

```
/** fit best SDE with different inits */

libname SAScode '/folders/myfolders/';
filename reffile '/folders/myfolders/SATZcovars.csv';
filename reffile2 '/folders/myfolders/SATZallchildrenSAS.csv';
/*filename reffile2 '/folders/myfolders/SATZtraj.csv';*/
proc import datafile=reffile dbms=csv out=SAScode.covars replace;
  datarow=2;
  getnames=YES;
  guessingrows=MAX;
run;
proc import datafile=reffile2 dbms=csv out=SAScode.traj replace;
  datarow=2;
  getnames=YES;
  guessingrows=MAX;
run;

data traj;
set SAScode.traj;
intercept=1;/** intercept for all patients */
if country='TZ' then country2=1;
else country2=0;
agects12=agects1**2;
agects13=agects1**3;
agects14=agects1**4;
agects15=agects1**5;
run;

data covars;
set SAScode.covars;
if diarrhea_prop^=.;
if household_income^=.;
keep pid month_ss diarrhea_prop household_income;
run;

proc stdize data=covars out=covars;
var household_income;
run;

proc sql;
create table combined as select distinct a.*,b.diarrhea_prop, b.household_income
from traj a, covars b
  where a.subjid=b.pid and a.agemnth0=b.month_ss;
quit;

proc sort data=combined out=combined;
by subjidN agemnth0;
run;

proc export data=work.combined
  outfile="/folders/myfolders/combined.csv"
  dbms=csv
  replace;
run;

ods html5 file='/folders/myfolders/SI3output.html';

/*****
/** SDE Models general form */
/*****
/* $ dX_t = a2 + a3 t + a4 t^2 + a5 t^3 + a1 x, sigma dW_t $
/***** COUNTRY *****/
title 'SDE linear in t all params';
proc nlmixed data=combined;/** AIC=22140 BIC=22189 */
/** the best set! */
  parms sigma2a_ind=16
        sigma2b_ind=4
a1a_ind=-5
a1b_ind=-3
a2a_ind=5
a2b_ind=5
a3a_ind=-5
a3b_ind=-5
/*s2b1=2
s2b2=2
s2b3=1
s2b4=1*/;

        a1=a1a_ind*intercept+a1b_ind*country2+b1;
        a2=a2a_ind*intercept+a2b_ind*country2+b2;
```

```

a3=a3a_ind*intercept+a3b_ind*country2+b3;
a4=0;
a5=0;
sigma2=sigma2a_ind*intercept+sigma2b_ind*country2+b4;

/** condition mean with RVs for likelihood*/
var = ((-1.0+exp(2*a1*(agects1-agects0)))*sigma2)/(2*a1);

mean=(1/(a1**4))*exp(-a1*agects0)*(6*a5*(exp(a1*agects1) - exp(a1*agects0)) +
2*a1*(a4*exp(a1*agects1) - a4*exp(a1*agects0) - 3*a5*exp(a1*agects0)*agects1 +
3*a5*exp(a1*agects1)*agects0) +
a1**2*(a3*(exp(a1*agects1) - exp(a1*agects0)) - 2*a4*exp(a1*agects0)*agects1 -
3*a5*exp(a1*agects0)*agects1**2 + 2*a4*exp(a1*agects1)*agects0 + 3*a5*exp(a1*agects1)*agects0**2) +
a1**3*(a2*(exp(a1*agects1) - exp(a1*agects0)) - a3*exp(a1*agects0)*agects1 -
a4*exp(a1*agects0)*agects1**2 - a5*exp(a1*agects0)*agects1**3 + a3*exp(a1*agects1)*agects0 +
a4*exp(a1*agects1)*agects0**2 + a5*exp(a1*agects1)*agects0**3) + a1**4*exp(a1*agects1)*zwfl0);

model zwfl1 ~ normal(mean,var);
random b1 b2 b3 b4 ~ normal([0,0,0,0],
[s2b1,
0,s2b2,
0,0,s2b3,
