▼ Informations initiales

Liste des leçons.

```
> lecons := {$101..109, $120..126, $140..144, $150..162, 170,
  171, $180..183, 190,
  $201..209, $213..221, 223, 224, 226, $228..230, 232, $234..236,
  $239..241, $243..247, 249, $253..255, $260..264}:nops(%);
```

$$86 \tag{1.1}$$

Correspondances développements–leçons.

```
> dev_lecons := {["Decomposition_Dunford", {153, 155, 157, 218,
  226}], ["Theoreme_Rothstein_Trager", {122, 140, 143, 144, 236}
  ],
  ["Exponentielle_MnC_GLnC_surjective", {153, 156}],
  ["Algorithme_Faddeev", {144, 153, 226}],
  ["Composantes_connexes_fq_non_degen", {158, 170, 171, 204}],
  ["Sous_algebre_reduite", {108, 153, 154, 155, 157}],
  ["Borne_Bezout", {142, 143, 152}], ["Theoreme_Kronecker", {102,
  142, 144}],
  ["An_simple", {101, 103, 105, 108}],
  ["Classification_groupes_ordre_8", {103, 104}],
  ["Theoreme_Burnside", {104, 106, 153, 157}],
  ["Table_caracteres_S4", {105, 107, 109}],
  ["Partition_entier_parts_fixees", {124, 126, 140, 190}],
  ["Reduction_endo_normaux", {150, 154, 155, 157, 160, 161}],
  ["Theoreme_Hahn_Banach_geometrique", {159, 181, 253}],
  ["Theoreme_Molien", {101, 104, 107, 109, 124, 142, 151}],
  ["Irreductibilite_pol_cyclo", {102, 120, 121, 141, 144}],
  ["Generateurs_groupe_orthogonal", {106, 108, 159, 160, 161,
  162}],
  ["Primalite_nombres_Mersenne", {120, 121, 123, 141}],
  ["Theoreme_Lie_Kolchin", {103, 106, 154, 157, 204}],
  ["Comptage_racines_forme_quadratique", {144, 170, 171}],
  ["Endomorphismes_MnC_stabilisent_GLnC", {150, 151, 157}],
  ["Ellipse_Steiner", {180, 181, 182, 183}],
  ["Suite_polygones_converge", {102, 152, 181, 182}],
  ["Sous_groupes_finis_SO3", {101, 104, 161, 183}],
  ["expu_diago_ssi_u_diago", {153, 155, 156}],
  ["Theoreme_Sophie_Germain", {120, 121, 126}],
  ["Theoreme_Chevalley_Warning", {123, 142}],
  ["Nombres_Bell", {190, 224, 230, 243, 244, 247}],
  ["Nombre_matrices_diago_Fq", {101, 104, 123, 150, 155, 190}],
  ["Action_SOn_Sn-1", {101, 103, 106, 183}],
  ["Automorphismes_KX", {125, 140, 151}], ["Cardinal_SO2q", {104,
  106, 170, 190}], ["Theoreme_deux_carres", {121, 122, 126}],
  ["Points_extremaux_BLE", {160, 161, 181}],
  ["Existence_corps_finis", {123, 125, 141, 144}],
  ["Definition_bifocale_coniques", {180}],
  ["Groupes_distingues_table_caracteres", {107, 109}],
  ["Theoreme_Frobenius_Zolotarev", {105, 106, 120, 121, 123, 152}
  ],
  ["Isometries_cube_tetraedre", {105, 160, 161, 183}],
  ["Reciprocite_quadratique", {101, 104, 120, 121, 123, 150, 159,
  170, 190}], ["Algo_facteurs_invariants", {122, 162}],
```

```
      ["Lemme_Morse", {150, 158, 170, 171, 214, 215, 217, 218, 219}],
      ["Extrema_lies", {159, 215, 217, 219}],
      ["Theoreme_Cartan_vonNeumann", {156, 214, 215, 217}],
      ["Calcul_integrale_Fresnel", {236, 245}],
      ["Formule_complements", {236, 245}],
      ["Theoreme_Brouwer", {202, 206, 215}], ["TIL", {206, 214, 215}
      ], ["Theoreme_Riesz_Fischer", {201, 205, 208, 234, 241, 262}],
      ["Theoreme_Cauchy_Lipschitz", {205, 206, 220}],
      ["Inegalite_isoperimetrique", {216, 219, 246}],
      ["Theoreme_Grothendieck", {201, 205, 234}],
      ["Polynomes_orthogonaux", {201, 202, 207, 213, 234, 240, 245}],
      ["Theoreme_Muntz", {202, 209, 241, 245}],
      ["Loi_even_rares", {249, 261, 264}], ["Galton_Watson", {223,
      226, 229, 260, 261, 264}], ["Lp_inclus_Lq", {201, 234}],
      ["Methode_Newton", {215, 218, 223, 226, 232, 253}],
      ["Theoreme_Frechet_Kolmogorov", {203, 234}], ["Lemme_Borel",
      {207, 228, 241}],
      ["Theoreme_Chudnovsky", {203, 209}],
      ["Semi_normes_invariantes_similitude", {150, 208}],
      ["Sev_C01_normsup_2", {201}], ["Sev_dim_finie_C01_CVS_CVU",
      {151, 152}],
      ["Ensembles_Julia", {204, 245}], ["Geodesique_IH", {219, 220,
      239}], ["Operateur_algebrique_Banach", {205, 208}],
      ["Densite_C01_fonctions_continues_nullepart_der", {202, 228}],
      ["Theoreme_Browder_Goehde", {205, 206, 213, 253}],
      ["Theoreme_boule_chevelue", {206, 215}], ["Simplicite_SOn",
      {215}], ["Pendule_amorti", {220}], ["Simplicite_SO3", {103,
      106, 108, 150, 160, 161, 204}],
      ["Operateur_hypercyclique", {202, 205}],
      ["Prolongement_appl_lipsch", {205, 207, 208, 213}],
      ["Reduction_sym_cpct", {203, 205, 208, 213}],
      ["Sev_fermes_Cab", {201, 203, 205}], ["Operateurs_et_adjoint",
      {201, 205, 208}], ["Theoreme_Jordan_C1", {203, 204, 217, 239}],
      ["Prolongement_dzeta_Re_pos", {207, 230, 241, 245}],
      ["Theoreme_Abel_angulaire", {207, 223, 230, 241, 243, 244, 247}
      ], ["Theoreme_Bernstein", {202, 209, 228, 249, 260, 264}],
      ["Formule_Poisson", {230, 240, 246, 254, 255}],
      ["Inversion_Fourier_distrib", {239, 240, 254, 255, 261}],
      ["Inversion_Fourier_L1", {239, 240, 247, 263}],
      ["Couronnes_biholomorphes", {203, 207, 219, 223, 245}],
      ["Equation_Hill_Mathieu", {155, 220, 221}],
      ["Prolongement_gamma", {207, 223, 235, 239, 241, 245}],
      ["Nombres_normaux", {249, 264}],
      ["Theoreme_lacunes_Hadamard", {207, 241, 243, 244}],
      ["Etude_asymptotique_suite_polynomes", {220, 221, 224, 228}],
      ["Theoreme_Fejer", {202, 209, 235, 240, 246}],
      ["Transformee_Fourier_gaussienne", {236, 239, 240, 245, 261}],
      ["Algorithme_Wiedemann", {123, 153, 159, 162, 226, 264}],
      ["Theoreme_Plancherel", {201, 207, 234, 239, 240}],
      ["Methode_gradient_conjugue", {158, 162, 170, 229, 232, 253}],
      ["Etude_astroide", {216}], ["Serie_harmonique", {224, 230, 247}
      ], ["TCL", {224, 235, 241, 245, 262, 263}], ["LGN", {201, 230,
      235, 241, 260, 262}], ["Courbe_brachistochrone", {216, 219,
      220, 229, 253}], ["Loi_Gamma", {236, 239, 240, 261, 263}]}:
```

