GTOC X, The 10^{th} Global Trajectory Optimisation Competition
– Settlers of the Galaxy –
Format Specification for Solution Files

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Released: 15 May 2019

Preliminaries

A solution file contains the data for the entire settlement tree computed by a team. All trajectories that are part of the tree are recorded in the file. If a team wishes to alter part or all of their solution, a new file for the entire settlement tree must be submitted. The submission epoch used in scoring the new file will be the epoch at which that new file was submitted. If the file passes the final validation step and the scoring step, the team's current Leaderboard entry will be updated if the new submission improves upon it.

The file format is summarized in Table 1 and described below.

Table 1: **Solution File format**

Line num in file	Data
line 1	— header line, discarded —
line 2	$-1,\ 0,\ N_{sp},\ M,\ T_1,\ \dots\ ,\ T_M,\ \Delta V1_x,\ \Delta V1_y,\ \Delta V1_z,\ \dots\ ,\ \Delta VM_x,\ \Delta VM_y,\ \Delta VM_z$
line 3	$-1,\ 1,\ ID1,\ T,\ \Delta V_x,\ \Delta V_y,\ \Delta V_z$
line 4	$-1,\ 2,\ ID2,\ T,\ \Delta V_x,\ \Delta V_y,\ \Delta V_z$
⋮	⋮ ⋮
line $N_{sp}+2$	$-1,\ N_{sp},\ IDN_{sp},\ T,\ \Delta V_x,\ \Delta V_y,\ \Delta V_z$
line $N_{sp}+3$	$-2,\ 0,\ \dots\ \dots$
line $N_{sp}+4$	$-2,\ 1,\ \dots$
⋮	⋮ ⋮
line p	$-3,\ 0,\ \dots\ \dots$
⋮	⋮ ⋮
line q	$-11,\ ID,\ T_1,\ T_2,\ \Delta V1_x,\ \Delta V1_y,\ \Delta V1_z,\ \Delta V2_x,\ \Delta V2_y,\ \Delta V2_z$
line $q+1$	$-12,\ ID,\ T_1,\ T_2,\ \Delta V1_x,\ \Delta V1_y,\ \Delta V1_z,\ \Delta V2_x,\ \Delta V2_y,\ \Delta V2_z$
line $q+2$	$ID_{dep1},\ ID_{arr1},\ M,\ T_1,\ \dots\ ,\ T_M,\ \Delta V1_x,\ \Delta V1_y,\ \Delta V1_z,\ \dots\ ,\ \Delta VM_x,\ \Delta VM_y,\ \Delta VM_z$
line $q+3$	$ID_{dep1},\ ID_{arr2},\ M,\ T_1,\ \dots\ ,\ T_M,\ \Delta V1_x,\ \Delta V1_y,\ \Delta V1_z,\ \dots\ ,\ \Delta VM_x,\ \Delta VM_y,\ \Delta VM_z$
line $q+4$	$ID_{dep1},\ ID_{arr3},\ M,\ T_1,\ \dots\ ,\ T_M,\ \Delta V1_x,\ \Delta V1_y,\ \Delta V1_z,\ \dots\ ,\ \Delta VM_x,\ \Delta VM_y,\ \Delta VM_z$
line $q+5$	$ID_{dep2},\ ID_{arr1},\ M,\ T_1,\ \dots\ ,\ T_M,\ \Delta V1_x,\ \Delta V1_y,\ \Delta V1_z,\ \dots\ ,\ \Delta VM_x,\ \Delta VM_y,\ \Delta VM_z$
line $q+6$	$ID_{dep3},\ ID_{arr1},\ M,\ T_1,\ \dots\ ,\ T_M,\ \Delta V1_x,\ \Delta V1_y,\ \Delta V1_z,\ \dots\ ,\ \Delta VM_x,\ \Delta VM_y,\ \Delta VM_z$
line $q+7$	$ID_{dep3},\ ID_{arr2},\ M,\ T_1,\ \dots\ ,\ T_M,\ \Delta V1_x,\ \Delta V1_y,\ \Delta V1_z,\ \dots\ ,\ \Delta VM_x,\ \Delta VM_y,\ \Delta VM_z$
line $q+8$	$ID_{dep3},\ ID_{arr3},\ M,\ T_1,\ \dots\ ,\ T_M,\ \Delta V1_x,\ \Delta V1_y,\ \Delta V1_z,\ \dots\ ,\ \Delta VM_x,\ \Delta VM_y,\ \Delta VM_z$
line $q+9$	$ID_{dep4},\ ID_{arr1},\ M,\ T_1,\ \dots\ ,\ T_M,\ \Delta V1_x,\ \Delta V1_y,\ \Delta V1_z,\ \dots\ ,\ \Delta VM_x,\ \Delta VM_y,\ \Delta VM_z$
⋮	⋮ ⋮

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File format

The solution file must be an ASCII text file. The data layout in the file is shown in Table 1. The first line of the file is a header line and is discarded. The first data line of the file is line 2. Data lines contain only numerical data, specifically integers and floating point numbers; numbers must be separated by either spaces, a comma, or a comma and spaces. The following describes the data:

- **The file has three main sections:** One for Mother Ships and their Settlement Pods, one for Fast Ships and one for Settler Ships. **The sections must appear in that order.** If no Mother Ships are used or no Fast Ships are used, the corresponding section is simply omitted; of course, at least one of those two sections must be present, otherwise the settlement tree cannot get started.

- **Units and numeric types:** Epochs are in Myr past Year Zero. ΔV components are in km/s. All epochs and ΔV components are floating point numbers. All other numbers are integers.

- **For all Ships**, maneuvers are enumerated starting at 1 for the maneuver performed to depart from Sol or a settled star.

- **Mother Ships** are enumerated in the order $-1, -2, -3$ (indicated by the first number on the line). Each Mother Ship has a line for itself (lines 2, $(N_{sp}+3)$, p for Mother Ships -1, -2, -3), followed by a line for each Settlement Pod it releases. The second number on these lines indicates the Settlement Pod sequential ID number, except for 0 denoting the Mother Ship itself. The remainder of the Mother Ship line (*e.g.,* **line 2: Ship −1**) is as follows:

  - $N_{sp} \leq 10$: number of Settlement Pods released by the Mother Ship
  - $M \leq 3$: number of maneuvers performed by the Mother Ship
  - $T_1 \ldots T_M$: the epochs of the Mother Ship maneuvers (Myr past Year Zero)
  - $\Delta Vi_x, \Delta Vi_y, \Delta Vi_z$: the x, y, z Cartesian components of the i^{th} maneuver (km/s)

  The line for each Settlement Pod (*e.g.,* **line 4**), is as follows: Mother Ship ID, Settlement Pod number (*e.g.,* 2^{nd} Pod released), star ID, epoch of Pod release, x, y, z Cartesian components of the Pod's arrival maneuver.

- **Fast Ships** are enumerated in the order -11, -12. There is one line per Fast Ship, **lines q, $(q+1)$**, with the following data: Fast Ship ID, star ID, epoch of departure from Sol, epoch of arrival at star, x, y, z Cartesian components of the departure maneuver, x, y, z Cartesian components of the arrival maneuver.

- **Settler Ships** are listed one per line. All Settler Ships departing a given star (a maximum of three Ships) must be listed on consecutive lines, in order of departure epoch from the star, *e.g.,* **lines $(q+2)$ to $(q+4)$**. The line contains: ID of departure star, ID of arrival star, number of maneuvers performed (≤ 5), the epochs at which the maneuvers are performed (chronological order), x, y, z Cartesian components for each maneuver.