0,0,0,s2b4]) subject=subjidN;

run;

```

```

title 'SDE linear in t reduced - combined a2 a3 across country';
proc nlmixed data=combined;/** AIC=22165 BIC=22206 **/
/** the best set! */
parms sigma2a_ind=16
sigma2b_ind=4
a1a_ind=-5
a1b_ind=-3
a2_ind=5
a3_ind=-5
/*s2b1=2
s2b2=2
s2b3=1
s2b4=1*/;

a1=a1a_ind*intercept+a1b_ind*country2+b1;
a2=a2_ind+b2;
a3=a3_ind+b3;
a4=0;
a5=0;
sigma2=sigma2a_ind*intercept+sigma2b_ind*country2+b4;

/** condition mean with RVs for likelihood*/
var = ((-1.0+exp(2*a1*(agects1-agects0)))*sigma2)/(2*a1);

mean=(1/(a1**4))*exp(-a1*agects0)*(6*a5*(exp(a1*agects1) - exp(a1*agects0)) +
2*a1*(a4*exp(a1*agects1) - a4*exp(a1*agects0) - 3*a5*exp(a1*agects0)*agects1 +
3*a5*exp(a1*agects1)*agects0) +
a1**2*(a3*(exp(a1*agects1) - exp(a1*agects0)) - 2*a4*exp(a1*agects0)*agects1 -
3*a5*exp(a1*agects0)*agects1**2 + 2*a4*exp(a1*agects1)*agects0 + 3*a5*exp(a1*agects1)*agects0**2) +
a1**3*(a2*(exp(a1*agects1) - exp(a1*agects0)) - a3*exp(a1*agects0)*agects1 -
a4*exp(a1*agects0)*agects1**2 - a5*exp(a1*agects0)*agects1**3 + a3*exp(a1*agects1)*agects0 +
a4*exp(a1*agects1)*agects0**2 + a5*exp(a1*agects1)*agects0**3) + a1**4*exp(a1*agects1)*zwfl0);

model zwfl1 ~ normal(mean,var);
random b1 b2 b3 b4 ~ normal([0,0,0,0],
[s2b1,
0,s2b2,
0,0,s2b3,
0,0,0,s2b4]) subject=subjidN;

run;

```

```

title 'SDE quadratic in t all params';
proc nlmixed data=combined;/** AIC=21803 BIC=21861 **/
/** the best set! */
parms sigma2a_ind=17
sigma2b_ind=5
a1a_ind=-5
a1b_ind=-5
a2a_ind=5
a2b_ind=5
a3a_ind=-20
a3b_ind=-20

```

```

a4a_ind=20
a4b_ind=1
s2b1=20
s2b2=2
s2b3=1
s2b4=1
/*s2b5=0.1*/;

a1=a1a_ind*intercept+a1b_ind*country2+b1;
a2=a2a_ind*intercept+a2b_ind*country2+b2;
a3=a3a_ind*intercept+a3b_ind*country2+b3;
a4=a4a_ind*intercept+a4b_ind*country2;
a5=0;
sigma2=sigma2a_ind*intercept+sigma2b_ind*country2+b4;

/** condition mean with RVs for likelihood*/
var = ((-1.0+exp(2*a1*(agects1-agects0)))*sigma2)/(2*a1);

mean=(1/(a1**4))*exp(-a1*agects0)*(6*a5*(exp(a1*agects1) - exp(a1*agects0)) +
2*a1*(a4*exp(a1*agects1) - a4*exp(a1*agects0) - 3*a5*exp(a1*agects0)*agects1 +
3*a5*exp(a1*agects1)*agects0) +
a1**2*(a3*(exp(a1*agects1) - exp(a1*agects0)) - 2*a4*exp(a1*agects0)*agects1 -
3*a5*exp(a1*agects0)*agects1**2 + 2*a4*exp(a1*agects1)*agects0 + 3*a5*exp(a1*agects1)*agects0**2) +
a1**3*(a2*(exp(a1*agects1) - exp(a1*agects0)) - a3*exp(a1*agects0)*agects1 -
a4*exp(a1*agects0)*agects1**2 - a5*exp(a1*agects0)*agects1**3 + a3*exp(a1*agects1)*agects0 +
a4*exp(a1*agects1)*agects0**2 + a5*exp(a1*agects1)*agects0**3) + a1**4*exp(a1*agects1)*zwfl0);

model zwfl1 ~ normal(mean,var);
random b1 b2 b3 b4 ~ normal([0,0,0,0],
[s2b1,
0,s2b2,
0,0,s2b3,
0,0,0,s2b4]) subject=subjidN;

run;

title 'SDE quadratic in t reduced combined a2 a3 across country';
