SCRUM Domain Optimization Model
From Entities, Relationships, Goals, Conditions, Decision Variables

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Contents

1   1. Sets (Entities)

- $\mathcal{P}$ (Project): The product or initiative to be developed.

- $\mathcal{T}$ (Team): Self-organized, cross-functional development team.

- $\mathcal{W}$ (Worker/Employee): Individual team member working on the project. *(Alias "Employee" in relationships)*

- $\mathcal{F}$ (Feature): Mid-sized functionality.

- $\mathcal{S}$ (Skill): Professional or social 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 the team in applying Scrum.

- $\mathcal{PB}$ (ProductBacklog): Ordered list of all requirements.

- $\mathcal{SP}$ (Sprint): Fixed time period for creating an increment.

- $\mathcal{SPP}$ (SprintPlanning): Kick-off meeting for Sprint preparation.

- $\mathcal{DS}$ (DailyScrum): Daily 15-minute team meeting.

- $\mathcal{SR}$ (SprintReview): Presentation and acceptance of results.

- $\mathcal{SRE}$ (SprintRetrospective): Retrospective for process improvement.

- $\mathcal{SBL}$ (SprintBacklog): Selected backlog items + implementation plan.

- $\mathcal{SG}$ (SprintGoal): Objective to be achieved within the sprint.

- $\mathcal{E}$ (Epic): Large requirement that can be split into stories.

- $\mathcal{US}$ (UserStory): Requirement from the perspective of a user.

- $\mathcal{TSK}$ (Task): Smallest unit of work within a sprint.

- $\mathcal{DEV}$ (DevelopmentSnapshot): Product at the end of a sprint.

- $\mathcal{BL}$ (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 representation of tasks during the sprint.

- $\mathcal{FED}$ (FeatureDocumentation): Documentation for a specific feature.

Relationship-induced feasibility subsets (from Relationships.csv)

- $\mathcal{T} \rightarrow \mathcal{P}$: allowed team–project assignments (R1).

- $\mathcal{W} \rightarrow \mathcal{T}$: allowed worker–team memberships (R2).

- $\mathcal{W} \rightarrow \mathcal{S}$, $\mathcal{W} \rightarrow \mathcal{R}$: worker–skill and worker–role links (R3,R4).

- $\mathcal{PO} \leftrightarrow \mathcal{PB}$: one-to-one (R5).

- $\mathcal{T} \leftrightarrow \mathcal{SM}$: one-to-one (R6).

- $\mathcal{PB} \rightarrow \mathcal{F}$, $\mathcal{PB} \rightarrow \mathcal{E}$: backlog contains features/epics (R7,R8).

- $\mathcal{E} \rightarrow \mathcal{US}$: epic contains user stories (R9).

- $\mathcal{US} \rightarrow \mathcal{TSK}$: user story consists of tasks (R10).

- $\mathcal{US} \leftrightarrow \mathcal{SBL}$: user story assigned to sprint backlog (many-to-many) (R11). Feasible pair set $\mathcal{A}_{US,SBL} \subseteq \mathcal{US} \times \mathcal{SBL}$.

- $\mathcal{SBL} \rightarrow \mathcal{SP}$: each sprint backlog belongs to one sprint (R12).

- $\mathcal{SP} \rightarrow \mathcal{SG}$: each sprint pursues one goal (R13).

- $\mathcal{SCB} \rightarrow \mathcal{TSK}$: board contains sprint tasks (R14).

- $\mathcal{FED} \leftrightarrow \mathcal{F}$: documentation belongs to feature (R15).

- $\mathcal{TSK} \leftrightarrow \mathcal{BL}$: tasks can be blocked by blockers (R16).

- $\mathcal{SH} \rightarrow \mathcal{SR}$: stakeholders participate in sprint reviews (R17).

- $\mathcal{SM} \rightarrow \mathcal{SRE}$: SM moderates retrospectives (R18).

- $\mathcal{VEL} \leftrightarrow \mathcal{T}$: velocity refers to team (R19).

- $\mathcal{REP} \rightarrow \mathcal{F}$: release plan includes features (R20). Feasible pair set $\mathcal{A}_{F,REP} \subseteq \mathcal{F} \times \mathcal{REP}$.

- $\mathcal{REP} \rightarrow \mathcal{RM}$: release plan is part of roadmap (R21).

- $\mathcal{SP} \rightarrow \mathcal{DEV}$: sprint generates development snapshot (R22).

2 2. Indices

- $p \in \mathcal{P}$, $t \in \mathcal{T}$, $w \in \mathcal{W}$, $f \in \mathcal{F}$, $s \in \mathcal{S}$, $r \in \mathcal{R}$.

