Optimization Model for Scrum-based Software Development

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Contents

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
- DEV = Development Snapshots
- BL = Blockers
- SH = Stakeholders
- VEL = Velocity
- REP = Release Plans
- RM = Roadmaps
- SCB = Scrum Boards
- FED = Feature Documentations

2 Indices

- $p \in P$
- $t \in T$
- $w \in W$
- $f \in F$
- $s \in S$
- $r \in R$
- $po \in PO$
- $sm \in SM$
- $pb \in PB$
- $sp \in SP$
- $sg \in SG$
- $us \in US$
- $tsk \in TSK$
- $dev \in DEV$
- $bl \in BL$
- $sh \in SH$
- $vel \in VEL$

- $rep \in REP$
- $rm \in RM$
- $scb \in SCB$
- $fed \in FED$

3 Goals

- **G0: maximize_project_budget**
  Maximize $\sum_{p \in P} budget_p$
  Mathematical representation: $\max \sum_{p \in P} budget_p$
- **G1: minimize_project_duration**
  Minimize $\sum_{p \in P} (project\_end_p - project\_start_p)$
  Mathematical representation: $\min \sum_{p \in P} (project\_end_p - project\_start_p)$
- **G2: maximize_team_velocity**
  Maximize $\sum_{vel \in VEL} avg\_story\_points_{vel}$
  Mathematical representation: $\max \sum_{vel \in VEL} avg\_story\_points_{vel}$
- **G3: maximize_sprint_goal_achievement**
  Maximize $\sum_{sg \in SG} achievement\_status_{sg}$
  Mathematical representation: $\max \sum_{sg \in SG} achievement\_status_{sg}$
- **G4: minimize_blocker_severity**
  Minimize $\sum_{bl \in BL} severity_{bl}$
  Mathematical representation: $\min \sum_{bl \in BL} severity_{bl}$
- **G5: maximize_feature_completion**
  Maximize $\sum_{f \in F} status_f$
  Mathematical representation: $\max \sum_{f \in F} status_f$
- **G6: minimize_task_effort**
  Minimize $\sum_{tsk \in TSK} effort_{tsk}$
  Mathematical representation: $\min \sum_{tsk \in TSK} effort_{tsk}$
- **G7: maximize_stakeholder_satisfaction**
  Maximize $\sum_{sh \in SH} relevance\_to\_feature_{sh}$
  Mathematical representation: $\max \sum_{sh \in SH} relevance\_to\_feature_{sh}$
- **G8: maximize_sprint_review_feedback**
  Maximize $\sum_{sp \in SP} feedback\_documentation_{sp}$
  Mathematical representation: $\max \sum_{sp \in SP} feedback\_documentation_{sp}$
- **G9: minimize_sprint_retrospective_improvement_actions**
  Minimize $\sum_{sp \in SP} improvement\_actions_{sp}$
  Mathematical representation: $\min \sum_{sp \in SP} improvement\_actions_{sp}$

- **G10: maximize_development_snapshot_quality**
  Maximize $\sum_{dev \in DEV} test\_status_{dev}$
  Mathematical representation: $\max \sum_{dev \in DEV} test\_status_{dev}$
- **G11: maximize_product_owner_availability**
  Maximize $\sum_{po \in PO} availability_{po}$
  Mathematical representation: $\max \sum_{po \in PO} availability_{po}$
- **G12: minimize_scrum_master_experience**
  Minimize $\sum_{sm \in SM} experience_{sm}$
  Mathematical representation: $\min \sum_{sm \in SM} experience_{sm}$
- **G13: maximize_team_size**
  Maximize $\sum_{t \in T} team\_size_t$
  Mathematical representation: $\max \sum_{t \in T} team\_size_t$
- **G14: maximize_user_story_completion**
  Maximize $\sum_{us \in US} status_{us}$
  Mathematical representation: $\max \sum_{us \in US} status_{us}$