proc nlmixed data=combined;/** AIC=21800 BIC=21850 **/
/** the best set! */
parms sigma2a_ind=17
sigma2b_ind=5
a1a_ind=-5
a1b_ind=-5
a2_ind=5
a3_ind=-20
a4a_ind=20
a4b_ind=1
s2b1=20
s2b2=2
s2b3=1
s2b4=1
/*s2b5=0.1*/;

a1=a1a_ind*intercept+a1b_ind*country2+b1;
a2=a2_ind+b2;
a3=a3_ind+b3;
a4=a4a_ind*intercept+a4b_ind*country2;
a5=0;
sigma2=sigma2a_ind*intercept+sigma2b_ind*country2+b4;

/** condition mean with RVs for likelihood*/
var = ((-1.0+exp(2*a1*(agects1-agects0)))*sigma2)/(2*a1);

mean=(1/(a1**4))*exp(-a1*agects0)*(6*a5*(exp(a1*agects1) - exp(a1*agects0)) +
2*a1*(a4*exp(a1*agects1) - a4*exp(a1*agects0) - 3*a5*exp(a1*agects0)*agects1 +
3*a5*exp(a1*agects1)*agects0) +
a1**2*(a3*(exp(a1*agects1) - exp(a1*agects0)) - 2*a4*exp(a1*agects0)*agects1 -
3*a5*exp(a1*agects0)*agects1**2 + 2*a4*exp(a1*agects1)*agects0 + 3*a5*exp(a1*agects1)*agects0**2) +
a1**3*(a2*(exp(a1*agects1) - exp(a1*agects0)) - a3*exp(a1*agects0)*agects1 -
a4*exp(a1*agects0)*agects1**2 - a5*exp(a1*agects0)*agects1**3 + a3*exp(a1*agects1)*agects0 +
a4*exp(a1*agects1)*agects0**2 + a5*exp(a1*agects1)*agects0**3) + a1**4*exp(a1*agects1)*zwfl0);

model zwfl1 ~ normal(mean,var);
random b1 b2 b3 b4 ~ normal([0,0,0,0],
[s2b1,
0,s2b2,
0,0,s2b3,
0,0,0,s2b4]) subject=subjidN;

run;

```

```

title 'SDE cubic most params - not a5a a5b so converges';
proc nlmixed data=combined;/** AIC=21722 BIC=21784 **/
    /*parms sigma2a_ind=15 a1a_ind=-5 a1b_ind=-5 a2_ind=5 a3a_ind=-20 a4a_ind=20
        s2b1=20 s2b2=2 s2b5=0.1;*/
/** the best set! */
    parms sigma2a_ind=17
        sigma2b_ind=5
a1a_ind=-5
a1b_ind=-5
a2a_ind=5
a2b_ind=5
a3a_ind=-20
a3b_ind=-20
a4a_ind=20
a4b_ind=1
a5_ind=1
s2b1=20
s2b2=2
s2b3=1
s2b4=1
/*s2b5=0.1*/;

    a1=a1a_ind*intercept+a1b_ind*country2+b1;
    a2=a2a_ind*intercept+a2b_ind*country2+b2;
    a3=a3a_ind*intercept+a3b_ind*country2+b3;
    a4=a4a_ind*intercept+a4b_ind*country2;
    a5=a5_ind;
    sigma2=sigma2a_ind*intercept+sigma2b_ind*country2+b4;

    /** condition mean with RVs for likelihood*/
    var = ((-1.0+exp(2*a1*(agects1-agects0)))*sigma2)/(2*a1);

    mean=(1/(a1**4))*exp(-a1*agects0)*(6*a5*(exp(a1*agects1) - exp(a1*agects0)) +
2*a1*(a4*exp(a1*agects1) - a4*exp(a1*agects0) - 3*a5*exp(a1*agects0)*agects1 +
3*a5*exp(a1*agects1)*agects0) +
a1**2*(a3*(exp(a1*agects1) - exp(a1*agects0)) - 2*a4*exp(a1*agects0)*agects1 -
3*a5*exp(a1*agects0)*agects1**2 + 2*a4*exp(a1*agects1)*agects0 + 3*a5*exp(a1*agects1)*agects0**2) +
a1**3*(a2*(exp(a1*agects1) - exp(a1*agects0)) - a3*exp(a1*agects0)*agects1 -
a4*exp(a1*agects0)*agects1**2 - a5*exp(a1*agects0)*agects1**3 + a3*exp(a1*agects1)*agects0 +
a4*exp(a1*agects1)*agects0**2 + a5*exp(a1*agects1)*agects0**3) + a1**4*exp(a1*agects1)*zwfl0);

