Optimization Model for a SCRUM-based Software Development Process

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Contents

1 Sets (Entities)

- The set of all **Projects**, denoted by $P = \{p_1, \ldots, p_{|P|}\}$.
- The set of all **Teams**, denoted by $T = \{t_1, \ldots, t_{|T|}\}$.
- The set of all **Workers**, denoted by $W = \{w_1, \ldots, w_{|W|}\}$.
- The set of all **Features**, denoted by $F = \{f_1, \ldots, f_{|F|}\}$.
- The set of all **Skills**, denoted by $S = \{s_1, \ldots, s_{|S|}\}$.
- The set of all **Roles**, denoted by $R = \{r_1, \ldots, r_{|R|}\}$.
- The set of all **ProductOwners**, denoted by $PO = \{po_1, \ldots, po_{|PO|}\}$.
- The set of all **ScrumMasters**, denoted by $SM = \{sm_1, \ldots, sm_{|SM|}\}$.
- The set of all **ProductBacklogs**, denoted by $PB = \{pb_1, \ldots, pb_{|PB|}\}$.
- The set of all **Sprints**, denoted by $SP = \{sp_1, \ldots, sp_{|SP|}\}$.
- The set of all **SprintPlannings**, denoted by $SPP = \{spp_1, \ldots, spp_{|SPP|}\}$.
- The set of all **DailyScrums**, denoted by $DS = \{ds_1, \ldots, ds_{|DS|}\}$.
- The set of all **SprintReviews**, denoted by $SR = \{sr_1, \ldots, sr_{|SR|}\}$.
- The set of all **SprintRetrospectives**, denoted by $SRE = \{sre_1, \ldots, sre_{|SRE|}\}$.
- The set of all **SprintBacklogs**, denoted by $SBL = \{sbl_1, \ldots, sbl_{|SBL|}\}$.
- The set of all **SprintGoals**, denoted by $SG = \{sg_1, \ldots, sg_{|SG|}\}$.
- The set of all **Epics**, denoted by $E = \{e_1, \ldots, e_{|E|}\}$.
- The set of all **UserStories**, denoted by $US = \{us_1, \ldots, us_{|US|}\}$.
- The set of all **Tasks**, denoted by $TSK = \{tsk_1, \ldots, tsk_{|TSK|}\}$.
- The set of all **DevelopmentSnapshots**, denoted by $DEV = \{dev_1, \ldots, dev_{|DEV|}\}$.
- The set of all **Blockers**, denoted by $BL = \{bl_1, \ldots, bl_{|BL|}\}$.
- The set of all **Stakeholders**, denoted by $SH = \{sh_1, \ldots, sh_{|SH|}\}$.
- The set of all **Velocities**, denoted by $VEL = \{vel_1, \ldots, vel_{|VEL|}\}$.
- The set of all **ReleasePlans**, denoted by $REP = \{rep_1, \ldots, rep_{|REP|}\}$.
- The set of all **Roadmaps**, denoted by $RM = \{rm_1, \ldots, rm_{|RM|}\}$.
- The set of all **ScrumBoards**, denoted by $SCB = \{scb_1, \ldots, scb_{|SCB|}\}$.
- The set of all **FeatureDocumentations**, denoted by $FED = \{fed_1, \ldots, fed_{|FED|}\}$.

2 Indices

- $p \in P$: An index for a Project.
- $t \in T$: An index for a Team.
- $w \in W$: An index for a Worker.
- $f \in F$: An index for a Feature.
- $s \in S$: An index for a Skill.
- $r \in R$: An index for a Role.
- $po \in PO$: An index for a ProductOwner.
- $sm \in SM$: An index for a ScrumMaster.
- $pb \in PB$: An index for a ProductBacklog.
- $sp \in SP$: An index for a Sprint.
- $us \in US$: An index for a UserStory.
- $tsk \in TSK$: An index for a Task.
- $bl \in BL$: An index for a Blocker.
- $sh \in SH$: An index for a Stakeholder.
- $rep \in REP$: An index for a ReleasePlan.

3 Goals (Objective Functions)

- **ID:** G0
  Name: maximize_story_points_per_sprint
  Formulation: Let SP_{us} be the story points for user story us. Let $y_{us,sp}$ be a decision variable that is 1 if us is assigned to sprint sp.

$$\text{maximize} \sum_{sp \in SP} \sum_{us \in US} SP_{us} \cdot y_{us,sp}$$

- **ID:** G1
  Name: minimize_effort_per_feature
  Formulation: Let $Effort_f$ be the estimated effort for feature f. Let $z_{f,rep}$ be 1 if f is in release plan rep.

