Optimization Model for SCRUM-Based Software Development

Domain Modeling and Optimization Team

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Contents

1 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 for projects.

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

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

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

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

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

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

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

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

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

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

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

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

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

3   3. Goals

G0: maximize_project_budget
Maximize total budget of active projects.
$\max \sum_{p \in \mathcal{P}} \text{budget}_p \cdot \mathbb{I}(\text{status}_p = \text{active})$
Weight: 1.5

G1: minimize_project_duration
Minimize total project duration (end - start).
$\min \sum_{p \in \mathcal{P}} (\text{project\_end}_p - \text{project\_start}_p)$
Weight: 1.3

G2: maximize_team_size
Maximize sum of team sizes.
$\max \sum_{t \in \mathcal{T}} \text{team\_size}_t$
Weight: 1.0

G3: minimize_worker_start_date
Minimize average worker start date (earlier = more experienced).
$\min \frac{1}{|\mathcal{W}|} \sum_{w \in \mathcal{W}} \text{start\_date}_w$
Weight: 0.9

G4: maximize_worker_availability
Maximize total worker availability (as percentage).
$\max \sum_{w \in \mathcal{W}} \text{availability}_w$
Weight: 1.2

G5: maximize_feature_priority
Maximize sum of feature priorities.
$\max \sum_{f \in \mathcal{F}} \text{priority}_f$
Weight: 1.4

G6: minimize_sprint_duration
Minimize average sprint duration.
$\min \frac{1}{|\mathcal{SP}|} \sum_{sp \in \mathcal{SP}} (\text{end\_date}_{sp} - \text{start\_date}_{sp})$
Weight: 1.1

G7: maximize_sprint_achievement
Maximize average sprint goal achievement.
$\max \frac{1}{|\mathcal{SP}|} \sum_{sp \in \mathcal{SP}} \text{achievement\_of\_goal}_{sp}$
Weight: 1.6

G8: maximize_story_points
Maximize total completed story points.
$\max \sum_{us \in \mathcal{US}} \text{story\_points}_{us} \cdot \mathbb{I}(\text{status}_{us} = \text{done})$
Weight: 1.3

G9: minimize_task_effort
Minimize effort spent on tasks blocked by high-severity issues.
$\min \sum_{tsk \in \mathcal{TSK}} \text{effort}_{tsk} \cdot \mathbb{I}(\exists bl \in \mathcal{BL} : \text{severity}_{bl} = \text{high} \wedge \text{status}_{bl} = \text{open})$
Weight: 0.8

G10: maximize_velocity_trend

Maximize positive velocity trend.

$\max \sum_{vel \in \mathcal{VEL}} \text{trend}_{vel}$

Weight: 1.5

G11: minimize_number_of_blockers

Minimize number of open blockers.

$\min \sum_{bl \in \mathcal{BL}} \mathbb{I}(\text{status}_{bl} = \text{open})$

Weight: 1.2

G12: maximize_documentation_coverage

Maximize number of features with linked documentation.

$\max \sum_{f \in \mathcal{F}} \mathbb{I}(\exists fed \in \mathcal{FED} : \text{linked\_requirements}_{fed} \ni f)$

Weight: 1.0

G13: minimize_release_delay

Minimize total delay in release plans.

$\min \sum_{rep \in \mathcal{REP}} \max(0, \text{current\_date} - \text{planned\_date}_{rep})$

Weight: 1.1

G14: maximize_stakeholder_influence

Maximize sum of influence levels of stakeholders involved in reviews.

$\max \sum_{sh \in \mathcal{SH}} \text{influence\_level}_{sh} \cdot \mathbb{I}(sh \text{ participated in sprint review})$

Weight: 1.0

4   4. Conditions

C0: required_project_status

All considered projects must be active.

$\forall p \in \mathcal{P} : \text{status}_p = \text{active}$

CriteriaType: Must-Match (2), Weight: 1.0

C1: forbidden_worker_status

Workers must not be inactive.

$\forall w \in \mathcal{W} : \text{status}_w \neq \text{inactive}$

CriteriaType: Cannot-Match (0), Weight: 0.9

C2: required_team_status

Teams must be active.

$\forall t \in \mathcal{T} : \text{team\_status}_t = \text{active}$

CriteriaType: Must-Match (2), Weight: 1.0

C3: required_feature_status

Features must be in progress or done.

$\forall f \in \mathcal{F} : \text{status}_f \in \{\text{in progress}, \text{done}\}$

CriteriaType: Must-Match (2), Weight: 1.2

C4: forbidden_task_status

Tasks cannot be cancelled.

