Optimally Scheduling Resource Constraint Project Using SAS/OR®

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ABSTRACT

This paper shares with SAS users an approach to effectively distribute programming resources in a clinical study project or among several projects by using procedures and macros in SAS/OR®.

Considering some activities in a project may have precedence and time constraints, and each programmer may also have different time constraints, such as different start date and quit date on a project, personal vacation, etc., one effective method is to use constraint programming procedure CLP to optimally schedule these activities for project management. By incorporating a specific calendar, user can estimate the project target date with the constraint resource, or forecast the required programming resource with the constraint target date.

Plot procedures NETDRAW and GANTT for visualizing activity data are described in this paper as well.

Keywords: SAS/OR, CLP, NETDRAW, GANTT, CSP, Project Management

INTRODUCTION

From SAS 9.1, the constraint programming procedure PROC CLP was introduced in SAS/OR® for solving constraint satisfaction problems (CSP) with linear, logical, global, and scheduling constraints. Here CSP can be described by a set of variables X, a set of possible values D for each variable, and a set of constraints C between the variables. Different methods of constraint programming are used to determine whether there exists an assignment of values to variables, so that all the constraints are satisfied.

There are two modes in the context of the CLP procedure to solve two different type of constraint satisfy problems: standard CSPs and scheduling CSPs. The standard mode is to resolve linear constraints, all-different constraints, and array constraints. For example, the Send More Money problem and the Eight Queens problem are two standard CSPs. The scheduling mode can process some scheduling constraints such as temporal constraints and resource constraints.

In scheduling mode, the variables are referred to as activities and the solution is referred to as a schedule. In a statistical programming environment of clinical study project, activities could be but not limited to all sorts of analyses in study level or product level, such as UAT, CSR, PSR, DMC, ISS/ISE, etc. Even in each analysis, we can divide the project into activities such as SDTM creation, ADaM generation, TLG programming, etc. Constraints in a project could be the timeline of all activities or limited resources such as available SAS programmers. Based on the constraint time, or constraint programming resource, or both, a schedule as the solution can be analyzed by PROC CLP.

ACTIVITY DATA WITH CONSTRAINTS

In this paper, a real-life clinical statistical programming project is used as an example to show the usage of resource-constraint scheduling with temporal constraints by CLP procedure. Table 1 displays the programming activities, precedence constraints among activities, duration of each activity, and resource constraints. Each activity belongs to a group such as SDTM, ADaM, TLG, etc. We can consider it a milestone when completing each group of activities. Each group has been added a null start activity and null end activity to indicate the milestone. The duration for such null activities is zero. The numbers in the "Resource" column represent SAS programmers such as programmer P1, programmer P2, and programmer P3. Most activities can be performed by any programmer ("P1, P2, P3"). Some specific activity can be assigned to specific programmer. For example, in the table, activity "DM" is assigned to programmer P1. The "Status" column is the status of activity completion. If it is completed, it will be shown as "FINISH". We name this programming activity dataset as PgmAct.

The activity dataset accepted by CLP procedure requires at least two default variables: one is _ACTIVITY_ which determines the activity, and the other is _DURATION_ which determines the activity duration. Without the required variables CLP procedure can't execute. Default variable _SUCCESSOR_ in the activity dataset defines precedence-type relationships between activities. The following code creates the required activity dataset ActData from dataset PgmAct. Partial observations from dataset ActData are displayed in Table 2.

```
proc sql noprint; ①
    select activity into :sdtm separated by ','
    from PgmAct where group='SDTM'
    ;
    select activity into :lkup separated by ','
```

```
from PgmAct where group='LKUP'
  select activity into :adam separated by ','
  from PgmAct where group='ADAM'
  select activity into :tlq separated by ','
  from PqmAct where group='TLG'
quit;
data PgmAct; 0
  length predecessors $1000;
  set PgmAct;
  if activity='E_SDTM' then predecessors="&sdtm";
  else if activity='E_LKUP' then predecessors="&lkup";
  else if activity='E_ADAM' then predecessors="&adam";
  else if activity='E TLG' then predecessors="&tlq";
  order=_n_;
run:
proc sort data=PgmAct;
by activity;
run;
data pred(keep=_ACTIVITY__SUCCESSOR_); 0
 length _ACTIVITY _ SUCCESSOR_ $11;
 set PgmAct(rename=(activity= SUCCESSOR ));
 predecessors=compress(predecessors);
 if predecessors > "" then do;
  nPred=length(predecessors)-length(compress(predecessors, ', '))+1;
   do i=1 to nPred;
      ACTIVITY =scan(predecessors, i);
      output;
   end;
 end;
run:
proc sort data=pred;
by ACTIVITY ;
run;
data ActData(keep=_ACTIVITY__SUCCESSOR__DURATION__DESC_ order); 0
 merge PgmAct(rename=(activity=_ACTIVITY__description=_DESC_))
        pred;
 by ACTIVITY ;
  DURATION =duration;
  label _ACTIVITY_ = 'Activity'
       _SUCCESSOR_ = 'Successor Activity'
                   = 'Description of Activity'
        DESC
        ;
run;
proc sort data=ActData;
by order;
run;
```

The PROC SQL statements and data step marked by **0** replace "All activities from xxx" with all real activity names from group xxx. Here xxx may be "SDTM", "LKUP", "ADAM", or "TLG". Data steps marked by **0** transform records from predecessors to _SUCCESSOR_.

To visualize the activity data, a network diagram of the activities is drawn by PROC NETDRAW in SAS/OR®. In Figure 1, nodes represent the activities, and arcs represent the precedence relationships among the activities.

```
run;
```

Option data= marked by ③ is for the activity dataset used by PROC NETDRAW to produce a network diagram. Option act= in ACTNET statement marked by ④ specifies the variable in the activity dataset that names the nodes. Here we assign variable _ACTIVITY_ as the nodes to option act=. Option succ= specifies all the immediate successors of the node specified by _ACTIVITY_. Here we assign variable _SUCCESSOR_ to option succ=.

CLP PROCEDURE

When the activity dataset with required variables is ready, we can call PROC CLP to generate an optimal scheduling plan.

```
proc clp actdata=actdata scheddata=scheddata;
    schedule edgefinder=first finish=60;
    resource (P1-P3);
    requires &req;
    run;
    %put &_ORCLP_;
```

Option actdata= in proc clp statement accepts input dataset that defines the activities and temporal constraints. If there is no activity dataset assigned, the activities and temporal constraint should be specified in the activity statement, which is one of the statements in CLP procedure not shown in the above code. Option scheddata= identifies the output dataset that contains the scheduling solution to the resource constraint project.

Option edgefinder= in the schedule statement[®] invokes the edge-finding consistency routine for scheduling problem. Edge-finding consistency routine can determine each activity's priority based on the same resource or set of resources so as to form the processing order of a set of activities. Specifying edgefinder=first here is to detect whether a given activity must be processed first in a set of activities that require the same resource or set of resource. Option finish= is to specify the finish time for the schedule. Here finish=60 means whether a scheduling solution exists when the project is required to be finished within 60 days.

The resource statement specifies all resources allocated to the activities. In our example, available resources are three programmers (P1-P3).

The requires statement specifies the available resources associated with each activity. Macro variable $req\Theta$ is the specification generated from dataset PgmAct by the following code:

```
** Create macro varible for REQUIRES statement in CLP procedure **;
proc sort data=PgmAct out=requires;
by resource activity;
where resource > '';
run;
data _null_;
  length requires $2000;
  set requires end=last;
 by resource activity;
  retain requires '';
  if first.resource then requires=trim(requires) || ' (';
  requires=trim(requires) || ' '||strip(activity);
  if last.resource then
     requires=trim(requires) | | ') = (' | strip(resource) | ')';
  if last then call symput('req',strip(requires));
run:
```

Macro _ORCLP_ is automatically generated by the CLP procedure to indicate the completion status of the procedure. In the log file, we can find the message "STATUS=SUCCESSFUL SOLUTIONS_FOUND=1" printed by the macro _ORCLP_, which indicates the CLP procedure executes successfully and there is one scheduling solution to finish this project in 60 days by three programmers.

