

Optimization Model for Scrum-based Software Development

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September 5, 2025

Contents

1	Sets (Entities)	1
2	Indices	2
3	Goals	3
4	Conditions	4
5	Decision Variables	5

1 Sets (Entities)

- Project (P)
- Team (T)
- Worker (W)
- Feature (F)
- Skill (S)
- Role (R)
- ProductOwner (PO)
- ScrumMaster (SM)
- ProductBacklog (PB)
- Sprint (SP)
- SprintPlanning (SPP)
- DailyScrum (DS)

- SprintReview (SR)
- SprintRetrospective (SRE)
- SprintBacklog (SBL)
- SprintGoal (SG)
- Epic (E)
- UserStory (US)
- Task (TSK)
- DevelopmentSnapshot (DEV)
- Blocker (BL)
- Stakeholder (SH)
- Velocity (VEL)
- ReleasePlan (REP)
- Roadmap (RM)
- ScrumBoard (SCB)
- FeatureDocumentation (FED)

2 Indices

- $p \in P$ (Project)
- $t \in T$ (Team)
- $w \in W$ (Worker)
- $f \in F$ (Feature)
- $s \in S$ (Skill)
- $r \in R$ (Role)
- $po \in PO$ (ProductOwner)
- $sm \in SM$ (ScrumMaster)
- $pb \in PB$ (ProductBacklog)
- $sp \in SP$ (Sprint)
- $sg \in SG$ (SprintGoal)

- $e \in E$ (Epic)
- $us \in US$ (UserStory)
- $tsk \in TSK$ (Task)
- $dev \in DEV$ (DevelopmentSnapshot)
- $bl \in BL$ (Blocker)
- $sh \in SH$ (Stakeholder)
- $vel \in VEL$ (Velocity)
- $rep \in REP$ (ReleasePlan)
- $rm \in RM$ (Roadmap)
- $scb \in SCB$ (ScrumBoard)
- $fed \in FED$ (FeatureDocumentation)

3 Goals

- G0: maximize_team_velocity $\max \sum_{t \in T} VEL_t$
where $VEL_t = avg_story_points_t$
- G1: minimize_blocker_severity $\min \sum_{bl \in BL} severity_{bl}$
where $severity_{bl} \in \{1, 2, 3, 4, 5\}$
- G2: maximize_sprint_goal_achievement $\max \sum_{sp \in SP} achievement_status_{sp}$
where $achievement_status_{sp} \in \{0, 1\}$
- G3: minimize_sprint_duration $\min \sum_{sp \in SP} duration_{sp}$
where $duration_{sp} \in \{1, 2, 3, 4\}$
- G4: maximize_feature_completion $\max \sum_{f \in F} status_f$
where $status_f \in \{0, 1\}$
- G5: minimize_task_effort $\min \sum_{tsk \in TSK} effort_{tsk}$
where $effort_{tsk} \in \{1, 2, 3, 4, 5, 6, 7, 8\}$
- G6: maximize_stakeholder_satisfaction $\max \sum_{sh \in SH} satisfaction_{sh}$
where $satisfaction_{sh} \in \{0, 1\}$
- G7: minimize_release_plan_delay $\min \sum_{rep \in REP} delay_{rep}$
where $delay_{rep} \in \{0, 1, 2, 3, 4, 5\}$
- G8: maximize_product_backlog_quality $\max \sum_{pb \in PB} quality_{pb}$
where $quality_{pb} \in \{0, 1\}$

- G9: minimize_development_snapshot_bugs $\min \sum_{dev \in DEV} bugs_{dev}$
where $bugs_{dev} \in \{0, 1\}$
- G10: maximize_scrum_board_efficiency $\max \sum_{scb \in SCB} efficiency_{scb}$
where $efficiency_{scb} \in \{0, 1\}$
- G11: maximize_worker_availability $\max \sum_{w \in W} availability_w$
where $availability_w \in \{0, 1\}$
- G12: minimize_project_cost $\min \sum_{p \in P} cost_p$
where $cost_p \in \{1000, 2000, \dots, 100000\}$
- G13: maximize_feature_documentation_quality $\max \sum_{fed \in FED} quality_{fed}$
where $quality_{fed} \in \{0, 1\}$
- G14: minimize_task_blockers $\min \sum_{tsk \in TSK} blockers_{tsk}$
where $blockers_{tsk} \in \{0, 1, 2, 3, 4, 5\}$

