Optimization Model for SCRUM-based Software Development

Sets and Indices

- T: set of Tasks / Sub-Tasks, indexed by t
- S: set of Sprints, indexed by s
- U: set of User Stories, indexed by u
- E: set of Employees, indexed by e
- F: set of Features, indexed by f
- B: set of Blockers, indexed by b
- R: set of Roles, indexed by r

Decision Variables

$$
\begin{aligned}
&x_t \in \mathbb{Z}_+ && \text{Effort (hours) for task } t, \quad 1 \le x_t \le 100 \\
&y_s \in \mathbb{Z}_+ && \text{Duration (days) of sprint } s, \quad 7 \le y_s \le 30 \\
&z_e \in \mathbb{Z}_+ && \text{Team size for team with employee } e, \quad 3 \le z_e \le 15 \\
&a_e \in \mathbb{Z}_+ && \text{Hours available for employee } e, \quad 0 \le a_e \le 160 \\
&sp_u \in \mathbb{Z}_+ && \text{Story points for user story } u, \quad 1 \le sp_u \le 50 \\
&nTasks_s \in \mathbb{Z}_+ && \text{Number of tasks in sprint backlog } s, \quad 0 \le nTasks_s \le 200 \\
&p_t \in \mathbb{Z}_+ && \text{Priority of task } t, \quad 1 \le p_t \le 5 \\
&bUsage \in \mathbb{R}_+ && \text{Budget usage}, \quad 0 \le bUsage \le 10^7 \\
&nBlockers_t \in \mathbb{Z}_+ && \text{Number of blockers for task } t, \quad 0 \le nBlockers_t \le 50 \\
&g_s \in [0, 100] && \text{Sprint goal achievement percentage for sprint } s
\end{aligned}
$$

Parameters

- Cap_{team}: maximum capacity (effort hours) of a team
- $SkillMatch_{e,t}$: binary parameter if employee e has skills for task t
- $Assigned_{u,s}$: binary if user story u assigned to sprint s
- $Blocked_t$: binary if task t is currently blocked
- PO: binary if product owner assigned to product backlog (must be 1)
- SM: binary if scrum master assigned to team (must be 1)
- $Priority_f$: priority level of feature f
- $Included_f$: binary if feature f included in release plan

Objective Functions

We consider a multi-objective function:

$$\max \quad w_1 \sum_{s \in S} \text{Velocity}_s + w_2 \sum_{f \in F} \text{CompletedFeatures}_f - w_3 \sum_{t \in T} nBlockers_t - w_4 bUsage + w_5 \text{StakeholderSatisfaction} + w_6 \text{TeamSa}$$

Where weights w_i balance importance of objectives.

Constraints

(C1) Each user story must be assigned to at least one sprint:	(1)
$\sum_{s \in S} Assigned_{u,s} \geq 1, \quad \forall u \in U$	(2)
	(3)
(C2) Product backlog managed by exactly one product owner:	(4)
$PO = 1$	(5)
	(6)
(C3) Team capacity not exceeded:	(7)
$\sum_{t \in T_{team}} x_t \leq Cap_{team}$	(8)
	(9)
(C4) Task priority order respected:	(10)
$p_t \leq p_{t'} \implies x_t$ scheduled before $x_{t'}, \quad \forall t, t' \in T$	(11)
	(12)
(C5) Prefer skill match for task assignment:	(13)
If task t assigned to employee e, $\quad SkillMatch_{e,t} = 1 \quad$ preferred	(14)
	(15)
(C6) Blocked tasks cannot be started:	(16)
$x_t = 0, \quad$ if $Blocked_t = 1$	(17)
	(18)
(C7) Scrum master assigned per team:	(19)
$SM = 1$	(20)
	(21)
(C8) Sprint goal achievement percentage $g_s \in [0, 100]$	(22)
	(23)
(C9) Sprint dates immutable after start (modeled by parameters)	(24)
	(25)
(C10) High priority features must be included in release plans:	(26)
If $Priority_f$ is high, $\quad Included_f = 1$	(27)

Additional Notes

- Effort and availability variables ensure workload balance.

- Blockers reduce achievable velocity.

- Team and stakeholder satisfaction could be modeled as auxiliary variables derived from retrospective data.