On obtient la liste des développements :

```
> dev := map(x -> x[1], dev_lecons):
```

Procédure qui prend en argument un développement et qui retourne les leçons dans lesquelles il peut aller.

```
> hash := proc(s)
      local i;
      for i in dev_lecons do
          if i[1] = s then
              return i[2];
          end if;
      end do;
  end proc:
```

À partir de l'ensemble dev_lecons, on construit celui qui donne les correspondances leçons–développements.

```
> construit_lecons_dev := proc()
      local i, devl, dev;
      global lecons_dev := op({});
      for i in lecons do
        dev := op({});
        for devl in dev_lecons do
            if i in devl[2] then
                dev := dev, devl[1];
            end if;
        end do;
        lecons_dev := lecons_dev, [i, {dev}];
      end do;
      lecons_dev := {lecons_dev};
  end proc:
> construit_lecons_dev();
```

$\{[101, \{$"An_simple", "Action_SOn_Sn-1", "Theoreme_Molien", $\qquad\qquad$ **(1.2)**
"Reciprocite_quadratique", "Sous_groupes_finis_SO3", "Nombre_matrices_diago_Fq"$\}]$
, $[102, \{$"Theoreme_Kronecker", "Irreductibilite_pol_cyclo",
"Suite_polygones_converge"$\}]$, $[103, \{$"An_simple", "Action_SOn_Sn-1",
"Simplicite_SO3", "Theoreme_Lie_Kolchin", "Classification_groupes_ordre_8"$\}]$,
$[104, \{$"Cardinal_SO2q", "Theoreme_Molien", "Theoreme_Burnside",
"Reciprocite_quadratique", "Sous_groupes_finis_SO3", "Nombre_matrices_diago_Fq",
"Classification_groupes_ordre_8"$\}]$, $[105, \{$"An_simple", "Table_caracteres_S4",
"Isometries_cube_tetraedre", "Theoreme_Frobenius_Zolotarev"$\}]$, $[106,$
$\{$"Action_SOn_Sn-1", "Cardinal_SO2q", "Simplicite_SO3", "Theoreme_Burnside",
"Theoreme_Lie_Kolchin", "Generateurs_groupe_orthogonal",
"Theoreme_Frobenius_Zolotarev"$\}]$, $[107, \{$"Theoreme_Molien",
"Table_caracteres_S4", "Groupes_distingues_table_caracteres"$\}]$, $[108, \{$"An_simple",
"Simplicite_SO3", "Sous_algebre_reduite", "Generateurs_groupe_orthogonal"$\}]$, $[109,$
$\{$"Theoreme_Molien", "Table_caracteres_S4", "Groupes_distingues_table_caracteres"$\}]$
, $[120, \{$"Reciprocite_quadratique", "Theoreme_Sophie_Germain",
"Irreductibilite_pol_cyclo", "Primalite_nombres_Mersenne",
"Theoreme_Frobenius_Zolotarev"$\}]$, $[121, \{$"Reciprocite_quadratique",
"Theoreme_Sophie_Germain", "Theoreme_deux_carres", "Irreductibilite_pol_cyclo",