$$\text{minimize} \sum_{rep \in REP} \sum_{f \in F} Effort_f \cdot z_{f,rep}$$

- **ID:** G2
  Name: maximize_team_satisfaction
  Formulation: Let Sat_{sre} be the team satisfaction recorded in retrospective sre.

$$\text{maximize} \sum_{sre \in SRE} Sat_{sre}$$

- **ID:** G3
  Name: minimize_number_of_open_blockers
  Formulation: Let $Status_{bl}$ be a parameter that is 1 if blocker bl is open. Let r_{bl} be 1 if we decide to resolve bl.
$$\text{minimize} \sum_{bl \in BL} Status_{bl} \cdot (1 - r_{bl})$$

- **ID:** G4
  Name: maximize_priority_of_user_stories
  Formulation: Let $Prio_{us}$ be the priority for user story us.
$$\text{maximize} \sum_{sp \in SP} \sum_{us \in US} Prio_{us} \cdot y_{us,sp}$$

4 Conditions (Constraints)

- **ID:** C0
  Name: sprint_capacity_limit
  Formulation: The sum of story points in a sprint cannot exceed the velocity of the team assigned to that sprint. Let Vel_t be the velocity of team t, and let $Team(sp)$ be the team assigned to sprint sp.
$$\sum_{us \in US} SP_{us} \cdot y_{us,sp} \leq Vel_{Team(sp)} \quad \forall sp \in SP$$

- **ID:** C1
  Name: project_budget_limit
  Formulation: The allocated budget for a project must not exceed its maximum budget. Let b_p be the budget decision variable for project p, and B_p be the maximum budget parameter.
$$b_p \leq B_p \quad \forall p \in P$$

- **ID:** C2 & C3
  Name: team_size_minimum & team_size_maximum
  Formulation: The size of each team must be within a defined range. Let $size_t$ be the decision variable for the size of team t.
$$3 \leq size_t \leq 10 \quad \forall t \in T$$

- **ID:** C4
  Name: worker_availability
  Formulation: A worker cannot be assigned to any team if their status is 'on leave'. Let $x_{w,t}$ be 1 if worker w is assigned to team t. Let $OnLeave_w$ be a parameter that is 1 if worker w is on leave.
$$\sum_{t \in T} x_{w,t} \leq (1 - OnLeave_w) \quad \forall w \in W$$

- **ID:** C6 & C7
  Name: must_have_product_owner & must_have_scrum_master
  Formulation: Each team must have exactly one Product Owner and one Scrum Master. Let $IsPO_w$ and $IsSM_w$ be parameters indicating if worker w has the respective role.
$$\sum_{w \in W} IsPO_w \cdot x_{w,t} = 1 \quad \forall t \in T$$
$$\sum_{w \in W} IsSM_w \cdot x_{w,t} = 1 \quad \forall t \in T$$

- **ID:** C9
  Name: task_blocked_status
  Formulation: A task cannot be 'Done' if it has an active blocker. Let $Done_{tsk}$ be 1 if task tsk is done. Let $IsBlocked_{tsk}$ be 1 if it has an active blocker.

$$Done_{tsk} + IsBlocked_{tsk} \leq 1 \quad \forall tsk \in TSK$$

5 Decision Variables

- **ID:** DV0
  Name: assign_worker_to_team
  Variable: $x_{w,t} \in \{0, 1\}$, 1 if worker $w \in W$ is assigned to team $t \in T$.

- **ID:** DV1
  Name: assign_user_story_to_sprint
  Variable: $y_{us,sp} \in \{0, 1\}$, 1 if user story $us \in US$ is assigned to sprint $sp \in SP$.

- **ID:** DV2
  Name: select_feature_for_release
  Variable: $z_{f,rep} \in \{0, 1\}$, 1 if feature $f \in F$ is selected for release plan $rep \in REP$.

- **ID:** DV3
  Name: assign_task_to_worker
  Variable: $a_{tsk,w} \in \{0, 1\}$, 1 if task $tsk \in TSK$ is assigned to worker $w \in W$.

- **ID:** DV4
  Name: determine_team_size
  Variable: $size_t \in \mathbb{Z}^+$, the number of workers in team $t \in T$.

- **ID:** DV5
  Name: allocate_project_budget
  Variable: $b_p \in \mathbb{R}^+$, the budget allocated to project $p \in P$.

- **ID:** DV6
  Name: set_sprint_duration
  Variable: $d_{sp} \in \{7, 14, 21, 28\}$, the duration in days of sprint $sp \in SP$.

- **ID:** DV7
  Name: estimate_story_points
  Variable: $sp_{us} \in \{1, 2, 3, 5, 8, \dots\}$, the story points for user story $us \in US$.

- **ID:** DV10
  Name: resolve_blocker
  Variable: $r_{bl} \in \{0, 1\}$, 1 if a decision is made to resolve blocker $bl \in BL$.