2 画 ; HGM ∽

Risa/Asir 2 画 ; HGM ∽域

1.1

2017 綛 3 3

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1 2画 ; HGM ∽域 吾 ゃ

吾 c HGM(holonomic gradient method) 2 画 ; ∽違 ゃ . ChangeLog www.openxm.org cvsweb 純若鴻潟若茯 宴吾 .

筝 y .

- [GM2016] Y.Goto, K.Matsumoto, Pfaffian equations and contiguity relations of the hypergeometric function of type (k+1,k+n+2) and their applications, arxiv:1602.01637 (version 1)
- [T2016] Y.Tachibana, 綏 冗羈 ≪吾ャ 若<純 荐膊 , 2016, 腑後ぇ絖 信紕 .
- [GTT2016] Y.Goto, Y.Tachibana, N.Takayama, 2 画 ; 綏 冗羈 荅, 亥茗腥狗 (画篋絎).
- [TKT2015] N.Takayama, S.Kuriki, A.Takemura, A-hypergeometric distributions and Newton polytopes. arxiv:1510.02269

ャ≪ ц ∽違 違 箴 gtt_ekn/test-t1.rr .

2 2 画 ; HGM ∽

2.1 莇綛鞘∽ E(k,n)

2.1.1 gtt_ekn.gmvector

`gtt_ekn.gmvector(beta,p)`
:: 昇 *beta*, 祉 ∈ *p* 画 ; 莇綛鞘∽ E(k,n) ゃ潟 小 ゃ祉.

`gtt_ekn.ekn_cBasis_2(beta,p)`
ュ c .

return , 莇綛鞘∽違 ゃ 小. 荅潟 荐.

beta 茵, 鴻. 鴻 c .

p 篋画 ; 祉 ∈ 鴻

- gmvector Gauss-Manin vector ャ c [GM2016].
- gmvector 祉ゃ [GM2016] 6 腴 p.23 S c . [GM2016] 腴 y 臂 F 医 c , 違 膃 [GM2016] 腴 y 臂 膣 S ゃ 浦 .
- r1 x r2 画 ; . m+1=r1, n+1=r2 . 罩 h 絎 Z 画 ; u (m+1) (n+1) 茵 p^u/u! c . y *beta* c u c [TKT2015], [GM2016]. S 綣 Z p

```
[[1,y11,...,y1n],
 [1,y21,...,y2n],...,
 [1,ym1, ...,ymn],
 [1,1, ..., 1]]
```

  (1 L 絖 研), 荀膣違 c .
- 2x(n+1) 画 ; , gmvector 祉ゃ Lauricella F_D ф吾 篁ヤ c (b[2][1]-b[1][1] >= 0 翫). b[1][1], b[1][2] , 1 茵 , 2 茵 , b[2][i] i c .

```
S=F_D(-b[1,1], [-b[2,2],...,-b[2,n+1]], b[2,1]-b[1,1]+1 ; y)/C,
```

  C=b[1,1]! b[2,2]! ... b[2][n+1]! (b[2,1]-b[1,1])! . 1/C L 絖 画 ;

```
[[b[1,1],        0,       ..., 0        ],
 [b[2,1]-b[1,1],b[2,2], ..., b[2,n+1]]]
```

  綽. gmvector

```
[S,(y11/a2) d_11 S,(y12/a3) d_12 S, ..., (y1n/a_(n+1)) d_1n S]
```

  c . d_ij yij ゃ 小,

```
  [a0,      a1, ...                          ,a_(n+2)]
= [-b[1,2],-b[1,1],b[2,2], ..., b[2,n+1],b[2,1]]
```

  c .
- 昇 *beta* 荀絎違 祉 ∈ *p* ゃ 紊綣 E(k,n) ゃц;障 c . [TKT2015], [GM2016] .
- option crt=1 (crt = Chinese remainder theorem) 筝, h 膊 [T2016]. h 膊 腮 < 若帥 ┃絎 gtt_ekn.setup ц .