SCHEDULING SOLUTION GENERATED FROM CLP PROCEDURE

The "product" generated by CLP procedure is the dataset scheddata. In dataset scheddata, besides the variable ACTIVITY and DUR, there are new variables: SOLUTION, START, FINISH, P1, P2, and P3. Since there is only one solution

in the example, values of SOLUTION are all 1. START and FINISH are scheduled start day and end day. P1, P2, and P3 are flags of the activities assigned to the programmers. Here we combine P1, P2, P3 into one variable RESOURCE and display the data in Table 3. Although this project has 60 day time-constraint, the optimal scheduling solution generated by the CLP procedure only requires 49 days.

```
data scheduling(keep=activity dur start finish resource);
   set scheddata;
   length RESOURCE $2;
   if P1=1 then resource='P1';
   else if P2=1 then resource='P2';
   else if P3=1 then resource='P3';
run;
proc sort data=scheduling;
   by start finish resource;
run;
```

To visualize the scheduled programming activity in dataset scheduling, GANTT procedure is used to generate a Gannt chart segmented by the scheduled programming activity of each programmer (Figure 2).

```
** Create variable _pattern for PATTERN= option in GANTT procedure***;
** pattern variable is used to identify the pattern for drawing the bar**;
data sched;
set scheduling;
 _pattern=_n_;
run;
proc sort data=sched;
     by resource start;
run;
*** Add segmt_no variable to identify the number of segments ***;
data newsched;
set sched:
retain segmt no;
if resource ne laq(resource) then segmt no=1;
else segmt_no = segmt_no + 1;
output;
run;
***create reference line data for REF= option in GANTT procedure ***;
proc sql noprint;
    select distinct start into : ref separated by ' '
    from scheduling
   where activity in ('E_SDTM' 'E_ADAM' 'E_TLG' 'E_LKUP');
guit:
*** Create label data ***;
data labels;
    y=-1;
    _xvar="start";
    _flabel="";
    _hlabel=1;
   _yoffset = -.2;
run:
pattern1 v=s r=25;
title h=3 j=1 ' Gantt Chart: Scheduled Programming Activities by Each Programmer';
proc gantt data=newsched labdata=labels graphics;
  id resource:
  chart / ss=start sf=finish compress labsplit='.' scale=2
          nolegend nojobnum skip=3 ref=&ref; 0
run;
```

In the Gantt chart, every row corresponds to a programmer. Every bar on each row consists of multiple segments, and every segment represents an activity. The x-axis lists the schedule timeline in days, and therefore the start and end of each segment represent the start and finish times for each activity. We notice there are four light blue reference lines in Figure 2, which are created by ref= option in the chart statement $\mathbf{0}$. We use these reference lines to indicate different project milestones:

completion of SDTM, lookup tables, ADaM, and TLG. The chart is very efficient to track the progress of multi jobs multi programmers at the same time.

DISCUSSIONS

<u>Scenario 1</u>

If we know the exact programming activities and number of programmers available for the project, how can we know the optimal timeline to arrange each programmer on the project? That is, how to finish the project with minimum time under the available resource? An approach already has been shown to optimize the resource-constraint scheduling in this paper. In the example, three programmers are schedule to finish the project in 49 days.

Scenario 2

If the project timeline is very tight and it is required to be finished in less time, what we should do? Go back to our example in this paper, and we can ask if we can finish the project in 30 days by three programmers. To test this case, we replace the option finish=60^o with finish=30, and execute the CLP procedure again. The string of macro variable _ORCLP_^o will show there is no solution to schedule the project based on the current resource constraint and time constraint. In order to resolve this problem, we can increase the number of programmer from three to four to achieve a solution. By this way we can forecast the resource need for oncoming project.

Scenario 3

In the middle of project progress, if any programming activity is added or dropped, or if any programmer joins in or quits, or if the target date is changed, how can we reschedule the timeline and reallocate the resource on the project? In the dataset PgmAct listed in Table 1, we have variable status which identified the status of each activity. If an activity is finished, "FINISH" will be updated in the variable status and the duration of the activity will be set to zero. We can update the programming resource and project target day by updating schedule@, resource@, and requires@ statements in the CLP procedure. A scheduling solution can be achieved any time by rerunning the CLP procedure. By incorporating the actual schedule for finished activities in the Gantt chart, the project overall status can be easily monitored.

Scenario 4

Finally, a SAS macro %SASTOMSP in SAS/OR® can be used to convert the scheduled SAS dataset into a form that is readable by Microsoft Project. Each programmer can get their individual task schedule in the format of Microsoft Project.

CONCLUSION

CLP procedure is an effective approach to optimally scheduling resource and time constraint programming projects. By using this approach, ongoing project resource can be rescheduled and reallocated, and resource requirement for the future projects can be forecasted. The visualized schedule data in Gantt charts can display complex timelines and keep project status updated.

