Optimization Model for a SCRUM-Based Software Development Project

AI Analyst

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Contents

1 Sets (Entities)

- Project = $\{p | p$ is a project$\}$, with attributes: id, name, project_start, project_end, description, bu
- Team = $\{t | t$ is a team$\}$, with attributes: id, name, team_size, team_start, team_status, location, t
- Worker = $\{w | w$ is a worker$\}$, with attributes: id, name, first_name, email, start_date, status, avail
- Feature = $\{f | f$ is a feature$\}$, with attributes: id, title, description, status, priority, estimated_effor
- Skill = $\{s | s$ is a skill$\}$, with attributes: id, label, description, level, certified, category
- Role = $\{r | r$ is a role$\}$, with attributes: id, role_name, description, area_of_responsibility
- ProductOwner, ScrumMaster, ProductBacklog, Sprint, SprintPlanning, DailyScrum, SprintReview, (Defined analogously)

2 Indices

- $p \in$ Project
- $t \in$ Team
- $w \in$ Worker
- $f \in$ Feature
- $s \in$ Skill
- $us \in$ UserStory
- $tsk \in$ Task
- $bl \in$ Blocker
- $sg \in$ SprintGoal
- $vel \in$ Velocity
- $sh \in$ Stakeholder

3 Goals

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

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

- **G1: minimize_project_budget** - Minimize the total budget spent on the project.

$$\text{Minimize budget}(p) \quad \forall p \in \text{Project}$$

- **G2: maximize_feature_priority** - Maximize the number of high-priority features delivered.

$$\text{Maximize} \sum_{f \in \text{Feature}} \text{priority}(f)$$

- **G3: minimize_blocker_severity** - Minimize the impact of blockers by focusing on high severity ones.

$$\text{Minimize} \sum_{bl \in \text{Blocker}} \text{severity}(bl)$$

- **G4: maximize_sprint_goal_achievement** - Maximize the rate of successfully achieved sprint goals.

$$\text{Maximize} \sum_{sg \in \text{SprintGoal}} \text{achievement\_status}(sg)$$

- **G5: maximize_velocity** - Maximize the team's average velocity to improve throughput.

$$\text{Maximize avg\_story\_points}(vel) \quad \forall vel \in \text{Velocity}$$

- **G6: minimize_task_effort** - Minimize the total effort required to complete all tasks.

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

- **G7: maximize_stakeholder_influence** - Prioritize features for stakeholders with high influence.

$$\text{Maximize} \sum_{sh \in \text{Stakeholder}} \text{influence\_level}(sh)$$

- **G8: minimize_sprint_duration** - Minimize the duration of sprints to increase feedback frequency.

$$\text{Minimize } (\text{end\_date}(sp) - \text{start\_date}(sp)) \quad \forall sp \in \text{Sprint}$$

4 Conditions

- **C0: condition_team_cross_functional** - Ensure the team possesses a diverse set of skills (cross-functional).

$$\sum_{s \in \text{Skill}} \text{level}(s) \geq \text{Threshold}_{\text{skills}} \quad \forall t \in \text{Team}$$

- **C1: condition_scrum_master_experience** - The assigned Scrum Master must have sufficient experience.

$$\text{experience}(sm) \geq \text{Threshold}_{\text{exp}} \quad \forall sm \in \text{ScrumMaster}$$

- **C2: condition_user_story_acceptance** - All user stories must meet their acceptance criteria before completion.

$$\text{status}(us) = \text{"Done"} \implies \text{acceptance\_criteria}(us) = \text{True} \quad \forall us \in \text{UserStory}$$

- **C3: condition_snapshot_test_status** - The development snapshot must pass testing before release.

$$\text{test\_status}(dev) = \text{"Pass"} \quad \forall dev \in \text{DevelopmentSnapshot}$$

- **C4: condition_project_on_time** - The project must not exceed its planned end date.

$$\text{actual\_end\_date}(p) \leq \text{project\_end}(p) \quad \forall p \in \text{Project}$$

- **C5: condition_worker_certified** - Critical tasks require workers with certified skills.

$$\text{task\_type}(tsk) = \text{"Critical"} \implies \exists w \in \text{Worker}, s \in \text{Skill} : \text{certified}(s) = \text{True}$$

- **C6: condition_feature_audience_match** - Features must be developed for the project's target audience.

  $$\text{target\_audience}(f) \subseteq \text{target\_audience}(p) \quad \forall f \in \text{Feature}, p \in \text{Project}$$

- **C7: condition_backlog_prioritized** - The product backlog must be ordered by priority.

  $$\text{priority}(\text{item}_i) \geq \text{priority}(\text{item}_{i+1}) \quad \forall i \in \{1, ..., \text{number\_of\_entries}-1\}$$

- **C8: condition_retrospective_actions** - Improvement actions from retrospectives must be documented.

  $$\text{improvement\_actions}(sre) \neq \emptyset \quad \forall sre \in \text{SprintRetrospective}$$

5 Decision Variables

- DV0: $x_{w,tsk} \in \{0, 1\}$ - Binary decision to assign worker w to task tsk.
- DV1: $d_{sp} \in Z^+$ - The length of sprint sp in days, $d_{sp} \in [7, 30]$.
- DV2: $n_t \in Z^+$ - The number of workers assigned to team t, $n_t \in [3, 9]$.
- DV3: $pts_{us} \in Z^+$ - The number of story points assigned to user story us, $pts_{us} \in [1, 20]$.
- DV4: $e_{tsk} \in Z^+$ - The estimated effort for task tsk in hours, $e_{tsk} \in [1, 40]$.
- DV5: $pr_f \in Z^+$ - The priority level of feature f, $pr_f \in [1, 5]$.
- DV6: $a_w \in R$ - The percentage of time worker w is available for project work, $a_w \in [0.0, 1.0]$.
- DV7: $b_f \in R^+$ - The amount of budget allocated to feature f, $b_f \in [0.0, 1,000,000.0]$.
- DV8: $g_{sp} \in \{0, 1\}$ - Binary status indicating if the goal for sprint sp was met.
- DV9: $r_{bl} \in \{0, 1\}$ - Binary decision to allocate resources to resolve blocker bl.