Optimization Model for SCRUM-Based Software Development

Domain Modeling and Optimization Team

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1 1. Sets (Entities)

$\mathcal{P}$: Set of Projects $\{p \mid p \in \text{Project}\}$

$\mathcal{T}$: Set of Teams $\{t \mid t \in \text{Team}\}$

$\mathcal{W}$: Set of Workers $\{w \mid w \in \text{Worker}\}$

$\mathcal{F}$: Set of Features $\{f \mid f \in \text{Feature}\}$

$\mathcal{S}$: Set of Skills $\{s \mid s \in \text{Skill}\}$

$\mathcal{R}$: Set of Roles $\{r \mid r \in \text{Role}\}$

$\mathcal{PO}$: Set of Product Owners $\{po \mid po \in \text{ProductOwner}\}$

$\mathcal{SM}$: Set of Scrum Masters $\{sm \mid sm \in \text{ScrumMaster}\}$

$\mathcal{PB}$: Set of Product Backlogs $\{pb \mid pb \in \text{ProductBacklog}\}$

$\mathcal{SP}$: Set of Sprints $\{sp \mid sp \in \text{Sprint}\}$

$\mathcal{SPP}$: Set of Sprint Plannings $\{spp \mid spp \in \text{SprintPlanning}\}$

$\mathcal{DS}$: Set of Daily Scrums $\{ds \mid ds \in \text{DailyScrum}\}$

$\mathcal{SR}$: Set of Sprint Reviews $\{sr \mid sr \in \text{SprintReview}\}$

$\mathcal{SRE}$: Set of Sprint Retrospectives $\{sre \mid sre \in \text{SprintRetrospective}\}$

$\mathcal{SBL}$: Set of Sprint Backlogs $\{sbl \mid sbl \in \text{SprintBacklog}\}$

$\mathcal{SG}$: Set of Sprint Goals $\{sg \mid sg \in \text{SprintGoal}\}$

$\mathcal{E}$: Set of Epics $\{e \mid e \in \text{Epic}\}$

$\mathcal{US}$: Set of User Stories $\{us \mid us \in \text{UserStory}\}$

$\mathcal{TSK}$: Set of Tasks $\{tsk \mid tsk \in \text{Task}\}$

$\mathcal{DEV}$: Set of Development Snapshots $\{dev \mid dev \in \text{DevelopmentSnapshot}\}$

$\mathcal{BL}$: Set of Blockers $\{bl \mid bl \in \text{Blocker}\}$

$\mathcal{SH}$: Set of Stakeholders $\{sh \mid sh \in \text{Stakeholder}\}$

$\mathcal{VEL}$: Set of Velocity Records $\{vel \mid vel \in \text{Velocity}\}$

$\mathcal{REP}$: Set of Release Plans $\{rep \mid rep \in \text{ReleasePlan}\}$

$\mathcal{RM}$: Set of Roadmaps $\{rm \mid rm \in \text{Roadmap}\}$

$\mathcal{SCB}$: Set of Scrum Boards $\{scb \mid scb \in \text{ScrumBoard}\}$

$\mathcal{FED}$: Set of Feature Documentations $\{fed \mid fed \in \text{FeatureDocumentation}\}$

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

$po \in \mathcal{PO}$: Index for Product Owners

$sm \in \mathcal{SM}$: Index for Scrum Masters

$pb \in \mathcal{PB}$: Index for Product Backlogs

$sp \in \mathcal{SP}$: Index for Sprints

$sbl \in \mathcal{SBL}$: Index for Sprint Backlogs

$sg \in \mathcal{SG}$: Index for Sprint Goals

$e \in \mathcal{E}$: Index for Epics

$us \in \mathcal{US}$: 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

3 3. Goals

G0: maximize_project_budget
Maximize total project budget:

$$\max \sum_{p \in \mathcal{P}} \text{budget}(p) \quad \text{with weight } 1.5$$

G1: minimize_project_duration
Minimize total project duration (end - start):

$$\min \sum_{p \in \mathcal{P}} (\text{project\_end}(p) - \text{project\_start}(p)) \quad \text{with weight } 1.2$$

G2: maximize_team_size
Maximize total team size:

$$\max \sum_{t \in \mathcal{T}} \text{team\_size}(t) \quad \text{with weight } 1.0$$

G3: minimize_worker_start_date
Minimize average worker start date (earlier hires):

$$\min \frac{1}{|\mathcal{W}|} \sum_{w \in \mathcal{W}} \text{start\_date}(w) \quad \text{with weight } 0.8$$

G4: maximize_feature_priority
Maximize sum of feature priorities:

$$\max \sum_{f \in \mathcal{F}} \text{priority}(f) \quad \text{with weight } 1.3$$

G5: minimize_task_effort
Minimize total effort across all tasks:

$$\min \sum_{tsk \in \mathcal{TSK}} \text{effort}(tsk) \quad \text{with weight } 1.1$$

G6: maximize_story_points
Maximize total story points in completed user stories:

$$\max \sum_{us \in \mathcal{US}} \text{story\_points}(us) \quad \text{with weight } 1.4$$

G7: minimize_sprint_duration
Minimize average sprint duration:

$$\min \frac{1}{|\mathcal{SP}|} \sum_{sp \in \mathcal{SP}} (\text{end\_date}(sp) - \text{start\_date}(sp)) \quad \text{with weight } 0.9$$

G8: maximize_velocity_avg_story_points
Maximize average velocity:

$$\max \sum_{vel \in \mathcal{VEL}} \text{avg.\_story\_points}(vel) \quad \text{with weight } 1.6$$