"Primalite_nombres_Mersenne", "Theoreme_Frobenius_Zolotarev"}], [122, {"Theoreme_deux_carres", "Algo_facteurs_invariants", "Theoreme_Rothstein_Trager"}], [123, {"Algorithme_Wiedemann", "Existence_corps_finis", "Reciprocite_quadratique", "Nombre_matrices_diago_Fq", "Primalite_nombres_Mersenne", "Theoreme_Chevalley_Warning", "Theoreme_Frobenius_Zolotarev"}], [124, {"Theoreme_Molien", "Partition_entier_parts_fixees"}], [125, {"Automorphismes_KX", "Existence_corps_finis"}], [126, {"Theoreme_Sophie_Germain", "Theoreme_deux_carres", "Partition_entier_parts_fixees"}], [140, {"Automorphismes_KX", "Theoreme_Rothstein_Trager", "Partition_entier_parts_fixees"}], [141, {"Existence_corps_finis", "Irreductibilite_pol_cyclo", "Primalite_nombres_Mersenne"}], [142, {"Borne_Bezout", "Theoreme_Molien", "Theoreme_Kronecker", "Theoreme_Chevalley_Warning"}], [143, {"Borne_Bezout", "Theoreme_Rothstein_Trager"}], [144, {"Algorithme_Faddeev", "Theoreme_Kronecker", "Existence_corps_finis", "Irreductibilite_pol_cyclo", "Theoreme_Rothstein_Trager", "Comptage_racines_forme_quadratique"}], [150, {"Lemme_Morse", "Simplicite_SO3", "Reciprocite_quadratique", "Reduction_endo_normaux", "Nombre_matrices_diago_Fq", "Endomorphismes_MnC_stabilisent_GLnC", "Semi_normes_invariantes_similitude"}], [151, {"Theoreme_Molien", "Automorphismes_KX", "Sev_dim_finie_C01_CVS_CVU", "Endomorphismes_MnC_stabilisent_GLnC"}], [152, {"Borne_Bezout", "Sev_dim_finie_C01_CVS_CVU", "Suite_polygones_converge", "Theoreme_Frobenius_Zolotarev"}], [153, {"Algorithme_Faddeev", "Theoreme_Burnside", "Algorithme_Wiedemann", "Decomposition_Dunford", "Sous_algebre_reduite", "expu_diago_ssi_u_diago", "Exponentielle_MnC_GLnC_surjective"}], [154, {"Reduction_endo_normaux", "Sous_algebre_reduite", "Theoreme_Lie_Kolchin"}], [155, {"Decomposition_Dunford", "Equation_Hill_Mathieu", "Reduction_endo_normaux", "Sous_algebre_reduite", "expu_diago_ssi_u_diago", "Nombre_matrices_diago_Fq"}], [156, {"expu_diago_ssi_u_diago", "Theoreme_Cartan_vonNeumann", "Exponentielle_MnC_GLnC_surjective"}], [157, {"Theoreme_Burnside", "Decomposition_Dunford", "Reduction_endo_normaux", "Sous_algebre_reduite", "Theoreme_Lie_Kolchin", "Endomorphismes_MnC_stabilisent_GLnC"}], [158, {"Lemme_Morse", "Methode_gradient_conjugue", "Composantes_connexes_fq_non_degen"}], [159, {"Extrema_lies", "Algorithme_Wiedemann", "Reciprocite_quadratique", "Generateurs_groupe_orthogonal", "Theoreme_Hahn_Banach_geometrique"}], [160, {"Simplicite_SO3", "Points_extremaux_BLE", "Reduction_endo_normaux", "Isometries_cube_tetraedre", "Generateurs_groupe_orthogonal"}], [161, {"Simplicite_SO3", "Points_extremaux_BLE", "Reduction_endo_normaux", "Sous_groupes_finis_SO3", "Isometries_cube_tetraedre",

