

SCRUM Planning Optimization Model

Generated Model

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Contents

1	1. Sets (Entities)	1
2	2. Indices	2
3	3. Goals	3
4	4. Conditions	4
5	5. DecisionVariables	5

Introduction

This document formulates a mixed-integer optimization model that uses the provided Entities, Relationships, Goals, Conditions, and Decision Variables to plan SCRUM delivery: assign teams and workers, plan sprints, select backlog items, respect capacities and budgets, and schedule releases while maximizing value and minimizing risk.

1 1. Sets (Entities)

- P : Projects (**Project**)
- T : Teams (**Team**)
- W : Workers (**Worker**)
- F : Features (**Feature**)
- S : Skills (**Skill**)
- R : Roles (**Role**)
- PO : Product Owners (**ProductOwner**)
- SM : Scrum Masters (**ScrumMaster**)
- PB : Product Backlogs (**ProductBacklog**)
- SP : Sprints (**Sprint**)
- SPP : Sprint Plannings (**SprintPlanning**)
- DS : Daily Scrums (**DailyScrum**)

- *SR*: Sprint Reviews (**SprintReview**)
- *SRE*: Sprint Retrospectives (**SprintRetrospective**)
- *SBL*: Sprint Backlogs (**SprintBacklog**)
- *SG*: Sprint Goals (**SprintGoal**)
- *E*: Epics (**Epic**)
- *US*: User Stories (**UserStory**)
- *TSK*: Tasks (**Task**)
- *DEV*: Development Snapshots (**DevelopmentSnapshot**)
- *BL*: Blockers (**Blocker**)
- *SH*: Stakeholders (**Stakeholder**)
- *VEL*: Velocity records (**Velocity**)
- *REP*: Release Plans (**ReleasePlan**)
- *RM*: Roadmaps (**Roadmap**)
- *SCB*: Scrum Boards (**ScrumBoard**)
- *FED*: Feature Documentation items (**FeatureDocumentation**)

2 2. Indices

- Indices: $p \in P, t \in T, w \in W, f \in F, e \in E, us \in US, tsk \in TSK, sp \in SP, sbl \in SBL, sr \in SR, bl \in BL, sh \in SH, rep \in REP, pb \in PB$.
- Relationship-induced subsets (from **Relationships.csv**):
 - $T(p)$: teams assigned to project p (R1).
 - $W(t)$: workers belonging to team t (R2; Employee \equiv Worker).
 - $S(w)$: skills of worker w (R3).
 - $RL(w)$: roles of worker w (R4).
 - $F(pb)$: features in product backlog pb (R7).
 - $E(pb)$: epics in product backlog pb (R8).
 - $US(e)$: user stories in epic e (R9).
 - $TSK(us)$: tasks of user story us (R10).
 - $SBL(sp)$: the sprint backlog belonging to sprint sp (R12).
 - $SG(sp)$: the sprint goal associated with sprint sp (R13).
 - $TSK(sp)$: tasks shown on the Scrum Board for sprint sp (R14).
 - $BL(tsk)$: blockers that can block task tsk (R16).
 - $SR(sh)$: reviews attended by stakeholder sh (R17; maps to **SprintReview**).
 - $SRE(sm)$: retrospectives moderated by scrum master sm (R18).
 - $T(vel)$: team referenced by velocity record vel (R19).
 - $F(rep)$: features included by release plan rep (R20).

– $REP(rm)$: release plans in roadmap rm (R21).

- Attribute functions (from **Entities.csv**): $story_points(us)$, $priority(f)$, $effort(tsk)$, $severity(bl)$, $budget(p)$, $trend(vel)$, $avgSP(vel)$, $attendees_count(sr)$, $number_of_cards(scb)$, $total_effort(sbl)$, $availability(w)$, $achievement_status(sg)$, etc.

3. Goals

- **G0 maximize_story_points_completed** (max):

$$\max \sum_{us \in US} story_points(us) \cdot c_{us}$$

where $c_{us} = complete_user_story[us] \in \{0, 1\}$.

- **G1 minimize_total_task_effort** (min):

$$\min \sum_{tsk \in TSK} effort(tsk) \cdot z_{tsk}$$

with $z_{tsk} = complete_task[tsk] \in \{0, 1\}$.

- **G2 minimize_open_blocker_severity** (min):

$$\min \sum_{bl \in BL} severity(bl) \cdot (1 - r_{bl})$$

where $r_{bl} = resolve_blocker[bl]$.

- **G3 maximize_sprint_goal_achievement** (max):

$$\max \sum_{sp \in SP} g_{sp}, \quad g_{sp} = achieve_sprint_goal[sp] \in \{0, 1\}.$$

- **G4 maximize_feature_priority_delivered** (max):

$$\max \sum_{rep \in REP} \sum_{f \in F} priority(f) \cdot q_{f,rep},$$

where $q_{f,rep} = include_feature_in_release[f, rep]$.

