Glossary

Algorithm Stepwise procedure for finding the solution of a problem.

Backtracking Traveling a tree graph from a leaf node towards the root node.

Backward graph Directed acyclic graph modeling the optimal transitions among all the possible states of the system, with root on the end time of the latest end time pass, and with edges pointing from earlier to later nodes.

Belief network Directed acyclic graph which nodes represent random variables, and edges conditional dependencies among them.

Best pair of nodes in stage Nodes in a stage of the directed acyclic graph modeling the optimal transitions among all the possible states of the system, one of them including the pass associated with that stage and the other not, and only one of them belonging to the longest path of the graph depending on the priority of that pass.

Class NP (Nondeterministic polynomial). Set of problems which solution can be verified with a polynomial time algorithm.

Class P (Polynomial). Set of problems for which a polynomial time algorithm is known.

Clique problem Problem of finding a subgraph with a certain number of nodes, with all pairs of nodes connected.

Complexity We refer to the computational complexity of an algorithm as the time required to obtain a solution as a function of the size of the input of the problem.

Conflict Two passes are said to be conflicting if they are both time-overlapping and associated with the same satellite or ground station, or if they are associated with the same request.

Decision problem Problem which solution is a boolean value.

Directed acyclic graph (DAG) Graph with nodes connected by directed edges, and which does not contain any directed path starting and ending in the same node.

Distributed scheduler Scheduler based on the decisions of multiple agents with different objectives and/or available information.

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Due time of a request Deadline of the request.

Earth observation Aerospace application field which objective is the imaging of specific spots of the Earth, generally performed through low Earth orbit (LEO) satellites.

Event Tuple associated with start and end times of the passes used for the generation of the graph modeling the transitions among all the possible states of the system.

Executed schedule Set of passes that have been tracked, that is, the communication (or observation) has been successful, at the end of the scheduling horizon.

Expected metric In a scenario involving uncertainty, the expected metric of the schedule provides the average metric if the schedule were executed a large number of times.

Extensive form representation Tree graph representing all the possible actions of the players in a game, with each level of the graph representing the action of a player, and with the leaves of the tree having associated payoffs for all the players.

Feasible schedule Schedule with no conflicts.

Fixed interval This term is equivalent to no-slack.

Fixed number of entities (FNE) The number of ground stations and satellites is constant.

Follower In a feedback Stackelberg game, player that takes action after the leader.

Forward graph Directed acyclic graph modeling the optimal transitions among all the possible states of the system, with root on the start time of the earliest start time pass, and with edges pointing from later to earlier nodes.

Frontier Set of nodes that are checked in the creation of the next stage for the graph modeling the transitions among all the possible states of the system.

Game theory Discipline that models multi-agent strategic decision making.

General scheduling Also called machine scheduling, it is a field of research focused on the allocation of jobs in a set of resources.

Geostationary orbit Circular equatorial prograde orbit with the same orbital period as the Earth, so the satellite remains over the same spot on Earth at all times.

Graph Set of nodes connected by edges.

Greedy algorithm Algorithm which iteratively takes locally optimal solutions according to a heuristic, but in general does not guarantee finding the optimal global solution.

Ground segment Facilities for the communication, command and operation of the satellite, and for reception and distribution of data in a satellite mission. It is composed by one or various ground stations, mission control centers, data distribution centers, and an interconnection network.

Ground station Telecommunication facilities for communicating to a satellite.

Ground station network Set of ground stations grouped for increasing the coverage and capabilities of the satellite mission.

Heuristic Rule followed in a suboptimal solution algorithm, like the ordering of tasks in a greedy algorithm.

Heuristic algorithm Algorithm that does not guarantee finding the optimal solution.

Indegree of a node Number of edges ending in the node.

Interval graph Undirected graph where nodes represent intervals, and edges among pairs of nodes the intersection among pairs of intervals.

Job Input unit in a scheduling problem basically associated with a resource for a certain period of time.

Leader In a feedback Stackelberg game, player that takes action first.

Leader satellite Satellite that decides which edge is dismissed in an end time stage in noncooperative SRS.

Leaf node (of directed tree graph) Node with null indegree in a tree directed towards the root.

Line of sight (LOS) Two objects are in line of sight if the imaginary line that connects them does not intersect any object. More specifically, a satellite is in line of sight with a ground station if it is above its horizon.

Longest path For a pair of nodes in a graph, it is the path between them which sum of priorities associated with its edges is maximal.

Low Earth orbit (LEO) Earth orbit with an altitude smaller than around 10^3 km.

***m*-ary capacity** Constraint that applies to scenarios where satellites may communicate to at most m ground stations at the same time (or vice versa).

Machine scheduling See general scheduling.

Maximin payoff Maximum payoff achievable by a player for the worst case.

Metric Sum of the priorities (preference value) of a feasible schedule.

Mission control center Facilities for the operation of the satellite.

Multiple-interval graph Undirected graph where nodes represent sets of intervals, and edges among pairs of nodes the intersection among pairs of intervals from the two corresponding sets of intervals.

