

SCRUM Project Optimization Model

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Introduction

This document formally defines a multi-objective optimization model for resource allocation and planning in a software development company utilizing the SCRUM framework. The model is derived from a defined domain structure (Entities and Relationships) and is governed by a set of Goals, Conditions, and Decision Variables.

1 Sets (Entities)

- Project = $\{p_1, p_2, \dots, p_n\}$
- Team = $\{t_1, t_2, \dots, t_n\}$
- Worker = $\{w_1, w_2, \dots, w_n\}$
- Feature = $\{f_1, f_2, \dots, f_n\}$
- Skill = $\{s_1, s_2, \dots, s_n\}$
- Role = $\{r_1, r_2, \dots, r_n\}$
- ProductOwner = $\{po_1, po_2, \dots, po_n\}$
- ScrumMaster = $\{sm_1, sm_2, \dots, sm_n\}$
- ProductBacklog = $\{pb_1, pb_2, \dots, pb_n\}$
- Sprint = $\{sp_1, sp_2, \dots, sp_n\}$
- SprintPlanning = $\{spp_1, spp_2, \dots, spp_n\}$
- DailyScrum = $\{ds_1, ds_2, \dots, ds_n\}$
- SprintReview = $\{sr_1, sr_2, \dots, sr_n\}$
- SprintRetrospective = $\{sre_1, sre_2, \dots, sre_n\}$
- SprintBacklog = $\{sbl_1, sbl_2, \dots, sbl_n\}$
- SprintGoal = $\{sg_1, sg_2, \dots, sg_n\}$
- Epic = $\{e_1, e_2, \dots, e_n\}$
- UserStory = $\{us_1, us_2, \dots, us_n\}$
- Task = $\{tsk_1, tsk_2, \dots, tsk_n\}$
- DevelopmentSnapshot = $\{dev_1, dev_2, \dots, dev_n\}$
- Blocker = $\{bl_1, bl_2, \dots, bl_n\}$
- Stakeholder = $\{sh_1, sh_2, \dots, sh_n\}$
- Velocity = $\{vel_1, vel_2, \dots, vel_n\}$
- ReleasePlan = $\{rep_1, rep_2, \dots, rep_n\}$
- Roadmap = $\{rm_1, rm_2, \dots, rm_n\}$
- ScrumBoard = $\{scb_1, scb_2, \dots, scb_n\}$
- FeatureDocumentation = $\{fed_1, fed_2, \dots, fed_n\}$

2 Indices

- $p, p' \in \text{Project}$
- $t, t' \in \text{Team}$
- $w, w' \in \text{Worker}$
- $f, f' \in \text{Feature}$
- $s, s' \in \text{Skill}$
- $r, r' \in \text{Role}$
- $po, po' \in \text{ProductOwner}$
- $sm, sm' \in \text{ScrumMaster}$
- $pb, pb' \in \text{ProductBacklog}$
- $sp, sp' \in \text{Sprint}$
- $sbl, sbl' \in \text{SprintBacklog}$
- $us, us' \in \text{UserStory}$
- $tsk, tsk' \in \text{Task}$
- $bl, bl' \in \text{Blocker}$
- $vel, vel' \in \text{Velocity}$
- $rep, rep' \in \text{ReleasePlan}$

3 Goals

- **G0: maximize_team_availability** - Maximize the overall availability of team members.

$$\text{Maximize } \sum_{w \in W} \text{availability}(w)$$

- **G1: minimize_blocker_severity** - Minimize the severity of active blockers.

$$\text{Minimize } \sum_{\substack{bl \in BL \\ \text{status}(bl)=\text{active}}} \text{severity}(bl)$$

- **G2: maximize_feature_priority** - Maximize the total priority of selected features.

$$\text{Maximize } \sum_{f \in F} \text{priority}(f) \cdot x_f \quad \text{where } x_f = 1 \text{ if feature } f \text{ is selected}$$

- **G3: minimize_sprint_effort_variance** - Minimize effort variance in the sprint backlog.

$$\text{Minimize } |\text{estimated_effort}(sbl) - \text{total_effort}(sbl)| \quad \forall sbl \in SBL$$

- **G4: maximize_velocity** - Maximize the team's average velocity.