篋: 罨< 2 x 2 画 ; ц [5,1], [3,3], 祉 ∈ [[1/2,1/3],[1/7,1/5]] 翫 gmvector ゃ c .

```
[3000] load("gtt_ekn.rr");
[3001] ekn_gtt.gmvector([[5,1],[3,3]],[[1/2,1/3],[1/7,1/5]])
[775/27783]
[200/9261]
```

: 2 x m 画 ; (Lauricella FD) ゃ 宴若 tk_fd c 等荐 膈 荐膊 c . 絎膀蚊 違 違 紕 莠, debug .

```
[3080] import("tk_fd.rr");
[3081] A=tk_fd.marginal2abc([4,5],[2,4,3]);
[-4,[-4,-3],-1]  // 2 紊 FD    <若. a,[b1,b2],c
[3082] tk_fd.fd_hessian2(A[0],A[1],A[2],[1/2,1/3]);
Computing Dmat(ca) for parameters B=[-4,-3],X=[ 1/2 1/3 ]
[4483/124416,[ 1961/15552 185/1728 ],
 [ 79/288 259/864 ]
 [ 259/864 47/288 ]]
// 糸ゃ [F=F_D, gradient(F), Hessian(F)]

// ekn_gt  c      <若.
[3543] A=tk_fd.marginal2abc([5,1],[3,3]);
[-5,[-3],-1]
[3544] tk_fd.fd_hessian2(A[0],A[1],A[2],[(1/3)*(1/7)/((1/2)*(1/5))]);
Computing Dmat(ca) for parameters B=[-3],X=[ 10/21 ]
[775/27783,[ 20/147 ],[ 17/42 ]]
```

: 筝 A 絽 荀絎違 ゃ Hessian 膊 薑 package ot_hessian_ahg.rr y 荅 鴻 . (障 鴻 y 阪綵 √ 膈絨 ョ 眼.)

```
import("ot_hgm_ahg.rr");
import("ot_hessian_ahg.rr");
def  htest4() {
  extern C11_A;
  extern C11_Beta;
  Hess=newmat(7,7);
  A =C11_A;
  Beta0= [b0,b1,b2,b3];
  BaseIdx=[4,5,6];
  X=[x0,x1,x2,x3,x4,x5,x6];
  for (I=0; I<7; I++) for (J=0; J<7; J++) {
    Idx = [I,J];
    H=hessian_simplify(A,Beta0,X,BaseIdx,Idx);
    Hess[I][J]=H;
    printf("[I,J]=%a, Hessian_ij=%a\n",Idx,H);
  }
  return(Hess);
}
[2917] C11_A;
[[0,0,0,1,1,1,1],[1,0,0,1,0,1,0],[0,1,1,0,1,0,1],[1,1,0,1,1,0,0]]
[2918] C11_Beta;
[166,36,290,214]
```

```
[2919] Ans=htest4$
[2920] Ans[0][0];
[[((b1-b0-1)*x4)/(x0^2),[4]],[((b1-b0-1)*x6)/(x0^2),[6]],
 [(b1^2+(-2*b0-1)*b1+b0^2+b0)/(x0^2),[]],[(x6)/(x0),[6,0]],[(x4)/(x0),[4,0]]]
```

Section 2.1.5 [gtt_ekn.setup], page 8 ⟨undefined⟩ [gtt_ekn.pfaffian_basis], page ⟨undefined⟩

ChangeLog

- ∽違 [GM2016] ≪ 眼 冴 [T2016] modular method 蕭絎荅 c .
- 紊眼<ゃ OpenXM/src/asir-contrib/packages/src/gtt_ekn.rr 1.1, gtt_ekn/ekn_pfaffian_8.rr

2.1.2 gtt_ekn.nc

gtt_ekn.nc(*beta*,*p*)

:: 昇 *beta*, 祉 ∈ *p* 画 ; >散篁腆榊 荀絎 Z 潟 小 ゃ祉.

return [Z,[[d_11 Z, d_12 Z, ...], ..., [d_m1 Z, d_m2 Z, ..., d_mn Z]]]

beta 茵, 鴻. 鴻 c .