- $\text{po} \in \mathcal{PO}$, $\text{sm} \in \mathcal{SM}$, $\text{pb} \in \mathcal{PB}$, $sp \in \mathcal{SP}$, $spp \in \mathcal{SPP}$.

- $ds \in \mathcal{DS}$, $sr \in \mathcal{SR}$, $sre \in \mathcal{SRE}$, $sbl \in \mathcal{SBL}$, $sg \in \mathcal{SG}$.

- $e \in \mathcal{E}$, $us \in \mathcal{US}$, $tsk \in \mathcal{TSK}$, $dev \in \mathcal{DEV}$, $bl \in \mathcal{BL}$.

- $sh \in \mathcal{SH}$, $v \in \mathcal{VEL}$, $rep \in \mathcal{REP}$, $rm \in \mathcal{RM}$, $scb \in \mathcal{SCB}$, $fed \in \mathcal{FED}$.

Parameters (selected attributes as numeric inputs) For each referenced entity attribute in Goals/Conditions we assume given nonnegative parameters:

- effort_{tsk} (Task.effort), priority_f (Feature.priority), severity_{bl} (Blocker.severity).

- $\overline{\text{storypts}}_{us}$ (UserStory.story_points), attendees_{sr} (SprintReview.attendees_count).

- milestones_{rm} (Roadmap.milestones), entries_{pb} (ProductBacklog.number_of_entries).

- avgSP_v, maxV_v, minV_v (Velocity.avg_story_points, max_velocity, min_velocity).

- goalach_{sg} (SprintGoal.achievement_status), sat_{sre} (SprintRetrospective.team_satisfaction).

- budgetCap_p (cap for Project.budget), $\text{statusActive}_p \in \{0,1\}$ (Project.status).

- numTasks_{sbl}, capEffort_{sbl} (SprintBacklog.number_of_tasks, total_effort).

- cards_{scb} (ScrumBoard.number_of_cards), prio_f (Feature.priority).

- $\text{open}_{bl} \in \{0,1\}$ (Blocker.status indicator "open"), $\text{done}_{tsk} \in \{0,1\}$ (Task.status indicator "done").

- avail_{po} (ProductOwner.availability).

Incidence/helper sets

- $\mathcal{A}_{US,SBL} \subseteq \mathcal{US} \times \mathcal{SBL}$ (feasible user story $\leftrightarrow$ sprint backlog pairs).

- $\mathcal{A}_{F,REP} \subseteq \mathcal{F} \times \mathcal{REP}$ (feasible feature $\leftrightarrow$ release plan pairs).

- $\mathcal{B}(tsk) = \{bl \in \mathcal{BL} : (tsk, bl) \text{ linked (R16)}\}$ (blockers of a task).

3 3. Goals

We aggregate multiple (min/max) goals into a single weighted objective:

$$\max \ Z \ = \ \sum_{g \in \mathcal{G}} \omega_g \, s_g \, G_g(\cdot),$$

where $\omega_g > 0$ is the weight from `Goals.csv`, $s_g = +1$ for GoalType = `max` and $s_g = -1$ for GoalType = `min`, and $G_g(\cdot)$ is the corresponding goal expression.

- **G0 maximize_total_story_points** (ID: G0)
  Logical: Maximize total planned story points of user stories selected into any sprint backlog.
  Mathematical:
  $$G_0 \ = \ \sum_{(us,sbl) \in \mathcal{A}_{US,SBL}} \overline{\text{storypts}}_{us} \, x_{us,sbl}.$$

- **G1 minimize_total_task_effort** (ID: G1)
  Logical: Minimize the aggregate estimated effort of tasks in scope.
  Mathematical:
  $$G_1 \ = \ \sum_{tsk \in \mathcal{TSK}} \text{effort}_{tsk}.$$

- **G2 maximize_sprint_goal_achievement** (ID: G2)
  Logical: Maximize reported achievement of sprint goals.
  Mathematical:
  $$G_2 \ = \ \sum_{sg \in \mathcal{SG}} \text{goalach}_{sg}.$$

- **G3 minimize_blocker_severity** (ID: G3)
  Logical: Reduce severity of blockers impacting work.
  Mathematical:
  $$G_3 = \sum_{bl \in \mathcal{BL}} \text{severity}_{bl}.$$

- **G4 maximize_delivery_of_high_priority_features** (ID: G4)
  Logical: Favor inclusion of higher-priority features into releases.
  Mathematical:
  $$G_4 = \sum_{(f,rep) \in \mathcal{A}_{F,REP}} \text{priority}_f \, y_{f,rep}.$$

- **G5 maximize_velocity_average_story_points** (ID: G5)
  Logical: Increase average velocity (story points) over observed sprints.
  Mathematical:
  $$G_5 = \sum_{v \in \mathcal{VEL}} \text{avgSP}_v.$$

- **G6 minimize_daily_scrum_time** (ID: G6)
  Logical: Keep the total scheduled Daily Scrum time low.
  Mathematical:
  $$G_6 = \sum_{ds \in \mathcal{DS}} \text{durDS}_{ds},$$

  where durDS_{ds} is the decision variable for Daily Scrum duration (see Section 5).

