

SCRUM Domain Optimization Model

Generated from Entities, Relationships, Goals, Conditions, Decision Variables

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Notation Prelude (Relationships as Incidence Sets & Parameters)

To use *all* CSV inputs coherently, we introduce incidence sets (from `Relationships.csv`) and parameters (from `Entities.csv` attributes). Whenever an entity attribute is needed, we denote it by a parameter named after the attribute, indexed by the entity's index (see Sections 1–2). For example, story_points_{us} for a user story $us \in \mathcal{US}$, effort_{tsk} for a task $tsk \in \mathcal{TSK}$, budget_p for a project $p \in \mathcal{P}$, etc.

Incidence Sets from `Relationships.csv`:

- $A^{\text{TP}} \subseteq \mathcal{T} \times \mathcal{P}$ (R1: `is_assigned_to_project`)
- $A^{\text{WT}} \subseteq \mathcal{W} \times \mathcal{T}$ (R2: `belongs_to_team`) (*Employee interpreted as Worker*)
- $A^{\text{WS}} \subseteq \mathcal{W} \times \mathcal{S}$ (R3: `has_skill`)
- $A^{\text{WR}} \subseteq \mathcal{W} \times \mathcal{R}$ (R4: `takes_on_role`)
- $A^{\text{PO,PB}} \subseteq \mathcal{PO} \times \mathcal{PB}$ (R5: `manages_backlog`)
- $A^{\text{T,SM}} \subseteq \mathcal{T} \times \mathcal{SM}$ (R6: `is_supported_by`)
- $A^{\text{PB,F}} \subseteq \mathcal{PB} \times \mathcal{F}$ (R7: `contains_feature`)
- $A^{\text{PB,E}} \subseteq \mathcal{PB} \times \mathcal{E}$ (R8: `contains_epic`)
- $A^{\text{E,US}} \subseteq \mathcal{E} \times \mathcal{US}$ (R9: `contains_user_story`)
- $A^{\text{US,TSK}} \subseteq \mathcal{US} \times \mathcal{TSK}$ (R10: `consists_of_tasks`)
- $A^{\text{US,SBL}} \subseteq \mathcal{US} \times \mathcal{SBL}$ (R11: `is_in_sprint_backlog`)
- $A^{\text{SBL,SP}} \subseteq \mathcal{SBL} \times \mathcal{SP}$ (R12: `belongs_to_sprint`)
- $A^{\text{SP,SG}} \subseteq \mathcal{SP} \times \mathcal{SG}$ (R13: `pursues_goal`)
- $A^{\text{SCB,TSK}} \subseteq \mathcal{SCB} \times \mathcal{TSK}$ (R14: `contains_tasks`)
- $A^{\text{FED,F}} \subseteq \mathcal{FED} \times \mathcal{F}$ (R15: `documents_feature`)
- $A^{\text{TSK,BL}} \subseteq \mathcal{TSK} \times \mathcal{BL}$ (R16: `is_blocked_by`)
- $A^{\text{SH,SR}} \subseteq \mathcal{SH} \times \mathcal{SR}$ (R17: `participates_in`)
- $A^{\text{SM,SRE}} \subseteq \mathcal{SM} \times \mathcal{SRE}$ (R18: `moderates_retrospective`)
- $A^{\text{VEL,T}} \subseteq \mathcal{VEL} \times \mathcal{T}$ (R19: `refers_to_team`)
- $A^{\text{REP,F}} \subseteq \mathcal{REP} \times \mathcal{F}$ (R20: `plans_release`)
- $A^{\text{REP,RM}} \subseteq \mathcal{REP} \times \mathcal{RM}$ (R21: `is_part_of_roadmap`)
- $A^{\text{SP,DEV}} \subseteq \mathcal{SP} \times \mathcal{DEV}$ (R22: `generates_snapshot`)

1 1. Sets (Entities)

We define one set per entity (from `Entities.csv`). The mnemonic in parentheses is the entity's `SetName`.

- \mathcal{P} (P): Projects
- \mathcal{T} (T): Teams
- \mathcal{W} (W): Workers
- \mathcal{F} (F): Features
- \mathcal{S} (S): Skills
- \mathcal{R} (R): Roles
- \mathcal{PO} (PO): Product Owners
- \mathcal{SM} (SM): Scrum Masters
- \mathcal{PB} (PB): Product Backlogs
- \mathcal{SP} (SP): Sprints
- \mathcal{SPP} (SPP): Sprint Plannings
- \mathcal{DS} (DS): Daily Scrums
- \mathcal{SR} (SR): Sprint Reviews
- \mathcal{SRE} (SRE): Sprint Retrospectives
- \mathcal{SBL} (SBL): Sprint Backlogs
- \mathcal{SG} (SG): Sprint Goals
- \mathcal{E} (E): Epics
- \mathcal{US} (US): User Stories
- \mathcal{TSK} (TSK): Tasks
- \mathcal{DEV} (DEV): Development Snapshots
- \mathcal{BL} (BL): Blockers
- \mathcal{SH} (SH): Stakeholders
- \mathcal{VEL} (VEL): Velocity records
- \mathcal{REP} (REP): Release Plans
- \mathcal{RM} (RM): Roadmaps
- \mathcal{SCB} (SCB): Scrum Boards
- \mathcal{FED} (FED): Feature Documentations