p 篋画 ; 祉 ∈ 鴻

- r1 x r2 画 ; . m=r1, n=r2 . 罩h絎 Z 画 ; u m n 茵 p^u/u! c . y *beta* c u c [TKT2015], [GM2016]. p^u p_ij^u_ij , u! u_ij! c . d_ij Z Z p_ij ゃ 綴 茵 .
- nc gmvector ゃ, [GM2016] Prop 7.1 冴ャ Z ゃ荐膊.
- option crt=1 (crt = Chinese remainder theorem) 筝, h膊 . h膊 腮 <若帥 絎 gtt_ekn.setup ц .

篋: 2x3 画 ; c Z 小 膊.

```
[2237] gtt_ekn.nc([[4,5],[2,4,3]],[[1,1/2,1/3],[1,1,1]]);
[4483/124416,[ 353/7776 1961/15552 185/1728 ]
[ 553/20736 1261/15552 1001/13824 ]]
```

: 2 x m 画 ; (Lauricella FD) ゃ 宴若 tk_fd c 筝荐 膈 荐膊 c .

```
[3076] import("tk_fd.rr");
[3077] A=tk_fd.marginal2abc([4,5],[2,4,3]);
[-4,[-4,-3],-1]
[3078] tk_fd.ahmat_abc(A[0],A[1],A[2],[[1,1/2,1/3],[1,1,1]]);
RS=[ 4 5 ], CSnew=[ 2 4 3 ], Ynew=[ 1 1/2 1/3 ]
[ 1 1 1 ]
Computing Dmat(ca) for parameters B=[-4,-3],X=[ 1/2 1/3 ]
[4483/124416,[[353/7776,1961/15552,185/1728],
                [553/20736,1261/15552,1001/13824]]]
// 糸ゃ [Z, [[d_11 Z, d_12 Z, d_13 Z],
//           [d_21 Z, d_22 Z, d_23 Z]]]   .
//          d_ij  i,j  ゃ   小茵  .
```

Section 2.1.5 [gtt_ekn.setup], page 8 Section 2.1.3 [gtt_ekn.lognc], page 5

ChangeLog

- 紊眼<ゃ OpenXM/src/asir-contrib/packages/src/gtt_ekn.rr 1.1, gtt_ekn/ekn_eval.rr

2.1.3 gtt_ekn.lognc

`gtt_ekn.lognc(beta,p)`

:: 昇 *beta*, 祉 ∈ *p* 画; >散篁腆榊 荀絎 Z log 篌弱ゃ潟 小 篌弱ゃ祉 .

return [log(Z), [[d_11 log(Z), d_12 log(Z), ...], [d_21 log(Z),...], ...]

beta 茵, 鴻. 鴻 c .

p 篋画; 祉 ∈ 鴻

- >散篁絨ゆ [TKT2015].
- option crt=1 (crt = Chinese remainder theorem) 箏, h膊 . h膊 腮 <若帥 | 絎 gtt_ekn.setup ц .

箴: 2 3 画 ; c . 膃 粋篌弱.

```
[2238] gtt_ekn.lognc([[4,5],[2,4,3]],[[1,1/2,1/3],[1,1,1]]);
[-3.32333832422461674630,[ 5648/4483 15688/4483 13320/4483 ]
[ 3318/4483 10088/4483 9009/4483 ]]
```

: 2 x m 画 ; (Lauricella FD) ゃ 宴若 tk_fd c 筝荐 膈 荐膊 c .

```
[3076] import("tk_fd.rr");
[3077] A=tk_fd.marginal2abc([4,5],[2,4,3]);
[-4,[-4,-3],-1]
[3078] tk_fd.log_ahmat_abc(A[0],A[1],A[2],[[1,1/2,1/3],[1,1,1]]);
RS=[ 4 5 ], CSnew=[ 2 4 3 ], Ynew=[ 1 1/2 1/3 ]
[ 1 1 1 ]
Computing Dmat(ca) for parameters B=[-4,-3],X=[ 1/2 1/3 ]
[-3.3233383242246167463948579771920932221726053926724604532O,
 [[1.2598706, 3.499442, 2.971224],
  [0.7401293, 2.250278, 2.009591]]]
// 糸ゃ [log(Z),
//          [[d_11 log(Z), d_12 log(Z), d_13 log(Z)],
//           [d_21 log(Z), d_22 log(Z), d_23 log(Z)]]]
//  篌弱.
```