$\forall tsk \in \mathcal{TSK} : \text{status}_{tsk} \neq \text{cancelled}$
CriteriaType: Cannot-Match (0), Weight: 0.8

C5: required_sprint_status
Sprints must be active or completed.
$\forall sp \in \mathcal{SP} : \text{status}_{sp} \in \{\text{active}, \text{completed}\}$
CriteriaType: Must-Match (2), Weight: 1.1

C6: required_user_story_status
User stories must not be rejected.
$\forall us \in \mathcal{US} : \text{status}_{us} \neq \text{rejected}$
CriteriaType: Must-Match (2), Weight: 1.0

C7: required_skill_certification
Skills used must be certified.
$\forall s \in \mathcal{S} : \text{certified}_s = \text{true}$
CriteriaType: Must-Match (2), Weight: 1.3

C8: required_role_area
Roles must be in development or QA.
$\forall r \in \mathcal{R} : \text{area\_of\_responsibility}_r \in \{\text{development}, \text{QA}\}$
CriteriaType: May-Match (1), Weight: 0.9

C9: required_blocker_severity
Only high or medium severity blockers are considered.
$\forall bl \in \mathcal{BL} : \text{severity}_{bl} \in \{\text{high}, \text{medium}\}$
CriteriaType: Must-Match (2), Weight: 1.1

C10: required_snapshot_test_status
Development snapshots must pass testing.
$\forall dev \in \mathcal{DEV} : \text{test\_status}_{dev} = \text{passed}$
CriteriaType: Must-Match (2), Weight: 1.0

C11: required_planned_release
Releases must be in planned status.
$\forall rep \in \mathcal{REP} : \text{status}_{rep} = \text{planned}$
CriteriaType: Must-Match (2), Weight: 0.9

C12: required_roadmap_milestones
Roadmaps must have defined milestones.
$\forall rm \in \mathcal{RM} : \text{milestones}_{rm} \neq \emptyset$
CriteriaType: Must-Match (2), Weight: 1.0

C13: required_board_update
Scrum boards must be updated within the last 24 hours.
$\forall scb \in \mathcal{SCB} : \text{last\_updated}_{scb} \geq \text{current\_time} - 24\text{h}$
CriteriaType: Must-Match (2), Weight: 0.8

C14: required_stakeholder_relevance
Stakeholders must be relevant to current feature.
$\forall sh \in \mathcal{SH} : \text{relevance\_to\_feature}_{sh} = \text{high}$
CriteriaType: Must-Match (2), Weight: 1.1

5 5. Decision Variables

$x_p \in [0.0, 1.0]$: `project_priority_weight` — Priority weight assigned to project p.

$y_t \in \{0, 1, 2, 3, 4\}$: `team_allocation_count` — Number of teams assigned to a project.

$l_w \in [0.0, 1.0]$: `worker_load_percentage` — Fraction of full-time capacity assigned to current sprint.

$d_{sp} \in \{5, 10, 14, 21, 30\}$: `sprint_length_days` — Duration of sprint sp in calendar days.

$r_{tsk} \in \{1, 2, 3, 4, 5\}$: `task_priority_rank` — Priority rank of task tsk.

$e_f \in \{1, 2, 3, 5, 8, 13\}$: `feature_estimated_effort` — Estimated effort (in story points) for feature f.

$v_{rep} \in \{1.0, 2.0, 3.0, 4.0, 5.0\}$: `planned_release_version` — Version number for release plan rep.

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

$t_{bl} \in \{1, 2, 3, 5, 7, 14\}$: `blocker_resolution_time` — Expected resolution time (days) for blocker bl.

$v_{vel} \in \{5, 10, 15, 20, 25, 30\}$: `velocity_prediction` — Forecasted velocity (story points) for next sprint.

$m_{evt} \in \{15, 30, 60, 90, 120\}$: `meeting_duration_minutes` — Duration of Scrum event (e.g., planning, retrospective).

$s_w \in \{1, 2, 3, 4, 5\}$: `worker_skill_level` — Skill level of worker w (1=Junior, 5=Expert).

$sat_{sre} \in \{1, 2, 3, 4, 5\}$: `retrospective_satisfaction` — Team satisfaction score from retrospective sre.

$a_{sg} \in [0.0, 1.0]$: `goal_achievement_score` — Measured achievement of sprint goal sg.

$I_f \in \{0, 1\}$: `feature_inclusion_flag` — Binary indicator if feature f is included in next release.