2 2. Indices

Index symbols (from `Entities.csv` `Index` column) and their domains:

- $p \in \mathcal{P}$, $t \in \mathcal{T}$, $w \in \mathcal{W}$, $f \in \mathcal{F}$, $s \in \mathcal{S}$, $r \in \mathcal{R}$
- $po \in \mathcal{PO}$, $sm \in \mathcal{SM}$, $pb \in \mathcal{PB}$, $sp \in \mathcal{SP}$, $spp \in \mathcal{SPP}$
- $ds \in \mathcal{DS}$, $sr \in \mathcal{SR}$, $sre \in \mathcal{SRE}$, $sbl \in \mathcal{SBL}$, $sg \in \mathcal{SG}$
- $e \in \mathcal{E}$, $us \in \mathcal{US}$, $tsk \in \mathcal{TSK}$, $dev \in \mathcal{DEV}$, $bl \in \mathcal{BL}$
- $sh \in \mathcal{SH}$, $vel \in \mathcal{VEL}$, $rep \in \mathcal{REP}$, $rm \in \mathcal{RM}$, $scb \in \mathcal{SCB}$, $fed \in \mathcal{FED}$

3 3. Goals

Each goal item shows (**ID, snake_case name**) followed by its logical intent and mathematical form. Weights from `Goals.csv` appear as ω . `CriteriaType` $\in \{2 \text{ (must)}, 1 \text{ (may)}, 0 \text{ (cannot)}\}$ acts as a filter on eligible items.

- **G0 maximize_total_story_points** (Criteria: 1, $\omega = 1.0$).
Logic: Prefer selecting user stories with higher story_points into sprints.
Math: $\max \omega \sum_{us \in \mathcal{US}} \sum_{sp \in \mathcal{SP}} z_{us,sp} \cdot \text{story_points}_{us}$
- **G1 minimize_total_task_effort** (Criteria: 2, $\omega = 1.0$).
Logic: Reduce the aggregate planned effort of tasks.
Math: $\min \omega \sum_{tsk \in \mathcal{TSK}} \text{effort}_{tsk}$
- **G2 maximize_velocity_average** (Criteria: 1, $\omega = 1.0$).
Logic: Increase average velocity (story points per sprint) per team.
Math: $\max \omega \sum_{vel \in \mathcal{VEL}} \bar{v}_{vel}$
- **G3 maximize_velocity_peak** (Criteria: 1, $\omega = 0.8$).
Logic: Prefer configurations correlating with higher observed peak velocity.
Math: $\max \omega \sum_{vel \in \mathcal{VEL}} v_{vel}^{\max}$
- **G4 maximize_velocity_trend** (Criteria: 1, $\omega = 0.6$).
Logic: Encourage positive velocity trend over time.
Math: $\max \omega \sum_{vel \in \mathcal{VEL}} \text{trend}_{vel}$
- **G5 minimize_blocker_severity_sum** (Criteria: 2, $\omega = 1.0$).
Logic: Reduce cumulative severity of *open* blockers only.
Math: $\min \omega \sum_{bl \in \mathcal{BL}^{open}} \text{severity}_{bl}$ with $\mathcal{BL}^{open} = \{bl \in \mathcal{BL} : \text{status}_{bl} \neq \text{resolved}\}$
- **G6 minimize_project_budget** (Criteria: 1, $\omega = 1.0$).
Logic: Minimize approved budget across projects.
Math: $\min \omega \sum_{p \in \mathcal{P}} A_p$ (DV12)