REFERENCES

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S.PROJECTStart of Frugect0FINISHS.S.DTMStart of SUTM CreationS.PROJECT0FINISHABSUTMAntropographicsSSDTM2P1ABSUTMAdverse EventsDM1P1.P.P.P.BAESDTMConconitant MeticationsDM1P1.P.P.P.BCMSDTMConconitant MeticationsDM1P1.P.P.P.BDFSDTMDiscoster FindingsDM3P1.P.P.P.BDFSDTMDiscoster FindingsDM1P1.P.P.P.BEKSDTMExposureDM1P1.P.P.P.BEKSDTMLaboratory Test ResultsDM1P1.P.P.P.BIESDTMLaboratory Test ResultsDM1P1.P.P.P.BIBSDTMLaboratory Test ResultsDM1P1.P.P.P.BIBSDTMLaboratory Test ResultsDM1P1.P.P.P.BIBSDTMUnror ResultsDM1P1.P.P.P.BIBSDTMUnror ResultsDM1P1.P.P.P.BIGSDTMUnror ResultsDM1P1.P.P.P.BIGSDTMUnror ResultsDM1P1.P.P.P.BIGSDTMUnror ResultsDM1P1.P.P.P.BIGSDTMUnror ResultsDM1P1.P.P.P.BIGSDTMUnror ResultsSLKUP1P1.P.P.P.BIGSDTMUnror ResultsSLKUP1P1.P.P.P	Activity	Group	Description	Predecessors	Duration	Resource	Status
S_SDTMSlatid SDTM CreationS_PROJECT0FINISHDMSDTMDemographicsS_SDTM2P1ABSDTMArthodyDM1P1, P2, P3AFSDTMConcomitant MedicationsDM1P1, P2, P3CMSDTMConcomitant MedicationsDM3P1, P2, P3CMSDTMConcomitant MedicationsDM3P1, P2, P3DFSDTMDisorder FindingsDM3P1, P2, P3DFSDTMDisorder FindingsDM1P1, P2, P3EGSDTMECGDM1P1, P2, P3EKSDTMLaboratory Test ResultsDM1P1, P2, P3IESDTMInclusion/Exclusion CriteriaDM1P1, P2, P3IESDTMInclusion/Exclusion CriteriaDM1P1, P2, P3IESDTMInclusion/Exclusion CriteriaDM1P1, P2, P3IESDTMUnactionariansDM1P1, P2, P3STMSDTMConcentrationsDM3P1, P2, P3STMSDTMTumor identificationsDM1P1, P2, P3Start of Lookup TableS_LKUP1P2P2LKUP_AELKUPAll Cookup TableS_LKUP1P2LKUP_AELKUPAll Cookup TableS_LKUP1P3ASADAMAnbalva Analysis DataADSL, AE, LKUP, AP1, P2, P3AABADAMAnbalva	S_PROJECT		Start of Project		0		FINISH
DMSDTMDemographicsS_SDTM2PIABSDTMAntibodyDM1P1, P2, P3AESDTMConcentiant MedicationsDM1P1, P2, P3CMSDTMConcentiant MedicationsDM1P1, P2, P3CMSDTMConcentiant MedicationsDM3P1, P2, P3COSDTMDispositionDM3P1, P2, P3DFSDTMDispositionDM3P1, P2, P3DSSDTMExposureDM1P1, P2, P3EGSDTMExposureDM1P1, P2, P3LESDTMIncuston/Exclusion CriteriaDM1P1, P2, P3LBSDTMLaboratory Test ResultsDM1P1, P2, P3DSSDTMLaboratory Test ResultsDM1P1, P2, P3DSSDTMQuestomairesDM1P1, P2, P3TRSDTMQuestomairesDM3P1, P2, P3TRSDTMTumor desultificatorsDM3P1, P2, P3TUSDTMTumor desultificatorsDM1P1, P2, P3LKUP_ACLLUP ACSLKUP <t< td=""><td>S_SDTM</td><td></td><td>Start of SDTM Creation</td><td>S_PROJECT</td><td>0</td><td></td><td>FINISH</td></t<>	S_SDTM		Start of SDTM Creation	S_PROJECT	0		FINISH
ABSDTMAnibodyDM1P1, P2, P3AESDTMAdverse EventsDM2P1, P2, P3CMSDTMConcomitant MedicationsDM1P1, P2, P3COSDTMDisorder FindingsDM3P1, P2, P3DFSDTMDisorder FindingsDM3P1, P2, P3EGSDTMExposinoDM1P1, P2, P3EGSDTMExposinoDM1P1, P2, P3EKSDTMExposinoDM1P1, P2, P3EKSDTMLaboratory Test ResultsDM1P1, P2, P3LBSDTMLaboratory Test ResultsDM1P1, P2, P3DFSDTMMedical and Procedural InterventionsDM2P1, P2, P3SXSDTMOuestionnalesDM1P1, P2, P3SXSDTMSurgical and Procedural InterventionsDM3P1, P2, P3TUSDTMTumor KeinlikationsDM3P1, P2, P3VSSDTMTumor KeinlikationsDM3P1, P2, P3VSSDTMVital SignsDM1P1, P2, P3USSDTMVital SignsDM1P2LKUP_AHLKUPAE Lookup TableS_LKUP1P2LKUP_AHLKUPMH Lookup TableS_LKUP1P2LKUP_AHLKUPMH Lookup TableS_LKUP4P1, P2, P3AABADAMSubject Level Informati	DM	SDTM	Demographics	S_SDTM	2	P1	
AESDTMAdverse EventsDM2P1, P2, P3CMSDTMConcomitant MedicationsDM1P1, P2, P3CGSDTMDisorder FindingsDM3P1, P2, P3DFSDTMDisorder FindingsDM3P1, P2, P3DSSDTMDispositionDM3P1, P2, P3EGSDTMExposureDM1P1, P2, P3EKSDTMInclusion/Exclusion CriteriaDM1P1, P2, P3IBSDTMInclusion/Exclusion CriteriaDM1P1, P2, P3MHSDTMMedical HistoryDM1P1, P2, P3OSSDTMOutoratory Fsr ResultsDM1P1, P2, P3OSSDTMOutoratory Fsr ResultsDM1P1, P2, P3CSSDTMSurgical and Proceedural InterventionsDM3P1, P2, P3TUSDTMTurner ResultsDM3P1, P2, P3TUSDTMTurner ResultsDM3P1, P2, P3TUSDTMTurner ResultsDM1P1, P2, P3LKUP_ACLKUPAt old obstrate resultsS, KUP1P2LKUP_ACLKUP	AB	SDTM	Antibody	DM	1	P1, P2, P3	
CM SDTM Conconnent Medications DM 1 P1, P2, P3 CO SDTM Disposition DM 3 P1, P2, P3 DF SDTM Disposition DM 3 P1, P2, P3 DS SDTM Exposure DM 1 P1, P2, P3 EG SDTM Exposure DM 1 P1, P2, P3 EK SDTM Exposure DM 1 P1, P2, P3 EK SDTM Inclusion/Exclusion Criteria DM 1 P1, P2, P3 LB SDTM Medical History DM 1 P1, P2, P3 DS SDTM Ovestionnaires DM 1 P1, P2, P3 SX SDTM Surgical and Procedural Interventions DM 3 P1, P2, P3 TR SDTM Tumor Results DM 1 P1, P2, P3 VS SDTM Vital Signs DM 1 P1, P2, P3 LKUP_AE LKUP AE Lookup Table S_LKU	AE	SDTM	Adverse Events	DM	2	P1, P2, P3	
CQSDTMCommentsDM1P1, P2, P3DFSDTMDisorder FindingsDM3P1, P2, P3DSSDTMExposureDM1P1, P2, P3EGSDTMExposureDM2P1, P2, P3EXSDTMIcbustom Exclusion CriteriaDM1P1, P2, P3IBSDTMIcbustom Exclusion CriteriaDM1P1, P2, P3IBSDTMIcbustom Exclusion CriteriaDM1P1, P2, P3IBSDTMIcbustom Exclusion CriteriaDM1P1, P2, P3VISDTMIcbustom ExclusionDM1P1, P2, P3PESDTMMedical HistoryDM1P1, P2, P3SXSDTMSurgical and Procedural InterventionsDM2P1, P2, P3TRSDTMTumor IdentificationsDM3P1, P2, P3VSSDTMVital SignsDM1P1, P2, P3VSSDTMVital SignsDM1P1, P2, P3VSSDTMVital SignsDM1P1, P2, P3VSSDTMVital SignsSLKUP1P2LKUP_AMLKUPAE Lookup Tables CreationS, PROJECT0LKUP_AMLKUPML Lookup Tables CreationS, SLKUP1P2LKUP_AMADAMAntibody Analysis DataADSL, AB1P1, P2, P3ADSLADAMAntibody Analysis DataADSL, AB, LKUP_AC2P1, P2, P3	СМ	SDTM	Concomitant Medications	DM	1	P1, P2, P3	
DFSDTMDisorder FindingsDM3P1, P2, P3DSSDTMDispositionDM3P1, P2, P3EGSDTMECGDM1P1, P2, P3EXSDTMInclusion/Tsclusion CriteriaDM1P1, P2, P3IESDTMInclusion/Tsclusion CriteriaDM1P1, P2, P3IBSDTMInclusion/TsclusionDM1P1, P2, P3IBSDTMMedical HistoryDM1P1, P2, P3CSSDTMMedical HistoryDM1P1, P2, P3CSSDTMQuestionnairesDM1P1, P2, P3CSSDTMSurgical and Procedural InterventionsDM3P1, P2, P3TRSDTMTumor ResultsDM3P1, P2, P3TUSDTMTumor ResultsDM3P1, P2, P3TUSDTMTumor ResultsDM1P1, P2, P3VSSDTMVital SignsDM1P1, P2, P3UKUP_CKLKUPAL ookup Tables CreationS_PROJECT0S_JKUPSlart of ADaM CreationAl-Activities from SDTM0S_JKUPLKUPAnd Antibody Analysis DataADSL, AB1P2LKUP_CMLKUPMil Lookup TablesS_LKUP1P2LKUP_CMLKUPAndorerationS_PROJECT0S_PROJECTADSLADAMAntibody Analysis DataADSL, AB1P1, P2, P3ADSLADAM	CO	SDTM	Comments	DM	1	P1, P2, P3	
DSSDTMDispositionDM3P1, P2, P3EGSDTMECGDM1P1, P2, P3EXSDTMInclusion/Exclusion CriteriaDM2P1, P2, P3IESDTMLaboratory Test ResultsDM1P1, P2, P3LBSDTMMedical HistoryDM1P1, P2, P3CSSDTMMedical HistoryDM1P1, P2, P3QSSDTMQuestionnairesDM1P1, P2, P3QSSDTMSurgical and Procedural InterventionsDM2P1, P2, P3TRSDTMTumor ResultsDM3P1, P2, P3VSSDTMVital SignsDM1P1, P2, P3VSSDTMVital SignsDM1P1, P2, P3VSSDTMVital SignsDM1P1, P2, P3VSSDTMVital SignsDM1P1, P2, P3LKUP_ACLKUPAEI ocloup Tables CreationS_FCOLECT0LKUP_ACMLKUPMI Lookup Tables CreationS_FCOLECT0S_ADAMLKUPMI Lookup Tables CreationS_PROJECT9AABADAMSubject Level Information Analysis DataADSL, AE, LKUP1ADSLADAMSubject Level Information Analysis DataADSL, CM, LKUP_CM, DF, P3P1, P2, P3AAEADAMAdverse Events Analysis DataADSL, CM, LKUP_CM, DF, P2, P3P1, P2, P3AAEADAMAdverse Events Analysis DataADSL, CM, LKUP_CM,	DF	SDTM	Disorder Findings	DM	3	P1, P2, P3	
EGSDTMECGDM1P1, P2, P3EXSDTMExposureDM2P1, P2, P3IESDTMInduson/Exclusion CriteriaDM1P1, P2, P3IBSDTMLaboratory Test ResultsDM1P1, P2, P3MHSDTMMedical HistoryDM1P1, P2, P3SXSDTMOuesilonnairesDM1P1, P2, P3SXSDTMSurgical and Procedural InterventionsDM2P1, P2, P3TRSDTMTumor IdentificationsDM3P1, P2, P3TUSDTMTumor IdentificationsDM3P1, P2, P3TUSDTMTumor IdentificationsDM1P1, P2, P3E_SDTMEnd of SDTM CreationS_ROJECT0S_LKUPStart of Lookup Tables CreationS_ROJECT0LKUP_ACMLKUPMH Lookup Tables CreationS_PROJECT0LKUP_MHKUPMH Lookup Tables CreationS_PROJECT0AABADAMAduerse Events Analysis DataADSL, AB1P1, P2, P3AAGEADAMAduerse Events Analysis DataADSL, RB1P1, P2, P3AAEADAMAdverse Events Analysis DataADSL, RL, LKUP_AE2P1, P2, P3AAEADAMAdverse Events Analysis DataADSL, RL, LKUP_AE2P1, P2, P3AAEADAMAdverse Events Analysis DataADSL, RL, LKUP_AE2P1, P2, P3AAEADAM <td>DS</td> <td>SDTM</td> <td>Disposition</td> <td>DM</td> <td>3</td> <td>P1, P2, P3</td> <td></td>	DS	SDTM	Disposition	DM	3	P1, P2, P3	
EXSDTMExposureDM2P1, P2, P3IESDTMInclusion/Exclusion CriteriaDM1P1, P2, P3LBSDTMLaboratory Test ResultsDM1P1, P2, P3LBSDTMMedical HistoryDM1P1, P2, P3PESDTMPhysical ExamsDM1P1, P2, P3OSSDTMOuestionnairesDM1P1, P2, P3SXSDTMSurgical and Procedural InterventionsDM2P1, P2, P3TRSDTMTumor ResultsDM3P1, P2, P3TUSDTMTumor IdentificationsDM1P1, P2, P3VSSDTMVital SignsDM1P1, P2, P3E_SDTMEad of SDTM CreationAlfchivilies from SDTM0E_SLVPStart of Lookup TableS_LKUP1P2LKUP_AELKUPAE Lookup TableS_LKUP1P2LKUP_MLLKUPCM Lookup TableS_LKUP1P2LKUP_MLLKUPEnd of Lookup Tables CreationAlfchivilies from LKUP0S_ADAMSubject Level Information Analysis DataADSL, AB1P1, P2, P3AABADAMAubidy Analysis DataADSL, ABP1, P2, P3ADSLAABADAMAdverse Events Analysis DataADSL, CM, LKUP_CM, DP1, P2, P3AAEADAMConcomitant Medications Analysis DataADSL, CM, LKUP_CM, DP1, P2, P3ACMADAMConcomitant Medications Ana	EG	SDTM	ECG	DM	1	P1, P2, P3	