"Generateurs_groupe_orthogonal"}], [162, {"Algorithme_Wiedemann", "Algo_facteurs_invariants", "Methode_gradient_conjugue", "Generateurs_groupe_orthogonal"}], [170, {"Lemme_Morse", "Cardinal_SO2q", "Reciprocite_quadratique", "Methode_gradient_conjugue", "Composantes_connexes_fq_non_degen", "Comptage_racines_forme_quadratique"}], [171, {"Lemme_Morse", "Composantes_connexes_fq_non_degen", "Comptage_racines_forme_quadratique"}], [180, {"Ellipse_Steiner", "Definition_bifocale_coniques"}], [181, {"Ellipse_Steiner", "Points_extremaux_BLE", "Suite_polygones_converge", "Theoreme_Hahn_Banach_geometrique"}], [182, {"Ellipse_Steiner", "Suite_polygones_converge"}], [183, {"Action_SOn_Sn-1", "Ellipse_Steiner", "Sous_groupes_finis_SO3", "Isometries_cube_tetraedre"}], [190, {"Cardinal_SO2q", "Nombres_Bell", "Reciprocite_quadratique", "Nombre_matrices_diago_Fq", "Partition_entier_parts_fixees"}], [201, {"LGN", "Lp_inclus_Lq", "Sev_fermes_Cab", "Sev_C01_normsup_2", "Theoreme_Plancherel", "Operateurs_et_adjoint", "Polynomes_orthogonaux", "Theoreme_Grothendieck", "Theoreme_Riesz_Fischer"}], [202, {"Theoreme_Fejer", "Theoreme_Muntz", "Theoreme_Bernstein", "Theoreme_Brouwer", "Operateur_hypercyclique", "Polynomes_orthogonaux", "Densite_C01_fonctions_continues_nullepart_der"}], [203, {"Sev_fermes_Cab", "Reduction_sym_cpct", "Theoreme_Chudnovsky", "Theoreme_Jordan_C1", "Couronnes_biholomorphes", "Theoreme_Frechet_Kolmogorov"}], [204, {"Ensembles_Julia", "Simplicite_SO3", "Theoreme_Jordan_C1", "Theoreme_Lie_Kolchin", "Composantes_connexes_fq_non_degen"}], [205, {"Sev_fermes_Cab", "Reduction_sym_cpct", "Operateur_hypercyclique", "Operateurs_et_adjoint", "Theoreme_Browder_Goehde", "Theoreme_Grothendieck", "Theoreme_Riesz_Fischer", "Operateur_algebrique_Banach", "Prolongement_appl_lipsch", "Theoreme_Cauchy_Lipschitz"}], [206, {"TIL", "Theoreme_Brouwer", "Theoreme_Browder_Goehde", "Theoreme_boule_chevelue", "Theoreme_Cauchy_Lipschitz"}], [207, {"Lemme_Borel", "Prolongement_gamma", "Theoreme_Plancherel", "Couronnes_biholomorphes", "Polynomes_orthogonaux", "Theoreme_Abel_angulaire", "Prolongement_appl_lipsch", "Prolongement_dzeta_Re_pos", "Theoreme_lacunes_Hadamard"}], [208, {"Reduction_sym_cpct", "Operateurs_et_adjoint", "Theoreme_Riesz_Fischer", "Operateur_algebrique_Banach", "Prolongement_appl_lipsch", "Semi_normes_invariantes_similitude"}], [209, {"Theoreme_Fejer", "Theoreme_Muntz", "Theoreme_Bernstein", "Theoreme_Chudnovsky"}], [213, {"Reduction_sym_cpct", "Polynomes_orthogonaux", "Theoreme_Browder_Goehde", "Prolongement_appl_lipsch"}], [214, {"TIL", "Lemme_Morse", "Theoreme_Cartan_vonNeumann"}], [215, {"TIL", "Lemme_Morse", "Extrema_lies", "Methode_Newton", "Simplicite_SOn", "Theoreme_Brouwer", "Theoreme_boule_chevelue", "Theoreme_Cartan_vonNeumann"}], [216, {"Etude_astroide", "Courbe_brachistochrone", "Inegalite_isoperimetrique"}], [217,