- **G7 maximize_team_size_utilization** (Criteria: 1, $\omega = 0.7$).
Logic: Favor higher effective capacity (via team size).
Math: $\max \omega \sum_{t \in T} \text{team_size}_t$
- **G8 maximize_sprint_goal_achievement** (Criteria: 2, $\omega = 1.0$).
Logic: Maximize achievement score recorded on sprints.
Math: $\max \omega \sum_{sp \in SP} \text{achievement_of_goal}_{sp}$
- **G9 maximize_review_attendance** (Criteria: 1, $\omega = 0.5$).
Logic: Increase stakeholder attendance in sprint reviews.
Math: $\max \omega \sum_{sr \in SR} \text{attendees_count}_{sr}$
- **G10 minimize_daily_scrum_duration** (Criteria: 1, $\omega = 0.3$).
Logic: Keep daily scrums short (10–15 minutes).
Math: $\min \omega \sum_{ds \in DS} m_{ds}$ (DV11)
- **G11 maximize_board_throughput** (Criteria: 1, $\omega = 0.4$).
Logic: Prefer higher number of cards processed on Scrum boards.
Math: $\max \omega \sum_{scb \in SCB} \text{number_of_cards}_{scb}$

4 4. Conditions

Each condition item shows (**ID, snake_case name**) with logical and mathematical expressions. CriteriaType drives filtering; where applicable we define filtered subsets (Must: restrict domain; May: soft preference; Cannot: exclusion). We also incorporate relationship-based consistency.

- **C0 active_projects_only** (Must, weight 1.0).
Logic: Consider only active projects.
Math: $\mathcal{P}^{act} = \{p \in \mathcal{P} : \text{status}_p = \text{active}\}$; replace \mathcal{P} by \mathcal{P}^{act} in budget/assignment sums.
- **C1 exclude_resolved_blockers** (Cannot, weight 1.0).
Logic: Ignore resolved blockers in penalties/goals.
Math: $\mathcal{BL}^{open} = \{bl \in \mathcal{BL} : \text{status}_{bl} \neq \text{resolved}\}$.
- **C2 user_stories_with_acceptance_criteria** (Must, weight 1.0).
Logic: Schedule only user stories that specify acceptance criteria.
Math: For any us with $z_{us,sp} = 1$: $\text{acceptance_criteria}_{us} \neq \emptyset$.
- **C3 focus_on_development_tasks** (May, weight 0.6).
Logic: Prefer tasks with type = development.
Math (soft): Add $-0.6 \sum_{tsk} \mathbf{1}[\text{type}_{tsk} = \text{development}]$ to the objective.
- **C4 active_sprints_only** (Must, weight 1.0).
Logic: Only active sprints eligible for scheduling.
Math: If $z_{us,sp} = 1$ then $\text{status}_{sp} = \text{active}$.
- **C5 prefer_certified_skills** (May, weight 0.7).
Logic: Prefer workers with certified skills on assigned work.
Math (soft): $-0.7 \sum_{(w,s) \in A^{ws}} \mathbf{1}[\text{certified}_s = \text{true}]$.

- **C6 roles_with_defined_responsibility** (Must, weight 0.9).
Logic: Any worker-role assignment requires specified responsibility.
Math: $\forall(w, r) \in A^{\text{WR}} : \text{area_of_responsibility}_r \neq \emptyset$.
- **C7 exclude_inactive_workers** (Cannot, weight 1.0).
Logic: Inactive workers cannot be assigned to teams.
Math: $\forall(w, t) \in A^{\text{WT}} : \text{status}_w \neq \text{inactive}$.
- **C8 goal_achievement_reported** (Must, weight 0.9).
Logic: Sprint goals must report achievement status.
Math: $\forall(sp, sg) \in A^{\text{SP,SG}} : \text{achievement_status}_{sg} \in \{\text{achieved, partial, missed}\}$.
- **C9 prefer_current_backlog** (May, weight 0.5).
Logic: Prefer product backlogs with manageable status (e.g., current).
Math (soft): $-0.5 \sum_{pb \in \mathcal{PB}} \mathbf{1}[\text{status}_{pb} = \text{current}]$.
- **C10 epics_with_valid_status** (Must, weight 0.8).
Logic: Only epics with a valid status can be scheduled into backlogs/sprints via their stories.
Math: If $(e, us) \in A^{\text{E,US}}$ and $z_{us,sp} = 1$ then $\text{status}_e \in \{\text{proposed, approved, in_progress}\}$.
- **C11 exclude_blocked_tasks** (Cannot, weight 1.0).
Logic: Tasks with blocking blockers cannot be scheduled/executed.
Math: If $(us, tsk) \in A^{\text{US,TSK}}$ and $(tsk, bl) \in A^{\text{TSK,BL}}$ with $\text{status}_{bl} \neq \text{resolved}$, then tsk cannot be started (e.g., effort allocation $a_{tsk} = 0$).

