Optimization Model for SCRUM-Based Software Development

Domain Modeling System

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Contents

1. Sets (Entities)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$us \in \mathcal{US}$: Index for User Stories

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$sh \in \mathcal{SH}$: Index for Stakeholders

$rep \in \mathcal{REP}$: Index for Release Plans

3. Goals

`maximize_team_utilization`: $\max \sum_{t \in \mathcal{T}} \text{team\_size}(t)$ with weight 1.2

`minimize_project_duration`: $\min(\text{project\_end}(p) - \text{project\_start}(p))$ for $p \in \mathcal{P}$

`maximize_velocity`: $\max \sum_{vel \in \mathcal{VEL}} \text{avg\_story\_points}(vel)$ with weight 1.8

`minimize_blocker_severity`: $\min \sum_{bl \in \mathcal{BL}} \text{severity}(bl)$ with weight 1.4

`maximize_feature_completion`: $\max \sum_{f \in \mathcal{F}} I[\text{status}(f) = \text{Done}]$ with weight 1.1

`minimize_sprint_goal_failure`: $\min \sum_{sp \in \mathcal{SP}} I[\text{achievement\_status}(sp) = \text{Failed}]$ with weight 1.6

`maximize_stakeholder_influence`: $\max \sum_{sh \in \mathcal{SH}} \text{influence\_level}(sh)$ with weight 1.0

`minimize_task_effort_deviation`: $\min \sum_{tsk \in \mathcal{TSK}} |\text{effort}(tsk) - \hat{e}(tsk)|$ with weight 1.3

`maximize_documentation_coverage`: $\max \sum_{f \in \mathcal{F}} I[\exists fed \in \mathcal{FED} : \text{linked\_requirements}(fed) \ni f]$ with weight 0.9

`minimize_budget_expenditure`: $\min \sum_{p \in \mathcal{P}} \text{budget}(p)$ with weight 1.7

`maximize_worker_certified_skills`: $\max \sum_{w \in \mathcal{W}, s \in \mathcal{S}} I[\text{certified}(s) = \text{True}]$ with weight 1.1

`minimize_sprint_planning_time`: $\min \sum_{spp \in \mathcal{SPP}} \text{duration\_}(min)(spp)$ with weight 1.0

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

`minimize_daily_scrum_overrun`: $\min \sum_{ds \in \mathcal{DS}} \max(0, \text{duration}(ds) - 15)$ with weight 0.8

`maximize_team_satisfaction`: $\max \frac{1}{|\mathcal{SRE}|} \sum_{sre \in \mathcal{SRE}} \text{team\_satisfaction}(sre)$ with weight 1.3

4. Conditions

`require_product_owner_assigned`: $\forall p \in \mathcal{P}, \exists po \in \mathcal{PO} : \text{manages\_backlog}(po, pb_p)$

`require_scrum_master_per_team`: $\forall t \in \mathcal{T}, \exists! sm \in \mathcal{SM} : \text{is\_supported\_by}(t, sm)$

`enforce_sprint_duration`: $\forall sp \in \mathcal{SP}, 1 \leq (\text{end\_date}(sp) - \text{start\_date}(sp)) \leq 28$

`limit_work_in_progress`: $\forall w \in \mathcal{W}, \sum_{tsk \in \mathcal{TSK}} I[\text{status}(tsk) = \text{In Progress} \wedge \text{assigned\_to}(tsk, w)] \leq 3$

`enforce_backlog_ordering`: $\forall pb \in \mathcal{PB}, \text{number\_of\_entries}(pb) > 0 \Rightarrow \forall f \in \mathcal{F} \cup \mathcal{E}, \text{priority}(f) \in Z^+$

`require_user_story_acceptance_criteria`: $\forall us \in \mathcal{US}, \text{acceptance\_criteria}(us) \neq \emptyset$

`ensure_task_belongs_to_story`: $\forall tsk \in \mathcal{TSK}, \exists us \in \mathcal{US} : \text{consists\_of\_tasks}(us, tsk)$

`prevent_duplicate_emails`: $\forall w_1, w_2 \in \mathcal{W}, w_1 \neq w_2 \Rightarrow \text{email}(w_1) \neq \text{email}(w_2)$

`enforce_skill_level_range`: $\forall s \in \mathcal{S}, 1 \leq \text{level}(s) \leq 5$

`require_sprint_goal_defined`: $\forall sp \in \mathcal{SP}, \exists sg \in \mathcal{SG} : \text{pursues\_goal}(sp, sg) \wedge \text{objective\_description}(sg) \neq$ ""

`limit_epic_size`: $\forall e \in \mathcal{E}, \text{estimated\_effort}(e) \leq 20$

`mandate_daily_scrum_frequency`: $\forall sp \in \mathcal{SP}$, number of $ds \in \mathcal{DS}$ during $[\text{start\_date}(sp), \text{end\_date}(sp)] \geq 5 \times \text{weeks}$

`require_development_snapshot`: $\forall sp \in \mathcal{SP}, \exists dev \in \mathcal{DEV} : \text{generates\_snapshot}(sp, dev)$

`enforce_unique_feature_title`: $\forall f_1, f_2 \in \mathcal{F}, f_1 \neq f_2 \Rightarrow \text{title}(f_1) \neq \text{title}(f_2)$

`require_stakeholder_feedback`: $\forall sr \in \mathcal{SR}, \text{attendees\_count}(sr) \geq 2$

5. DecisionVariables

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

$d_{sp} \in [\text{2024-01-01}, \text{2025-12-31}]$: Start date of sprint sp

$e_{tsk} \in [0, 72]$: Estimated effort (hours) for task tsk

$\pi_f \in [1, 1000]$: Priority rank of feature f

$b_p \in [0, 1000000]$: Budget allocated to project p

$y_{f,rep} \in \{0, 1\}$: Feature f included in release plan rep

$g_{sp} \in \mathcal{G}$: Textual sprint goal for sprint sp

$s_{tsk} \in \{\text{To Do, In Progress, Done}\}$: Status of task tsk

$m_{sm,sre} \in \{0, 1\}$: Scrum Master sm moderates retrospective sre

$doc_f \in \{0, 1\}$: Feature f is documented

$r_{bl} \in [\text{2024-01-01}, \text{2025-12-31}]$: Resolution date of blocker bl

$l_{w,s} \in \{1, 2, 3, 4, 5\}$: Skill level of worker w in skill s

$v_{pred} \in [0, 100]$: Predicted velocity (avg story points)

$m_{rm} \in [\text{2024-01-01}, \text{2026-12-31}]$: Milestone date in roadmap

$c_{sh} \in [0, 10]$: Communication frequency with stakeholder sh