{"Lemme_Morse", "Extrema_lies", "Theoreme_Jordan_C1", "Theoreme_Cartan_vonNeumann"}], [218, {"Lemme_Morse", "Methode_Newton", "Decomposition_Dunford"}], [219, {"Lemme_Morse", "Extrema_lies", "Geodesique_IH", "Courbe_brachistochrone", "Couronnes_biholomorphes", "Inegalite_isoperimetrique"}], [220, {"Geodesique_IH", "Pendule_amorti", "Courbe_brachistochrone", "Equation_Hill_Mathieu", "Theoreme_Cauchy_Lipschitz", "Etude_asymptotique_suite_polynomes"}], [221, {"Equation_Hill_Mathieu", "Etude_asymptotique_suite_polynomes"}], [223, {"Galton_Watson", "Methode_Newton", "Prolongement_gamma", "Couronnes_biholomorphes", "Theoreme_Abel_angulaire"}], [224, {"TCL", "Nombres_Bell", "Serie_harmonique", "Etude_asymptotique_suite_polynomes"}], [226, {"Galton_Watson", "Methode_Newton", "Algorithme_Faddeev", "Algorithme_Wiedemann", "Decomposition_Dunford"}], [228, {"Lemme_Borel", "Theoreme_Bernstein", "Etude_asymptotique_suite_polynomes", "Densite_C01_fonctions_continues_nullepart_der"}], [229, {"Galton_Watson", "Courbe_brachistochrone", "Methode_gradient_conjugue"}], [230, {"LGN", "Formule_Poisson", "Nombres_Bell", "Serie_harmonique", "Theoreme_Abel_angulaire", "Prolongement_dzeta_Re_pos"}], [232, {"Methode_Newton", "Methode_gradient_conjugue"}], [234, {"Lp_inclus_Lq", "Theoreme_Plancherel", "Polynomes_orthogonaux", "Theoreme_Grothendieck", "Theoreme_Riesz_Fischer", "Theoreme_Frechet_Kolmogorov"}], [235, {"LGN", "TCL", "Theoreme_Fejer", "Prolongement_gamma"}], [236, {"Loi_Gamma", "Formule_complements", "Calcul_integrale_Fresnel", "Theoreme_Rothstein_Trager", "Transformee_Fourier_gaussienne"}], [239, {"Loi_Gamma", "Geodesique_IH", "Prolongement_gamma", "Theoreme_Jordan_C1", "Theoreme_Plancherel", "Inversion_Fourier_L1", "Inversion_Fourier_distrib", "Transformee_Fourier_gaussienne"}], [240, {"Loi_Gamma", "Formule_Poisson", "Theoreme_Fejer", "Theoreme_Plancherel", "Inversion_Fourier_L1", "Polynomes_orthogonaux", "Inversion_Fourier_distrib", "Transformee_Fourier_gaussienne"}], [241, {"LGN", "TCL", "Lemme_Borel", "Theoreme_Muntz", "Prolongement_gamma", "Theoreme_Abel_angulaire", "Theoreme_Riesz_Fischer", "Prolongement_dzeta_Re_pos", "Theoreme_lacunes_Hadamard"}], [243, {"Nombres_Bell", "Theoreme_Abel_angulaire", "Theoreme_lacunes_Hadamard"}], [244, {"Nombres_Bell", "Theoreme_Abel_angulaire", "Theoreme_lacunes_Hadamard"}], [245, {"TCL", "Ensembles_Julia", "Theoreme_Muntz", "Formule_complements", "Prolongement_gamma", "Couronnes_biholomorphes", "Polynomes_orthogonaux", "Calcul_integrale_Fresnel", "Prolongement_dzeta_Re_pos", "Transformee_Fourier_gaussienne"}], [246, {"Formule_Poisson", "Theoreme_Fejer", "Inegalite_isoperimetrique"}], [247, {"Nombres_Bell", "Serie_harmonique", "Inversion_Fourier_L1", "Theoreme_Abel_angulaire"}], [249, {"Loi_even_rares", "Nombres_normaux", "Theoreme_Bernstein"}], [253, {"Methode_Newton",

"Courbe_brachistochrone", "Theoreme_Browder_Goehde",
"Methode_gradient_conjugue", "Theoreme_Hahn_Banach_geometrique"}], [254,
{"Formule_Poisson", "Inversion_Fourier_distrib"}], [255, {"Formule_Poisson",
"Inversion_Fourier_distrib"}], [260, {"LGN", "Galton_Watson",
"Theoreme_Bernstein"}], [261, {"Loi_Gamma", "Galton_Watson", "Loi_even_rares",
"Inversion_Fourier_distrib", "Transformee_Fourier_gaussienne"}], [262, {"LGN",
"TCL", "Theoreme_Riesz_Fischer"}], [263, {"TCL", "Loi_Gamma",
"Inversion_Fourier_L1"}], [264, {"Galton_Watson", "Loi_even_rares",
"Nombres_normaux", "Theoreme_Bernstein", "Algorithme_Wiedemann"}]}

Pour chaque leçon, on affiche le nombre de développements qui peuvent y entrer.

```
> map(x -> [x[1], nops(x[2])], %);
```

$\{[101, 6], [102, 3], [103, 5], [104, 7], [105, 4], [106, 7], [107, 3], [108, 4], [109, 3],$ **(1.3)**
$[120, 5], [121, 6], [122, 3], [123, 7], [124, 2], [125, 2], [126, 3], [140, 3], [141, 3],$
$[142, 4], [143, 2], [144, 6], [150, 7], [151, 4], [152, 4], [153, 7], [154, 3], [155, 6],$
$[156, 3], [157, 6], [158, 3], [159, 5], [160, 5], [161, 6], [162, 4], [170, 6], [171, 3],$
$[180, 2], [181, 4], [182, 2], [183, 4], [190, 5], [201, 9], [202, 7], [203, 6], [204, 5],$
$[205, 10], [206, 5], [207, 9], [208, 6], [209, 4], [213, 4], [214, 3], [215, 8], [216, 3],$
$[217, 4], [218, 3], [219, 6], [220, 6], [221, 2], [223, 5], [224, 4], [226, 5], [228, 4],$
$[229, 3], [230, 6], [232, 2], [234, 6], [235, 4], [236, 5], [239, 8], [240, 8], [241, 9],$
$[243, 3], [244, 3], [245, 10], [246, 3], [247, 4], [249, 3], [253, 5], [254, 2], [255, 2],$
$[260, 3], [261, 5], [262, 3], [263, 3], [264, 5]\}$