- **G5 minimize_project_budget_used** (min):

$$\min \sum_{p \in P} b_p, \quad b_p = budget_used[p] \in \mathbb{R}_+.$$

- **G6 maximize_velocity** (max):

$$\max \sum_{sp \in SP} v_{sp}, \quad v_{sp} = sprint_velocity[sp] \in \mathbb{Z}_+.$$

- **G7 minimize_release_time** (min):

$$\min \sum_{rep \in REP} \tau_{rep}, \quad \tau_{rep} = release_time[rep] \in \mathbb{Z}_+.$$

- **G8 maximize_stakeholder_relevance_covered** (*max*):

$$\max \sum_{sh \in SH} \sum_{f \in F} \text{stakeholder_coverage}[sh, f] \cdot \text{relevance_to_feature}(sh).$$

- **G9 minimize_sprint_wip_cards** (*min*):

$$\min \sum_{scb \in SCB} \text{number_of_cards}(scb).$$

- **G10 maximize_review_attendance** (*max*):

$$\max \sum_{sr \in SR} a_{sr}, \quad a_{sr} = \text{review_attendance_count}[sr] \in \mathbb{Z}_+.$$

- **G11 maximize_documentation_coverage** (*max*):

$$\max \sum_{fed \in FED} \text{linked_requirements}(fed).$$

4 4. Conditions

- **C0 capacity_per_team_not_exceeded**:

$$\sum_{us \in US} \sum_{sp \in SP} \text{story_points}(us) \cdot y_{us,sp} \leq \sum_{sp \in SP} v_{sp},$$

$$y_{us,sp} = \text{select_user_story_in_sprint}[us, sp] \in \{0, 1\}.$$

- **C1 story_points_within_sprint_velocity**:

$$\forall sp \in SP : \sum_{us \in US} \text{story_points}(us) \cdot y_{us,sp} \leq v_{sp}.$$

- **C2 daily_scrum_duration_cap**:

$$\forall ds \in DS : \text{duration}(ds) \leq 15.$$

- **C3 sprint_duration_bounds**:

$$\forall sp \in SP : 1 \leq d_{sp} \leq 30, \quad d_{sp} = \text{sprint_duration_days}[sp].$$

- **C4 worker_availability_respected**:

$$\forall w \in W : \sum_{tsk \in TSK} \text{effort}(tsk) \cdot \alpha_{w,tsk} \leq \text{availability}(w),$$

where $\alpha_{w,tsk} \in \{0, 1\}$ (implicit assignment of a task to a worker; derived from $W(t)$ and team ownership).

- **C5 product_backlog_active_only** (logical):

$$\forall pb \in PB : \text{status}(pb) \neq \text{'archived'}.$$

- **C6 sprint_goal_defined_and_tracked:**

$$\forall sp \in SP : g_{sp} \leq \frac{1}{|US|} \sum_{us \in US} \sum_{s \in SP} y_{us,s}, \quad g_{sp} \in \{0, 1\}.$$

- **C7 blockers_resolved_before_task_completion:**

$$\forall tsk \in TSK, \forall bl \in BL(tsk) : z_{tsk} \leq r_{bl}, \quad r_{bl} \in \{0, 1\}.$$

- **C8 sprint_backlog_effort_consistency:**

$$\forall sp \in SP : \text{total_effort}(SBL(sp)) = \sum_{tsk \in TSK} \text{effort}(tsk) \cdot s_{tsk,sp},$$

$$s_{tsk,sp} = \text{assign_task_to_sprint}[tsk, sp] \in \{0, 1\}.$$

- **C9 scrum_board_cards_consistency:**

$$\forall sp \in SP : \text{number_of_cards}(SCB(sp)) = \sum_{tsk \in TSK} s_{tsk,sp}.$$

- **C10 release_includes_ready_features_only** (logical):

$$\forall rep \in REP, \forall f \in F : q_{f,rep} \leq \mathbf{1}\{\text{status}(f) = \text{'ready'}\}.$$

- **C11 velocity_trend_nonnegative:**

$$\forall vel \in VEL : \text{trend}(vel) \geq 0.$$

- **C12 minimum_review_attendance:**

$$\forall sr \in SR : a_{sr} \geq A_{\min},$$

with threshold $A_{\min} \in \mathbb{Z}_+$ (policy parameter).

- *Linking user-story completion to tasks (supports G0):*

$$\forall us \in US : c_{us} \leq \frac{1}{|TSK(us)|} \sum_{tsk \in TSK(us)} z_{tsk}, \quad c_{us} \in \{0, 1\}.$$

5 5. Decision Variables

- $x_{t,p} = \text{assign_team_to_project}[t, p] \in \{0, 1\}$
- $k_{w,t} = \text{assign_worker_to_team}[w, t] \in \{0, 1\}$
- $y_{us,sp} = \text{select_user_story_in_sprint}[us, sp] \in \{0, 1\}$
- $z_{tsk} = \text{complete_task}[tsk] \in \{0, 1\}$
- $r_{bl} = \text{resolve_blocker}[bl] \in \{0, 1\}$
- $g_{sp} = \text{achieve_sprint_goal}[sp] \in \{0, 1\}$
- $q_{f,rep} = \text{include_feature_in_release}[f, rep] \in \{0, 1\}$
- $d_{sp} = \text{sprint_duration_days}[sp] \in \mathbb{Z}_+$

- $a_{sr} = \text{review_attendance_count}[sr] \in \mathbb{Z}_+$
- $v_{sp} = \text{sprint_velocity}[sp] \in \mathbb{Z}_+$
- $b_p = \text{budget_used}[p] \in \mathbb{R}_+$
- $h_{sh,f} = \text{stakeholder_coverage}[sh, f] \in \{0, 1\}$
- $c_{us} = \text{complete_user_story}[us] \in \{0, 1\}$
- $s_{tsk,sp} = \text{assign_task_to_sprint}[tsk, sp] \in \{0, 1\}$