IESDTMInclusion/Exclusion CriteriaDM1P1, P2, P3LBSDTMLaboratory Test ResultsDM1P1, P2, P3MHSDTMMedical HistoryDM1P1, P2, P3QSSDTMQuestionnairesDM1P1, P2, P3QSSDTMSurgical and Procedural InterventionsDM2P1, P2, P3TRSDTMSurgical and Procedural InterventionsDM3P1, P2, P3TRSDTMTumor ResultsDM3P1, P2, P3VSSDTMVital SignsDM1P1, P2, P3VSSDTMVital SignsDM1P1, P2, P3VSSDTMVital SignsDM1P1, P2, P3LKUP_ACKLUPEnd of SDTM CreationAll Activities from SDTM0S_LKUPEnd of Lookup Tables CreationS_PROJECT0LKUP_AHLKUPCM Lookup Tables CreationS_LKUP1P2LKUP_MHLKUPMH Lookup Tables CreationS_PROJECT0S_ADAMSubject Level Information Analysis DataADSL, AB1P1, P2, P3AABADAMSubject Level Information Analysis DataADSL, CM, LKUP_CM, DM, DS, SX, TR, TU, VS4P3AABADAMAdverse Events Analysis DataADSL, CM, LKUP_CM, DF, DM, DS, CX, TR, TU, VS4P3AABADAMConcomitant Medications Analysis DataADSL, CM, LKUP_CM, ADSL, ACK, MAM, Analysis DataADSL, CS3P1, P2, P3	EX	SDTM	Exposure	DM	2	P1, P2, P3	
LBSDTMLaboratory Test ResultsDM1P1, P2, P3MHSDTMMedical HistoryDM1P1, P2, P3PESDTMPhysical ExamsDM1P1, P2, P3OSSDTMSurgical and Procedural InterventionsDM2P1, P2, P3SXSDTMSurgical and Procedural InterventionsDM3P1, P2, P3TUSDTMTumor IdentificationsDM3P1, P2, P3TUSDTMTumor IdentificationsDM3P1, P2, P3VSSDTMVital SignsDM1P1, P2, P3E_SDTMEnd of SDTM CreationS, PROJECT0LKUP_AELKUPStart of Lookup Tables CreationS, LKUP1P2LKUP_AELKUPMH Lookup TableS, LKUP1P2LKUP_MHLKUPMH Lookup TableS, LKUP1P2LKUP_MHKUPMH Lookup TableS, LKUP1P2LKUP_MHKUPMH Lookup TableS, LKUP1P2LKUP_AMMSubject Level Information Analysis DataADSL, AB1P1, P2, P3AABADAMAnterseite DataADSL, AB1P1, P2, P3AABADAMAdverse Events Analysis DataADSL, AB, LKUP,AE2P1, P2, P3AABADAMDisposition Analysis DataADSL, CM, LKUP_CM, DFP1, P2, P3P1, P2, P3ACMADAMECG Analysis DataADSL, CS, PE1P1, P2, P3 <tr< td=""><td>IE</td><td>SDTM</td><td>Inclusion/Exclusion Criteria</td><td>DM</td><td>1</td><td>P1, P2, P3</td><td></td></tr<>	IE	SDTM	Inclusion/Exclusion Criteria	DM	1	P1, P2, P3	
MHSDTMMedical HistoryDM1P1, P2, P3PESDTMPhysical ExamsDM1P1, P2, P3OSSDTMQuestionnairesDM1P1, P2, P3SXSDTMSurgical and Procedural InterventionsDM3P1, P2, P3TRSDTMTumor ResultsDM3P1, P2, P3TUSDTMTumor IdentificationsDM3P1, P2, P3VSSDTMVital SignsDM1P1, P2, P3E_SDTMEnd of SDTM CreationS_PROJECT0E_SLVPStart of Lookup Tables CreationS_PROJECT0LKUP_CMLKUPAE Lookup TableS_LKUP1P2LKUP_CMLKUPCM Lookup TableS_LKUP1P2LKUP_CMLKUPMH Lookup TableS_LKUP1P2LKUP_CMLKUPMH Lookup TableS_LKUP1P2LKUP_CMLKUPMH Lookup TableS_LKUP1P2LKUP_CMLKUPMH colkup Tables CreationS_PROJECT0S_ADAMSubject Level Information Analysis DataADSL, KE, IK, PC, DP, DX, SA, RE, RCM, DF, DK, RK, RK, RCM, DF, DK, RK, RK, RK, RK, RK, RK, RK, RK, RK, R	LB	SDTM	Laboratory Test Results	DM	1	P1, P2, P3	
PESDTMPhysical ExamsDM1P1, P2, P3QSSDTMQuestionnairesDM1P1, P2, P3SXSDTMSurgical and Procedural InterventionsDM2P1, P2, P3SXSDTMTumor ResultsDM3P1, P2, P3TUSDTMTumor IdentificationsDM3P1, P2, P3TUSDTMVital SignsDM1P1, P2, P3E_SDTMEnd of SDTM CreationAll Activities from SDTM0S_LKUPEnd of SDTM CreationS_LKUP1P2LKUP_AELKUPAE Lookup Tables CreationS_LKUP1P2LKUP_CMLKUPMH Lookup Tables CreationS_LKUP1P2LKUP_MHLKUPMH Lookup Tables CreationS_LROP1P2LKUP_MHLKUPMH Lookup Tables CreationS_LROP1P2S_ADAMSubject Level Information Analysis DataADSL, AB1P1, P2, P3AABADAMAntibody Analysis DataADSL, AB1P1, P2, P3AABADAMAntibody Analysis DataADSL, AB1P1, P2, P3AAEGADAMLorocontiant Medications Analysis DataADSL, CM, LKUP_CM, DF1P1, P2, P3AEGADAMConcomitant Medications Analysis DataADSL, CM, LKUP_CM, DF1P1, P2, P3AEGADAMLaboratory Analysis DataADSL, VS, PE1P1, P2, P3ALBADAMLaboratory Analysis DataADSL, VS	MH	SDTM	Medical History	DM	1	P1, P2, P3	
OSSDTMQuestionnairesDM1P1, P2, P3SXSDTMSurgical and Procedural InterventionsDM2P1, P2, P3TRSDTMTumor ResultsDM3P1, P2, P3TUSDTMTumor IdentificationsDM1P1, P2, P3TUSDTMVital SignsDM1P1, P2, P3E_SDTMEnd of SDTM CreationAll Activities from SDTM0S_LKUPStart of Lookup Tables CreationS_PROJECT0LKUP_AELKUPAE Lookup Tables CreationS_LKUP1LKUP_CMLKUPCM Lookup TableS_LKUP1LKUP_MHLKUPMH Lookup TableS_LKUP1E_LKUPEnd of Lookup Tables CreationAll Activities from LKUP0S_ADAMStart of ADaM CreationS_DPROJECT DM, DS, EX, LB, PE,0AABADAMAntibody Analysis DataADSL, AB1P1, P2, P3AABADAMAntibody Analysis DataADSL, AB1P1, P2, P3AAEADAMConcomitant Medications Analysis DataADSL, AB1P1, P2, P3ACMADAMConcomitant Medications Analysis DataADSL, CM, LKUP_CM, DFP1, P2, P3AEGADAMConcomitant Medications Analysis DataADSL, CM, LKUP_CM, DFP1, P2, P3AEGADAMConcomitant Medications Analysis DataADSL, CS1P1, P2, P3AEGADAMLaboratory Analysis DataADSL, CS1P1, P2, P3 <td< td=""><td>PE</td><td>SDTM</td><td>Physical Exams</td><td>DM</td><td>1</td><td>P1, P2, P3</td><td></td></td<>	PE	SDTM	Physical Exams	DM	1	P1, P2, P3	
SXSDTMSurgical and Procedural InterventionsDM2P1, P2, P3TRSDTMTumor ResultsDM3P1, P2, P3TUSDTMTumor IdentificationsDM3P1, P2, P3VSSDTMVital SignsDM1P1, P2, P3E_SDTMEnd of SDTM CreationAll Activities from SDTM0S_LKUPStart of Lookup Tables CreationS_PROJECT0LKUP_AELKUPAE Lookup TableS_LKUP1P2LKUP_CMLKUPCM Lookup TableS_LKUP1P2LKUP_MHLKUPMH Lookup TableS_LKUP1P2LKUP_MHLKUPMH Lookup TableS_LKUP1P2S_ADAMStart of ADaM CreationS_PROJECT0SS_ADAMSubject Level Information Analysis DataQS, SX, TR, TU, VS4P3AABADAMAntibody Analysis DataADSL, AB1P1, P2, P3AAEADAMDisposition Analysis DataADSL, AE, LKUP_AE2P1, P2, P3ACMADAMConcomitiant Medications Analysis DataADSL, CM, LKUP_CM, DF1P1, P2, P3ACMADAMConcomitiant Medications Analysis DataADSL, CM, LKUP_CM, ADSL, CM, LKUP_CM,P1, P2, P3AEGADAMConcomitiant Medications Analysis DataADSL, CM, LKUP_CM, ADSL, EK91, P2, P3AEGADAMConcomitiant Medications Analysis DataADSL, KS, PE1P1, P2, P3AEGADAMLab	QS	SDTM	Questionnaires	DM	1	P1, P2, P3	
TRSDTMTumor ResultsDM3P1, P2, P3TUSDTMTumor IdentificationsDM3P1, P2, P3VSSDTMVital SignsDM1P1, P2, P3E_SDTMEnd of SDTM CreationAll Activities from SDTM0S_LKUPStart of Lockup Tables CreationS_PROJECT0LKUP_AELKUPAE Lockup TableS_LKUP1P2LKUP_MHLKUPCM Lockup TableS_LKUP1P2LKUP_MHLKUPMH Lockup TableS_LKUP1P2LKUP_MHLKUPMH Lockup TableS_LKUP1P2LKUP_MHLKUPMH Lockup TableS_LKUP1P2ADSLStart of ADaM CreationS_PROJECT0S_ADAM, AE, CM, DF, DM, SS, EX, LB, PE, DM, SS, ST, RT, UY S4P3AABADAMAntibody Analysis DataADSL, AB1P1, P2, P3AAEADAMAdverse Events Analysis DataADSL, AE, LKUP_AE2P1, P2, P3AAEADAMDisposition Analysis DataADSL, CM, LKUP_CM, DF, DF, DR, P2, P3ADSL, AEADSL, DS3P1, P2, P3ACMADAMConcomitant Medications Analysis DataADSL, CM, LKUP_CM, DF, DL, P3ADSL, MS, SDAADSL, KE, S3P1, P2, P3AEGADAMAnalysis DataADSL, CM, LKUP_CM, DF, DL, P3ADSL, KE, S3P1, P2, P3AKEADAM <td< td=""><td>SX</td><td>SDTM</td><td>Surgical and Procedural Interventions</td><td>DM</td><td>2</td><td>P1, P2, P3</td><td></td></td<>	SX	SDTM	Surgical and Procedural Interventions	DM	2	P1, P2, P3	
TUSDTMTumor IdentificationsDM3P1, P2, P3VSSDTMVital SignsDM1P1, P2, P3E_SDTMEnd of SDTM CreationAll Activities from SDTM0S_LKUPStart of Lookup Tables CreationS_PROJECT0LKUP_AELKUPAE Lookup TableS_LKUP1P2LKUP_MHLKUPCM Lookup TableS_LKUP1P2LKUP_MHLKUPMH Lookup TableS_LKUP1P2E_LKUPEnd of Lookup Tables CreationAll Activities from LKUP0	TR	SDTM	Tumor Results	DM	3	P1, P2, P3	
VSSDTMVital SignsDM1P1, P2, P3E_SDTMEnd of SDTM CreationAll Activities from SDTM0S_LKUPStart of Lookup Tables CreationS_PROJECT0LKUP_AELKUPA Lookup Tables CreationS_LKUP1P2LKUP_CMLKUPMH Lookup TableS_LKUP1P2LKUP_MILKUPMH Lookup Tables CreationAll Activities from LKUP0P2E_LKUPEnd of Lookup Tables CreationAll Activities from LKUP0P2S_ADAMStart of ADaM CreationS_PROJECT S_ADAM, AE, CM, DF, DM, DS, EX, LB, PE,P3ADSLADAMSubject Level Information Analysis DataADSL, AB1P1, P2, P3AABADAMAntibody Analysis DataADSL, AB, LKUP_AE2P1, P2, P3AAEADAMAdverse Events Analysis DataADSL, AE, LKUP_AE2P1, P2, P3ACMADAMConcomitant Medications Analysis DataADSL, AE, LKUP_CM, DFP1, P2, P3P1, P2, P3AEGADAMAnalysis Data Investigational Product Administration Vital SignsPhysical Examination Vital SignsPhysical Examination Vital SignsPhysical Examination Vital SignsPhysical Examination Target and Non-target Lesion Analysis DataADSL, VS, PE1P1, P2, P3AUSADAMQuestionnaire Analysis Data ADSLADSL, US, SE1P1, P2, P3ALSADAMLebration Analysis Data MMADSL, OS1P1, P2, P3AEFFADAMMedical and Surgical History<	TU	SDTM	Tumor Identifications	DM	3	P1, P2, P3	