Puis on retient celles qui n'ont qu'un nombre < 2 de développements (si l'on n'obtient pas {} cela veut dire que, à moins de faire des impasses, on doit rajouter des développements dans notre ensemble dev_lecons).

```
> select(x -> evalb(x[2] <= 1), %);
```

$\{\ \}$ **(1.4)**

▼ À venir

On rentre ici les développements que l'on connaît.

```
> dev_connus := {"Methode_Newton", "Theoreme_Riesz_Fischer",
"Polynomes_orthogonaux", "Couronnes_biholomorphes",
"Theoreme_Bernstein", "Galton_Watson", "Prolongement_gamma",
"Etude_asymptotique_suite_polynomes", "Extrema_lies",
"Reduction_sym_cpct", "Nombres_normaux",
"Densite_C01_fonctions_continues_nullepart_der",
"Theoreme_Jordan_C1", "Theoreme_Fejer",
"Decomposition_Dunford", "Theoreme_Rothstein_Trager",
"Equation_Hill_Mathieu", "Simplicite_SO3",
"Transformee_Fourier_gaussienne", "Sous_algebre_reduite",
"Borne_Bezout", "Theoreme_Kronecker",
"Irreductibilite_pol_cyclo", "Nombre_matrices_diago_Fq",
"expu_diago_ssi_u_diago", "Reduction_endo_normaux",
"Reciprocite_quadratique", "Theoreme_Frobenius_Zolotarev",
"Partition_entier_parts_fixees", "Table_caracteres_S4",
"Theoreme_Molien", "Lemme_Morse", "Existence_corps_finis",
```

```
    "Theoreme_deux_carres", "Exponentielle_MnC_GLnC_surjective",
    "Automorphismes_KX", "Suite_polygones_converge",
    "Action_SOn_Sn-1", "Ellipse_Steiner",
    "Composantes_connexes_fq_non_degen",
    "Algo_facteurs_invariants", "Nombres_Bell"}:
```

Cette ligne a pour but de vérifier que l'on ne s'est pas trompé dans l'écriture des développements (teste si dev_connus estun sous-ensemble de dev) ; donne également le nombre de développements connus.

```
> evalb(dev_connus subset dev), nops(dev_connus);
```
$$\textit{true}, 42 \tag{2.1}$$

Retourne la correspondance leçons–développements avec seulement les développements connus.
```
> lecons_dev_connus := map(x -> [x[1], x[2] intersect
  dev_connus], lecons_dev):
```

Retourne les couplages d'ores et déjà prêts.
```
> construit_lecons_dev_pret := proc()
    local i, res := op({});
    global lecons_dev_pret := lecons_dev_connus;
    for i in lecons_dev_connus do
      if nops(i[2]) >= 2 then
        res := res, i;
      end if;
    end do;
    lecons_dev_pret := {res};
  end proc:
> construit_lecons_dev_pret();
```
$$\{[101, \{\text{"Action\_SOn\_Sn-1", "Theoreme\_Molien", "Reciprocite\_quadratique",}} \tag{2.2}$$
"Nombre_matrices_diago_Fq"}], [102, {"Theoreme_Kronecker",
"Irreductibilite_pol_cyclo", "Suite_polygones_converge"}], [103,
{"Action_SOn_Sn-1", "Simplicite_SO3"}], [104, {"Theoreme_Molien",
"Reciprocite_quadratique", "Nombre_matrices_diago_Fq"}], [105,
{"Table_caracteres_S4", "Theoreme_Frobenius_Zolotarev"}], [106,
{"Action_SOn_Sn-1", "Simplicite_SO3", "Theoreme_Frobenius_Zolotarev"}], [107,
{"Theoreme_Molien", "Table_caracteres_S4"}], [108, {"Simplicite_SO3",
"Sous_algebre_reduite"}], [109, {"Theoreme_Molien", "Table_caracteres_S4"}], [120,
{"Reciprocite_quadratique", "Irreductibilite_pol_cyclo",
"Theoreme_Frobenius_Zolotarev"}], [121, {"Reciprocite_quadratique",
"Theoreme_deux_carres", "Irreductibilite_pol_cyclo",
"Theoreme_Frobenius_Zolotarev"}], [122, {"Theoreme_deux_carres",
"Algo_facteurs_invariants", "Theoreme_Rothstein_Trager"}], [123,
{"Existence_corps_finis", "Reciprocite_quadratique", "Nombre_matrices_diago_Fq",
"Theoreme_Frobenius_Zolotarev"}], [124, {"Theoreme_Molien",
"Partition_entier_parts_fixees"}], [125, {"Automorphismes_KX",
"Existence_corps_finis"}], [126, {"Theoreme_deux_carres",
"Partition_entier_parts_fixees"}], [140, {"Automorphismes_KX",
"Theoreme_Rothstein_Trager", "Partition_entier_parts_fixees"}], [141,