4 Conditions

- **C0: project_status_must_be_active**
  $status_p = active, \forall p \in P$
  Mathematical representation: $status_p = 1, \forall p \in P$
- **C1: team_status_must_be_active**
  $team\_status_t = active, \forall t \in T$
  Mathematical representation: $team\_status_t = 1, \forall t \in T$
- **C2: product_owner_availability_must_be_high**
  $availability_{po} \geq 0.8, \forall po \in PO$
  Mathematical representation: $availability_{po} \geq 0.8, \forall po \in PO$
- **C3: scrum_master_experience_must_be_high**
  $experience_{sm} \geq 5, \forall sm \in SM$
  Mathematical representation: $experience_{sm} \geq 5, \forall sm \in SM$
- **C4: feature_priority_must_be_high**
  $priority_f \geq 4, \forall f \in F$
  Mathematical representation: $priority_f \geq 4, \forall f \in F$
- **C5: user_story_priority_must_be_high**
  $priority_{us} \geq 4, \forall us \in US$
  Mathematical representation: $priority_{us} \geq 4, \forall us \in US$
- **C6: task_status_must_be_in_progress**
  $status_{tsk} = in\_progress, \forall tsk \in TSK$
  Mathematical representation: $status_{tsk} = 1, \forall tsk \in TSK$

- **C7: sprint_goal_must_be_achievable**
  $achievement\_status_{sg} \geq 0.8, \forall sg \in SG$
  Mathematical representation: $achievement\_status_{sg} \geq 0.8, \forall sg \in SG$

- **C8: blocker_severity_must_be_low**
  $severity_{bl} \leq 2, \forall bl \in BL$
  Mathematical representation: $severity_{bl} \leq 2, \forall bl \in BL$

- **C9: stakeholder_relevance_must_be_high**
  $relevance\_to\_feature_{sh} \geq 4, \forall sh \in SH$
  Mathematical representation: $relevance\_to\_feature_{sh} \geq 4, \forall sh \in SH$

- **C10: sprint_review_feedback_must_be_positive**
  $feedback\_documentation_{sp} = positive, \forall sp \in SP$
  Mathematical representation: $feedback\_documentation_{sp} = 1, \forall sp \in SP$

- **C11: sprint_retrospective_improvement_actions_must_be_low**
  $improvement\_actions_{sp} \leq 2, \forall sp \in SP$
  Mathematical representation: $improvement\_actions_{sp} \leq 2, \forall sp \in SP$

- **C12: development_snapshot_quality_must_be_high**
  $test\_status_{dev} \geq 0.9, \forall dev \in DEV$
  Mathematical representation: $test\_status_{dev} \geq 0.9, \forall dev \in DEV$

- **C13: team_velocity_must_be_high**
  $avg\_story\_points_{vel} \geq 50, \forall vel \in VEL$
  Mathematical representation: $avg\_story\_points_{vel} \geq 50, \forall vel \in VEL$

- **C14: product_backlog_status_must_be_active**
  $status_{pb} = active, \forall pb \in PB$
  Mathematical representation: $status_{pb} = 1, \forall pb \in PB$

5 Decision Variables

- **D0: project_start_date**
  $project\_start\_date_p \in \{2022-01-01, 2025-12-31\}, \forall p \in P$

- **D1: team_size**
  $team\_size_t \in \{1, 2, ..., 10\}, \forall t \in T$

- **D2: product_owner_availability**
  $availability_{po} \in [0, 1], \forall po \in PO$

- **D3: scrum_master_experience**
  $experience_{sm} \in \{1, 2, ..., 10\}, \forall sm \in SM$

- **D4: feature_priority**
  $priority_f \in \{1, 2, ..., 5\}, \forall f \in F$

- **D5: user_story_priority**
  $priority_{us} \in \{1, 2, ..., 5\}, \forall us \in US$
- **D6: task_status**
  $status_{tsk} \in \{0, 1, 2\}, \forall tsk \in TSK$
- **D7: sprint_goal_achievement**
  $achievement\_status_{sg} \in [0, 1], \forall sg \in SG$
- **D8: blocker_severity**
  $severity_{bl} \in \{1, 2, ..., 5\}, \forall bl \in BL$
- **D9: stakeholder_relevance**
  $relevance\_to\_feature_{sh} \in \{1, 2, ..., 5\}, \forall sh \in SH$
- **D10: sprint_review_feedback**
  $feedback\_documentation_{sp} \in \{0, 1\}, \forall sp \in SP$
- **D11: sprint_retrospective_improvement_actions**
  $improvement\_actions_{sp} \in \{0, 1, ..., 5\}, \forall sp \in SP$
- **D12: development_snapshot_quality**
  $test\_status_{dev} \in [0, 1], \forall dev \in DEV$
- **D13: team_velocity**
  $avg\_story\_points_{vel} \in [0, 100], \forall vel \in VEL$
- **D14: product_backlog_status**
  $status_{pb} \in \{0, 1\}, \forall pb \in PB$