SCRUM Domain Optimization Model

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

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1 1. Sets (Entities)

- $\mathcal{P}$ (Project): product or initiative to be developed.
- $\mathcal{T}$ (Team): self-organized, cross-functional development team.
- $\mathcal{W}$ (Worker): individual team member working on the project.
- $\mathcal{F}$ (Feature): mid-sized functionality.
- $\mathcal{S}$ (Skill): competence of a worker.
- $\mathcal{R}$ (Role): defined responsibilities within the Scrum team.
- $\mathcal{PO}$ (ProductOwner): responsible for product vision and Product Backlog.
- $\mathcal{SM}$ (ScrumMaster): supports team in applying Scrum.
- $\mathcal{PB}$ (ProductBacklog): ordered list of all requirements.
- $\mathcal{SP}$ (Sprint): fixed time-box to create an increment.
- $\mathcal{SPP}$ (SprintPlanning): sprint planning meeting.
- $\mathcal{DS}$ (DailyScrum): daily 15-minute meeting.
- $\mathcal{SR}$ (SprintReview): presentation and acceptance of results.
- $\mathcal{SRE}$ (SprintRetrospective): retrospective for improvement.
- $\mathcal{SBL}$ (SprintBacklog): selected backlog items + implementation plan.
- $\mathcal{SG}$ (SprintGoal): objective to be achieved in the sprint.
- $\mathcal{E}$ (Epic): large requirement split into stories.
- $\mathcal{US}$ (UserStory): requirement from a user perspective.
- $\mathcal{TSK}$ (Task): smallest unit of work.
- $\mathcal{DEV}$ (DevelopmentSnapshot): product state at sprint end.
- $\mathcal{BL}$ (Blocker): obstacle hindering progress.
- $\mathcal{SH}$ (Stakeholder): interested party in the product.
- $\mathcal{VEL}$ (Velocity): average amount of work per sprint.
- $\mathcal{REP}$ (ReleasePlan): plan for releasing specific features.
- $\mathcal{RM}$ (Roadmap): long-term planning across releases.
- $\mathcal{SCB}$ (ScrumBoard): visual board of sprint tasks.
- $\mathcal{FED}$ (FeatureDocumentation): documentation for a specific feature.

2 2. Indices

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

Data Parameters (derived from attributes and relationships). Where needed, categorical attributes (e.g., `status`) are represented by numeric indicator parameters derived from the CSVs:

- $s_u^{\text{done}} \in \{0,1\}$ (`UserStory.status` == done), $\text{sp}_u \in \mathbb{Z}_{\geq 0}$ (`UserStory.story_points`).
- $eff_\tau \in \mathbb{R}_{\geq 0}$ (`Task.effort`), $is\_not\_done_f \in \{0,1\}$ (`Feature.status` $\neq$ done).
- $avail_w \in [0,1]$ (`Worker.availability`), $sev_b \in \mathbb{R}_{\geq 0}$ (`Blocker.severity`).
- $cost_f \in \mathbb{R}_{\geq 0}$ (proxy from `Feature.estimated_effort` and unit cost).
- $rel_{sh,f} \in \mathbb{R}_{\geq 0}$ (from `Stakeholder.relevance_to_feature`).
- $align_f \in \mathbb{R}_{\geq 0}$ (alignment to `Roadmap.objectives`).
- $fbq_{sp} \in \mathbb{R}_{\geq 0}$ (quality of `SprintReview.feedback_documentation` for sprint sp).

Relationship-incidence parameters (from Relationships.csv):

- $R_{u,\tau}^{US\text{-}TSK} \in \{0,1\}$ (R10: story u consists of task τ).
- $R_{pb,u}^{PB\text{-}US} \in \{0,1\}$ and $R_{pb,f}^{PB\text{-}F} \in \{0,1\}$ (R7, R11 via epic/story expansion).
- $R_{sbl,u}^{SBL\text{-}US} \in \{0,1\}$ (R11), $R_{sp,sbl}^{SP\text{-}SBL} \in \{0,1\}$ (R12), $R_{sp,sg}^{SP\text{-}SG} \in \{0,1\}$ (R13).
- $R_{rp,f}^{REP\text{-}F} \in \{0,1\}$ (R20), $R_{rp,rm}^{REP\text{-}RM} \in \{0,1\}$ (R21).
- $R_{fd,f}^{FED\text{-}F} \in \{0,1\}$ (R15).

3 3. Goals

For each goal Gk we show (i) ID and snake_case name, (ii) logical intent, and (iii) mathematical form. We use weights $w_k > 0$ from the CSV (default 1.0 where unspecified). A single scalar objective can be built by a weighted sum of goals of type "max" (added) and type "min" (subtracted), or treated as separate scenarios.