E_SDTMEnd of SDTM CreationAll Activities from SDTM0S_LKUPStart of Lookup Tables CreationS_PROJECT0LKUP_AELKUPAE Lookup TableS_LKUP1P2LKUP_CMLKUPCM Lookup TableS_LKUP1P2LKUP_MHLKUPMH Lookup TableS_LKUP1P2LKUP_MHLKUPMH Lookup TableS_LKUP1P2S_ADAMStart of ADaM CreationAll Activities from LKUP0S_PROJECT0S_ADAMSubject Level Information Analysis DataADSL, AB, PE, DM, DS, EX, LB, EX3P1, P2, P3ACMADAMConcomitant Medications Analysis DataADSL, CM, LKUP_CM, DF, DF, DP, P2, P3P1, P2, P3AESADAMAnalysis DataADSL, SX, SF E1P1, P2, P3ACMADAMLaboratory Analysis DataADSL, OS1P1, P2, P3ACMADAMLaboratory Analysis DataADSL, CS, ST, T1P1, P2, P3ACM </td <td>VS</td> <td>SDTM</td> <td>Vital Signs</td> <td>DM</td> <td>1</td> <td>P1, P2, P3</td> <td></td>	VS	SDTM	Vital Signs	DM	1	P1, P2, P3	
S_LKUPStart of Lookup Tables CreationS_PROJECT0LKUP_AELKUPAE Lookup TableS_LKUP1P2LKUP_CMLKUPCM Lookup TableS_LKUP1P2LKUP_MHLKUPMH Lookup Tables CreationAll Activities from LKUP0S_ADAMStart of ADaM CreationS_PROJECT0S_ADAMStart of ADaM CreationS_PROJECT D0S_ADAMStart of ADAM CreationS_PROJECT D0ADSLADAMSubject Level Information Analysis DataQS, SX, TR, TU, VS4P3AABADAMAntibody Analysis DataADSL, AB1P1, P2, P3AAEADAMAdverse Events Analysis DataADSL, AE, LKUP_AE2P1, P2, P3ADSADAMDisposition Analysis DataADSL, CM, LKUP_CM, DF1P1, P2, P3ACMADAMConcomitant Medications Analysis DataADSL, CM, LKUP_CM, DF1P1, P2, P3AEGADAMECG Analysis Data Investigational Product Administration Investigational Product Administration Vital Signs/Physical ExaminationADSL, CS, VS, PE1P1, P2, P3AVSADAMLaboratory Analysis DataADSL, QS1P1, P2, P3ALBADAMLaboratory Analysi	E_SDTM		End of SDTM Creation	All Activities from SDTM	0		
LKUP_AELKUPAE Lookup TableS_LKUP1P2LKUP_CMLKUPCM Lookup TableS_LKUP1P2LKUP_MHLKUPMH Lookup TableS_LKUP1P2E_LKUPEnd of Lookup Tables CreationAll Activities from LKUP0	S_LKUP		Start of Lookup Tables Creation	S_PROJECT	0		
LKUP_CMLKUPCM Lookup TableS_LKUP1P2LKUP_MHLKUPMH Lookup TableS_LKUP1P2E_LKUPEnd of Lookup Tables CreationAll Activities from LKUP0S_ADAMStart of ADaM CreationS_PROJECT S_ADAM, AE, CM, DF, DM, DS, EX, LB, PE,0ADSLADAMSubject Level Information Analysis DataADSL, AB1P1, P2, P3AABADAMAntibody Analysis DataADSL, AB1P1, P2, P3AAEADAMAdverse Events Analysis DataADSL, AE, LKUP_AE2P1, P2, P3ADSADAMDisposition Analysis DataADSL, CM, LKUP_CM, DF1P1, P2, P3ACMADAMConcomitant Medications Analysis DataADSL, CM, LKUP_CM, DF1P1, P2, P3ACMADAMAnalysis Data Investigational Product Administration Mtal Signs/Physical ExaminationADSL, EG1P1, P2, P3ALBADAMLaboratory Analysis Data Investigational Product Administration ALBADSL, US, PE1P1, P2, P3ALBADAMLaboratory Analysis Data Investigational Product Administration Target and Non-target Lesion Analysis DataADSL, US, PE1P1, P2, P3ALBADAMLaboratory Analysis DataADSL, US, SE1P1, P2, P3ALBADAMLaboratory Analysis DataADSL, US, SE1P1, P2, P3ALBADAMLaboratory Analysis DataADSL, US, SE1P1, P2, P3ALBADAMLaboratory Analysis Da	LKUP_AE	LKUP	AE Lookup Table	S_LKUP	1	P2	
LKUP_MHLKUPMH Lookup TableS_LKUP1P2E_LKUPEnd of Lookup Tables CreationAll Activities from LKUP0S_ADAMStart of ADaM CreationS_PROJECT S_ADAM, AE, CM, DF, DM, DS, EX, LB, PE,0ADSLADAMSubject Level Information Analysis DataQS, SX, TR, TU, VS4P3AABADAMAntibody Analysis DataADSL, AB1P1, P2, P3AAEADAMAdverse Events Analysis DataADSL, AE, LKUP_AE2P1, P2, P3ADSADAMDisposition Analysis DataADSL, CM, LKUP_CM, DF3P1, P2, P3ACMADAMConcomitant Medications Analysis DataADSL, CM, LKUP_CM, DF1P1, P2, P3ACMADAMECG Analysis Data Investigational Product Administration ARXADAMAnalysis Data Natalysis DataADSL, EG1P1, P2, P3ALBADAMLaboratory Analysis Data Investigational Product Administration ARXADAMAnalysis Data Natalysis DataADSL, EX3P1, P2, P3ALBADAMLaboratory Analysis Data Target and Non-target Lesion Analysis DataADSL, QS1P1, P2, P3ALBADAMDuestionnaire Analysis Data Target and Non-target Lesion Analysis DataADSL, QS1P1, P2, P3ALBADAMDataADSL, SL, DF, SX, TArget and Non-target Lesion Analysis DATAADSL, ALE, DF, SX, TR, TU ADSL, ALE, DF, SX, TR, TU ADSL, ALE, SCH, SK, ATSP1P1ALBADAMEfficacy Summary Analys	LKUP_CM	LKUP	CM Lookup Table	S_LKUP	1	P2	
E_LKUPEnd of Lookup Tables CreationAll Activities from LKUP0S_ADAMStart of ADaM CreationS_PROJECT S_ADAM, AE, CM, DF, DM, DS, EX, IB, PE, QS, SX, TR, TU, VS4ADSLADAMSubject Level Information Analysis DataADSL, AB1AABADAMAntibody Analysis DataADSL, AB1AAEADAMAdverse Events Analysis DataADSL, AB1AAEADAMDisposition Analysis DataADSL, AE, LKUP_AE2ACMADAMDisposition Analysis DataADSL, DS3ACMADAMConcomitant Medications Analysis DataADSL, CM, LKUP_CM, DF1ACMADAMECG Analysis DataADSL, CM, LKUP_CM, DF1AEGADAMECG Analysis DataADSL, EG1AEXADAMAnalysis DataADSL, VS, PE1AVSADAMLaboratory Analysis DataADSL, VS, PE1AVSADAMLaboratory Analysis DataADSL, VS, PE1AUBADAMQuestionnaire Analysis DataADSL, VS, PE1AUBADAMQuestionnaire Analysis DataADSL, OS1ALBADAMMedical and Surgical History Target and Non-larget Lesion Analysis Target and Non-larget Lesion Analysis <br< td=""><td>LKUP_MH</td><td>LKUP</td><td>MH Lookup Table</td><td>S_LKUP</td><td>1</td><td>P2</td><td></td></br<>	LKUP_MH	LKUP	MH Lookup Table	S_LKUP	1	P2	
S_ADAMStart of ADaM CreationS_PROJECT S_ADAM, AE, CM, DF, DM, DS, EX, LB, PE, OS, SX, TR, TU, VS0ADSLADAMSubject Level Information Analysis DataADSL, AB1P3AABADAMAntibody Analysis DataADSL, AB1P1, P2, P3AAEADAMAdverse Events Analysis DataADSL, AE, LKUP_AE2P1, P2, P3ADSADAMDisposition Analysis DataADSL, DS3P1, P2, P3ACMADAMConcomitant Medications Analysis DataADSL, CM, LKUP_CM, DF1P1, P2, P3AEGADAMConcomitant Medications Analysis DataADSL, EG1P1, P2, P3AEGADAMAnalysis Data Investigational Product Administration Vital Signs/Physical ExaminationADSL, ES3P1, P2, P3AVSADAMAnalysis Data Vital Signs/Physical ExaminationADSL, VS, PE1P1, P2, P3AUBADAMLaboratory Analysis Data Vital Signs/Physical ExaminationADSL, US, PE1P1, P2, P3AUBADAMLaboratory Analysis DataADSL, US, PE1P1, P2, P3ALBADAMQuestionnaire Analysis DataADSL, MH, LKUP_MH1P1, P2, P3AUSADAMDataADSL, OS, ST, TT, TU ADSL, AE, DF, SX, ACSL, AE, ACM, AMH, ADSL, AE, ACM, AMH, ADSL, ALS, DF, SX,3P1ALBADAMEfficacy Summary Analysis DataADSL, AE, ACM, AMH, ADSL, AE, ACM, AMH, ADSL, AAE, A	E_LKUP		End of Lookup Tables Creation	All Activities from LKUP	0		
ADSLADAMSubject Level Information Analysis DataS_ADAM, AE, CM, DF, DM, DS, EX, LB, PE, QS, SX, TR, TU, VS4P3AABADAMAntibody Analysis DataADSL, AB1P1, P2, P3AAEADAMAdverse Events Analysis DataADSL, AE, LKUP_AE2P1, P2, P3ADSADAMDisposition Analysis DataADSL, DS3P1, P2, P3ACMADAMConcomitant Medications Analysis DataADSL, CM, LKUP_CM, DF1P1, P2, P3ACMADAMECG Analysis Data Investigational Product Administration AEXADAMAnalysis Data Nestigational Product Administration ADSL, CS, VS, PE1P1, P2, P3AVSADAMAnalysis Data Investigational Product Administration AVSADAMAnalysis Data ADSL, VS, PE1P1, P2, P3ALBADAMLaboratory Analysis DataADSL, VS, PE1P1, P2, P3AQSADAMLaboratory Analysis DataADSL, QS1P1, P2, P3ALBADAMQuestionnaire Analysis DataADSL, QS1P1, P2, P3ALSADAMDataADSL, CS1P1, P2, P3ALSADAMDataADSL, ALS, DF, SX, ADSL, ALS, DF, SX,2P1, P2, P3ALSADAMEfficacy Summary Analysis DataADSL, AAE, ACM, AMH, ADSL, AAE, ACM, AMH, ADSL, AAE, ACM, AMH, ADSL, AAE, ACM, AMH, ADSL, AAE, ACM, AMH,P1	S_ADAM		Start of ADaM Creation	S_PROJECT	0		
ADSLADAMSubject Level Information Analysis DataDM, DS, X, TR, TU, VS4P3AABADAMAntibody Analysis DataADSL, AB1P1, P2, P3AAEADAMAdverse Events Analysis DataADSL, AE, LKUP_AE2P1, P2, P3ADSADAMDisposition Analysis DataADSL, DS3P1, P2, P3ACMADAMConcomitant Medications Analysis DataADSL, CM, LKUP_CM, DF1P1, P2, P3ACMADAMECG Analysis Data Investigational Product Administration Vital Signs/Physical ExaminationADSL, EG1P1, P2, P3AVSADAMAnalysis Data Investigational Product Administration Vital Signs/Physical ExaminationADSL, VS, PE1P1, P2, P3AUSADAMLaboratory Analysis Data Investigational Product Administration AVSADAMLaboratory Analysis DataADSL, VS, PE1P1, P2, P3ALBADAMLaboratory Analysis DataADSL, US, VS, PE1P1, P2, P3P1AQSADAMQuestionnaire Analysis DataADSL, QS1P1, P2, P3ALSADAMDataADSL, CS1P1, P2, P3ALSADAMDataADSL, CS, TR, TU ADSL, ALS, DF, SX, ADSL, ALS, DF, SX, ADSL, ALS, DF, SX,3P1AEFFADAMEfficacy Summary Analysis DataADSL, MH, LKUP_MH1P1, P2, P3AEFFADAMSafe Summary Analysis DataAEX, AVS, ALB, SX3P1				S_ADAM, AE, CM, DF,			