    model zwfl1 ~ normal(mean,var);
    random b1 b2 b3 b4 ~ normal([0,0,0,0],
                                [s2b1,
0,s2b2,
0,0,s2b3,
0,0,0,s2b4]) subject=subjidN;

run;

title 'SDE cubic reduced';
proc nlmixed data=combined;/** AIC=21718 BIC=21772 **/
    /*parms sigma2a_ind=15 a1a_ind=-5 a1b_ind=-5 a2_ind=5 a3a_ind=-20 a4a_ind=20
        s2b1=20 s2b2=2 s2b5=0.1;*/
/** the best set! */
    parms sigma2a_ind=17
        sigma2b_ind=5
a1a_ind=-5
a1b_ind=-5
a2_ind=5
a3_ind=-20
a4a_ind=20
a4b_ind=1
a5_ind=1
s2b1=20
s2b2=2
s2b3=1
s2b4=1
/*s2b5=0.1*/;

    a1=a1a_ind*intercept+a1b_ind*country2+b1;
    a2=a2_ind+b2;
    a3=a3_ind+b3;
    a4=a4a_ind*intercept+a4b_ind*country2;
    a5=a5_ind;
    sigma2=sigma2a_ind*intercept+sigma2b_ind*country2+b4;

    /** condition mean with RVs for likelihood*/
    var = ((-1.0+exp(2*a1*(agects1-agects0)))*sigma2)/(2*a1);

```



```

mean=(1/(a1**4))*exp(-a1*agects0)*(6*a5*(exp(a1*agects1) - exp(a1*agects0)) +
2*a1*(a4*exp(a1*agects1) - a4*exp(a1*agects0) - 3*a5*exp(a1*agects0)*agects1 +
3*a5*exp(a1*agects1)*agects0) +
a1**2*(a3*(exp(a1*agects1) - exp(a1*agects0)) - 2*a4*exp(a1*agects0)*agects1 -
3*a5*exp(a1*agects0)*agects1**2 + 2*a4*exp(a1*agects1)*agects0 + 3*a5*exp(a1*agects1)*agects0**2) +
a1**3*(a2*(exp(a1*agects1) - exp(a1*agects0)) - a3*exp(a1*agects0)*agects1 -
a4*exp(a1*agects0)*agects1**2 - a5*exp(a1*agects0)*agects1**3 + a3*exp(a1*agects1)*agects0 +
a4*exp(a1*agects1)*agects0**2 + a5*exp(a1*agects1)*agects0**3) + a1**4*exp(a1*agects1)*zwfl0);

model zwfl1 ~ normal(mean,var);
random b1 b2 b3 b4 ~ normal([0,0,0,0],
[s2b1,
0,s2b2,
0,0,s2b3,
0,0,0,s2b4]) subject=subjidN out=rvs;
predict mean out=PredCondCu;** conditional residuals **/
ods output ParameterEstimates=params;

run;

/*filename outfile "&_SASWS_/Users/lewisfa/R/predcondCu30Jan.csv";
filename outfile2 "&_SASWS_/Users/lewisfa/R/rvs30Jan.csv";
filename outfile3 "&_SASWS_/Users/lewisfa/R/params30Jan.csv"; */

filename outfile "/folders/myfolders/predcondSDE.csv";
filename outfile2 "/folders/myfolders/rvsSDE.csv";
filename outfile3 "/folders/myfolders/paramsSDE.csv";

proc export data=work.PredCondCu
outfile=outfile
dbms=csv
replace;
run;
proc export data=work.rvs
outfile=outfile2
dbms=csv
replace;
run;
proc export data=work.params
outfile=outfile3
dbms=csv
replace;
run;
/*****

/*****
/**** CURVE FITTING COMPARISONS *****/
/*****
/**** BEST MODEL AT THE END ****/
/*****
/**** CURVE FITTING MODELS *****/

title 'linear lmm + country fixed - no R-side';
proc mixed data=combined method=ml ic;** AIC=22709.2 BIC=22750.5 **/
class country;
model zwfl1 = agects1 country / s;
random intercept agects1 agects12/ type=un sub=subjidN g;
run;

title 'linear lmm + country fixed - R-side AR(1)';
proc mixed data=combined method=ml ic;** AIC=22172.7 BIC=22218.1 **/