{"Existence_corps_finis", "Irreductibilite_pol_cyclo"}], [142, {"Borne_Bezout", "Theoreme_Molien", "Theoreme_Kronecker"}], [143, {"Borne_Bezout", "Theoreme_Rothstein_Trager"}], [144, {"Theoreme_Kronecker", "Existence_corps_finis", "Irreductibilite_pol_cyclo", "Theoreme_Rothstein_Trager"}], [150, {"Lemme_Morse", "Simplicite_SO3", "Reciprocite_quadratique", "Reduction_endo_normaux", "Nombre_matrices_diago_Fq"}], [151, {"Theoreme_Molien", "Automorphismes_KX"}], [152, {"Borne_Bezout", "Suite_polygones_converge", "Theoreme_Frobenius_Zolotarev"}], [153, {"Decomposition_Dunford", "Sous_algebre_reduite", "expu_diago_ssi_u_diago", "Exponentielle_MnC_GLnC_surjective"}], [154, {"Reduction_endo_normaux", "Sous_algebre_reduite"}], [155, {"Decomposition_Dunford", "Equation_Hill_Mathieu", "Reduction_endo_normaux", "Sous_algebre_reduite", "expu_diago_ssi_u_diago", "Nombre_matrices_diago_Fq"}], [156, {"expu_diago_ssi_u_diago", "Exponentielle_MnC_GLnC_surjective"}], [157, {"Decomposition_Dunford", "Reduction_endo_normaux", "Sous_algebre_reduite"}], [158, {"Lemme_Morse", "Composantes_connexes_fq_non_degen"}], [159, {"Extrema_lies", "Reciprocite_quadratique"}], [160, {"Simplicite_SO3", "Reduction_endo_normaux"}], [161, {"Simplicite_SO3", "Reduction_endo_normaux"}], [170, {"Lemme_Morse", "Reciprocite_quadratique", "Composantes_connexes_fq_non_degen"}], [171, {"Lemme_Morse", "Composantes_connexes_fq_non_degen"}], [181, {"Ellipse_Steiner", "Suite_polygones_converge"}], [182, {"Ellipse_Steiner", "Suite_polygones_converge"}], [183, {"Action_SOn_Sn-1", "Ellipse_Steiner"}], [190, {"Nombres_Bell", "Reciprocite_quadratique", "Nombre_matrices_diago_Fq", "Partition_entier_parts_fixees"}], [201, {"Polynomes_orthogonaux", "Theoreme_Riesz_Fischer"}], [202, {"Theoreme_Fejer", "Theoreme_Bernstein", "Polynomes_orthogonaux", "Densite_C01_fonctions_continues_nullepart_der"}], [203, {"Reduction_sym_cpct", "Theoreme_Jordan_C1", "Couronnes_biholomorphes"}], [204, {"Simplicite_SO3", "Theoreme_Jordan_C1", "Composantes_connexes_fq_non_degen"}], [205, {"Reduction_sym_cpct", "Theoreme_Riesz_Fischer"}], [207, {"Prolongement_gamma", "Couronnes_biholomorphes", "Polynomes_orthogonaux"}], [208, {"Reduction_sym_cpct", "Theoreme_Riesz_Fischer"}], [209, {"Theoreme_Fejer", "Theoreme_Bernstein"}], [213, {"Reduction_sym_cpct", "Polynomes_orthogonaux"}], [215, {"Lemme_Morse", "Extrema_lies", "Methode_Newton"}], [217, {"Lemme_Morse", "Extrema_lies", "Theoreme_Jordan_C1"}], [218, {"Lemme_Morse", "Methode_Newton", "Decomposition_Dunford"}], [219, {"Lemme_Morse", "Extrema_lies", "Couronnes_biholomorphes"}], [220, {"Equation_Hill_Mathieu", "Etude_asymptotique_suite_polynomes"}], [221, {"Equation_Hill_Mathieu", "Etude_asymptotique_suite_polynomes"}], [223, {"Galton_Watson", "Methode_Newton", "Prolongement_gamma", "Couronnes_biholomorphes"}], [224, {"Nombres_Bell",

"Etude_asymptotique_suite_polynomes"}], [226, {"Galton_Watson",
"Methode_Newton", "Decomposition_Dunford"}], [228, {"Theoreme_Bernstein",
"Etude_asymptotique_suite_polynomes",
"Densite_C01_fonctions_continues_nullepart_der"}], [234,
{"Polynomes_orthogonaux", "Theoreme_Riesz_Fischer"}], [235, {"Theoreme_Fejer",
"Prolongement_gamma"}], [236, {"Theoreme_Rothstein_Trager",
"Transformee_Fourier_gaussienne"}], [239, {"Prolongement_gamma",
"Theoreme_Jordan_C1", "Transformee_Fourier_gaussienne"}], [240,
{"Theoreme_Fejer", "Polynomes_orthogonaux", "Transformee_Fourier_gaussienne"}],
[241, {"Prolongement_gamma", "Theoreme_Riesz_Fischer"}], [245,
{"Prolongement_gamma", "Couronnes_biholomorphes", "Polynomes_orthogonaux",
"Transformee_Fourier_gaussienne"}], [249, {"Nombres_normaux",
"Theoreme_Bernstein"}], [260, {"Galton_Watson", "Theoreme_Bernstein"}], [261,
{"Galton_Watson", "Transformee_Fourier_gaussienne"}], [264, {"Galton_Watson",
"Nombres_normaux", "Theoreme_Bernstein"}]}