G9: minimize_blocker_resolved_on
Minimize average blocker resolution time:

$$\min \frac{1}{|\mathcal{BL}|} \sum_{bl \in \mathcal{BL}} \text{resolved\_on}(bl) \quad \text{with weight } 1.0$$

G10: maximize_sprint_goal_achievement
Maximize number of achieved sprint goals:

$$\max \sum_{sg \in \mathcal{SG}} \mathbb{I}[\text{achievement\_status}(sg) = \text{achieved}] \quad \text{with weight } 1.3$$

G11: minimize_sprint_backlog_total_effort
Minimize total effort in sprint backlogs:

$$\min \sum_{sbl \in \mathcal{SBL}} \text{total\_effort}(sbl) \quad \text{with weight } 0.9$$

G12: maximize_release_plan_included_features
Maximize number of features in release plans:

$$\max \sum_{rep \in \mathcal{REP}} |\text{included\_features}(rep)| \quad \text{with weight } 1.2$$

G13: minimize_dev_deployment_target
Minimize deployment delay (optimize target assignment):

$$\min \sum_{dev \in \mathcal{DEV}} \delta(\text{deployment\_target}(dev)) \quad \text{(indicator for late target)} \quad \text{with weight } 0.7$$

4 4. Conditions

C0: require_project_status_active
Only active projects:

$$\forall p \in \mathcal{P} : \text{status}(p) = \text{active} \quad \text{weight } 1.0$$

C1: require_team_status_active
Only active teams:

$$\forall t \in \mathcal{T} : \text{team\_status}(t) = \text{active} \quad \text{weight } 1.0$$

C2: require_worker_status_active
Only active workers:

$$\forall w \in \mathcal{W} : \text{status}(w) = \text{active} \quad \text{weight } 1.0$$

C3: require_feature_status_completed
Only completed features:

$$\forall f \in \mathcal{F} : \text{status}(f) \neq \text{completed} \Rightarrow f \notin \text{considered set} \quad \text{weight } 0.5$$

C4: require_task_status_done
Only tasks marked 'done':

$$\forall tsk \in \mathcal{TSK} : \text{status}(tsk) = \text{done} \quad \text{weight } 1.2$$

C5: require_sprint_status_completed
Only completed sprints:

$$\forall sp \in \mathcal{SP} : \text{status}(sp) = \text{completed} \quad \text{weight } 1.1$$

C6: require_user_story_status_done
Only completed user stories:

$$\forall us \in \mathcal{US} : \text{status}(us) = \text{done} \quad \text{weight } 1.0$$

C7: require_blocker_status_resolved
Only resolved blockers:

$$\forall bl \in \mathcal{BL} : \text{status}(bl) = \text{resolved} \quad \text{weight } 0.9$$

C8: require_skill_certified
Only certified skills:

$$\forall s \in \mathcal{S} : \text{certified}(s) = \text{true} \quad \text{weight } 1.1$$

C9: require_role_area_defined
Only roles with defined responsibility:

$$\forall r \in \mathcal{R} : \text{area\_of\_responsibility}(r) \neq \emptyset \quad \text{weight } 0.8$$

C10: require_sprint_goal_achievement_met
Only sprints where goal was achieved:

$$\forall sg \in \mathcal{SG} : \text{achievement\_status}(sg) = \text{achieved} \quad \text{weight } 1.3$$

C11: require_velocity_trend_positive
Only teams with positive velocity trend:

$$\forall vel \in \mathcal{VEL} : \text{trend}(vel) > 0 \quad \text{weight } 1.0$$

C12: require_release_status_planned
Only planned releases:

$$\forall rep \in \mathcal{REP} : \text{status}(rep) = \text{planned} \quad \text{weight } 0.9$$

C13: require_dev_test_status_passed
Only development snapshots with passed tests:

$$\forall dev \in \mathcal{DEV} : \text{test\_status}(dev) = \text{passed} \quad \text{weight } 1.1$$

5 5. DecisionVariables

`project_priority_weight` $\in [0.0, 1.0]$: Weight for project priority in scoring

`team_size_capacity` $\in \{5, 6, 7, 8, 9, 10\}$: Max number of members per team

`worker_availability_hours` $\in \mathbb{Z}^+ \cap [0, 40]$: Weekly worker availability

`task_effort_estimate` $\in \mathbb{Z}^+ \cap [1, 16]$: Estimated hours per task

`story_points_estimate` $\in \{1, 2, 3, 5, 8, 13\}$: Story points for a user story

`sprint_duration_days` $\in \{7, 14, 21, 28\}$: Duration of a sprint

`skill_level_rating` $\in \{1, 2, 3, 4, 5\}$: Skill proficiency level

`blocker_severity_level` $\in \{1, 2, 3\}$: Severity of a blocker

`velocity_min_threshold` $\in [5.0, 20.0]$: Minimum acceptable velocity

`release_version_number` $\in [1.0, 10.0]$: Version number for releases

`documentation_completeness_ratio` $\in [0.0, 1.0]$: Ratio of complete docs

`meeting_duration_minutes` $\in \mathbb{Z}^+ \cap [15, 180]$: Duration of Scrum meetings

`task_type_category` $\in \{\text{development}, \text{testing}, \text{bugfix}, \text{documentation}\}$: Task type

`stakeholder_influence_score` $\in \{1, 2, 3, 4, 5\}$: Influence level of stakeholders