Multiple Resource Range Scheduling Problem (MuRRSP) Term used in literature for Satellite Range Scheduling (SRS) for multiple ground stations and satellites.

Multiply connected belief network Belief network that contains at least a pair of nodes connected by different paths.

Nash equilibrium Solution of a game where no player can improve its payoff by unilaterally deviating from this solution.

Noncooperative game theory Branch of game theory that considers players which have conflicting interests.

NP-complete A decision problem is said to be NP-complete if its solution can be verified in polynomial time (i.e., it belongs to the class NP) and it can be transformed in polynomial time into another known NP-complete problem.

NP-hard A problem is NP-hard if it is at least as complicated as an NP-complete problem (i.e., it can be transformed into another known NP-complete problem).

Operations plan Set of rules and procedures for the operation of the satellite from which the communication (or observation) requests are generated.

Optimal schedule Feasible schedule with maximal metric.

Outdegree of a node Number of edges originating in the node.

Pass Tuple modeling an interaction with fixed start and end times between a ground station and a satellite, and with an assigned priority. It is the analogous to fixed-interval job in general scheduling.

Path (directed) Given a pair of nodes in a directed tree, a path is a directed sub-tree that has one of those nodes as root and the other node as the only leaf.

Payoff Metric specific for each player in a game.

Precedence Constraint applicable to an SRS problem if a pass requires another pass already executed to initiate.

Preemption Constraint applicable to an SRS problem if a pass can be interrupted along its execution.

Price of anarchy (PoA) Ratio between the sum of the payoffs for all players and the centralized metric of the optimal solution.

Priority (or suitability) function Function that models the preference of a request depending on its duration and location in the visibility window.

Priority of a pass Value for modeling preference relations among passes.

Probabilistic inference Calculation of probabilities in a belief network.

Rational player In game theory, player that aims at maximizing its own associated metric.

Reactive scheduler Scheduler that recomputes the optimal schedule after the priority changes are known, aiming at reducing the recomputation time.

Redundancy Constraint applicable to an SRS problem if conflicts of some kind are allowed. See *m*-ary capacity.

Release time of a request Time after which the interaction can start.

Request Tuple modeling an interaction between a ground station and a satellite, which must be executed between a release time and a due time, which duration is smaller or equal to the difference of these times and which priority depends on its start time and duration. It is the analogous to job in general scheduling.

Robust schedule Schedule, not necessarily feasible, which has the highest expected metric.

Robust scheduler Scheduler that generates a static schedule taking into account uncertainty.

Root node (of directed tree graph) Node with null outdegree (in a tree graph directed towards the root).

Satellite Orbiting spacecraft with communication, observation, or experimentation applications.

Satellite communication We refer to communication involving a satellite and a ground station.

Satellite mission Project for launching and operating a satellite with a particular objective.

Satellite operator Staff in charge of planning, scheduling and commanding the satellite.

Satellite Range Scheduling (SRS) Problem of allocating a set of time intervals (requests) among two kinds of entities (generally ground stations and satellites). These intervals may have a variety of constraints, like mutual exclusion between some of them, and preference relations.

Schedule Subset of the initial set of passes.

Scheduler System which, given an initial set of requests, provides a schedule satisfying certain conditions depending on the type of problem.

Scheduling horizon Time window that contains all the time intervals associated with the initial set of requests.

Security strategy Set of actions that guarantees to the player a maximin payoff regardless of the actions of the other players.

Selfish A selfish satellite is that which aims at maximizing its own associated metric, instead of the (centralized) metric of the schedule.

Single Resource Range Scheduling Problem (SiRRSP) Term used in literature for Satellite Range Scheduling (SRS) for a single ground station or satellite.

Slack Applied to requests that have no fixed start and end times.

Social welfare (SW) In noncooperative SRS, it is equivalent to the metric of the schedule.

Stackelberg equilibrium Solution of a Stackelberg game in which no player can improve its payoff by unilaterally deviating from this solution.

Stackelberg game Game where players take actions in pre-specified turns.

Stage Set of nodes associated with the same event in a forward (or backward) graph.

Static scheduler Scheduler that provides a schedule only once before the scheduling horizon.

Suboptimal solution algorithm Algorithm that provides a solution which performance (metric of the schedule) is smaller than that of the optimal.

Task See job.

Time overlapping Two intervals are said to be time overlapping if the start time of one of them is between the start and end times of the other one.

Time varying graph (TVG) Graph which edges' presence varies along time.

Tractable We say that a problem is tractable if it can be solved in polynomial time.

Tree graph (directed towards root) Graph with a single undirected path between every pair of nodes, and with every node having unitary outdegree, except one of them (root) which has null outdegree.

Unified notation Notation widely used in general scheduling literature to classify problems.

Unitary capacity Constraint that applies to scenarios where satellites may only communicate to one ground station at the same time and vice versa.

Visibility window Time window during which there is line of sight between two objects.

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