

Optimization Model for SCRUM-Based Software Development

Domain Modeling and Optimization Team

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1. Sets (Entities)

This section defines the core entities (sets) in the SCRUM domain model.

\mathcal{P} : Set of Projects, where each $p \in \mathcal{P}$ has attributes: id, name, project_start, project_end, description, budget, status, target_audience, priority.

\mathcal{T} : Set of Teams, where each $t \in \mathcal{T}$ has attributes: id, name, team_size, team_start, team_status, location, team_type.

\mathcal{W} : Set of Workers, where each $w \in \mathcal{W}$ has attributes: id, name, first_name, email, start_date, status, availability.

\mathcal{F} : Set of Features, where each $f \in \mathcal{F}$ has attributes: id, title, description, status, priority, estimated_effort.

\mathcal{S} : Set of Skills, where each $s \in \mathcal{S}$ has attributes: id, label, description, level, certified, category.

\mathcal{R} : Set of Roles, where each $r \in \mathcal{R}$ has attributes: id, role_name, description, area_of_responsibility.

\mathcal{PO} : Set of Product Owners, where each $po \in \mathcal{PO}$ has attributes: id, name, email, availability.

\mathcal{SM} : Set of Scrum Masters, where each $sm \in \mathcal{SM}$ has attributes: id, name, email, experience.

\mathcal{PB} : Set of Product Backlogs, where each $pb \in \mathcal{PB}$ has attributes: id, created_on, last_updated, number_of_entries, status.

\mathcal{SP} : Set of Sprints, where each $sp \in \mathcal{SP}$ has attributes: id, sprint_number, start_date, end_date, status, achievement_of_goal.

\mathcal{SPP} : Set of Sprint Plannings, where each $spp \in \mathcal{SPP}$ has attributes: id, date, duration_(min), moderation, outcome_documentation.

\mathcal{DS} : Set of Daily Scrums, where each $ds \in \mathcal{DS}$ has attributes: id, date, time, duration, moderation.

\mathcal{SR} : Set of Sprint Reviews, where each $sr \in \mathcal{SR}$ has attributes: id, date, duration, feedback_documentation, attendees_count.

\mathcal{SRE} : Set of Sprint Retrospectives, where each $sre \in \mathcal{SRE}$ has attributes: id, date, duration, improvement_actions, team_satisfaction, moderation.

\mathcal{SBL} : Set of Sprint Backlogs, where each $sbl \in \mathcal{SBL}$ has attributes: id, number_of_tasks, last_updated, status, total_effort.

\mathcal{SG} : Set of Sprint Goals, where each $sg \in \mathcal{SG}$ has attributes: id, objective_description, achievement_status, benefit.

\mathcal{E} : Set of Epics, where each $e \in \mathcal{E}$ has attributes: id, title, description, priority, status, estimated_effort.

\mathcal{US} : Set of User Stories, where each $us \in \mathcal{US}$ has attributes: id, title, description, acceptance_criteria, priority, story_points, status.

\mathcal{TSK} : Set of Tasks, where each $tsk \in \mathcal{TSK}$ has attributes: id, title, description, status, effort, type.

\mathcal{DEV} : Set of Development Snapshots, where each $dev \in \mathcal{DEV}$ has attributes: id, version_number, creation_date, test_status, deployment_target, documentation.

\mathcal{BL} : Set of Blockers, where each $bl \in \mathcal{BL}$ has attributes: id, title, description, severity, status, detected_on, resolved_on.

\mathcal{SH} : Set of Stakeholders, where each $sh \in \mathcal{SH}$ has attributes: id, name, organization, role, email, area_of_interest, influence_level, relevance_to_feature.

\mathcal{VEL} : Set of Velocity Records, where each $vel \in \mathcal{VEL}$ has attributes: id, number_of_sprints_used, avg_story_points, max_velocity, min_velocity, trend.

\mathcal{REP} : Set of Release Plans, where each $rep \in \mathcal{REP}$ has attributes: id, version, planned_date, included_features, status.

\mathcal{RM} : Set of Roadmaps, where each $rm \in \mathcal{RM}$ has attributes: id, start_date, end_date, milestones, objectives, versions.

\mathcal{SCB} : Set of Scrum Boards, where each $scb \in \mathcal{SCB}$ has attributes: id, board_type, columns_(todo/done...), number_of_cards, last_updated.

\mathcal{FED} : Set of Feature Documentations, where each $fed \in \mathcal{FED}$ has attributes: id, title, description, creation_date, change_log, linked_requirements, author.

2. Indices

Indices are used to reference elements within the defined sets.

$p \in \mathcal{P}$: Index for a specific Project.

$t \in \mathcal{T}$: Index for a specific Team.

$w \in \mathcal{W}$: Index for a specific Worker.

$f \in \mathcal{F}$: Index for a specific Feature.

$s \in \mathcal{S}$: Index for a specific Skill.

$r \in \mathcal{R}$: Index for a specific Role.

$po \in \mathcal{PO}$: Index for a Product Owner.

$sm \in \mathcal{SM}$: Index for a Scrum Master.

