

SCRUM Domain Optimization Model

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

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1 1. Sets (Entities)

- P — set of **Projects** (Project)
- T — set of **Teams** (Team)
- W — set of **Workers** (Worker)
- F — set of **Features** (Feature)
- S — set of **Skills** (Skill)
- R — set of **Roles** (Role)
- PO — set of **Product Owners** (ProductOwner)
- SM — set of **Scrum Masters** (ScrumMaster)
- PB — set of **Product Backlogs** (ProductBacklog)
- SP — set of **Sprints** (Sprint)
- SPP — set of **Sprint Plannings** (SprintPlanning)
- DS — set of **Daily Scrums** (DailyScrum)
- SR — set of **Sprint Reviews** (SprintReview)
- SRE — set of **Sprint Retrospectives** (SprintRetrospective)
- SBL — set of **Sprint Backlogs** (SprintBacklog)
- SG — set of **Sprint Goals** (SprintGoal)
- E — set of **Epics** (Epic)
- US — set of **User Stories** (UserStory)
- K — set of **Tasks** (Task)
- DEV — set of **Development Snapshots** (DevelopmentSnapshot)
- BL — set of **Blockers** (Blocker)
- SH — set of **Stakeholders** (Stakeholder)
- VEL — set of **Velocity records** (Velocity)
- REP — set of **Release Plans** (ReleasePlan)
- RM — set of **Roadmaps** (Roadmap)
- SCB — set of **Scrum Boards** (ScrumBoard)
- FED — set of **Feature Documentations** (FeatureDocumentation)
- Relationship-induced subsets:
 - $F(PB)$ — features contained in a product backlog (R7).
 - $E(PB)$ — epics contained in a product backlog (R8).
 - $US(e)$ — user stories contained in epic e (R9).
 - $K(u)$ — tasks belonging to user story u (R10).
 - $BL(k)$ — blockers that block task k (R16).

2 2. Indices

- Indices follow the initial letters of the sets: $p \in P$, $t \in T$, $w \in W$, $f \in F$, $s \in S$, $r \in R$, $po \in PO$, $sm \in SM$, $pb \in PB$, $\sigma \in SP$, $spp \in SPP$, $ds \in DS$, $sr \in SR$, $sre \in SRE$, $sbl \in SBL$, $g \in SG$, $e \in E$, $u \in US$, $k \in K$, $d \in DEV$, $b \in BL$, $sh \in SH$, $v \in VEL$, $rep \in REP$, $rm \in RM$, $scb \in SCB$, $fed \in FED$.
- Attribute parameters (derived from Entities.csv; sample symbols used later):
 - $sp_u := \text{story_points}$ of user story u .
 - $\hat{e}_f := \text{estimated_effort}$ of feature f .
 - $sev_b := \text{severity}$ of blocker b .
 - $prio_u^{US} := \text{priority}$ of user story u ; $prio_f^F := \text{priority}$ of feature f .
 - $att_{sr}^{SR} := \text{attendees_count}$ of sprint review sr .
 - $sat_{sre} := \text{team_satisfaction}$ at retrospective sre .
 - $bud_p := \text{budget}$ of project p .
 - $v_t^{\max} := \text{max_velocity}$ for team t from $v \in VEL$ that refers to t (R19).
 - $\overline{N}^{SBL} := \text{capacity parameter for number_of_tasks}$ in the current sprint backlog.
 - $\overline{E}^{SBL} := \text{capacity parameter for total_effort}$ in the current sprint backlog.
 - \overline{dur}^{DS} , \overline{dur}^{SPP} , $\overline{dur}^{SR} := \text{reasonable upper bounds on durations for Daily Scrum, Sprint Planning, and Sprint Review.}$
 - $avail_{po} := \text{availability}$ of Product Owner po ; $exp_{sm} := \text{experience}$ of Scrum Master sm .

3 3. Goals

Notation. We employ decision variables from Section 5; where attributes are summed, selection variables gate inclusion. Each goal G_i is presented with ID, name, logic, and its mathematical form.

