

Optimization Model for SCRUM-Based Software Development Planning

Domain Modeling
Optimization Team

September 5, 2025

Contents

| | | |
|---|-----------------------|---|
| 1 | 1. Sets (Entities) | 2 |
| 2 | 2. Indices | 3 |
| 3 | 3. Goals | 3 |
| 4 | 4. Conditions | 5 |
| 5 | 5. Decision Variables | 6 |

1. Sets (Entities)

\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 2. Indices

$p \in \mathcal{P}$: Index over projects.

$t \in \mathcal{T}$: Index over teams.

$w \in \mathcal{W}$: Index over workers.

$f \in \mathcal{F}$: Index over features.

$s \in \mathcal{S}$: Index over skills.

$r \in \mathcal{R}$: Index over roles.

$sp \in \mathcal{SP}$: Index over sprints.

$us \in \mathcal{US}$: Index over user stories.

$tsk \in \mathcal{TSK}$: Index over tasks.

$bl \in \mathcal{BL}$: Index over blockers.

$sh \in \mathcal{SH}$: Index over stakeholders.

$vel \in \mathcal{VEL}$: Index over velocity records.

$rep \in \mathcal{REP}$: Index over release plans.

$rm \in \mathcal{RM}$: Index over roadmaps.

3 3. Goals

Each goal is defined with its identifier, name, and mathematical/logical formulation. Let w_g denote the weight of goal g .

maximize_project_budget: Maximize total project budget.

$$\max \sum_{p \in \mathcal{P}} w_{G0} \cdot \text{budget}(p)$$

`maximize_team_size`: Maximize total team size.

$$\max \sum_{t \in \mathcal{T}} w_{G1} \cdot \text{team_size}(t)$$

`maximize_worker_availability`: Maximize sum of worker availability.

$$\max \sum_{w \in \mathcal{W}} w_{G2} \cdot \text{availability}(w)$$

`minimize_project_duration`: Minimize total project duration.

$$\min \sum_{p \in \mathcal{P}} w_{G3} \cdot (\text{project_end}(p) - \text{project_start}(p))$$

`maximize_feature_priority`: Maximize sum of feature priorities.

$$\max \sum_{f \in \mathcal{F}} w_{G4} \cdot \text{priority}(f)$$

`maximize_story_points`: Maximize completed story points.

$$\max \sum_{us \in \mathcal{US}} w_{G5} \cdot \text{story_points}(us)$$

`minimize_task_effort`: Minimize total task effort.

$$\min \sum_{tsk \in \mathcal{TSK}} w_{G6} \cdot \text{effort}(tsk)$$

`maximize_sprint_achievement`: Maximize average sprint goal achievement.

$$\max \frac{1}{|\mathcal{SP}|} \sum_{sp \in \mathcal{SP}} w_{G7} \cdot \text{achievement_of_goal}(sp)$$

`maximize_velocity_trend`: Maximize positive trend in velocity.

$$\max \sum_{vel \in \mathcal{VEL}} w_{G8} \cdot \text{trend}(vel)$$

`minimize_blocker_severity`: Minimize total blocker severity.

$$\min \sum_{bl \in \mathcal{BL}} w_{G9} \cdot \text{severity}(bl)$$

`maximize_stakeholder_influence`: Maximize influence of engaged stakeholders.

$$\max \sum_{sh \in \mathcal{SH}} w_{G10} \cdot \text{influence_level}(sh)$$

`maximize_documentation_coverage`: Maximize number of documented features.

$$\max \sum_{fed \in \mathcal{FED}} w_{G11} \cdot \mathbb{I}[\text{linked_requirements}(fed) \neq \emptyset]$$

`minimize_sprint_duration`: Minimize total sprint duration.

$$\min \sum_{sp \in \mathcal{SP}} w_{G12} \cdot (\text{end_date}(sp) - \text{start_date}(sp))$$

`maximize_release_inclusion`: Maximize features included in releases.

$$\max \sum_{rep \in \mathcal{REP}} w_{G13} \cdot |\text{included_features}(rep)|$$

`maximize_epic_effort_estimate`: Maximize estimated effort of epics.

$$\max \sum_{e \in \mathcal{E}} w_{G14} \cdot \text{estimated_effort}(e)$$

4 4. Conditions

Each condition is a constraint with logical formulation. Let c denote the condition ID.