5 5. DecisionVariables

Decision variables (from `DecisionVariables.csv`) including domains and bounds:

- **DV0 assign_team_to_project:** $x_{t,p} \in \{0, 1\}$ (binary), for $(t, p) \in \mathcal{T} \times \mathcal{P}$. Bounds: $0 \leq x_{t,p} \leq 1$. (R1 consistency: $x_{t,p} = 1 \Rightarrow (t, p) \in A^{\text{TP}}$)
- **DV1 assign_worker_to_team:** $y_{w,t} \in \{0, 1\}$ (binary), for $(w, t) \in \mathcal{W} \times \mathcal{T}$. Bounds: $0 \leq y_{w,t} \leq 1$. (R2)
- **DV2 assign_user_story_to_sprint:** $z_{us,sp} \in \{0, 1\}$ (binary), linking via $A^{\text{US,SBL}}$ and $A^{\text{SBL,SP}}$. Bounds: $0 \leq z_{us,sp} \leq 1$.
- **DV3 select_feature_for_release:** $u_{f,rep} \in \{0, 1\}$ (binary), $(f, rep) \in \mathcal{F} \times \mathcal{REP}$. Bounds: $0 \leq u_{f,rep} \leq 1$. (R20)
- **DV4 select_epic_for_backlog:** $v_{e,pb} \in \{0, 1\}$ (binary), $(e, pb) \in \mathcal{E} \times \mathcal{PB}$. Bounds: $0 \leq v_{e,pb} \leq 1$. (R8)
- **DV5 plan_sprint_length_days:** $\ell_{sp} \in \mathbb{Z}$, $7 \leq \ell_{sp} \leq 30$.
- **DV6 allocate_task_effort_hours:** $a_{tsk} \in \mathbb{Z}$, $1 \leq a_{tsk} \leq 80$.
- **DV7 set_team_size:** $n_t \in \mathbb{Z}$, $3 \leq n_t \leq 11$.
- **DV8 set_story_points:** $s_{us} \in \mathbb{Z}$, $1 \leq s_{us} \leq 13$.
- **DV9 set_blocker_severity:** $bsev_{bl} \in \mathbb{Z}$, $1 \leq bsev_{bl} \leq 5$.
- **DV10 set_scrum_board_column_count:** $c_{scb}^{col} \in \mathbb{Z}$, $2 \leq c_{scb}^{col} \leq 7$.
- **DV11 schedule_daily_scrum_minutes:** $m_{ds} \in \mathbb{Z}$, $10 \leq m_{ds} \leq 15$.
- **DV12 approve_budget_per_project:** $A_p \in \mathbb{R}_{\geq 0}$, $0 \leq A_p \leq 1,000,000$.

Canonical Combined Objective

If a single scalar objective is required, combine goal components with their weights (maximization form; convert minimizing terms by sign):

$$\max \quad \underbrace{\omega_{G0} \sum_{us,sp} z_{us,sp} \text{story_points}_{us}}_{G0} - \underbrace{\omega_{G1} \sum_{tsk} \text{effort}_{tsk}}_{G1} + \omega_{G2} \sum_{vel} \bar{v}_{vel} + \omega_{G3} \sum_{vel} v_{vel}^{\max} + \omega_{G4} \sum_{vel} \text{trend}_{vel} - \omega_{G5} \sum_{bl \in \mathcal{BL}} \dots$$

Soft “May” conditions (C3, C5, C9) can be embedded as additional positive bonuses or penalties on the objective, as shown in Section 4.

Selected Structural Constraints (Consistency & Relationships)

- **Team–Project assignment** (R1): $x_{t,p} = 0$ if $(t,p) \notin A^{\text{TP}}$.
- **Worker–Team assignment** (R2): $y_{w,t} = 0$ if $(w,t) \notin A^{\text{WT}}$; and (C7) $y_{w,t} = 0$ if $\text{status}_w = \text{inactive}$.
- **Story–Sprint link** (R11–R12): $z_{us,sp} \leq \sum_{sbl:(us,sbl) \in A^{\text{US,SBL}}} \mathbf{1}[(sbl, sp) \in A^{\text{SBL,SP}}]$.
- **Acceptance criteria** (C2): $z_{us,sp} \leq \mathbf{1}[\text{acceptance_criteria}_{us} \neq \emptyset]$.
- **Active sprints only** (C4): $z_{us,sp} \leq \mathbf{1}[\text{status}_{sp} = \text{active}]$.
- **Epic status validity** (C10): $z_{us,sp} \leq \mathbf{1}[\text{status}_e \in \{\text{proposed}, \text{approved}, \text{in_progress}\}]$ for any e with $(e, us) \in A^{\text{E,US}}$.
- **Blocked tasks excluded** (C11): For any $(us, tsk) \in A^{\text{US,TSK}}$, if $\exists bl : (tsk, bl) \in A^{\text{TSK,BL}}$ with $\text{status}_{bl} \neq \text{resolved}$, then $a_{tsk} = 0$.