4 Conditions

- C0: team_must_have_scrum_master $\forall t \in T \quad \exists sm \in SM \quad s.t. \quad team_has_scrum_master(t, sm) = 1$
- C1: product_owner_must_manage_backlog $\forall po \in PO \quad \exists pb \in PB \quad s.t. \quad product_owner_manages_backlog(po, pb) = 1$
- C2: sprint_must_have_goal $\forall sp \in SP \quad \exists sg \in SG \quad s.t. \quad sprint_has_goal(sp, sg) = 1$
- C3: task_must_have_effort $\forall tsk \in TSK \quad \exists effort \in \{1, 2, 3, 4, 5, 6, 7, 8\} \quad s.t. \quad task_has_effort(tsk, effort) = 1$
- C4: feature_must_have_priority $\forall f \in F \quad \exists priority \in \{1, 2, 3\} \quad s.t. \quad feature_has_priority(f, priority) = 1$
- C5: worker_must_have_skill $\forall w \in W \quad \exists s \in S \quad s.t. \quad worker_has_skill(w, s) = 1$
- C6: sprint_review_must_have_feedback $\forall sp \in SP \quad \exists feedback \in \{0, 1\} \quad s.t. \quad sprint_review_has_feedback(sp, feedback) = 1$
- C7: release_plan_must_have_features $\forall rep \in REP \quad \exists f \in F \quad s.t. \quad release_plan_has_feature(rep, f) = 1$
- C8: roadmap_must_have_objectives $\forall rm \in RM \quad \exists objective \in \{0, 1\} \quad s.t. \quad roadmap_has_objective(rm, objective) = 1$
- C9: scrum_board_must_have_tasks $\forall scb \in SCB \quad \exists tsk \in TSK \quad s.t. \quad scrum_board_has_task(scb, tsk) = 1$

- C10: development_snapshot_must_have_version $\forall dev \in DEV \quad \exists version \in \{0, 1\} \quad s.t. \quad development_snapshot_has_version(dev, version) = 1$
- C11: blocker_must_have_severity $\forall bl \in BL \quad \exists severity \in \{1, 2, 3, 4, 5\} \quad s.t. \quad blocker_has_severity(bl, severity) = 1$
- C12: feature_documentation_must_have_description $\forall fed \in FED \quad \exists description \in \{0, 1\} \quad s.t. \quad feature_documentation_has_description(fed, description) = 1$
- C13: project_must_have_budget $\forall p \in P \quad \exists budget \in \{1000, 2000, \dots, 100000\} \quad s.t. \quad project_has_budget(p, budget) = 1$

5 Decision Variables

- DV0: team_assignment $x_{t,p} \in \{0, 1\} \quad \forall t \in T, p \in P$
- DV1: worker_skill_level $y_{w,s} \in \{1, 2, 3, 4, 5\} \quad \forall w \in W, s \in S$
- DV2: sprint_duration $z_{sp} \in \{1, 2, 3, 4\} \quad \forall sp \in SP$
- DV3: task_effort $effort_{tsk} \in \{1, 2, 3, 4, 5, 6, 7, 8\} \quad \forall tsk \in TSK$
- DV4: feature_priority $priority_f \in \{1, 2, 3\} \quad \forall f \in F$
- DV5: worker_availability $availability_w \in \{0, 1\} \quad \forall w \in W$
- DV6: project_budget $budget_p \in \{1000, 2000, \dots, 100000\} \quad \forall p \in P$
- DV7: release_plan_delay $delay_{rep} \in \{0, 1, 2, 3, 4, 5\} \quad \forall rep \in REP$
- DV8: scrum_board_efficiency $efficiency_{scb} \in \{0, 1\} \quad \forall scb \in SCB$
- DV9: development_snapshot_quality $quality_{dev} \in \{0, 1\} \quad \forall dev \in DEV$
- DV10: feature_documentation_quality $quality_{fed} \in \{0, 1\} \quad \forall fed \in FED$
- DV11: blocker_severity $severity_{bl} \in \{1, 2, 3, 4, 5\} \quad \forall bl \in BL$
- DV12: sprint_goal_achievement $achievement_{sp} \in \{0, 1\} \quad \forall sp \in SP$
- DV13: task_blockers $blockers_{tsk} \in \{0, 1, 2, 3, 4, 5\} \quad \forall tsk \in TSK$
- DV14: project_cost $cost_p \in \{1000, 2000, \dots, 100000\} \quad \forall p \in P$