Section 2.1.5 [gtt_ekn.setup], page 8 Section 2.1.2 [gtt_ekn.nc], page 4

ChangeLog

- 紊眼<ゃ OpenXM/src/asir-contrib/packages/src/gtt_ekn.rr 1.1.

2.1.4 gtt_ekn.expectation

`gtt_ekn.expectation(beta,p)`

:: 昇 *beta*, 祉 ∈ *p* 画 ; 緇ゃ荐膊.

return 篋画 ; 祉 緇ゃ 鴻.

beta 茵, 鴻. 鴻 c .

p 篋画 ; 祉 ∈ 鴻

- [GM2016] Algorithm 7.8 茖.

- option crt=1 (crt = Chinese remainder theorem) 筝, h腆 . h腆 腮 <若帥 |
  絎 gtt_ekn.setup ц .
- option index 筝, 絎 緇や 粋腆. 2 x 2 画 ; index=[[0,0],[1,1]] 絎, 1 緇や 粋腆.

22, 33 画 ; 緇よ腆篋.

```
[2235] gtt_ekn.expectation([[1,4],[2,3]],[[1,1/3],[1,1]]);
[ 2/3 1/3 ]
[ 4/3 8/3 ]
[2236] gtt_ekn.expectation([[4,5],[2,4,3]],[[1,1/2,1/3],[1,1,1]]);
[ 5648/4483 7844/4483 4440/4483 ]
[ 3318/4483 10088/4483 9009/4483 ]

[2442] gtt_ekn.expectation([[4,14,9],[11,6,10]],[[1,1/2,1/3],[1,1/5,1/7],[1,1,1]]);
[ 207017568232262040/147000422096729819 163140751505489940/147000422096729819
                                         217843368649167296/147000422096729819 ]
[ 118548240101137878/147000422096729819 358095302885438604/147000422096729819
                                         514428205457640984/147000422096729819 ]
[ 224504673820628091/147000422096729819 360766478189450370/147000422096729819
                                         737732646860489910/147000422096729819 ]
```

: 2 x m 画 ; (Lauricella FD) ゃ 宴若 tk_fd c 筝荐 膈 荐腆 c .

```
[3076] import("tk_fd.rr");
[3077] A=tk_fd.marginal2abc([4,5],[2,4,3]);
[-4,[-4,-3],-1]
[3078] tk_fd.expectation_abc(A[0],A[1],A[2],[[1,1/2,1/3],[1,1,1]]);
RS=[ 4 5 ], CSnew=[ 2 4 3 ], Ynew=[ 1 1/2 1/3 ]
[ 1 1 1 ]
Computing Dmat(ca) for parameters B=[-4,-3],X=[ 1/2 1/3 ]
[[5648/4483,7844/4483,4440/4483],
 [3318/4483,10088/4483,9009/4483]]
// 祉 緇.
```

: 筝 A 絽 腆 ot_hgm_ahg.rr. 障絎薑 , module . ot_hgm_ahg.rr ゃ : K.Ohara, N.Takayama, Pfaffian Systems of A-Hypergeometric Systems II — Holonomic Gradient Method, arxiv:1505.02947

```
[3237] import("ot_hgm_ahg.rr");
// 2 x 2 画 ; .
[3238] hgm_ahg_expected_values_contiguity([[0,0,1,1],[1,0,1,0],[0,1,0,1]],
        [9,6,8],[1/2,1/3,1/5,1/7],[x1,x2,x3,x4]|geometric=1);
oohg_native=0, oohg_curl=1
[1376777025/625400597,1750225960/625400597,
 2375626557/625400597,3252978816/625400597]
// 2 x 2 画 ; 緇.

// 2 x 3 画 ; .
[3238] hgm_ahg_expected_values_contiguity(
 [[0,0,0,1,1,1],[1,0,0,1,0,0],[0,1,0,0,1,0],[0,0,1,0,0,1]],
 [5,2,4,3],[1,1/2,1/3,1,1,1],[x1,x2,x3,x4,x5,x6]|geometric=1);
```

```
[5648/4483,7844/4483,4440/4483,3318/4483,10088/4483,9009/4483]
// 2 x 3 画;  緇. 筝  蕁.
```

