

Optimization Model for Scrum-based Software Development

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1 Sets (Entities)

- P : Projects
- T : Teams
- W : Workers
- F : Features
- S : Skills
- R : Roles
- PO : Product Owners
- SM : Scrum Masters
- PB : Product Backlogs
- SP : Sprints
- SG : Sprint Goals
- US : User Stories

- *TSK*: Tasks
- *BL*: Blockers
- *SH*: Stakeholders
- *VEL*: Velocity
- *REP*: Release Plans
- *RM*: Roadmaps
- *DEV*: Development Snapshots
- *SCB*: Scrum Boards

2 Indices

- $p \in P$: Project index
- $t \in T$: Team index
- $w \in W$: Worker index
- $f \in F$: Feature index
- $s \in S$: Skill index
- $r \in R$: Role index
- $po \in PO$: Product Owner index
- $sm \in SM$: Scrum Master index
- $pb \in PB$: Product Backlog index
- $sp \in SP$: Sprint index
- $sg \in SG$: Sprint Goal index
- $us \in US$: User Story index
- $tsk \in TSK$: Task index
- $bl \in BL$: Blocker index
- $sh \in SH$: Stakeholder index

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 $severity_{bl} \in \{1, 2, 3\}$
- G2: maximize_sprint_goal_achievement $\max \sum_{sp \in SP} achievement_status_{sp}$
where $achievement_status_{sp} \in \{0, 1\}$
- G3: minimize_task_effort $\min \sum_{tsk \in TSK} effort_{tsk}$
where $effort_{tsk} \geq 0$
- G4: maximize_feature_priority $\max \sum_{f \in F} priority_f$
where $priority_f \in \{1, 2, 3\}$
- G5: minimize_project_duration $\min \sum_{p \in P} project_end_p - project_start_p$
where $project_start_p \leq project_end_p$
- G6: maximize_team_satisfaction $\max \sum_{t \in T} team_satisfaction_t$
where $team_satisfaction_t \in \{1, 2, 3, 4, 5\}$
- G7: minimize_number_of_blockers $\min \sum_{bl \in BL} 1$
where $bl \in BL$
- G8: maximize_release_plan_status $\max \sum_{rep \in REP} status_{rep}$
where $status_{rep} \in \{0, 1, 2\}$
- G9: minimize_task_status $\min \sum_{tsk \in TSK} status_{tsk}$
where $status_{tsk} \in \{0, 1, 2\}$
- G10: maximize_product_owner_availability $\max \sum_{po \in PO} availability_{po}$
where $availability_{po} \in \{1, 2, 3, 4, 5\}$
- G11: minimize_sprint_retrospective_improvement_actions $\min \sum_{sp \in SP} improvement_actions_{sp}$
where $improvement_actions_{sp} \geq 0$
- G12: maximize_stakeholder_influence_level $\max \sum_{sh \in SH} influence_level_{sh}$
where $influence_level_{sh} \in \{1, 2, 3\}$
- G13: minimize_development_snapshot_test_status $\min \sum_{dev \in DEV} test_status_{dev}$
where $test_status_{dev} \in \{0, 1\}$
- G14: maximize_scrum_master_experience $\max \sum_{sm \in SM} experience_{sm}$
where $experience_{sm} \in \{1, 2, 3, 4, 5\}$

4 Conditions

- C0: team_must_have_scrum_master $\sum_{sm \in SM} team_assignment_{t,sm} = 1 \quad \forall t \in T$
- C1: product_owner_must_manage_backlog $\sum_{po \in PO} product_backlog_assignment_{pb,po} = 1 \quad \forall pb \in PB$
- C2: sprint_must_have_goal $\sum_{sg \in SG} sprint_goal_assignment_{sp,sg} = 1 \quad \forall sp \in SP$
- C3: task_must_have_status $status_{tsk} \in \{0, 1, 2\} \quad \forall tsk \in TSK$
- C4: feature_must_have_priority $priority_f \in \{1, 2, 3\} \quad \forall f \in F$
- C5: blocker_must_have_severity $severity_{bl} \in \{1, 2, 3\} \quad \forall bl \in BL$
- C6: release_plan_must_have_features $\sum_{f \in F} release_plan_feature_assignment_{rep,f} \geq 1 \quad \forall rep \in REP$
- C7: sprint_retrospective_must_have_improvement_actions $improvement_actions_{sp} \geq 0 \quad \forall sp \in SP$
- C8: development_snapshot_must_have_test_status $test_status_{dev} \in \{0, 1\} \quad \forall dev \in DEV$
- C9: scrum_board_must_have_tasks $\sum_{tsk \in TSK} scrum_board_task_assignment_{scb,tsk} \geq 1 \quad \forall scb \in SCB$
- C10: product_backlog_must_have_features $\sum_{f \in F} product_backlog_feature_assignment_{pb,f} \geq 1 \quad \forall pb \in PB$
- C11: team_must_have_workers $\sum_{w \in W} team_worker_assignment_{t,w} \geq 1 \quad \forall t \in T$
- C12: worker_must_have_skills $\sum_{s \in S} worker_skill_assignment_{w,s} \geq 1 \quad \forall w \in W$
- C13: project_must_have_start_date $project_start_p \leq project_end_p \quad \forall p \in P$
- C14: sprint_must_have_start_and_end_date $sprint_start_{sp} \leq sprint_end_{sp} \quad \forall sp \in SP$

5 Decision Variables

- D0: team_assignment (Binary) $team_assignment_{t,p} \in \{0, 1\} \quad \forall t \in T, p \in P$
- D1: worker_assignment (Binary) $worker_assignment_{w,t} \in \{0, 1\} \quad \forall w \in W, t \in T$

- D2: task_status (Integer) $\text{task_status}_{tsk} \in \{0, 1, 2\} \quad \forall tsk \in TSK$
- D3: feature_priority (Integer) $\text{feature_priority}_f \in \{1, 2, 3\} \quad \forall f \in F$
- D4: blocker_severity (Integer) $\text{blocker_severity}_{bl} \in \{1, 2, 3\} \quad \forall bl \in BL$
- D5: sprint_goal_achievement (Binary) $\text{sprint_goal_achievement}_{sp} \in \{0, 1\} \quad \forall sp \in SP$
- D6: release_plan_status (Integer) $\text{release_plan_status}_{rep} \in \{0, 1, 2\} \quad \forall rep \in REP$
- D7: development_snapshot_test_status (Binary) $\text{development_snapshot_test_status}_{dev} \in \{0, 1\} \quad \forall dev \in DEV$
- D8: scrum_board_task_assignment (Binary) $\text{scrum_board_task_assignment}_{scb,tsk} \in \{0, 1\} \quad \forall scb \in SCB, tsk \in TSK$
- D9: product_backlog_feature_assignment (Binary) $\text{product_backlog_feature_assignment}_{pb,f} \in \{0, 1\} \quad \forall pb \in PB, f \in F$
- D10: team_satisfaction (Integer) $\text{team_satisfaction}_t \in \{1, 2, 3, 4, 5\} \quad \forall t \in T$
- D11: worker_availability (Integer) $\text{worker_availability}_w \in \{1, 2, 3, 4, 5\} \quad \forall w \in W$
- D12: product_owner_availability (Integer) $\text{product_owner_availability}_{po} \in \{1, 2, 3, 4, 5\} \quad \forall po \in PO$
- D13: scrum_master_experience (Integer) $\text{scrum_master_experience}_{sm} \in \{1, 2, 3, 4, 5\} \quad \forall sm \in SM$
- D14: project_duration (Integer) $\text{project_duration}_p \geq 0 \quad \forall p \in P$