- **G0: maximize_total_story_points**
 Logic: Select user stories to maximize total story points in the sprint.
 Math: $\max \sum_{u \in US} sp_u \cdot x_u^{US}$
- **G1: minimize_total_task_effort**
 Logic: Minimize total estimated task effort included via selected user stories.
 Math: $\min \sum_{u \in US} \sum_{k \in K(u)} e_k \cdot x_u^{US}$
- **G2: minimize_blocker_severity_sum**
 Logic: Prefer plans that include fewer/severity-lower blockers on chosen tasks.
 Math: $\min \sum_{u \in US} \sum_{k \in K(u)} \sum_{b \in BL(k)} sev_b \cdot x_u^{US}$
- **G3: maximize_sprint_goal_achievement**
 Logic: Favor sprints planned to achieve the sprint goal; use proxy variable $z^{SG} \in [0, 1]$.
 Math: $\max \sum_{\sigma \in SP} z_{\sigma}^{SG}$

- **G4: maximize_team_satisfaction**

Logic: Favor plans correlated with higher retrospective team satisfaction.

$$\text{Math: } \max \sum_{sre \in SRE} sat_{sre}$$

- **G5: minimize_project_budget**

Logic: Minimize allocated budget across active projects.

$$\text{Math: } \min \sum_{p \in P} B_p \quad (\text{where } B_p \text{ is decision variable in Sec. 5})$$

- **G6: maximize_velocity_max**

Logic: Encourage higher realized max velocity across teams.

$$\text{Math: } \max \sum_{t \in T} v_t^{\max}$$

- **G7: maximize_review_attendees**

Logic: Increase feedback by targeting more review attendees.

$$\text{Math: } \max \sum_{sr \in SR} A_{sr} \quad (A_{sr} \text{ decision variable})$$

- **G8: minimize_feature_estimated_effort**

Logic: Prefer smaller features for faster increments.

$$\text{Math: } \min \sum_{f \in F} \hat{e}_f \cdot x_f^F$$

- **G9: minimize_scrumboard_cards**

Logic: Limit WIP by capping cards on boards.

$$\text{Math: } \min \sum_{scb \in SCB} L_{scb} \quad (L_{scb} \text{ decision variable})$$

- **G10: minimize_daily_scrum_duration**

Logic: Keep the Daily Scrum short.

$$\text{Math: } \min \sum_{ds \in DS} D_{ds}^{DS} \quad (D_{ds}^{DS} \text{ decision variable})$$

- **G11: maximize_skill_level**

Logic: Prefer configurations that utilize higher skill levels.

$$\text{Math: } \max \sum_{w \in W} \sum_{s \in S} lvl_{w,s} \cdot u_{w,s} \quad (\text{where } lvl_{w,s} \text{ is skill level; } u_{w,s} \text{ indicates use})$$

(Optional) Weighted scalarization for multi-objective optimization Let weights ω_{G_i} be taken from the CSV `Weight` column. A single-objective scalarization is:

$$\max \sum_{i \in \{G0, \dots, G11\}} \text{sgn}(G_i) \omega_{G_i} \tilde{f}_{G_i},$$

where $\text{sgn}(G_i) = +1$ for maximization goals and -1 for minimization goals, and \tilde{f}_{G_i} are normalized versions of the goal expressions.

4 4. Conditions

Each condition C_i is stated with logic and a mathematical formulation. Bounds and thresholds correspond to CSV attributes or reasonable caps.