$pb \in \mathcal{PB}$: Index for a Product Backlog.

$sp \in \mathcal{SP}$: Index for a Sprint.

$spp \in \mathcal{SPP}$: Index for a Sprint Planning session.

$ds \in \mathcal{DS}$: Index for a Daily Scrum.

$sr \in \mathcal{SR}$: Index for a Sprint Review.

$sre \in \mathcal{SRE}$: Index for a Sprint Retrospective.

$sbl \in \mathcal{SBL}$: Index for a Sprint Backlog.
 $sg \in \mathcal{SG}$: Index for a Sprint Goal.
 $e \in \mathcal{E}$: Index for an Epic.
 $us \in \mathcal{US}$: Index for a User Story.
 $tsk \in \mathcal{TSK}$: Index for a Task.
 $dev \in \mathcal{DEV}$: Index for a Development Snapshot.
 $bl \in \mathcal{BL}$: Index for a Blocker.
 $sh \in \mathcal{SH}$: Index for a Stakeholder.
 $vel \in \mathcal{VEL}$: Index for a Velocity record.
 $rep \in \mathcal{REP}$: Index for a Release Plan.
 $rm \in \mathcal{RM}$: Index for a Roadmap.
 $scb \in \mathcal{SCB}$: Index for a Scrum Board.
 $fed \in \mathcal{FED}$: Index for Feature Documentation.

3 3. Goals

Optimization objectives, each with logical and mathematical representation.

G0: maximize_project_budget

Logical: Maximize the total budget of all active projects.

Mathematical: $\max \sum_{p \in \mathcal{P}} \text{budget}(p) \cdot \mathbb{I}_{\text{status}(p)=\text{active}} \times 1.5$

G1: maximize_team_size

Logical: Maximize the sum of team sizes across all teams.

Mathematical: $\max \sum_{t \in \mathcal{T}} \text{team_size}(t) \times 1.0$

G2: maximize_worker_availability

Logical: Maximize the sum of availability scores of all workers.

Mathematical: $\max \sum_{w \in \mathcal{W}} \text{availability}(w) \times 1.2$

G3: minimize_feature_estimated_effort

Logical: Minimize the total estimated effort for all features.

Mathematical: $\min \sum_{f \in \mathcal{F}} \text{estimated_effort}(f) \times 0.8$

G4: maximize_user_story_story_points

Logical: Maximize the sum of story points of all user stories in the sprint backlog.

Mathematical: $\max \sum_{us \in \mathcal{US}} \text{story_points}(us) \cdot x_{us} \times 1.3$, where $x_{us} = 1$ if assigned to sprint.

G5: minimize_sprint_duration

Logical: Minimize the duration between sprint start and end.

Mathematical: $\min(\text{end_date}(sp) - \text{start_date}(sp)) \times 1.0$

G6: maximize_sprint_achievement_of_goal

Logical: Maximize the average goal achievement across sprints.

Mathematical: $\max \frac{1}{|\mathcal{SP}|} \sum_{sp \in \mathcal{SP}} \text{achievement_of_goal}(sp) \times 1.6$

G7: minimize_blocker_severity

Logical: Minimize the average severity of unresolved blockers.

Mathematical: $\min \frac{1}{|\mathcal{BL}|} \sum_{bl \in \mathcal{BL}} \text{severity}(bl) \cdot \mathbb{I}_{\text{status}(bl) \neq \text{resolved}} \times 0.9$

G8: maximize_velocity_avg_story_points

Logical: Maximize the average story points delivered per sprint.

Mathematical: $\max \text{avg_story_points}(vel) \times 1.7$ for $vel \in \mathcal{VEL}$

G9: minimize_task_effort

Logical: Minimize the total effort of all tasks in the current sprint.

Mathematical: $\min \sum_{tsk \in \mathcal{TSK}} \text{effort}(tsk) \cdot y_{tsk} \times 0.7$, where $y_{tsk} = 1$ if task is active.

G10: maximize_sprint_review_attendees

Logical: Maximize the number of attendees in sprint reviews.

Mathematical: $\max \sum_{sr \in \mathcal{SR}} \text{attendees_count}(sr) \times 1.1$

G11: minimize_sprint_planning_duration

Logical: Minimize the duration of sprint planning meetings.

Mathematical: $\min \text{duration_}(\min)(spp) \times 0.6$

G12: maximize_team_satisfaction

Logical: Maximize team satisfaction in retrospectives.

Mathematical: $\max \text{team_satisfaction}(sre) \times 1.4$

G13: minimize_release_plan_delay

Logical: Minimize deviation from planned release dates.

Mathematical: $\min |\text{actual_date}(rep) - \text{planned_date}(rep)| \times 0.8$

G14: maximize_number_of_features_released

Logical: Maximize the count of features included in release plans.

Mathematical: $\max \sum_{rep \in \mathcal{REP}} |\text{included_features}(rep)| \times 1.3$

4. Conditions

Constraints and filtering rules applied to the model.

C0: require_project_status_active

Logical: Only projects with status "active" are considered.

