

SCRUM Project Optimization Model

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1 Sets (Entities)

This section defines the fundamental sets of the optimization model, derived from the `Entities.csv` file. Each set represents a core component of the SCRUM process.

- Project (P): The product or initiative to be developed.
- Team (T): Self-organized, cross-functional development team.
- Worker (W): Individual team member working on the project.
- Feature (F): Mid-sized functionality.
- Skill (S): Professional or social competence of a worker.
- Role (R): Defined responsibilities within the Scrum team.
- ProductOwner (PO): Responsible for product vision and Product Backlog.
- ScrumMaster (SM): Supports the team in applying Scrum.
- ProductBacklog (PB): Ordered list of all requirements.
- Sprint (SP): Fixed time period for creating an increment.
- SprintPlanning (SPP): Kick-off meeting for Sprint preparation.
- DailyScrum (DS): Daily 15-minute team meeting.
- SprintReview (SR): Presentation and acceptance of results.
- SprintRetrospective (SRE): Retrospective for process improvement.
- SprintBacklog (SBL): Selected backlog items + implementation plan.
- SprintGoal (SG): Objective to be achieved within the sprint.
- Epic (E): Large requirement that can be split into stories.
- UserStory (US): Requirement from the perspective of a user.
- Task (TSK): Smallest unit of work within a sprint.
- DevelopmentSnapshot (DEV): Product at the end of a sprint.
- Blocker (BL): Obstacle hindering progress.
- Stakeholder (SH): Interested party in the product (internal/external).
- Velocity (VEL): Average amount of work per sprint.
- ReleasePlan (REP): Plan for releasing specific features.
- Roadmap (RM): Long-term planning across releases.
- ScrumBoard (SCB): Visual representation of tasks during the sprint.
- FeatureDocumentation (FED): Documentation for a specific feature.

2 Indices

The following indices are used to iterate over the elements of their corresponding sets.

- $p \in P$: Index for the set of Projects.
- $t \in T$: Index for the set of Teams.
- $w \in W$: Index for the set of Workers.
- $f \in F$: Index for the set of Features.
- $s \in S$: Index for the set of Skills.
- $r \in R$: Index for the set of Roles.
- $po \in PO$: Index for the set of Product Owners.
- $sm \in SM$: Index for the set of Scrum Masters.
- $pb \in PB$: Index for the set of Product Backlogs.
- $sp \in SP$: Index for the set of Sprints.
- $spp \in SPP$: Index for the set of Sprint Plannings.
- $ds \in DS$: Index for the set of Daily Scrums.
- $sr \in SR$: Index for the set of Sprint Reviews.
- $sre \in SRE$: Index for the set of Sprint Retrospectives.
- $sbl \in SBL$: Index for the set of Sprint Backlogs.
- $sg \in SG$: Index for the set of Sprint Goals.
- $e \in E$: Index for the set of Epics.
- $us \in US$: Index for the set of User Stories.
- $tsk \in TSK$: Index for the set of Tasks.
- $dev \in DEV$: Index for the set of Development Snapshots.
- $bl \in BL$: Index for the set of Blockers.
- $sh \in SH$: Index for the set of Stakeholders.
- $vel \in VEL$: Index for the set of Velocities.
- $rep \in REP$: Index for the set of Release Plans.
- $rm \in RM$: Index for the set of Roadmaps.
- $scb \in SCB$: Index for the set of Scrum Boards.
- $fed \in FED$: Index for the set of Feature Documentations.

3 Goals

This section outlines the objective functions of the optimization model, based on `Goals.csv`. Let $X_{i,\text{attr}}$ denote the value of attribute ‘attr’ for an element i of set X .

- **G0: maximize_feature_priority**

Maximize the weighted sum of priorities for features selected for a release. Let $\delta_{f,rep}$ be a binary variable indicating if feature f is in release plan rep .

$$\text{maximize} \quad 1.5 \sum_{f \in F} \sum_{rep \in REP} X_{f,priority} \cdot \delta_{f,rep}$$

- **G2: maximize_story_points_per_sprint**

Maximize the total story points from user stories assigned to a sprint. Let $\delta_{us,sp}$ be a binary variable indicating if user story us is in sprint sp .

$$\text{maximize} \quad 1.2 \sum_{us \in US} \sum_{sp \in SP} X_{us,story_points} \cdot \delta_{us,sp}$$

- **G3: minimize_task_effort**

Minimize the total effort for all planned tasks.

$$\text{minimize} \quad 0.8 \sum_{tsk \in TSK} X_{tsk,effort}$$

- **G4: maximize_team_velocity**

Maximize the average team velocity.

$$\text{maximize} \quad 1.3 \sum_{t \in T} X_{vel(t),avg_story_points}$$

where $vel(t)$ is the velocity record associated with team t .