- **G0 maximize_completed_user_stories** (max): prioritize completed stories for the sprint.
  $\max\ w_0 \sum_{u \in \mathcal{US}} s_u^{\text{done}}\, x_u^{US}$

- **G1 minimize_open_blockers** (min): reduce impact of unresolved blockers.
  $\min\ w_1 \sum_{b \in \mathcal{BL}} sev_b \left(1 - x_b^{BL}\right)$

- **G2 maximize_velocity_trend** (max): proxy by maximizing story points planned.
  $\max\ w_2 \sum_{u \in \mathcal{US}} \text{sp}_u\, x_u^{US}$

- **G3 minimize_total_task_effort** (min): limit total selected task effort.
  $\min\ w_3 \sum_{\tau \in \mathcal{TSK}} eff_\tau\, x_\tau^{TSK}$

- **G4 maximize_sprint_goal_achievement** (max): favor sprints that meet their goals.
  $\max\ w_4 \sum_{sp \in \mathcal{SP}} x_{sp}^{SG}$

- **G5 minimize_feature_cycle_time** (min): proxy by avoiding not-done features in release.
  $\min\ w_5 \sum_{f \in \mathcal{F}} is\_not\_done_f \, x_f^{FR}$

- **G6 maximize_team_availability** (max): maximize available capacity assigned to teams.
  $\max\ w_6 \sum_{w \in \mathcal{W}} \sum_{t \in \mathcal{T}} avail_w \, x_{w,t}^{WT}$

- **G7 minimize_budget_spend** (min): proxy by minimizing cost of selected features.
  $\min\ w_7 \sum_{f \in \mathcal{F}} cost_f \, x_f^{FR}$

- **G8 maximize_stakeholder_relevance_coverage** (max): select features valued by stakeholders.
  $\max\ w_8 \sum_{sh \in \mathcal{SH}} \sum_{f \in \mathcal{F}} rel_{sh,f} \, x_f^{FR}$

- **G9 maximize_review_feedback_documentation** (max): encourage high-quality reviews (proxy via goal achievement).
  $\max\ w_9 \sum_{sp \in \mathcal{SP}} fbq_{sp} \, x_{sp}^{SG}$

- **G10 minimize_blocker_severity_exposure** (min): further penalize severe unresolved blockers.
  $\min\ w_{10} \sum_{b \in \mathcal{BL}} sev_b \left(1 - x_b^{BL}\right)$

- **G11 maximize_roadmap_objectives_alignment** (max): prefer features aligned to roadmap.
  $\max\ w_{11} \sum_{f \in \mathcal{F}} align_f \, x_f^{FR}$

4 4. Conditions

Each condition Ck is modeled as a constraint. (Logical descriptions reflect the CSV names; mathematical forms use the decision variables and relationship incidence.)

- **C0 minimize_unscheduled_tasks:** selected tasks must belong to a selected user story.
  $\forall \tau \in \mathcal{TSK}: \quad x_\tau^{TSK} \ \le\ \sum_{u \in \mathcal{US}} R_{u,\tau}^{US\text{-}TSK} \, x_u^{US}$

- **C1 minimize_unassigned_worker_roles:** if a worker is assigned to any team, at least one role must be taken.
  $\forall w \in \mathcal{W}: \quad \sum_{r \in \mathcal{R}} x_{w,r}^{WR} \ \ge\ \min\{1,\ \sum_{t \in \mathcal{T}} x_{w,t}^{WT}\}$

- **C2 minimize_unplanned_epics:** planning a story implies its epic is represented in a product backlog.
  $\forall u \in \mathcal{US}: \quad x_u^{US} \ \le\ \sum_{pb \in \mathcal{PB}} R_{pb,u}^{PB\text{-}US}$

- **C3 minimize_story_without_acceptance_criteria:** only stories with acceptance criteria may be selected.
  $\forall u \in \mathcal{US}: \quad x_u^{US} \ \le\ \mathbf{1}\{\texttt{acceptance\_criteria}(u) \neq \emptyset\}$

- **C4 minimize_sprint_without_goal:** a sprint marked achieved must reference a sprint goal.
  $\forall sp \in \mathcal{SP}: \quad x^{SG}_{sp} \;\le\; \sum_{sg \in \mathcal{SG}} R^{SP\text{-}SG}_{sp,sg}$

- **C5 minimize_exceeded_sprint_duration:** (feasibility check) end date after start date (data validity).
  $\forall sp \in \mathcal{SP}: \quad \texttt{end\_date}(sp) \;-\; \texttt{start\_date}(sp) \;\ge\; 0$

