Optimization Model for SCRUM-Based Software Development

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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

- $p, p' \in Project$
- $t \in Team$
- $w \in Worker$
- $f \in Feature$
- $s \in Skill$
- $r \in Role$
- $po \in ProductOwner$
- $sm \in ScrumMaster$
- $pb \in ProductBacklog$
- $sp \in Sprint$
- $spp \in SprintPlanning$
- $ds \in DailyScrum$
- $sr \in SprintReview$
- $sre \in SprintRetrospective$
- $sbl \in SprintBacklog$
- $sg \in SprintGoal$
- $e \in Epic$
- $us \in UserStory$
- $tsk \in Task$

- $dev \in DevelopmentSnapshot$
- $bl \in Blocker$
- $sh \in Stakeholder$
- $vel \in Velocity$
- $rep \in ReleasePlan$
- $rm \in Roadmap$
- $scb \in ScrumBoard$
- $fed \in FeatureDocumentation$

3 Goals

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

$$\text{maximize} \sum_{t} \text{velocity.avg\_story\_points}(t)$$

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

$$\text{minimize project.budget}(p)$$

- **G2: minimize_blocker_severity** - Minimize the severity of active blockers

$$\text{minimize} \sum_{bl} \text{blocker.severity}(bl)$$

- **G3: maximize_feature_priority** - Maximize the total priority of features in the release

$$\text{maximize} \sum_{f} \text{feature.priority}(f)$$

- **G4: maximize_worker_availability** - Maximize the overall availability of the team

$$\text{maximize} \sum_{w} \text{worker.availability}(w)$$

- **G5: minimize_sprint_duration** - Minimize the duration of sprint meetings

$$\text{minimize sprintplanning.duration\_min}(spp)$$

- **G6: maximize_stakeholder_influence** - Maximize the influence level of engaged stakeholders

$$\text{maximize} \sum_{sh} \text{stakeholder.influence\_level}(sh)$$

- **G7: minimize_task_effort** - Minimize the total effort of tasks in the sprint

$$\text{minimize} \sum_{tsk} \text{task.effort}(tsk)$$

- **G8: maximize_sprint_goal_achievement** - Maximize the achievement status of the sprint goal

$$\text{maximize sprintgoal.achievement\_status}(sg)$$

- **G9: maximize_skill_level** - Maximize the average skill level of the team

$$\text{maximize} \sum_{s} \text{skill.level}(s)$$

4 Conditions

- **C0: project_budget_limit** - The total project budget must not be exceeded

$$\text{project.budget}(p) \leq B_{\max}$$

- **C1: sprint_duration_fixed** - Sprint duration is fixed and cannot be changed

$$\text{sprint.end\_date}(sp) - \text{sprint.start\_date}(sp) = D_{\text{fixed}}$$

- **C2: team_size_minimum** - The team must have a minimum size

$$\text{team.team\_size}(t) \geq T_{\min}$$

- **C3: worker_availability_threshold** - Each worker's availability must be above a threshold

$$\text{worker.availability}(w) \geq A_{\min}, \forall w$$

- **C4: feature_priority_high** - Only high-priority features can be selected

$$\text{feature.priority}(f) \geq P_{\text{high}}, \forall f \text{ selected}$$

- **C5: story_points_capacity** - Total story points in a sprint cannot exceed team velocity

$$\sum_{us} \text{userstory.story\_points}(us) \cdot X_{us} \leq V_{\text{team}}$$

- **C6: task_effort_capacity** - Total effort of tasks cannot exceed team capacity

$$\sum_{tsk} \text{task.effort}(tsk) \cdot Y_{tsk} \leq C_{\text{team}}$$

- **C7: blocker_must_be_resolved** - Critical blockers must be resolved before deployment

$$\text{blocker.severity}(bl) \leq S_{\text{non-critical}}, \forall bl \text{ active}$$

- **C8: snapshot_test_status** - Development snapshot must pass tests before release

$$\text{developmentsnapshot.test\_status}(dev) = \text{"Pass"}$$

- **C9: skill_required_for_task** - Task assignment requires worker to have necessary skill

$$\text{skill.level}(s_w) \geq \text{skill.level}(s_{\text{req}}), \forall \text{assignment}$$

5 Decision Variables

- $DV0$: $assign\_worker\_to\_task(w, tsk) \in \{0, 1\}$: Whether a specific worker is assigned to a specific task

- $DV1$: $select\_feature\_for\_sprint(f, sp) \in \{0, 1\}$: Whether a specific feature is included in the current sprint
- $DV2$: $select\_user\_story\_for\_sprint(us, sp) \in \{0, 1\}$: Whether a specific user story is included in the current sprint
- $DV3$: $set\_sprint\_velocity(sp) \in Z^+, [5, 50]$: The planned velocity for the upcoming sprint
- $DV4$: $allocate\_budget\_to\_feature(f) \in R^+, [0, 1000000]$: The amount of budget allocated to a specific feature
- $DV5$: $set\_worker\_availability(w) \in R^+, [0, 100]$: The planned availability percentage for a worker
- $DV6$: $assign\_skill\_level(tsk, s) \in Z^+, [1, 5]$: The required skill level for a task
- $DV7$: $resolve\_blocker\_priority(bl) \in Z^+, [1, 3]$: The priority level for resolving a blocker
- $DV8$: $set\_sprint\_goal\_achievement(sg) \in R^+, [0, 100]$: The target achievement percentage for the sprint goal
- $DV9$: $number\_of\_sprints(p) \in Z^+, [1, 20]$: The total number of sprints for the project