- **G5: minimize_blocker_severity**

Minimize the sum of severities for all unresolved blockers.

$$\text{minimize} \quad 1.0 \sum_{bl \in BL} X_{bl,severity} \cdot \mathbb{I}(X_{bl,status} \neq \text{'resolved'})$$

where $\mathbb{I}(\cdot)$ is the indicator function.

- **G7: minimize_project_duration**

Minimize the project end date.

$$\text{minimize} \quad 1.1 \cdot X_{p,project_end}$$

- **G9: maximize_sprint_goal_achievement**

Maximize the achievement status of sprint goals.

$$\text{maximize} \quad 1.4 \sum_{sg \in SG} X_{sg,achievement_status}$$

4 Conditions

This section specifies the constraints of the model, derived from `Conditions.csv`. These must be satisfied in any feasible solution.

- **C0: constrain_team_size_max**

The size of any team must not exceed 9 members.

$$\forall t \in T : \quad X_{t, \text{team_size}} \leq 9$$

- **C1: constrain_team_size_min**

The size of any team must be at least 5 members.

$$\forall t \in T : \quad X_{t, \text{team_size}} \geq 5$$

- **C2: constrain_project_budget**

The total spent budget must not exceed the allocated budget for a project.

$$\forall p \in P : \quad \text{SpentBudget}_p \leq X_{p, \text{budget}}$$

- **C3: require_active_worker**

A worker can only be assigned to a task if their status is 'active'. Let $\alpha_{w, \text{tsk}}$ be the assignment variable.

$$\forall w \in W, \forall \text{tsk} \in TSK : \quad \alpha_{w, \text{tsk}} = 1 \implies X_{w, \text{status}} = \text{'active'}$$

- **C4: sprint_story_points_le_velocity**

The sum of story points in a sprint backlog cannot exceed the team's velocity. Let $t(sp)$ be the team assigned to sprint sp .

$$\forall sp \in SP : \quad \sum_{us \in US} X_{us, \text{story_points}} \cdot \delta_{us, sp} \leq X_{\text{vel}(t(sp)), \text{avg_story_points}}$$

- **C5: require_acceptance_criteria**

A user story can only be selected for a sprint if its acceptance criteria are defined (not NULL).

$$\forall us \in US, \forall sp \in SP : \quad \delta_{us, sp} = 1 \implies X_{us, \text{acceptance_criteria}} \neq \text{NULL}$$

- **C10: task_must_not_be_blocked**

A task's status cannot be 'in progress' if it has any unresolved blockers. Let B_{tsk} be the set of blockers for task tsk .

$$\forall \text{tsk} \in TSK : X_{\text{tsk}, \text{status}} = \text{'in progress'} \implies (\forall bl \in B_{\text{tsk}} : X_{bl, \text{status}} = \text{'resolved'})$$

- **C12: limit_sprint_backlog_effort**

The total effort in a sprint backlog must not exceed a given threshold E_{max} .

$$\forall sbl \in SBL : \quad X_{sbl, \text{total_effort}} \leq E_{\text{max}}$$

5 Decision Variables

These are the variables that the optimization model will determine, based on `DecisionVariables.csv`.

- **DV0: assign_worker_to_task**

Let $\alpha_{w,tsk}$ be a binary decision variable.

$$\alpha_{w,tsk} = \begin{cases} 1 & \text{if Worker } w \text{ is assigned to Task } tsk \\ 0 & \text{otherwise} \end{cases} \quad (\forall w \in W, \forall tsk \in TSK)$$

- **DV1: select_user_story_for_sprint**

Let $\delta_{us,sp}$ be a binary decision variable.

$$\delta_{us,sp} = \begin{cases} 1 & \text{if User Story } us \text{ is selected for Sprint } sp \\ 0 & \text{otherwise} \end{cases} \quad (\forall us \in US, \forall sp \in SP)$$

- **DV2: set_feature_priority**

Let π_f be an integer variable for the priority of Feature f .

$$\pi_f \in \{1, 2, 3, 4, 5\}, \quad \forall f \in F$$

- **DV3: adjust_team_size**

Let σ_t be an integer variable for the size of Team t .

$$\sigma_t \in \{3, 4, \dots, 9\}, \quad \forall t \in T$$

- **DV6: set_story_points_for_user_story**

Let ρ_{us} be an integer variable representing the story points for User Story us .

$$\rho_{us} \in \{1, 2, 3, 5, 8, 13\}, \quad \forall us \in US$$

- **DV9: approve_project_budget**

Let β_p be a continuous variable for the budget of Project p .

$$\beta_p \in \mathbb{R}^+, \quad 50000 \leq \beta_p \leq 2000000, \quad \forall p \in P$$

- **DV10: select_feature_for_release**

Let $\gamma_{f,rep}$ be a binary decision variable.

$$\gamma_{f,rep} = \begin{cases} 1 & \text{if Feature } f \text{ is selected for Release Plan } rep \\ 0 & \text{otherwise} \end{cases} \quad (\forall f \in F, \forall rep \in REP)$$