3 x 3 画 ; . 罕 0 筝.

```
/*
  dojo, p.221  若.  膰 3 篁ヤ  緇   蚊  ゃ.
  2 1 1
  8 3 3
  0 2 6

  row sum: 4,14,8
  column sum: 10,6,10
  0 筝ゅ   , (3,6)  A  7   .
*/

A=[[0,0,0,1,1,1, 0,0],
   [0,0,0,0,0,0, 1,1],
   [1,0,0,1,0,0, 0,0],
   [0,1,0,0,1,0, 1,0],
   [0,0,1,0,0,1, 0,1]];
B=[14,8,10,6,10];
hgm_ahg_expected_values_contiguity(A,B,[1,1/2,1/3,1,1/5,1/7,1,1],
[x1,x2,x3,x4,x5,x6,x7,x8]|geometric=1);

// 膈.
[14449864949304/9556267369631,
 10262588586540/9556267369631, 13512615942680/9556267369631,
 81112808747006/9556267369631,
 21816297744346/9556267369631, 30858636683482/9556267369631,

 25258717886900/9556267369631,51191421070148/9556267369631]
```

3 x 3 画 ; .

```
/*
 筝  若帥 0  1   .
  2 1 1
  8 3 3
  1 2 6

  row sum: 4,14,9
  column sum: 11,6,10
*/
A=[[0,0,0,1,1,1,0,0,0],
   [0,0,0,0,0,0,1,1,1],
   [1,0,0,1,0,0,1,0,0],
   [0,1,0,0,1,0,0,1,0],
   [0,0,1,0,0,1,0,0,1]];
B=[14,9,11,6,10];
```

```
hgm_ahg_expected_values_contiguity(A,B,[1,1/2,1/3,1,1/5,1/7,1,1,1],
                                   [x1,x2,x3,x4,x5,x6,x7,x8]|geometric=1);

// 緇, 腷.  x9 絎   , 9   緇ゃ 阪  .
[207017568232262040/147000422096729819,
 163140751505489940/147000422096729819,217843368649167296/147000422096729819,
 1185482401011137878/147000422096729819,
 358095302885438604/147000422096729819,514428205457640984/147000422096729819,
 224504673820628091/147000422096729819,360766478189450370/147000422096729819]

// Z  小 膊 hgm_ahg_contiguity ∽違 ,  亜ゃ潟帥若 c 若潟
// 障吾  .
```

Section 2.1.5 [gtt_ekn.setup], page 8 Section 2.1.2 [gtt_ekn.nc], page 4

ChangeLog

- 紊眼＜ゃ OpenXM/src/asir-contrib/packages/src/gtt_ekn.rr 1.1.

2.1.5 gtt_ekn.setup

gtt_ekn.setup()

:: h膊 医荐 . 上 医怨.

return

- 篏睡 祉潟 違 , 絨 違茵 ず. 羣 翫 茵 ず.
- 宴若吾 c h膊 違 cpu 荐膊罘 y 茵 喝 .
- option nps (障 number_of_processes) 筝 絎違 祉潟 .
- option nprm (障 number_of_primes) 筝 nprm 綣 翫絎膣違 潟 ＜ゃ 茯 粋昭. nprm 倶違 翫 option minp (minp =MINimum Prime) 筝 minp 紊 c 違 nprm. option fgp (障 file_of_generated_primes) 筝 膣違 潟＜ゃ fgp 綣.
- 筝荐 option 絎 c 翫罨＜ ゃ . nps=1. nprm=10. fgp=0.
- option report=1 筝 上 医 怨 帥茵. setup(|report=1) ュ report ∽違篏睡 c .
- option subprogs=[file1,file2,...] h膊 箴 祉潟 若潟＜ゃ file1, file2, ... 絎. default subprogs=["gtt_ekn/childprocess.rr"] c .
- gtt_ekn.set_debug_mode(Mode) Ekn_debug ゃ荐 .