AABADAMAntibody Analysis DataADSL, AB1P1, P2, P3AAEADAMAdverse Events Analysis DataADSL, AB, L, KUP_AE2P1, P2, P3ADSADAMDisposition Analysis DataADSL, AE, LKUP_AE2P1, P2, P3ADSADAMDisposition Analysis DataADSL, CM, LKUP_CM, DF1P1, P2, P3ACMADAMConcomitant Medications Analysis DataADSL, CM, LKUP_CM, DF1P1, P2, P3AEGADAMECG Analysis Data Investigational Product Administration Vital Signs/Physical ExaminationADSL, EG1P1, P2, P3AVSADAMAnalysis Data Vital Signs/Physical Examination Vital Signs/Physical ExaminationADSL, VS, PE1P1, P2, P3AUSADAMLaboratory Analysis Data Vital Signs/Physical ExaminationADSL, US, PE1P1, P2, P3AUSADAMLaboratory Analysis Data Vital Signs/Physical ExaminationADSL, US, PE1P1, P2, P3AUSADAMLaboratory Analysis DataADSL, QS1P1, P2, P3AQSADAMQuestionnaire Analysis DataADSL, QS1P1, P2, P3AUSADAMDataADSL, ALS, DF, SX, ADSL, ALS, DF, SX,2P1, P2, P3AEFFADAMEfficacy Summary Analysis DataADSL, ALS, DF, SX, AES, ALS, AE, ACM, AMH, ADSL, AAE, ACM, AMH, ADAMP2	ADSI	ADAM	Subject Level Information Analysis Data	DM, DS, EX, LB, PE, OS, SX, TR, TU, VS	4	P3	
AAEADAMAdverse Events Analysis DataADSL, AE, LKUP_AE2P1, P2, P3ADSADAMDisposition Analysis DataADSL, AE, LKUP_AE2P1, P2, P3ACMADAMDisposition Analysis DataADSL, DS3P1, P2, P3ACMADAMConcomitant Medications Analysis DataADSL, CM, LKUP_CM, DF1P1, P2, P3AEGADAMECG Analysis Data Investigational Product Administration Vital Signs/Physical ExaminationADSL, EG1P1, P2, P3AVSADAMAnalysis Data 	AAB	ADAM	Antibody Analysis Data	ADSL AB	1	P1, P2, P3	
ADSADAMDisposition Analysis DataADSL, DS3P1, P2, P3ACMADAMConcomitant Medications Analysis DataADSL, CM, LKUP_CM, DF1P1, P2, P3AEGADAMECG Analysis Data Investigational Product Administration Attal Signs/Physical ExaminationADSL, EG1P1, P2, P3AVSADAMAnalysis Data Investigational Product Administration Vital Signs/Physical ExaminationADSL, EX3P1, P2, P3AVSADAMAnalysis Data Analysis DataADSL, VS, PE1P1, P2, P3ALBADAMLaboratory Analysis Data Target and Non-target Lesion Analysis Target and Non-target Lesion Analysis Target and Non-target Lesion Analysis Target and Non-target Lesion Analysis ASFADAMEfficacy Summary Analysis DataADSL, TR, TU ADSL, ALE, ACM, AMH, AEX, AVS, ALB, SX9ASFADAMSafe Summary Analysis DataAEX, AVS, ALB, SX3P2	AAF	ADAM	Adverse Events Analysis Data	ADSL AF, I KUP AF	2	P1, P2, P3	
ACMADAMConcomitant Medications Analysis DataADSL, CM, LKUP_CM, DF1P1, P2, P3AEGADAMECG Analysis Data Investigational Product Administration Analysis DataADSL, EG1P1, P2, P3AEXADAMAnalysis Data Investigational Product Administration Vital Signs/Physical ExaminationADSL, EG1P1, P2, P3AVSADAMAnalysis Data Investigational Product AdministrationADSL, EX3P1, P2, P3AVSADAMAnalysis Data Vital Signs/Physical ExaminationADSL, VS, PE1P1, P2, P3ALBADAMLaboratory Analysis DataADSL, US3P1, P2, P3AQSADAMQuestionnaire Analysis DataADSL, QS1P1, P2, P3AMHADAMMedical and Surgical History Target and Non-target Lesion AnalysisADSL, MH, LKUP_MH1P1, P2, P3ALSADAMEfficacy Summary Analysis DataADSL, TR, TU ADSL, ALS, DF, SX, TR, TU2P1, P2, P3AEFFADAMEfficacy Summary Analysis DataAEX, AVS, ALB, SX3P1ASAFADAMSafe Summary Analysis DataAEX, AVS, ALB, SX3P2	ADS		Disposition Analysis Data		3	P1 P2 P3	
ACMADAMConcomitant Medications Analysis DataADSL, CM, LKUP_CM, DF1P1, P2, P3AEGADAMECG Analysis Data Investigational Product Administration Analysis Data Vital Signs/Physical ExaminationADSL, EG1P1, P2, P3AVSADAMAnalysis Data Vital Signs/Physical ExaminationADSL, VS, PE1P1, P2, P3AVSADAMAnalysis Data Vital Signs/Physical ExaminationADSL, VS, PE1P1, P2, P3ALBADAMLaboratory Analysis DataADSL, US, PE1P1, P2, P3AQSADAMQuestionnaire Analysis DataADSL, QS1P1, P2, P3AMHADAMMedical and Surgical History Target and Non-target Lesion AnalysisADSL, TR, TU ADSL, ALS, DF, SX,2P1, P2, P3AEFFADAMEfficacy Summary Analysis DataTR, TU ADSL, AAE, ACM, AMH, ASAF3P1ASAFADAMSafe Summary Analysis DataAEX, AVS, ALB, SX3P2	100	/ B/ III	Disposition vinarysis Data	1002,00	0	11,12,10	
ACMADAMConcontinitant Medications Analysis DataDF1P1, P2, P3AEGADAMECG Analysis Data Investigational Product Administration Vital Signs/Physical ExaminationADSL, EG1P1, P2, P3AEXADAMAnalysis Data Vital Signs/Physical ExaminationADSL, EX3P1, P2, P3AVSADAMAnalysis DataADSL, VS, PE1P1, P2, P3AUSADAMLaboratory Analysis DataADSL, VS, PE1P1, P2, P3ALBADAMLaboratory Analysis DataADSL, QS1P1, P2, P3AQSADAMQuestionnaire Analysis DataADSL, QS1P1, P2, P3AMHADAMMedical and Surgical History Target and Non-target Lesion AnalysisADSL, TR, TU2P1, P2, P3AEFFADAMEfficacy Summary Analysis DataTR, TU3P1ASAFADAMSafe Summary Analysis DataAEX, AVS, ALB, SX3P2			Concernitent Mediactions Analysis Date	ADSL, CM, LKUP_CM,	1	01 02 02	
AEGADAMECG Analysis Data Investigational Product Administration Newstigational Product AdministrationADSL, EG1P1, P2, P3AEXADAMAnalysis Data Vital Signs/Physical ExaminationADSL, EX3P1, P2, P3AVSADAMAnalysis DataADSL, VS, PE1P1, P2, P3ALBADAMLaboratory Analysis DataADSL, LB, EX3P1, P2, P3AQSADAMQuestionnaire Analysis DataADSL, QS1P1, P2, P3AMHADAMMedical and Surgical History Target and Non-target Lesion AnalysisADSL, TR, TU ADSL, ALS, DF, SX,2P1, P2, P3AEFFADAMEfficacy Summary Analysis DataTR, TU ADSL, AAE, ACM, AMH, ADSL, AAE, ACM, AMH,3P1ASAFADAMSafe Summary Analysis DataAEX, AVS, ALB, SX3P2	ACIVI	ADAIN	Concomitant medications Analysis Data	DF	I	PT, PZ, P3	
AEXADAMAnalysis Data Vital Signs/Physical ExaminationADSL, EX3P1, P2, P3AVSADAMAnalysis DataADSL, VS, PE1P1, P2, P3ALBADAMLaboratory Analysis DataADSL, LB, EX3P1, P2, P3AQSADAMQuestionnaire Analysis DataADSL, QS1P1, P2, P3AMHADAMMedical and Surgical History Target and Non-target Lesion AnalysisADSL, MH, LKUP_MH1P1, P2, P3ALSADAMDataADSL, TR, TU ADSL, ALS, DF, SX,2P1, P2, P3AEFFADAMEfficacy Summary Analysis DataTR, TU ADSL, AAE, ACM, AMH, ADSL, AAE, ACM, AMH,3P1ASAFADAMSafe Summary Analysis DataAEX, AVS, ALB, SX3P2	AEG	ADAM	ECG Analysis Data	ADSL, EG	1	P1, P2, P3	
AEXADAMAnalysis Data Vital Signs/Physical ExaminationADSL, EX3F1, F2, F3AVSADAMAnalysis DataADSL, VS, PE1P1, P2, P3ALBADAMLaboratory Analysis DataADSL, LB, EX3P1, P2, P3AQSADAMQuestionnaire Analysis DataADSL, QS1P1, P2, P3AMHADAMMedical and Surgical History Target and Non-target Lesion AnalysisADSL, MH, LKUP_MH1P1, P2, P3ALSADAMDataADSL, TR, TU ADSL, ALS, DF, SX,2P1, P2, P3AEFFADAMEfficacy Summary Analysis DataTR, TU ADSL, AAE, ACM, AMH,3P1ASAFADAMSafe Summary Analysis DataAEX, AVS, ALB, SX3P2			Investigational Product Administration		2	01 02 02	
AVSADAMAnalysis DataADSL, VS, PE1P1, P2, P3ALBADAMLaboratory Analysis DataADSL, LB, EX3P1, P2, P3AQSADAMQuestionnaire Analysis DataADSL, QS1P1, P2, P3AMHADAMMedical and Surgical History Target and Non-target Lesion AnalysisADSL, MH, LKUP_MH1P1, P2, P3ALSADAMDataADSL, TR, TU ADSL, ALS, DF, SX,2P1, P2, P3AEFFADAMEfficacy Summary Analysis DataTR, TU ADSL, AAE, ACM, AMH, ASAF3P1ASAFADAMSafe Summary Analysis DataAEX, AVS, ALB, SX3P2	ALA	ADAIVI	Vital Signs/Physical Examination	ADSL, EX	3	F1, F2, F3	
ALBADAMLaboratory Analysis DataADSL, LB, EX3P1, P2, P3AQSADAMQuestionnaire Analysis DataADSL, QS1P1, P2, P3AMHADAMMedical and Surgical History Target and Non-target Lesion AnalysisADSL, MH, LKUP_MH1P1, P2, P3ALSADAMDataADSL, TR, TU ADSL, ALS, DF, SX,2P1, P2, P3AEFFADAMEfficacy Summary Analysis DataTR, TU ADSL, AAE, ACM, AMH,3P1ASAFADAMSafe Summary Analysis DataAEX, AVS, ALB, SX3P2	AVS	ADAM	Analysis Data	ADSL, VS, PE	1	P1, P2, P3	
AQSADAMQuestionnaire Analysis DataADSL, QS1P1, P2, P3AMHADAMMedical and Surgical History Target and Non-target Lesion AnalysisADSL, MH, LKUP_MH1P1, P2, P3ALSADAMDataADSL, TR, TU ADSL, ALS, DF, SX,2P1, P2, P3AEFFADAMEfficacy Summary Analysis DataTR, TU ADSL, AAE, ACM, AMH,3P1ASAFADAMSafe Summary Analysis DataAEX, AVS, ALB, SX3P2	ALB	ADAM	Laboratory Analysis Data	ADSL, LB, EX	3	P1, P2, P3	
AMHADAMMedical and Surgical History Target and Non-target Lesion AnalysisADSL, MH, LKUP_MH1P1, P2, P3ALSADAMDataADSL, TR, TU ADSL, ALS, DF, SX,2P1, P2, P3AEFFADAMEfficacy Summary Analysis DataTR, TU ADSL, AAE, ACM, AMH,3P1ASAFADAMSafe Summary Analysis DataAEX, AVS, ALB, SX3P2	AQS	ADAM	Questionnaire Analysis Data	ADSL, QS	1	P1, P2, P3	
ALSADAMDataADSL, TR, TU2P1, P2, P3AEFFADAMEfficacy Summary Analysis DataTR, TU3P1ASAFADAMSafe Summary Analysis DataAEX, AVS, ALB, SX3P2	AMH	ADAM	Medical and Surgical History	ADSL, MH, LKUP_MH	1	P1, P2, P3	
AEFF ADAM Efficacy Summary Analysis Data ADSL, ALS, DF, SX, ASAF ADAM Safe Summary Analysis Data AEX, AVS, ALB, SX ASAF ADAM Safe Summary Analysis Data AEX, AVS, ALB, SX	ΔΙς	ΔΠΔΜ	Larget and Non-target Lesion Analysis	ADSI TR TU	2	D1 D2 D2	
AEFFADAMEfficacy Summary Analysis DataTR, TU3P1ASAFADAMSafe Summary Analysis DataAEX, AVS, ALB, SX3P2	ALU		Data	ADSL, ALS, DF, SX,	۷	I I, FZ, FJ	
ADSL, AAE, ACM, AMH, ASAF ADAM Safe Summary Analysis Data AEX, AVS, ALB, SX 3 P2	AEFF	ADAM	Efficacy Summary Analysis Data	TR, TU	3	P1	
	ASAF	ΔΠΔΜ	Safe Summary Analysis Data	ADSL, AAE, ACM, AMH, AFX AVS ALB SX	3	P2	
E ADAM End of ADaM Creation All Activities from ADAM O	F ADAM		End of ADaM Creation	All Activities from ADAM	0	12	

