

Optimization Model for SCRUM-Based Software Development

Sets

P : Projects
 T : Teams
 E : Employees (Workers)
 F : Features
 S : Skills
 R : Roles
 B : Sprints
 K : Tasks
 G : Sprint Goals
 D : Product Backlogs
 SM : Scrum Masters
 PO : Product Owners
 STK : Stakeholders

Parameters

effort_k : Estimated effort required for task $k \in K$
 avail_e : Availability (0-1) of employee $e \in E$
 priority_f : Priority of feature $f \in F$
 $\text{certified}_{e,s}$: 1 if employee e is certified in skill s , 0 otherwise
 $\text{required_skills}_{k,s}$: 1 if skill s is required for task k , 0 otherwise
 team_capacity_t : Max capacity of team t
 $\text{sprint_effort_limit}_b$: Effort limit for sprint b

Decision Variables

- $x_{e,k} \in \{0, 1\}$: 1 if employee e is assigned to task k
- $y_{t,p} \in \{0, 1\}$: 1 if team t is allocated to project p
- $z_{s,k,e} \in \{0, 1\}$: 1 if employee e applies skill s on task k
- $g_{b,g} \in \{0, 1\}$: 1 if sprint b focuses on goal g
- $d_f \in \{0, 1\}$: 1 if documentation is complete for feature f
- $sm_{t,sm} \in \{0, 1\}$: 1 if Scrum Master sm is assigned to team t
- $v_{stk,b} \in \{0, 1\}$: 1 if stakeholder stk participates in sprint review b

Objective Functions

$$\begin{aligned}
& \text{Maximize } \sum_{f \in F} \text{priority}_f \cdot d_f \quad (\text{Maximize delivery of high-priority features}) \\
& + \sum_{e \in E, k \in K} x_{e,k} \quad (\text{Maximize employee-task utilization}) \\
& - \sum_{b \in B} \left(\sum_{k \in K} \text{effort}_k \cdot x_{e,k} - \text{sprint_effort_limit}_b \right)^2 \quad (\text{Minimize sprint effort overrun}) \\
& - \sum_{e \in E} \text{ContextSwitchPenalty}_e \quad (\text{Minimize context switching})
\end{aligned}$$

Constraints

$$\begin{aligned}
& \sum_{k \in K} x_{e,k} \cdot \text{effort}_k \leq \text{avail}_e, \quad \forall e \in E \\
& \sum_{e \in E} x_{e,k} = 1, \quad \forall k \in K \quad (\text{Every task is assigned}) \\
& \sum_{s \in S} \text{required_skills}_{k,s} \cdot \sum_{e \in E} z_{s,k,e} \geq 1, \quad \forall k \in K \quad (\text{Skills match}) \\
& z_{s,k,e} \leq \text{certified}_{e,s}, \quad \forall e \in E, s \in S, k \in K \\
& \sum_{k \in K} x_{e,k} \cdot \text{overlap}(k) \leq 1, \quad \forall e \in E \quad (\text{No overlapping tasks}) \\
& \sum_{sm \in SM} sm_{t,sm} = 1, \quad \forall t \in T \quad (\text{One Scrum Master per team}) \\
& \sum_{e \in E} \text{role}_{e,t} \leq 1, \quad \forall t \in T \quad (\text{Single role per employee}) \\
& d_f = 1 \rightarrow \text{Feature } f \text{ is completed and documented}, \quad \forall f \in F
\end{aligned}$$

Notes

- All variables are binary unless otherwise specified.

- Penalties for context switching and effort overruns can be tuned using weight parameters.
- The overlap function identifies time conflicts among task assignments.