`require_project_status`: Only active or completed projects are valid.

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

`require_team_location`: Teams must be in allowed locations.

$$\forall t \in \mathcal{T} : \text{location}(t) \in L_{\text{allowed}}$$

where L_{allowed} is a predefined set of acceptable locations.

`require_worker_status`: Only active workers are eligible.

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

`require_feature_status`: Only approved features can be scheduled.

$$\forall f \in \mathcal{F} : \text{status}(f) = \text{approved}$$

`require_task_status`: Only todo or in-progress tasks are considered.

$$\forall tsk \in \mathcal{TSK} : \text{status}(tsk) \in \{\text{todo}, \text{in_progress}\}$$

`require_role_certification`: Only certified roles are assigned.

$$\forall r \in \mathcal{R} : \text{description}(r) \text{ must imply certification}$$

`require_user_story_status`: Only ready or accepted user stories are valid.

$$\forall us \in \mathcal{US} : \text{status}(us) \in \{\text{ready}, \text{accepted}\}$$

`require_sprint_status`: Only planned or active sprints are valid.

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

`require_blocker_status`: Active blockers must be resolved before sprint end.

$$\forall bl \in \mathcal{BL} : \text{status}(bl) = \text{resolved} \vee \text{resolved_on}(bl) < \text{end_date}(\text{sprint}(bl))$$

require_velocity_min_value: Minimum velocity threshold.

$$\forall vel \in \mathcal{VEL} : \text{min_velocity}(vel) \geq V_{\min}$$

where V_{\min} is a given threshold.

require_stakeholder_relevance: Stakeholders must have medium or high relevance.

$$\forall sh \in \mathcal{SH} : \text{relevance_to_feature}(sh) \in \{\text{medium}, \text{high}\}$$

require_skill_certified: Only certified skills are used.

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

require_documentation_author: Documentation must have an author.

$$\forall fed \in \mathcal{FED} : \text{author}(fed) \neq \text{null}$$

require_scumb_board_type: Only digital scrum boards allowed.

$$\forall scb \in \mathcal{SCB} : \text{board_type}(scb) = \text{digital}$$

require_development_test_status: Only tested snapshots are deployable.

$$\forall dev \in \mathcal{DEV} : \text{test_status}(dev) = \text{tested}$$

5. Decision Variables

$\omega_p \in \{0.0, 0.5, 1.0, 1.5, 2.0\}$: Project priority weight for $p \in \mathcal{P}$.

$u_t \in [0.0, 1.0]$: Team t 's capacity utilization rate.

$x_{w,tsk} \in \{0, 1\}$: Binary variable indicating if worker w is assigned to task tsk .

$y_{us} \in \{0, 1\}$: Binary variable indicating if user story us is included in current sprint.

$z_f \in \{0, 1\}$: Binary variable indicating if feature f is included in next release.

$a_w \in [0, 40]$: Weekly availability (hours) of worker w .

$sp_{us} \in \{1, 2, 3, 5, 8, 13\}$: Estimated story points for user story us .

$e_{tsk} \in [1, 100]$: Effort (hours) allocated to task tsk .

$d_{bl} \in [1, 30]$: Estimated resolution time (days) for blocker bl .

$c_{fed} \in [0.0, 1.0]$: Completeness score of feature documentation fed .

$g_{sp} \in [0.0, 1.0]$: Achievement score of sprint sp 's goal.

$v_{\text{next}} \in [0, 100.0]$: Predicted velocity for next sprint.

$\delta_r \in [-30, 30]$: Deviation in days from planned release date r .

$i_{sre} \in [0, 20]$: Number of improvement actions from retrospective sre .

$col_{tsk} \in \{0, 1, 2, 3\}$: Column index of task tsk on scrum board.