

Optimization Model for SCRUM-Based Software Development

FoPra_2025

Sets and Indices

- P : Set of Projects
- T : Set of Teams
- E : Set of Employees
- F : Set of Features
- S : Set of Skills
- R : Set of Roles
- SP : Set of Sprints
- TSK : Set of Tasks
- US : Set of User Stories
- EP : Set of Epics
- PO : Set of Product Owners
- SM : Set of Scrum Masters
- STK : Set of Stakeholders

Decision Variables

- $x_{et} \in \{0, 1\}$: 1 if employee e is assigned to team t
- $y_{tsk,e} \in \{0, 1\}$: 1 if task tsk is assigned to employee e
- $z_{f,p} \in \{0, 1\}$: 1 if feature f is part of project p
- $dur_{sp} \in \mathbb{Z}^+$: duration (in days) of sprint sp
- $eff_{tsk} \in \mathbb{R}^+$: effort allocated to task tsk
- $sp_{us} \in \mathbb{Z}^+$: story points assigned to user story us
- $bud_f \in \mathbb{R}^+$: budget allocated to feature f
- $imp_{sr} \in \mathbb{Z}^+$: improvement actions from retrospective sr

Objective Function

$$\begin{aligned}
\text{Maximize } Z = & - \sum_{sp \in SP} dur_{sp} \quad (\text{G1: Minimize Sprint Duration}) \\
& + \sum_{t \in T} \text{Utilization}(t) \quad (\text{G2: Maximize Team Utilization}) \\
& - \sum_{tsk \in TSK} \text{Blocked}(tsk) \quad (\text{G3: Minimize Blockers}) \\
& + \sum_{f \in F} \text{Completed}(f) \quad (\text{G4: Maximize Feature Completion}) \\
& - \sum_{e \in E} \sum_{tsk \in TSK} \text{Overlap}(tsk, e) \quad (\text{G5: Minimize Task Overlap}) \\
& + \sum_{e \in E} \text{SkillCoverage}(e) \quad (\text{G6: Maximize Skill Coverage}) \\
& + \sum_{stk \in STK} \text{Satisfaction}(stk) \quad (\text{G7: Maximize Stakeholder Satisfaction}) \\
& - \sum_{us \in US} \text{UnallocatedPoints}(us) \quad (\text{G8: Minimize Unused Story Points}) \\
& + \sum_{sr} imp_{sr} \quad (\text{G9: Maximize Retrospective Improvement}) \\
& + \sum_{p \in P} \text{ValuePerBudget}(p) \quad (\text{G10: Maximize Budget Efficiency})
\end{aligned}$$

Constraints

$$\begin{aligned}
3 \leq \sum_{e \in E} x_{et} \leq 9 & \quad \forall t \in T \quad (\text{C1: Team Size Limit}) \\
y_{tsk,e} \Rightarrow \text{HasSkill}(e, tsk) & \quad \forall e \in E, tsk \in TSK \quad (\text{C2: Skill Match}) \\
\text{RolesAssigned}(t) = \text{AllCoreRoles} & \quad \forall t \in T \quad (\text{C3: Role Completeness}) \\
\sum_{sp \in SP_p} 1 \leq 10 & \quad \forall p \in P \quad (\text{C4: Max Sprint Count}) \\
\sum_{tsk \in TSK_e} eff_{tsk} \leq \text{Availability}(e) & \quad \forall e \in E \quad (\text{C5: Workload Limit}) \\
\sum_{sm \in SM} \text{Supports}(sm, t) = 1 & \quad \forall t \in T \quad (\text{C6: One Scrum Master per Team}) \\
\sum_{po \in PO} \text{Manages}(po, b) = 1 & \quad \forall b \in \text{Backlogs} \quad (\text{C7: PO-Backlog Assignment}) \\
\text{ActivePeriod}(t) \supseteq \text{SprintPeriod}(sp) & \quad \forall t \in T, sp \in SP \quad (\text{C8: Team Availability}) \\
\text{BalanceTypes}(TSK) \text{ within tolerance} & \quad (\text{C9: Task Type Distribution}) \\
z_{f,p} \Rightarrow \exists ep \in EP : \text{Contains}(ep, f) & \quad \forall f \in F \quad (\text{C10: Feature-Epic Linking})
\end{aligned}$$