Optimization Model for SCRUM-Based Software Development

AI Assistant

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Contents

1 Sets (Entities)

- $Project$: The product or initiative to be developed
- $Team$: Self-organized, cross-functional development team
- $Worker$: Individual team member working on the project
- $Feature$: Mid-sized functionality
- $Skill$: Professional or social competence of a worker
- $Role$: Defined responsibilities within the Scrum team
- $ProductOwner$: Responsible for product vision and Product Backlog
- $ScrumMaster$: Supports the team in applying Scrum
- $ProductBacklog$: Ordered list of all requirements
- $Sprint$: Fixed time period for creating an increment
- $SprintPlanning$: Kick-off meeting for Sprint preparation
- $DailyScrum$: Daily 15-minute team meeting

- $SprintReview$: Presentation and acceptance of results
- $SprintRetrospective$: Retrospective for process improvement
- $SprintBacklog$: Selected backlog items + implementation plan
- $SprintGoal$: Objective to be achieved within the sprint
- $Epic$: Large requirement that can be split into stories
- $UserStory$: Requirement from the perspective of a user
- $Task$: Smallest unit of work within a sprint
- $DevelopmentSnapshot$: Product at the end of a sprint
- $Blocker$: Obstacle hindering progress
- $Stakeholder$: Interested party in the product (internal/external)
- $Velocity$: Average amount of work per sprint
- $ReleasePlan$: Plan for releasing specific features
- $Roadmap$: Long-term planning across releases
- $ScrumBoard$: Visual representation of tasks during the sprint
- $FeatureDocumentation$: Documentation for a specific feature

2 Indices

- $p, p' \in Project$
- $t, t' \in Team$
- $w, w' \in Worker$
- $f, f' \in Feature$
- $s, s' \in Skill$
- $r, r' \in Role$
- $po \in ProductOwner$
- $sm \in ScrumMaster$
- $pb \in ProductBacklog$
- $sp, sp' \in Sprint$
- $spp \in SprintPlanning$

- $ds \in DailyScrum$
- $sr \in SprintReview$
- $sre \in SprintRetrospective$
- $sbl \in SprintBacklog$
- $sg \in SprintGoal$
- $e, e' \in Epic$
- $us, us' \in UserStory$
- $tsk, tsk' \in Task$
- $dev \in DevelopmentSnapshot$
- $bl, bl' \in Blocker$
- $sh, sh' \in Stakeholder$
- $vel \in Velocity$
- $rep \in ReleasePlan$
- $rm \in Roadmap$
- $scb \in ScrumBoard$
- $fed \in FeatureDocumentation$

3 Goals

- **G0: maximize_team_velocity** - Maximize the average velocity of teams

$$\text{maximize} \sum_{t \in Team} vel.avg\_story\_points$$

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

$$\text{minimize} \sum_{p \in Project} p.budget$$

- **G2: maximize_feature_priority** - Maximize the sum of priorities for completed features

$$\text{maximize} \sum_{f \in Feature} f.priority$$

- **G3: minimize_blocker_severity** - Minimize the total severity of unresolved blockers

$$\text{minimize} \sum_{bl \in Blocker} bl.severity$$

- **G4: maximize_stakeholder_influence** - Maximize engagement from high-influence stakeholders

$$\text{maximize} \sum_{sh \in Stakeholder} sh.influence\_level$$

- **G5: minimize_sprint_goal_failure** - Minimize the number of sprints where the goal was not achieved

$$\text{minimize} \sum_{sp \in Sprint} (1 - sp.achievement\_of\_goal)$$

- **G6: maximize_worker_availability** - Maximize the total availability of all workers

$$\text{maximize} \sum_{w \in Worker} w.availability$$

- **G7: minimize_task_effort** - Minimize the total estimated effort for all tasks in the sprint backlog

$$\text{minimize} \sum_{tsk \in Task} tsk.effort$$

- **G8: maximize_skill_level** - Maximize the average certified skill level of the team

$$\text{maximize} \sum_{s \in Skill} s.level$$

- **G9: minimize_sprint_duration** - Minimize the total duration of all planned sprints

$$\text{minimize} \sum_{sp \in Sprint} (sp.end\_date - sp.start\_date)$$

4 Conditions

- **C0: project_must_have_team** - A project must have at least one team assigned

$$\forall p \in Project, \exists t \in Team : \text{is\_assigned\_to\_project}(t, p)$$

- **C1: worker_availability_threshold** - An individual worker's availability must be at least 80%

$$\forall w \in Worker, w.availability \geq 80$$

- **C2: feature_priority_range** - Feature priority must be between 1 (low) and 5 (critical)

$$\forall f \in Feature, 1 \leq f.priority \leq 5$$

- **C3: blocker_severity_limit** - No blocker can have a severity greater than 4 (critical)

$$\forall bl \in Blocker, bl.severity \leq 4$$

- **C4: sprint_goal_must_be_set** - Every sprint must have a defined goal

$$\forall sp \in Sprint, \exists sg \in SprintGoal : \text{pursues\_goal}(sp, sg)$$

- **C5: task_effort_positive** - The effort for any task must be a positive number

$$\forall tsk \in Task, tsk.effort > 0$$

- **C6: team_size_limit** - A team cannot have more than 9 members

$$\forall t \in Team, t.team\_size \leq 9$$

- **C7: user_story_has_acceptance_criteria** - Every user story must have defined acceptance criteria

$$\forall us \in UserStory, us.acceptance\_criteria \neq \emptyset$$

- **C8: sprint_duration_fixed** - The duration of a sprint must be exactly 2 weeks (14 days)

$$\forall sp \in Sprint, (sp.end\_date - sp.start\_date) = 14$$

- **C9: budget_not_exceeded** - The total project cost must not exceed the allocated budget

$$\sum_{p \in Project} p.budget\_spent \leq p.budget$$

5 DecisionVariables

- $assign\_worker\_to\_team_{w,t} \in \{0, 1\}$: Binary decision to assign a worker to a team
- $select\_feature\_for\_sprint_{f,sp} \in \{0, 1\}$: Binary decision to include a feature in a sprint
- $assign\_task\_to\_worker_{tsk,w} \in \{0, 1\}$: Binary decision to assign a task to a worker

- $team\_size_t \in Z^+$: The number of workers in a specific team, $1 \leq team\_size_t \leq 9$
- $project\_budget\_spent_p \in R^+$: The amount of budget used for the project so far, $0 \leq project\_budget\_spent_p$
- $sprint\_velocity_{sp} \in Z^+$: The achieved story points in a specific sprint, $0 \leq sprint\_velocity_{sp}$
- $worker\_availability\_percentage_w \in R^+$: The percentage of time a worker is available, $0 \leq worker\_availability\_percentage_w \leq 100$
- $feature\_priority\_value_f \in \{1, 2, 3, 4, 5\}$: The assigned priority level for a feature
- $blocker\_severity\_level_{bl} \in \{1, 2, 3, 4\}$: The severity level assigned to a blocker
- $sprint\_goal\_achieved_{sp} \in \{0, 1\}$: Binary status if the sprint goal was met