箴: 膣違 潟 ＜ゃ p.txt 御吾冴.

```
gtt_ekn.setup(|nps=2,nprm=20,minp=10^10,fgp="p.txt")$
```

Section 2.1.2 [gtt_ekn.nc], page 4 Section 2.1.1 [gtt_ekn.gmvector], page 2

ChangeLog

- 紊眼＜ゃ OpenXM/src/asir-contrib/packages/src/gtt_ekn.rr 1.1, gtt_ekn/g_mat_fac.rr

2.1.6 gtt_ekn.upAlpha

gtt_ekn.upAlpha(*i*,*k*,*n*)

::

i a_i a_i+1 contiguity relation.
k E(k+1,n+k+2) 綛鞘∽違 *k.* 画；c *(k+1)(n+1).*
n E(k+1,n+k+2) 綛鞘∽違 *n.* 画；c *(k+1)(n+1).*
return contiguity relation pfaffian_basis ゃ 茵 障祉. *[GM2016] Cor 6.3.*

- upAlpha [GM2016] Cor 6.3 U_i 祉.
- ∫ c ∽違 亜羮 .
- a_i a_i-1 翫 ∽ downAlpha .
- a_i 画； 昇荀 , ∽ marginaltoAlpha([茵,]) .
- pfaffian_basis [GM2016] 腴 F 綽緇 祉.

箴: 篁ヤ 22 画；(E(2,4)), 23 画；(E(2,5)) 翫 c . [2225] 障 c 阪ャ .

```
[2221] gtt_ekn.marginaltoAlpha([[1,4],[2,3]]);
[[a_0,-4],[a_1,-1],[a_2,3],[a_3,2]]
[2222] gtt_ekn.upAlpha(1,1,1);  // E(2,4)  a_1 劫
                                //     contiguity 茵  障茵
[2223] gtt_ekn.upAlpha(2,1,1);  // E(2,4)  a_2 劫
[2224] gtt_ekn.upAlpha(3,1,1);  // E(2,4)  a_3 劫
[2225] function f(x_1_1);
[2232] gtt_ekn.pfaffian_basis(f(x_1_1),1,1);
[ f(x_1_1) ]
[ (f1(x_1_1)*x_1_1)/(a_2) ]
[2233] function f(x_1_1,x_1_2);
f() redefined.
[2234] gtt_ekn.pfaffian_basis(f(x_1_1,x_1_2),1,2); // E(2,5), 2*3 画；
[ f(x_1_1,x_1_2) ]
[ (f1,0(x_1_1,x_1_2)*x_1_1)/(a_2) ]
[ (f0,1(x_1_1,x_1_2)*x_1_2)/(a_3) ]
```

Section 2.1.2 [gtt_ekn.nc], page 4 Section 2.1.1 [gtt_ekn.gmvector], page 2

ChangeLog

- ∽違 [GM2016] т≪ 眼 冴 contiguity relation 絨冴.
- 紊眼＜ゃ OpenXM/src/asir-contrib/packages/src/gtt_ekn/ekn_pfaffian_8.rr 1.1.

2.1.7 gtt_ekn.cmle

gtt_ekn.cmle(*u*) u 荀恰謙若帥 , P(U=u | row sum, column sum = these of U) 紊 y , 祉 ∈ 篌弱ゃ羆.