- **G7 minimize_wip_in_sprint_backlog** (ID: G7)
  Logical: Reduce the number of tasks in each sprint backlog (proxy for WIP).
  Mathematical:
  $$G_7 = \sum_{sbl \in \mathcal{SBL}} \text{numTasks}_{sbl}.$$

- **G8 maximize_team_satisfaction** (ID: G8)
  Logical: Maximize team satisfaction reported in retrospectives.
  Mathematical:
  $$G_8 = \sum_{sre \in \mathcal{SRE}} \text{sat}_{sre}.$$

- **G9 minimize_product_backlog_size** (ID: G9)
  Logical: Keep the number of entries in the product backlog lean.
  Mathematical:
  $$G_9 = \sum_{pb \in \mathcal{PB}} \text{entries}_{pb}.$$

- **G10 maximize_release_feature_coverage** (ID: G10)
  Logical: Maximize the number of features included across releases.
  Mathematical:
  $$G_{10} = \sum_{(f,rep) \in \mathcal{A}_{F,REP}} y_{f,rep}.$$

- **G11 maximize_roadmap_milestones** (ID: G11)
  Logical: Maximize the milestones realized on the roadmap.
  Mathematical:
  $$G_{11} = \sum_{rm \in \mathcal{RM}} \text{milestones}_{rm}.$$

4 4. Conditions

All conditions apply simultaneously. When a condition naturally limits a decision variable it is stated as a hard constraint.

- **C0 project_status_active_only** (ID: C0)
  Logical: Only projects with active status are considered.
  Mathematical:
  $$\forall p \in \mathcal{P} : \ \text{statusActive}_p = 1 \quad \text{(filter/feasibility)}.$$

- **C1 budget_cannot_exceed_limit** (ID: C1)
  Logical: Allocated budget per project must not exceed the approved cap.
  Mathematical:
  $$\forall p \in \mathcal{P} : \ \text{budget}_p \ \leq \ \text{budgetCap}_p.$$

- **C2 minimum_team_size** (ID: C2)
  Logical: Teams must meet a minimum effective size.
  Mathematical:
  $$\forall t \in \mathcal{T} : \ \text{teamsize}_t \ \geq \ \underline{n}^{\text{team}} \quad (\text{here } \underline{n}^{\text{team}} = 3 \text{ from DV11 bounds}).$$

- **C3 maximum_daily_scrum_duration** (ID: C3)
  Logical: Daily Scrum duration should not exceed the target.
  Mathematical:
  $$\forall ds \in \mathcal{DS} : \ \text{durDS}_{ds} \ \leq \ \overline{d}^{\text{DS}} \quad (\text{e.g., } \overline{d}^{\text{DS}} = 30 \text{ minutes from DV4}).$$

- **C4 po_availability_required** (ID: C4)
  Logical: Product Owner availability must be present during sprint.
  Mathematical:
  $$\forall po \in \mathcal{PO} : \ \text{avail}_{po} \ \geq \ \underline{a}^{\text{PO}} \quad \text{(feasibility threshold)}.$$

- **C5 scrum_master_experience_required** (ID: C5)
  Logical: Scrum Master experience must meet a minimum.
  Mathematical:
  $$\forall sm \in \mathcal{SM} : \ \exp_{sm} \ \geq \ \underline{e}^{\text{SM}} \quad \text{(feasibility threshold)}.$$

- **C6 limit_wip_on_board** (ID: C6)
  Logical: Number of cards on Scrum Board must not exceed its WIP cap.
  Mathematical:
  $$\forall scb \in \mathcal{SCB} : \ \text{cards}_{scb} \ \leq \ \text{wipcap}_{scb}.$$

- **C7 feature_effort_cap** (ID: C7)
  Logical: Do not pull features above an effort threshold.
  Mathematical:
  $$\forall f \in \mathcal{F} : \ \text{estEffort}_f \ \leq \ \overline{E}^{\text{feat}} \quad \text{(feasibility threshold)}.$$