Mathematical: $\forall p \in \mathcal{P}, \text{status}(p) = \text{active}$

C1: require_team_status_active

Logical: Only teams with status "active" are eligible.

Mathematical: $\forall t \in \mathcal{T}, \text{team_status}(t) = \text{active}$

C2: require_worker_status_active

Logical: Only workers with status "active" can be assigned.

Mathematical: $\forall w \in \mathcal{W}, \text{status}(w) = \text{active}$

C3: require_feature_status_not_done

Logical: Features must not be in "done" status.

Mathematical: $\forall f \in \mathcal{F}, \text{status}(f) \neq \text{done}$

C4: require_user_story_status_todo

Logical: Only user stories with status "To Do" are assignable.

Mathematical: $\forall us \in \mathcal{US}, \text{status}(us) = \text{To Do}$

C5: require_task_status_not_blocked

Logical: Tasks must not have status "blocked".

Mathematical: $\forall tsk \in \mathcal{TSK}, \text{status}(tsk) \neq \text{blocked}$

C6: require_blocker_status_resolved

Logical: Only resolved blockers are archived; active ones must be addressed.

Mathematical: $\forall bl \in \mathcal{BL}, \text{status}(bl) = \text{resolved} \Rightarrow \text{resolved_on}(bl) \leq \text{current_date}$

C7: require_sprint_status_active

Logical: Only active sprints are valid for assignment.

Mathematical: $\forall sp \in \mathcal{SP}, \text{status}(sp) = \text{active}$

C8: require_sprint_goal_achievement_pending

Logical: Sprint goal must not be marked as achieved yet.

Mathematical: $\forall sg \in \mathcal{SG}, \text{achievement_status}(sg) = \text{pending}$

C9: require_skill_certified

Logical: Only certified skills are valid for role assignment.

Mathematical: $\forall s \in \mathcal{S}, \text{certified}(s) = \text{true}$

C10: require_role_area_defined

Logical: Role must have a defined area of responsibility.

Mathematical: $\forall r \in \mathcal{R}, \text{area_of_responsibility}(r) \neq \emptyset$

C11: require_product_backlog_status_open

Logical: Only open backlogs can be modified.

Mathematical: $\forall pb \in \mathcal{PB}, \text{status}(pb) = \text{open}$

C12: require_velocity_trend_positive

Logical: Prefer teams with positive velocity trend.

Mathematical: $\forall vel \in \mathcal{VEL}, \text{trend}(vel) \geq 0$

C13: require_release_plan_status_active

Logical: Only active release plans are considered.

Mathematical: $\forall rep \in \mathcal{REP}, \text{status}(rep) = \text{active}$

C14: require_roadmap_milestones_defined

Logical: All roadmaps must have at least one milestone.

Mathematical: $\forall rm \in \mathcal{RM}, \text{milestones}(rm) \neq \emptyset$

5. Decision Variables

Variables that can be adjusted during optimization.

$dv_0 \in \mathbb{Z}$: project_priority_assignment, domain $\{1, 2, 3, 4, 5\}$, $1 \leq dv_0 \leq 5$

$dv_1 \in \mathbb{R}$: team_assignment_weight, continuous, $0.0 \leq dv_1 \leq 1.0$

$dv_2 \in \mathbb{R}$: worker_availability_score, $0.0 \leq dv_2 \leq 100.0$

$dv_3 \in \mathbb{Z}$: `feature_priority`, domain $\{1, 2, 3\}$, $1 \leq dv_3 \leq 3$
 $dv_4 \in \mathbb{Z}$: `user_story_priority`, domain $\{1, 2, 3\}$, $1 \leq dv_4 \leq 3$
 $dv_5 \in \mathbb{Z}$: `task_effort_estimate`, in hours, $1 \leq dv_5 \leq 40$
 $dv_6 \in \mathbb{Z}$: `sprint_duration_days`, $5 \leq dv_6 \leq 30$
 $dv_7 \in \mathbb{Z}$: `planning_meeting_duration`, in minutes, $60 \leq dv_7 \leq 180$
 $dv_8 \in \mathbb{Z}$: `daily_scrum_duration`, $10 \leq dv_8 \leq 30$
 $dv_9 \in \mathbb{R}$: `retrospective_moderation_score`, $1.0 \leq dv_9 \leq 5.0$
 $dv_{10} \in \mathbb{Z}$: `blocker_severity_level`, domain $\{1, 2, 3\}$, $1 \leq dv_{10} \leq 3$
 $dv_{11} \in \mathbb{Z}$: `velocity_calculation_window`, number of sprints, $1 \leq dv_{11} \leq 10$
 $dv_{12} \in \mathbb{R}$: `release_version_number`, interpreted as float, $1.0 \leq dv_{12} \leq 3.0$
 $dv_{13} \in \mathbb{Z}$: `roadmap_start_year`, $2023 \leq dv_{13} \leq 2030$
 $dv_{14} \in \mathbb{R}$: `documentation_completion_status`, percentage, $0.0 \leq dv_{14} \leq 100.0$