Table 1 P	rogramming	Activities	in A	Typical	Statistical	Analysis	(PgmAct)).
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Continued						
Activity	Group	Description	Predecessors	Duration	Resource	Status
S_TLG		Start of TLG Creation	S_PROJECT	0		
g_disp	TLG	Subject Disposition Graphs	ADS	1	P1, P2, P3	
g_inf_time	TLG	Infusion Times Graphs	AEX	1	P1, P2, P3	
g_dose	TLG	Cumulative Dose Bar Charts	ASAF	3	P1, P2, P3	
g_survival	TLG	Kaplan-Meier Plots Subject Incidence by Infusion	AEFF	3	P1, P2, P3	
g_infrea	TLG	Number	AAE, AEX	2	P1, P2, P3	
g_lab	TLG	Median Laboratory Value	ALB	2	P1, P2, P3	
g_vital	TLG	Median Vital Signs	AVS	2	P1, P2, P3	
l_sae	TLG	Serious Adverse Events	AAE, ADS	1	P1, P2, P3	
I_conmed	TLG	Subject Listing of CM Considered as Invest. Drug Infusion Reaction	ACM, AAE, AEX	1	P1, P2, P3	
t_death	TLG	Death Summary	ADSL, AAE, ADS	1	P1, P2, P3	
t_charact	TLG	Baseline Disease Characteristics	ADSL, AEG, ALB, ALS	2	P1, P2, P3	
t_sum_pana	TLG	Summary of the Primary Analysis of Survival Time Sensitivity Analysis for the Log-rank	ADSL, AEFF	3	P1, P2, P3	
t_pfsurtime	TLG	Test of Survival Univariate Cox Proportional Hazards	ADSL, AEFF	3	P1, P2, P3	
t_anatreat	TLG	Analysis	ADSL, AEFF	3	P1, P2, P3	
t_aes	TLG	Summary of Adverse Events	ADSL, AAE	2	P1, P2, P3	
t_infrea	TLG	Incidence of Infusion Reactions	ADSL, AAE, AEX	3	P1, P2, P3	
t_skintox	TLG	KM Analysis of Integument Toxicity	ADSL, ASAF	2	P1, P2, P3	
t_labshift	TLG	Lab Grade Shifts	ADSL, ALB	2	P1, P2, P3	
t_vitals	TLG	Summary of Vital Signs	ADSL, AVS	1	P1, P2, P3	
t_ab	TLG	Summary of Antibody Incidences Primary Analysis of Objective	ADSL, AAB	2	P1, P2, P3	
t_ab_paor	TLG	Response	ADSL, AAB, AEFF	2	P1, P2, P3	
e_tlg e projec		End of TLG Creation	All Activities from TLG E_LKUP, E_SDTM.	0		
T		End of Project	E_ADAM, E_TLG	0		