- **C6 minimize_overallocated_team_size:** assigned workers cannot exceed team capacity Cap_t.
  $\forall t \in \mathcal{T}: \quad \sum_{w \in \mathcal{W}} x^{WT}_{w,t} \;\le\; Cap_t$

- **C7 minimize_missing_feature_docs:** if a feature is selected for release, it must have documentation.
  $\forall f \in \mathcal{F}: \quad x^{FR}_{f} \;\le\; \sum_{fd \in \mathcal{FED}} R^{FED\text{-}F}_{fd,f}$

- **C8 minimize_stale_backlog:** only user stories in a recently updated backlog may be planned.
  $\forall u \in \mathcal{US}: \quad x^{US}_{u} \;\le\; \sum_{pb \in \mathcal{PB}} R^{PB\text{-}US}_{pb,u} \cdot \mathbf{1}\{\texttt{last\_updated}(pb) \ge \Delta\}$

- **C9 minimize_unmoderated_events:** (policy) retrospectives must be moderated if sprint goal is achieved.
  $\forall sp \in \mathcal{SP}: \quad x^{SG}_{sp} \;\le\; \mathbf{1}\{\exists\, sre \in \mathcal{SRE} \text{ with } \texttt{moderation}(sre) = \text{true}\}$

- **C10 minimize_unestimated_stories:** only estimated stories may be planned.
  $\forall u \in \mathcal{US}: \quad x^{US}_{u} \;\le\; \mathbf{1}\{\mathrm{sp}_u > 0\}$

- **C11 minimize_untracked_velocity:** velocity targets require historical basis $minSprints$.
  $\sum_{u \in \mathcal{US}} \mathrm{sp}_u \, x^{US}_{u} \;\le\; \big(\sum_{v \in \mathcal{VEL}} \mathbf{1}\{\texttt{number\_of\_sprints\_used}(v) \ge minSprints\}\big) \cdot V_{\max}$

5 5. DecisionVariables

We adopt the previously defined decision variables and domains.

- $x^{TP}_{t,p} \in \{0,1\}$ **(DV0 assign_team_to_project)**: team t is assigned to project p.
- $x^{WT}_{w,t} \in \{0,1\}$ **(DV1 assign_worker_to_team)**: worker w belongs to team t.
- $x^{WR}_{w,r} \in \{0,1\}$ **(DV2 assign_worker_role)**: worker w takes role r.
- $x^{WS}_{w,s} \in \{0,1\}$ **(DV3 assign_worker_skill)**: worker w has skill s (operational use for staffing).
- $x^{FR}_{f} \in \{0,1\}$ **(DV4 select_feature_for_release)**: feature f is included in a release plan.
- $x^{US}_{u} \in \{0,1\}$ **(DV5 place_story_in_sprint)**: user story u is assigned to a (current) sprint backlog.
- $x^{TSK}_{\tau} \in \{0,1\}$ **(DV6 select_task_for_sprint)**: task τ is included in the sprint plan/board.
- $x^{BL}_{b} \in \{0,1\}$ **(DV7 close_blocker)**: blocker b is resolved (closed) within the sprint.

- $x_{sp}^{SG} \in \{0,1\}$ **(DV8 set_sprint_goal_achieved)**: sprint sp achieves its goal.
- $y_{p,f}^{Bud} \in [0,1]$ **(DV9 allocate_budget_to_feature)**: share of project p budget allocated to feature f.
- $x_{po,pb}^{POB} \in \{0,1\}$ **(DV10 assign_product_owner_to_backlog)**: PO po manages backlog pb.
- $x_{sm,t}^{SM} \in \{0,1\}$ **(DV11 assign_scrum_master_to_team)**: Scrum Master sm supports team t.

Linking (illustrative) constraints. Typical couplings between decisions and budget:

$$\text{Budget per project:} \qquad \forall p \in \mathcal{P}: \quad \sum_{f \in \mathcal{F}} cost_f \, y_{p,f}^{Bud} \;\leq\; \texttt{budget}(p)$$

$$\text{Release-selection consistency:} \qquad \forall f \in \mathcal{F}: \quad x_f^{FR} \;\leq\; \sum_{p \in \mathcal{P}} y_{p,f}^{Bud}$$

Composite objective (optional). If a single-objective scalarization is desired, maximize

$$\max \sum_{k \in \{0,2,4,6,8,9,11\}} w_k \cdot \text{Goal}_k \;-\; \sum_{k \in \{1,3,5,7,10\}} w_k \cdot \text{Goal}_k,$$

where each Goal_k corresponds to the expressions enumerated in Section 3.