$$\text{Maximize } \text{avg_story_points}(vel)$$

- **G5: maximize_stakeholder_satisfaction** - Maximize stakeholder satisfaction.

$$\text{Maximize satisfaction_score}(sr) \quad \forall sr \in SR$$

- **G6: minimize_project_budget** - Minimize the total project budget spent.

$$\text{Minimize budget}(p)$$

- **G7: maximize_skill_coverage** - Maximize the coverage of required skills.

$$\text{Maximize } \sum_{s \in S} \text{level}(s) \cdot y_{w,s} \quad \text{where } y_{w,s} = 1 \text{ if worker } w \text{ has skill } s$$

- **G8: minimize_task_duration** - Minimize the time taken to complete tasks.

$$\text{Minimize } \sum_{tsk \in TSK} \text{effort}(tsk)$$

- **G9: maximize_sprint_goal_achievement** - Maximize the rate of achieved sprint goals.

$$\text{Maximize } \frac{|\{sg \in SG \mid \text{achievement_status}(sg) = \text{Done}\}|}{|SG|}$$

4 Conditions

- **C0: condition_project_active** - Only consider active projects.

$$\text{status}(p) = \text{'active'} \quad \forall p \in P \text{ considered}$$

- **C1: condition_worker_available** - Only include available workers.

$$\text{status}(w) = \text{'available'} \quad \forall w \in W \text{ assigned}$$

- **C2: condition_sprint_current** - Apply to the most recent sprint.

$$sp = \arg \max_{sp' \in SP} \text{start_date}(sp')$$

- **C3: condition_blocker_unresolved** - Consider only unresolved blockers.

$$\text{status}(bl) \neq \text{'resolved'} \quad \forall bl \in BL \text{ considered}$$

- **C4: condition_high_priority_feature** - Focus on high-priority features.

$$\text{priority}(f) \in \{\text{'High'}, \text{'Critical'}\} \quad \forall f \in F \text{ prioritized}$$

- **C5: condition_team_has_scrum_master** - Ensure team has a Scrum Master.

$$\exists sm \in SM \text{ such that } \text{is_supported_by}(t, sm) = \text{True} \quad \forall t \in T$$

- **C6: condition_story_estimated** - Only include estimated user stories.

$$\text{story_points}(us) > 0 \quad \forall us \in US \text{ planned}$$

- **C7: condition_sprint_has_goal** - Only evaluate sprints with a goal.

$$\text{objective_description}(sg) \neq \emptyset \quad \forall sg \in SG \text{ associated with } sp$$

- **C8: condition_certified_skills** - Prefer certified skills.

$$\text{certified}(s) = \text{True} \quad \forall s \in S \text{ preferred}$$

- **C9: condition_release_planned** - Only include features in a planned release.

$$\exists rep \in REP \text{ such that } f \in \text{included_features}(rep) \quad \forall f \in F \text{ considered}$$

5 Decision Variables

- **DV0:** $x_{w,t} \in \{0,1\}$ - Binary variable for assigning worker w to team t .
- **DV1:** $y_f \in \{0,1\}$ - Binary variable for selecting feature f for a release.
- **DV2:** $z_{us} \in \mathbb{Z}^+$, $1 \leq z_{us} \leq 20$ - Integer variable for story points of user story us .
- **DV3:** $d_{sp} \in \mathbb{Z}^+$, $7 \leq d_{sp} \leq 28$ - Integer variable for the duration of sprint sp in days.
- **DV4:** $a_{tsk,w} \in \{0,1\}$ - Binary variable for assigning task tsk to worker w .
- **DV5:** $size_t \in \mathbb{Z}^+$, $3 \leq size_t \leq 9$ - Integer variable for the target size of team t .
- **DV6:** $prio_e \in \{1,2,3,4\}$ - Integer variable for the priority level of epic e .
- **DV7:** $budget_f \in \mathbb{R}^+$, $0.0 \leq budget_f \leq 1,000,000.0$ - Continuous variable for budget allocated to feature f .
- **DV8:** $i_{sre} \in \{0,1\}$ - Binary variable for implementing an action from retrospective sre .
- **DV9:** $n_p \in \mathbb{Z}^+$, $1 \leq n_p \leq 50$ - Integer variable for the total number of sprints in project p .