d, t)$$

$$F'_s(t) = F_s(t) \; - \sum_{d\in\mathcal{D}} \beta_d \, \delta(s, d, t)$$

with sensitivity coefficients $\alpha_d, \beta_d \geq 0$.

Performance under distraction:

$$P'_s(t) = k \cdot T_s \cdot W'_s(t) \cdot F'_s(t).$$

Escalation condition to Phase 2: If distractions fail to degrade below resilience thresholds, i.e.

$$\forall d \in \mathcal{D} : \; \delta(s, d, t) < \varepsilon_d \quad \text{or} \quad W'_s(t) \geq W_{\text{crit}}, \; F'_s(t) \geq F_{\text{crit}},$$

then F_C escalates to Phase 2.

Phase 2 — Harassment (Hard Attack)

Let the harassment set be:

$\mathcal{H} = \{\text{Gossip } (H_G), \text{ Anonymous Messages } (H_{AM}), \text{ Cold Friends } (H_{CF}), \text{ Misunderstandings } (H_M), \text{ Physic}$

For each $h \in \mathcal{H}$, define a harassment intensity $\eta(s, h, t) \geq 0$.

Effective work, focus, and well-being:

$$W''_s(t) = W'_s(t) \; - \sum_{h\in\mathcal{H}} \gamma_h \, \eta(s, h, t)$$

$$F''_s(t) = F'_s(t) \; - \sum_{h\in\mathcal{H}} \delta_h \, \eta(s, h, t)$$

$$WB_s''(t) = WB_s(t) \; - \; \sum_{h \in \mathcal{H}} \lambda_h \, \eta(s,h,t)$$

with $\gamma_h, \delta_h, \lambda_h \geq 0$.

Performance under harassment:

$$P_s''(t) = k \cdot T_s \cdot W_s''(t) \cdot F_s''(t).$$

Crisis condition and recovery: If

$$WB_s''(t) < WB_{\text{crit}},$$

then a recovery period $\Delta t_{\text{recovery}}$ is forced, during which $W_s''(t) \approx 0$ and $F_s''(t) \approx 0$, implying $P_s''(t + \Delta t_{\text{recovery}}) \approx 0$.

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5) The Problem (Control Objective)

For the student $s \in \text{SS}$ (and supporting institutions), the goal is to **maximize performance** (or minimize degradation) under δ, η that are external to s.

Design strategies to:

- **Reduce sensitivities** $\{\alpha_d, \beta_d, \gamma_h, \delta_h, \lambda_h\}$.
- **Raise thresholds** $\{W_{\text{crit}}, F_{\text{crit}}, WB_{\text{crit}}\}$.
- **Shorten/soften recovery** $\Delta t_{\text{recovery}}$.

Formally:

$$\max_t \; P_s(t) \quad \text{s.t.} \quad (\delta, \eta) \text{ exogenous to } s,$$

equivalently minimize the performance gap:

$$\min_t \; \big[P_{\text{ideal}}(t) - P_s(t)\big], \quad P_{\text{ideal}}(t) = k \cdot T_s \cdot W_s(t) \cdot F_s(t).$$

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6) Proposed Solutions (Mitigation & Protection)

6.1 Student-Side Resilience (Internal Mitigation)

Define a **resilience function** $R_s(t) \geq 0$:

$$R_s(t) = \phi_1 \, \text{Awareness}(t) + \phi_2 \, \text{SocialSupport}(t) + \phi_3 \, \text{Documentation}(t) + \phi_4 \, \text{UnwaveringFocus}(t),$$

with weights $\phi_i \geq 0$.

Resilience offsets losses:

$$W_s'''(t) = W_s''(t) + \zeta_W \, R_s(t)$$
$$F_s'''(t) = F_s''(t) + \zeta_F \, R_s(t)$$
$$WB_s'''(t) = WB_s''(t) + \zeta_{WB} \, R_s(t),$$

where $\zeta_W, \zeta_F, \zeta_{WB} \geq 0$.

Goal: Maintain $WB_s'''(t) \geq WB_{\text{crit}}$ and keep $W_s'''(t), F_s'''(t)$ high.

6.2 Institution-Side Protection (External Mitigation)

Define an **Institutional Protective factor** $IP(t) \geq 0$:

$IP(t) = \psi_1\,\mathrm{ActiveProtection}(t) + \psi_2\,\mathrm{ComplaintValidity}(t) + \psi_3\,\mathrm{CharacterReward}(t)$,

with $\psi_i \geq 0$.

Mitigated attack inputs (clamped at 0):

$$\delta'(s,d,t) = \max\{\,\delta(s,d,t) - \theta_d\,IP(t),\ 0\,\},$$

$$\eta'(s,h,t) = \max\{\,\eta(s,h,t) - \theta_h\,IP(t),\ 0\,\},$$

where $\theta_d, \theta_h \geq 0$ are intervention efficacies.

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7) Final Desired State

With protection in place, the operational performance becomes:

$$P_{\text{final}}(t) = k \cdot T_s \cdot \Big(W_s(t) - \sum_{d\in\mathcal{D}} \alpha_d\,\delta'(s,d,t)\Big) \cdot \Big(F_s(t) - \sum_{d\in\mathcal{D}} \beta_d\,\delta'(s,d,t)\Big),$$

and we aim for:

$$P_{\text{final}}(t) \approx P_{\text{ideal}}(t) \quad \text{and} \quad WB_s'''(t) \geq WB_{\text{crit}} \quad \forall t.$$

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