- **C0: team_size_within_limit**
Logic: Team size equals assigned workers and respects min/max.
Math: $\forall t \in T : n_t = \sum_{w \in W} y_{w,t}, \quad 3 \leq n_t \leq 12.$
- **C1: ensure_worker_availability**
Logic: A worker can be assigned to at most one team (timebox) and only if available.
Math: $\forall w \in W : \sum_{t \in T} y_{w,t} \leq 1, \quad y_{w,t} \leq avail_w \quad \forall t.$
- **C2: cap_sprint_backlog_tasks**
Logic: Tasks induced by selected user stories fit the sprint backlog task cap.
Math: $\sum_{u \in US} \sum_{k \in K(u)} x_u^{US} \leq \overline{N}^{SBL}.$
- **C3: allow_only_active_sprints**
Logic: Consider only sprints with acceptable status (filter).
Math: $\sigma \in SP_{active} \subseteq SP.$
- **C4: limit_total_effort_in_sprint**
Logic: Sum of efforts for tasks of selected user stories within capacity.
Math: $\sum_{u \in US} \sum_{k \in K(u)} e_k \cdot x_u^{US} \leq \overline{E}^{SBL}.$
- **C5: reduce_blocker_severity**
Logic: Average blocker severity on selected tasks not above threshold Θ .
Math: $\frac{\sum_u \sum_{k \in K(u)} \sum_{b \in BL(k)} sev_b \cdot x_u^{US}}{\sum_u \sum_{k \in K(u)} x_u^{US} + \varepsilon} \leq \Theta, \quad \text{with } \Theta \text{ decision DV10 and } \varepsilon > 0.$
- **C6: keep_review_duration_reasonable**
Logic: Review duration bounded; attendees choice does not violate timebox.
Math: $\forall sr \in SR : dur_{sr}^{SR} \leq \overline{dur}^{SR}.$
- **C7: require_po_availability**
Logic: At least one Product Owner available for planning/review.
Math: $\sum_{po \in PO} \mathbf{1}[avail_{po} \geq \alpha_{PO}] \geq 1.$
- **C8: require_sm_experience**
Logic: At least one Scrum Master meets experience threshold.
Math: $\sum_{sm \in SM} \mathbf{1}[exp_{sm} \geq \alpha_{SM}] \geq 1.$
- **C9: keep_planning_duration_within_limit**
Logic: Sprint Planning sessions respect duration cap.
Math: $\forall spp \in SPP : D_{spp}^{SPP} \leq \overline{dur}^{SPP}.$
- **C10: prioritize_user_stories_above_threshold**
Logic: Only user stories with priority above threshold may be selected.
Math: $\forall u \in US : x_u^{US} \leq \mathbf{1}[prio_u^{US} \geq \pi^{US}].$
- **C11: limit_feature_priority_spread**
Logic: Limit number of low-priority features entering near-term plan.
Math: $\sum_{f \in F: prio_f^F < \pi^F} x_f^F \leq \kappa.$

5 5. DecisionVariables

Decision variables from `DecisionVariables.csv` are lifted to indexed forms in the natural sets.

- **DV0: select_feature** (x_f^F) — include feature $f \in F$ in next release; $x_f^F \in \{0, 1\}.$

- **DV1: select_user_story** (x_u^{US}) — include user story $u \in US$ in current sprint; $x_u^{US} \in \{0, 1\}$.
- **DV2: schedule_sprint_length** (L_σ) — length (days) of sprint $\sigma \in SP$; $L_\sigma \in \mathbb{Z}$, $7 \leq L_\sigma \leq 30$.
- **DV3: allocate_project_budget** (B_p) — budget allocated to project $p \in P$; $B_p \in \mathbb{R}_{\geq 0}$, $0 \leq B_p \leq 10^6$.
- **DV4: assign_worker_to_team** $(y_{w,t})$ — assignment of worker w to team t ; $y_{w,t} \in \{0, 1\}$.
- **DV5: set_team_size** (n_t) — configured size of team t ; $n_t \in \mathbb{Z}$, $3 \leq n_t \leq 12$.
- **DV6: set_daily_scrum_duration** (D_{ds}^{DS}) — minutes for daily scrum ds ; $D_{ds}^{DS} \in \mathbb{Z}$, $10 \leq D_{ds}^{DS} \leq 20$.
- **DV7: choose_review_attendees** (A_{sr}) — target attendees at review sr ; $A_{sr} \in \mathbb{Z}_{\geq 0}$, $0 \leq A_{sr} \leq 100$.
- **DV8: set_task_effort** (e_k) — effort units for task $k \in K$; $e_k \in \mathbb{Z}$, $1 \leq e_k \leq 13$.
- **DV9: choose_scrum_board_wip_limit** (L_{scb}) — WIP limit on board scb ; $L_{scb} \in \mathbb{Z}$, $1 \leq L_{scb} \leq 50$.
- **DV10: accept_blocker_risk_threshold** (Θ) — acceptable average blocker severity; $\Theta \in \mathbb{Z}$, $0 \leq \Theta \leq 5$.
- **DV11: set_story_priority** (π_u) — assigned priority for user story u ; $\pi_u \in \mathbb{Z}$, $1 \leq \pi_u \leq 5$.
- *Auxiliary variables used in goals/constraints:*
 $z_\sigma^{SG} \in [0, 1]$ proxy for sprint goal achievement; $u_{w,s} \in \{0, 1\}$ indicates use of worker w 's skill s .