- **C8 sprint_backlog_effort_cap** (ID: C8)
  Logical: Total planned effort in a sprint backlog must stay within its capacity.
  Mathematical (story-points proxy):
  $$\forall sbl \in \mathcal{SBL} : \sum_{\substack{us \in \mathcal{US} \\ (us,sbl) \in \mathcal{A}_{US,SBL}}} \overline{\text{storypts}}_{us} \, x_{us,sbl} \ \leq \ \text{capEffort}_{sbl}.$$

- **C9 min_sprint_review_attendees** (ID: C9)
  Logical: Sprint Review must have at least a minimum number of attendees.
  Mathematical:
  $$\forall sr \in \mathcal{SR} : \quad \text{attendees}_{sr} \geq \underline{A}^{\text{SR}}.$$

- **C10 min_velocity_floor** (ID: C10)
  Logical: Maintain a minimum team velocity across sprints.
  Mathematical:
  $$\forall v \in \mathcal{VEL} : \quad \text{minV}_v \geq \underline{V}.$$

- **C11 blocker_status_cannot_be_open_in_done** (ID: C11)
  Logical: No open blockers are allowed on tasks marked "done".
  Mathematical (implication as linear constraint via big-M indicator):
  $$\forall tsk \in \mathcal{TSK}, \ \forall bl \in \mathcal{B}(tsk) : \quad \text{done}_{tsk} = 1 \ \Rightarrow \ \text{open}_{bl} = 0.$$

  (In MILP one may encode $\text{open}_{bl} \leq 1 - \text{done}_{tsk}$.)

5   5. DecisionVariables

- **DV0 assign_user_story_to_sprint**:
  $x_{us,sbl} \in \{0,1\}$ for $(us, sbl) \in \mathcal{A}_{US,SBL}$ (assign user story to a sprint backlog).

- **DV1 select_feature_for_release**:
  $y_{f,rep} \in \{0,1\}$ for $(f, rep) \in \mathcal{A}_{F,REP}$ (include feature in a release plan).

- **DV2 allocate_worker_to_team**:
  $a_{w,t} \in \{0,1\}$ (assign worker to team for a sprint).

- **DV3 set_task_priority_level**:
  $\text{prioVar}_{tsk} \in \mathbb{Z}$ with $1 \leq \text{prioVar}_{tsk} \leq 5$.

- **DV4 schedule_daily_scrum_duration**:
  $\text{durDS}_{ds} \in \mathbb{Z}$ with $10 \leq \text{durDS}_{ds} \leq 30$ (minutes).

- **DV5 budget_allocation_per_project**:
  $\text{budget}_p \in \mathbb{R}_+$ with $0 \leq \text{budget}_p \leq 1{,}000{,}000$.

- **DV6 limit_wip_tasks_per_board**:
  $\text{wipcap}_{scb} \in \mathbb{Z}_+$ with $0 \leq \text{wipcap}_{scb} \leq 200$.

- **DV7 assign_scrum_master_to_team**:
  $z^{SM}_{\text{sm},t} \in \{0,1\}$ (Scrum Master to team).

- **DV8 prioritize_user_story**:
  $\pi_{us} \in \mathbb{Z}_+$ with $1 \leq \pi_{us} \leq 100$ (ordering rank).

- **DV9 estimate_story_points**:
  $\widehat{\text{SP}}_{us} \in \mathbb{Z}_+$ with $1 \leq \widehat{\text{SP}}_{us} \leq 13$ (planning estimate, if used in place of $\overline{\text{storypts}}_{us}$).

- **DV10 set_sprint_length_days**:
  $L_{sp} \in \mathbb{Z}_+$ with $7 \leq L_{sp} \leq 28$ (days).

- **DV11 set_team_size**:
  $\text{teamsize}_t \in \mathbb{Z}_+$ with $3 \leq \text{teamsize}_t \leq 12$.

Common logical/domain constraints

- Each user story assigned at most once:

$$\forall us \in \mathcal{US} : \sum_{\substack{sbl \in \mathcal{SBL} \\ (us,sbl) \in \mathcal{A}_{US,SBL}}} x_{us,sbl} \leq 1.$$

- Feature selection respects release feasibility:

$$\forall rep \in \mathcal{REP} : \sum_{\substack{f \in \mathcal{F} \\ (f,rep) \in \mathcal{A}_{F,REP}}} y_{f,rep} \leq \overline{N}_{rep}^{\text{feat}} \quad \text{(optional capacity)}.$$

- Unique Scrum Master per team (if required):

$$\forall t \in \mathcal{T} : \sum_{\text{sm} \in \mathcal{SM}} z_{\text{sm},t}^{SM} = 1.$$