::

u 荀恰謙若 *(*画；*)*
return 祉 ∈ *(*画；綵√*)*

- u 荀恰謙若帥 , P(U=u | row sum, column sum = these of U) 紊 y , 祉 ∈ 篌弱ゃ羆 .
- optional parameter algorithm (井違菴篌若, 罸絖絨違 , gradient descent step 綛) 茯炊眼鴻, 鑵 賢. 2017.03.03

箴: 2 x 4 画；.

```
U=[[1,1,2,3],[1,3,1,1]];
gtt_ekn.cmle(U);
 [[ 1 1 2 3 ]
  [ 1 3 1 1 ],[[7,6],[2,4,3,4]],   // Data, row sum, column sum
 [ 1 67147/183792 120403/64148 48801/17869 ]  // probability obtained.
 [ 1 1 1 1 ]]
```

箴: 箏 ∽違.

```
gtt_ekn.cmle_test3();
```

Section 2.1.4 [gtt_ekn.expectation], page 5

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- gtt_ekn/mle.rr .
- gtt_ekn.rr cmle ∽違 wrapper.

3 modular 荐膊

3.1 箏 遵遺絎 itor

3.1.1 gtt_ekn.chinese_itor

gtt_ekn.chinese_itor(*data*,*idlist*)
:: mod p ц膊腟 ( ) chinese remainder theorem, itor(integer to rational) ф違綣.

*return [val, n] val . 障, n = n1*n2*...*
data [[val1,n1],[val2,n2], ...], val mod n1 = val1, val mod n2 = val2,...
idlist chinese, itor 絎茵泣若 ID 鴻.

- 箏 遵遺絎 val0 mod n1 = val1, val0 mod n2 = val2, ... val0 羆. val algorithm itor .
- sqrt(n) val0 紊c itor val0 val=a/b . ゃ障 b*x =1 mod n x , x*a % n = val0 val 祉. 苟ゃ failure 祉.

箴: [3!, 5^3*3!]=[6,750] 祉. 6 mod 109 =6, 750 mod 109=96 違 [[6,96],109]. 篁ヤ罕.

```
gtt_ekn.setup(|nps=2,nprm=3,minp=101,fgp="p_small.txt");
SS=gtt_ekn.get_svalue();
SS[0];
  [103,107,109]   // list of primes
SS[1];
  [0,2]           // list of server ID's
gtt_ekn.chinese_itor([[[ 6,96 ],109],[[ 6,29 ],103],[[ 6,1 ],107]],SS[1]);
  [[ 6 750 ],1201289]

// 綣違 鴻 若c .
gtt_ekn.chinese_itor([[96,109],[29,103]],SS[1]);
  [[ 750 ],11227]
```

箴: gtt_ekn/childprocess.rr (server y茵) ∽ chinese (chinese remainder theorem) euclid.

```
load("gtt_ekn/childprocess.rr");
chinese([newvect(2,[6,29]),103],[newvect(2,[6,750]),107*109]);
  // mod 103  [6,29], mod (107*109)  [6,750]    違 mod 103*(107*109)
  // ф,
  [[ 6 750 ],1201289]
euclid(3,103);  // mod 103  c  3   . ゃ障 1/3
  -34
3*(-34) % 103; // 腆冴  .
   1
```

箴: gtt_ekn/childprocess.rr (server y茵) ∽ itor (integer to rational) . itor(Y,Q,Q2,Idx) c Y < Q2 Y 障丈祉. Idx index yソ 違c. 祉ゃ 鐚 .

```
load("gtt_ekn/childprocess.rr");
for (I=1;I<11; I++) print([I,itor(I,11,3,0)]);
[1,[1,0]]
```

```
[2,[2,0]]
[3,[-2/3,0]] //euclid(3,11); ->4,  4*(-2)%11 -> 3     x∈ -2/3     違 荅

[4,[failure,0]]
[5,[-1/2,0]]
[6,[1/2,0]]
[7,[-1/3,0]]
[8,[failure,0]]
[9,[-2,0]]
[10,[-1,0]]
```

Section 2.1.5 [gtt_ekn.setup], page 8

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- ∫ c < ゃ gtt_ekn/g_mat_fac.rr gtt_ekn/childprocess.rr

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