Optimization Model for SCRUM-Based Software Development

AI Assistant

September 4, 2025

Contents

Introduction

This document presents a formal mathematical optimization model for managing and improving the processes of a software development company utilizing the SCRUM framework. The model is derived from a detailed domain model encompassing entities, relationships, goals, constraints, and decision variables. The purpose of this model is to provide a structured approach for solving complex decision-making problems such as resource allocation, sprint planning, and release management.

1 Sets (Entities)

- Project = $\{p|p$ is a project$\}$
- Team = $\{t|t$ is a team$\}$
- Worker = $\{w|w$ is a worker$\}$
- Feature = $\{f|f$ is a feature$\}$
- Skill = $\{s|s$ is a skill$\}$
- Role = $\{r|r$ is a role$\}$
- ProductOwner = $\{po|po$ is a product owner$\}$
- ScrumMaster = $\{sm|sm$ is a scrum master$\}$
- ProductBacklog = $\{pb|pb$ is a product backlog$\}$
- Sprint = $\{sp|sp$ is a sprint$\}$
- SprintGoal = $\{sg|sg$ is a sprint goal$\}$
- UserStory = $\{us|us$ is a user story$\}$
- Task = $\{tsk|tsk$ is a task$\}$
- Blocker = $\{bl|bl$ is a blocker$\}$
- Stakeholder = $\{sh|sh$ is a stakeholder$\}$
- Velocity = $\{vel|vel$ is a velocity record$\}$
- ReleasePlan = $\{rep|rep$ is a release plan$\}$

2 Indices

- $w \in$ Worker
- $t \in$ Team
- $tsk \in$ Task
- $f \in$ Feature
- $us \in$ UserStory
- $bl \in$ Blocker

- $s \in$ Skill
- $sh \in$ Stakeholder
- $sp \in$ Sprint
- $sg \in$ SprintGoal

3 Goals

G0 minimize_total_effort

$$\text{Minimize } Z_{G0} = \sum_{tsk \in \text{Task}} \text{effort}(tsk)$$

G1 maximize_team_availability

$$\text{Maximize } Z_{G1} = \sum_{w \in \text{Worker}} \text{availability}(w)$$

G2 maximize_feature_priority_score

$$\text{Maximize } Z_{G2} = \sum_{f \in \text{Feature}} \text{priority}(f)$$

G3 minimize_blocker_severity

$$\text{Minimize } Z_{G3} = \sum_{bl \in \text{Blocker}} \text{severity}(bl)$$

G4 maximize_velocity_consistency

$$\text{Maximize } Z_{G4} = \text{avg\_story\_points}(vel) \quad \text{for the current team's velocity } vel$$

G5 minimize_context_switching

$$\text{Minimize } Z_{G5} = \sum_{w \in \text{Worker}} \mathbb{I}[\text{numberOfFeatures}(w) > 1]$$

G6 maximize_skill_task_match

$$\text{Maximize } Z_{G6} = \sum_{w \in \text{Worker}} \sum_{s \in \text{Skill}(w)} \text{level}(s)$$

G7 minimize_sprint_overcommit

$$\text{Minimize } Z_{G7} = |\text{committed\_story\_points}(sp) - \text{avg\_story\_points}(vel)|$$

G8 maximize_stakeholder_satisfaction

$$\text{Maximize } Z_{G8} = \sum_{sh \in \text{Stakeholder}} \text{influence\_level}(sh) \cdot \text{satisfied}(sh)$$

4 Conditions

C0 sprint_goal_must_be_met

$$\text{achievement\_status}(sg_{current}) = \text{'Achieved'} \quad \forall sg_{current} \in \text{SprintGoal}$$

C1 worker_availability_not_exceeded

$$\sum_{tsk \in \text{Task}(w)} \text{effort}(tsk) \leq \text{availability}(w) \quad \forall w \in \text{Worker}$$

C2 critical_skills_must_be_covered

$$\forall tsk \text{ requiring skill } s^* \text{ with level}(s^*) \geq 4, \exists w \text{ assigned to } tsk \text{ with certified}(s^*) = \text{True}$$

C3 high_severity_blockers_must_resolved

$$\text{severity}(bl) \leq 8 \quad \forall bl \in \text{Blocker}$$

C4 team_must_have_scrum_master

$$\sum_{sm \in \text{ScrumMaster}} \text{assignedTo}(sm, t) = 1 \quad \forall t \in \text{Team}$$

C5 user_story_must_have_acceptance

$$\text{acceptance\_criteria}(us) \neq \emptyset \quad \forall us \in \text{UserStory in the sprint backlog}$$

C6 task_must_have_assignee

$$\sum_{w \in \text{Worker}} \text{assign\_worker\_to\_task}(w, tsk) \geq 1 \quad \forall tsk \text{ where status}(tsk) \in \{\text{'To Do'}, \text{'In Progress'}\}$$

C7 budget_not_exceeded

$$\sum_{w \in \text{Worker}} \sum_{tsk \in \text{Task}} \text{effort}(tsk) \cdot \text{cost\_rate}(w) \leq \text{budget}(p) \quad \text{for project } p$$

C8 feature_documentation_complete

$$\text{documentation\_status}(fed) = \text{'Complete'} \quad \forall f \in \text{Feature marked for release, with doc } fed$$

5 Decision Variables

DV0 $\text{assign\_worker\_to\_task}(w, tsk) \in \{0, 1\} \quad \forall w \in \text{Worker}, \forall tsk \in \text{Task}$

DV1 $\text{include\_feature\_in\_sprint}(f) \in \{0, 1\} \quad \forall f \in \text{Feature}$

DV2 $\text{select\_user\_story\_for\_release}(us) \in \{0, 1\} \quad \forall us \in \text{UserStory}$

DV3 $\text{set\_sprint\_duration} \in \mathbb{Z}^+, \ [7, 21]$

DV4 $\text{assign\_story\_points}(us) \in \mathbb{Z}^+, \ [1, 13] \quad \forall us \in \text{UserStory}$

DV5 $\text{team\_size}(t) \in \mathbb{Z}^+,\ [3, 9] \quad \forall t \in \text{Team}$

DV6 $\text{worker\_availability\_factor}(w) \in \mathbb{R},\ [0.2, 1.0] \quad \forall w \in \text{Worker}$

DV7 $\text{task\_effort\_estimate}(tsk) \in \mathbb{Z}^+,\ [1, 40] \quad \forall tsk \in \text{Task}$

DV8 $\text{blocker\_severity\_score}(bl) \in \mathbb{Z}^+,\ [1, 10] \quad \forall bl \in \text{Blocker}$

DV9 $\text{feature\_priority}(f) \in \mathbb{Z}^+,\ [1, 100] \quad \forall f \in \text{Feature}$

DV10 $\text{stakeholder\_influence\_weight}(sh) \in \mathbb{R},\ [0.0, 1.0] \quad \forall sh \in \text{Stakeholder}$

DV11 $\text{skill\_proficiency\_level}(w, s) \in \mathbb{Z}^+,\ [1, 5] \quad \forall w \in \text{Worker}, \forall s \in \text{Skill}$