

Optimization Model for SCRUM-Based Software Development

Domain Optimization Engine

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1. Sets (Entities)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

3. Goals

maximize_project_budget: $\max \sum_{p \in \mathcal{P}} \text{budget}_p$
 minimize_project_duration: $\min \sum_{p \in \mathcal{P}} (\text{project_end}_p - \text{project_start}_p)$
 maximize_team_efficiency: $\max \sum_{v \in \mathcal{V}\mathcal{E}\mathcal{L}} \text{avg_story_points}_v$
 minimize_task_effort: $\min \sum_{tsk \in \mathcal{T}\mathcal{S}\mathcal{K}} \text{effort}_{tsk}$
 maximize_worker_availability: $\max \sum_{w \in \mathcal{W}} \text{availability}_w$
 minimize_sprint_goal_failure: $\min \sum_{sp \in \mathcal{S}\mathcal{P}} I(\text{achievement_status}_{sp} = \text{"failed"})$
 maximize_feature_completion: $\max \sum_{f \in \mathcal{F}} I(\text{status}_f = \text{"done"})$
 minimize_blocker_severity: $\min \sum_{bl \in \mathcal{B}\mathcal{L}} \text{severity}_{bl} \cdot I(\text{status}_{bl} = \text{"active"})$
 maximize_stakeholder_influence: $\max \sum_{sh \in \mathcal{S}\mathcal{H}} \text{influence_level}_{sh}$
 minimize_release_delay: $\min \sum_{rep \in \mathcal{R}\mathcal{E}\mathcal{P}} \max(0, \text{actual_date} - \text{planned_date}_{rep})$
 maximize_user_story_points: $\max \sum_{us \in \mathcal{U}\mathcal{S}} \text{story_points}_{us} \cdot I(\text{status}_{us} = \text{"done"})$
 minimize_daily_scrum_duration: $\min \frac{1}{|\mathcal{S}\mathcal{P}|} \sum_{sp \in \mathcal{S}\mathcal{P}} \text{duration}_{ds}$
 maximize_documentation_coverage: $\max \sum_{f \in \mathcal{F}} I(\exists fed \in \mathcal{F}\mathcal{E}\mathcal{D} : \text{linked_requirements}_{fed} \ni f)$
 minimize_sprint_waste: $\min \sum_{sp \in \mathcal{S}\mathcal{P}} I(\text{status}_{sp} = \text{"canceled"})$

4. Conditions

require_worker_email: $\forall w \in \mathcal{W}, \text{email}_w \neq \emptyset$
 require_team_location: $\forall t \in \mathcal{T}, \text{location}_t \neq \emptyset$
 require_product_owner: $\forall p \in \mathcal{P}, \exists po \in \mathcal{P}\mathcal{O} : \text{manages}(po, pb_p)$
 require_scrum_master: $\forall t \in \mathcal{T}, \exists sm \in \mathcal{S}\mathcal{M} : \text{supported_by}(t, sm)$
 enforce_task_status: $\forall tsk \in \mathcal{T}\mathcal{S}\mathcal{K}, \text{status}_{tsk} \in \{\text{todo}, \text{in progress}, \text{done}\}$
 require_user_story_priority: $\forall us \in \mathcal{U}\mathcal{S}, \text{priority}_{us} \in \{1, 2, 3\}$
 require_sprint_dates: $\forall sp \in \mathcal{S}\mathcal{P}, \text{start_date}_{sp} < \text{end_date}_{sp}$
 limit_worker_per_team: $\forall t \in \mathcal{T}, |\{w : \text{assigned}(w, t)\}| \leq M$
 enforce_feature_status: $\forall f \in \mathcal{F}, \text{status}_f \in \{\text{planned}, \text{in_progress}, \text{done}\}$
 require_release_status: $\forall rep \in \mathcal{R}\mathcal{E}\mathcal{P}, \text{status}_{rep} \neq \emptyset$
 ensure_backlog_entries: $\forall pb \in \mathcal{P}\mathcal{B}, \text{number_of_entries}_{pb} \geq 1$
 require_skill_certification: $\forall s \in \mathcal{S}, r \in \{\text{Dev}, \text{Architect}\}, \text{certified}_s = \text{true}$
 enforce_sprint_goal: $\forall sp \in \mathcal{S}\mathcal{P}, \exists sg \in \mathcal{S}\mathcal{G} : \text{pursues}(sp, sg) \wedge \text{objective_description}_{sg} \neq \emptyset$
 require_roadmap_milestones: $\forall rm \in \mathcal{R}\mathcal{M}, \text{milestones}_{rm} \neq \emptyset$
 prevent_duplicate_tasks: $\forall tsk_1, tsk_2 \in \mathcal{T}\mathcal{S}\mathcal{K}, tsk_1 \neq tsk_2 \Rightarrow \text{title}_{tsk_1} \neq \text{title}_{tsk_2}$

5. Decision Variables

$x_{w,t} \in \{0, 1\}$: Worker w assigned to team t

$y_{us,sp} \in \{0, 1\}$: User story us included in sprint sp

$e_{tsk} \in [0, 40]$: Estimated effort for task tsk

$d_{sp} \in [1, 30]$: Duration of sprint sp in days

$pr_f \in \{1, 2, 3\}$: Priority of feature f

$v_{rep} \in [1, 100]$: Version number of release plan rep

$m_{evt} \in [15, 180]$: Duration of Scrum event (e.g., DailyScrum)

$b_p \in [1000, 1000000]$: Budget allocated to project p

$a_w \in [0, 100]$: Availability (%) of worker w

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

$z_{s,r} \in \{0, 1\}$: Skill s activated for role r

$doc_s \in \{0, 1, 2\}$: Documentation status (0=missing, 1=draft, 2=final)

$rt_{bl} \in [0, 365]$: Resolution time in days for blocker bl

$\delta_v \in [-1.0, 1.0]$: Adjustment to velocity trend

$c_b \in [2, 6]$: Number of columns on scrum board b