class country;
model zwfl1 = agects1 country / s;
random intercept agects1 agects12/ type=un sub=subjidN g;
repeated / type=ar(1) sub=subjidN r;
run;

title 'quad lmm + country fixed';
proc mixed data=combined method=ml ic;** AIC=22058.2 BIC=22107.7 **/
class country;
model zwfl1 = agects1 agects12 country / s;
random intercept agects1 agects12/ type=un sub=subjidN g;
repeated / type=ar(1) sub=subjidN r;
run;

title 'cubic lmm + country fixed';
proc mixed data=combined method=ml ic;** AIC=21936.1 BIC=22006.4 **/
class country;
model zwfl1 = agects1 agects12 agects13 country / s;
random intercept agects1 agects12 agects13/ type=un sub=subjidN g;
repeated / type=ar(1) sub=subjidN r;

```

```

run;

title 'quartic lmm + country';
/** linear agects1 no longer significant at 0.05 and quadratic agects12 is only 0.01 */
proc mixed data=combined method=ml ic;/** AIC=21818.2 BIC=21913.2 **/
  class country;
  model zwfll = agects1 agects12 agects13 agects14 country / s;
  random intercept agects1 agects12 agects13 agects14/ type=un sub=subjidN g;
  repeated / type=ar(1) sub=subjidN r;
run;

title 'quartic lmm + country - reduced - no linear agects1 as not sig. in full model';
/** AIC/BIC much worse dropping linear so move back cubic skeleton to keep only
stat sig terms and now consider with interactions
Also G-matrix not positive definite so model seems to be misbehaving */
proc mixed data=combined method=ml ic;/** AIC=21984.6 BIC=22054.8 **/
  class country;
  model zwfll = agects12 agects13 agects14 country / s;
  random intercept agects12 agects13 agects14/ type=un sub=subjidN g;
  repeated / type=ar(1) sub=subjidN r;
run;

title 'cubic lmm + country*agects all terms';
proc mixed data=combined method=ml ic;/** AIC=21918.5 BIC=22001.1 **/
  class country;
  model zwfll = agects1 agects12 agects13 country country*agects1 country*agects12 country*agects13 / s;
  random intercept agects1 agects12 agects13/ type=un sub=subjidN g;
  repeated / type=ar(1) sub=subjidN r;
run;

title 'cubic lmm + country + country*agects1';
proc mixed data=combined method=ml ic;/** AIC=21918.6 BIC=21993.0 **/
  class country;
  model zwfll = agects1 agects12 agects13 country country*agects1 / s;
  random intercept agects1 agects12 agects13/ type=un sub=subjidN g;
  repeated / type=ar(1) sub=subjidN r;
run;

title 'cubic lmm + country + country*agects12';
proc mixed data=combined method=ml ic;/** AIC=21915.1 BIC=21989.5 **/
  class country;
  model zwfll = agects1 agects12 agects13 country country*agects12 / s;
  random intercept agects1 agects12 agects13/ type=un sub=subjidN g;
  repeated / type=ar(1) sub=subjidN r;
run;

title 'cubic lmm + country + country*agects13';