Table 2 Partial Observations in the Activity Dataset (ActData).

ACTIVITY	_DESC_	_SUCCESSOR_	_DURATION_
S_PROJECT	Start of Project	S_ADAM	0
S_PROJECT	Start of Project	S_LKUP	0
S_PROJECT	Start of Project	S_SDTM	0
S_PROJECT	Start of Project	S_TLG	0
S_SDTM	Start of SDTM Creation	DM	0
DM	Demographics	AB	2
DM	Demographics	ADSL	2
DM	Demographics	AE	2
DM	Demographics	СМ	2
DM	Demographics	СО	2



Figure 1 Network Diagram for Programming Activities.

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ACTIVITY	DUR	START	FINISH	RESOURCE	ACTIVITY	DUR	START	FINISH	RESOURCE
S_PROJECT	0	0	0	P1	g_vital	2	22	24	P1
S_SDTM	0	0	0	P2	AAB	1	23	24	P2
S_ADAM	0	0	0	P3	AEG	1	24	25	P2
S_LKUP	0	0	0	P3	AEX	3	24	27	P1
S_TLG	0	0	0	P3	ADS	4	24	28	P3
LKUP_CM	1	0	1	P1	ALS	2	25	27	P2
LKUP_AE	1	0	1	P2	ACM	1	27	28	P2
LKUP_MH	1	0	1	P3	AEFF	5	27	32	P1
E_LKUP	0	1	1	P3	t_ab	2	28	30	P2
DM	2	1	3	P1	ALB	4	28	32	P3
IE	1	3	4	P2	g_infrea	2	30	32	P2
AE	2	3	5	P1	g_disp	1	32	33	P3
DF	3	3	6	P3	t_aes	2	32	34	P2
MH	1	4	5	P2	g_survival	4	32	36	P1
VS	1	5	6	P2	t_sum_pana	3	33	36	P3
TU	3	5	8	P1	t_infrea	3	34	37	P2
SX	2	6	8	P2	t_anatreat	3	36	39	P3
EX	2	6	8	P3	t_labshift	4	36	40	P1
СМ	1	8	9	P1	t_pfsurtime	3	37	40	P2
СО	1	8	9	P3	ASAF	7	39	46	P3
TR	3	8	11	P2	l_sae	1	40	41	P2
QS	1	9	10	P1	g_lab	2	40	42	P1
AB	1	9	10	P3	t_death	1	41	42	P2
EG	1	10	11	P1	t_charact	2	42	44	P2
LB	1	10	11	P3	t_ab_paor	4	42	46	P1
PE	1	11	12	P1	t_vitals	1	44	45	P2
DS	3	11	14	P3	I_conmed	1	45	46	P2
E_SDTM	0	14	14	P3	E_ADAM	0	46	46	P2
ADSL	7	14	21	P1	g_inf_time	1	46	47	P2
AMH	1	21	22	P1	t_skintox	2	46	48	P3
AVS	1	21	22	P2	g_dose	3	46	49	P1
AAE	3	21	24	P3	E_TLG	0	49	49	P3
AQS	1	22	23	P2	E_PROJECT	0	49	49	P3

Table 3 A Scheduling Solution Generated by CLP Procedure (scheduling).

Figure 2	Gantt	Chart	for	Scheduled	Program	ming	Activities.
	oune	0110110		Senedared		B	1 1001 101000

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Programming

Scheduled

Chart:

Gantt