proc mixed data=combined method=ml ic;/** AIC=21915.1 BIC=21989.4 **/
  class country;
  model zwfll = agects1 agects12 agects13 country country*agects13 / s;
  random intercept agects1 agects12 agects13/ type=un sub=subjidN g;
  repeated / type=ar(1) sub=subjidN r;
run;

title 'cubic lmm + country + country*agects1+country*agects12';
proc mixed data=combined method=ml ic;/** AIC=21916.6 BIC=21995.1 **/
  class country;
  model zwfll = agects1 agects12 agects13 country country*agects1 country*agects12 / s;
  random intercept agects1 agects12 agects13/ type=un sub=subjidN g;
  repeated / type=ar(1) sub=subjidN r;
run;

title 'cubic lmm + country + country*agects1+country*agects13';
proc mixed data=combined method=ml ic;/** AIC=21917.0 BIC=21995.5 **/
  class country;
  model zwfll = agects1 agects12 agects13 country country*agects1 country*agects13 / s;
  random intercept agects1 agects12 agects13/ type=un sub=subjidN g;
  repeated / type=ar(1) sub=subjidN r;
run;

title 'cubic lmm + country + country*agects12+country*agects13';
proc mixed data=combined method=ml ic;/** AIC=21916.9 BIC=21995.4 **/
  class country;
  model zwfll = agects1 agects12 agects13 country country*agects12 country*agects13 / s;
  random intercept agects1 agects12 agects13/ type=un sub=subjidN g;
  repeated / type=ar(1) sub=subjidN r;
run;

title 'cubic lmm + country*agects1';

```

```
proc mixed data=combined method=ml ic;/** AIC=21916.7 BIC=21986.9 **/  
  class country;  
  model zwfll = agects1 agects12 agects13 country*agects1 / s outp=curvepredcond outpm=curvepredmarg;  
  random intercept agects1 agects12 agects13/ type=un sub=subjidN g;  
  repeated / type=ar(1) sub=subjidN r;  
run;  
  
title 'cubic lmm + country*agects13';  
proc mixed data=combined method=ml ic;/** AIC=21913.6 BIC=21983.5 **/  
  class country;  
  model zwfll = agects1 agects12 agects13 country*agects13 / s outp=curvepredcond outpm=curvepredmarg;  
  random intercept agects1 agects12 agects13/ type=un sub=subjidN g;  
  repeated / type=ar(1) sub=subjidN r;  
run;  
  
title 'cubic lmm + country*agects12';  
/** BEST CURVE **/  
proc mixed data=combined method=ml ic;/** AIC=21913.2 BIC=21983.5 **/  
  class country;  
  model zwfll = agects1 agects12 agects13 country*agects12 / s outp=curvepredcond outpm=curvepredmarg;  
  random intercept agects1 agects12 agects13/ type=un sub=subjidN g;  
  repeated / type=ar(1) sub=subjidN r;  
run;  
  
filename outfile "/folders/myfolders/curvepredcond.csv";  
/*filename outfile2 "/folders/myfolders/curvepredmarg.csv"; */  
proc export data=work.curvepredcond  
  outfile=outfile  
  dbms=csv  
  replace;  
run;  
  
/*proc export data=work.curvepredmarg  
  outfile=outfile2  
  dbms=csv  
  replace;  
run;  
*/  
  
ods html5 close;
```