Retourne l'ensemble puis le nombres des leçons apparaissant ci-dessus, i.e. les leçons qui possèdent au moins deux développements connus.

```
> lecons_pret := map(x -> x[1], lecons_dev_pret): %, nops(%);
```
{101, 102, 103, 104, 105, 106, 107, 108, 109, 120, 121, 122, 123, 124, 125, 126, 140, 141,   **(2.3)**
    142, 143, 144, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 170, 171,
    181, 182, 183, 190, 201, 202, 203, 204, 205, 207, 208, 209, 213, 215, 217, 218, 219,
    220, 221, 223, 224, 226, 228, 234, 235, 236, 239, 240, 241, 245, 249, 260, 261, 264}, 69

Les leçons qui restent :-)
```
> lecons_restantes := lecons minus lecons_pret:
```

Génère les couples leçon–développement qui ne possèdent pour l'instant qu'un seul développement connu.
```
> lecons_dev_presque_pret := proc()
    local i, res := op({});
      for i in lecons_dev_connus do
        if nops(i[2]) = 1 then
          res := res, i;
        end if;
      end do;
      return nops([res]), res;
  end proc:
> lecons_dev_presque_pret();
```
12, [162, {"Algo_facteurs_invariants"}], [180, {"Ellipse_Steiner"}], [214,   **(2.4)**
    {"Lemme_Morse"}], [229, {"Galton_Watson"}], [230, {"Nombres_Bell"}], [232,
    {"Methode_Newton"}], [243, {"Nombres_Bell"}], [244, {"Nombres_Bell"}], [246,
    {"Theoreme_Fejer"}], [247, {"Nombres_Bell"}], [253, {"Methode_Newton"}], [262,
    {"Theoreme_Riesz_Fischer"}]

Génère le nombre de leçons, le nombre de leçons presque prêtes (i.e. celles ci-dessus) et le nombre

de leçons prêtes (i.e. avec au moins deux développements connus).

```
> nops(lecons), %[1], nops(lecons_dev_pret);
```

$$86, 12, 69 \tag{2.5}$$

Génère la liste des couples développements–nombre de leçons pas du tout ou presques prêtes associées.

```
> prochain_devs := proc()
      local i, dev_lecons_restant := dev_lecons;
      for i in dev_lecons do
          if i[1] in dev_connus then
              dev_lecons_restant := subs(i = NULL,
  dev_lecons_restant);
          else
              dev_lecons_restant := subs(i = [i[1], i[2] intersect
  lecons_restantes], dev_lecons_restant);
          end if;
      end do;
      return sort([op(map(x -> [x[1], nops(x[2])],
  dev_lecons_restant))], (x, y) -> (x[2] > y[2]));
  end proc:
> prochain_devs();
```

$$[\,[\text{"Methode\_gradient\_conjugue"}, 4\,], [\text{"Theoreme\_Abel\_angulaire"}, 4\,], \tag{2.6}$$

["Formule_Poisson", 4], ["Courbe_brachistochrone", 3],

["Theoreme_lacunes_Hadamard", 2], ["Inversion_Fourier_distrib", 2],

["Inegalite_isoperimetrique", 2], ["Theoreme_Browder_Goehde", 2],

["Inversion_Fourier_L1", 2], ["Serie_harmonique", 2], ["TIL", 2],

["LGN", 2], ["Theoreme_Hahn_Banach_geometrique", 1],

["Generateurs_groupe_orthogonal", 1], ["Definition_bifocale_coniques", 1],

["Theoreme_Cauchy_Lipschitz", 1], ["Theoreme_Cartan_vonNeumann", 1],

["Prolongement_dzeta_Re_pos", 1], ["Theoreme_boule_chevelue", 1],

["Algorithme_Wiedemann", 1], ["Theoreme_Brouwer", 1], ["Etude_astroide", 1],

["Loi_Gamma", 1], ["Semi_normes_invariantes_similitude", 0],

["Groupes_distingues_table_caracteres", 0],

["Endomorphismes_MnC_stabilisent_GLnC", 0],

["Comptage_racines_forme_quadratique", 0], ["Classification_groupes_ordre_8", 0],

["Theoreme_Frechet_Kolmogorov", 0], ["Theoreme_Chevalley_Warning", 0],

["Sev_dim_finie_C01_CVS_CVU", 0], ["Prolongement_appl_lipsch", 0],

["Primalite_nombres_Mersenne", 0], ["Operateur_algebrique_Banach", 0],

["Isometries_cube_tetraedre", 0], ["Calcul_integrale_Fresnel", 0],

["Theoreme_Sophie_Germain", 0], ["Theoreme_Lie_Kolchin", 0],

["Theoreme_Grothendieck", 0], ["Sous_groupes_finis_SO3", 0],

["Points_extremaux_BLE", 0], ["Operateurs_et_adjoint", 0],

["Operateur_hypercyclique", 0], ["Theoreme_Plancherel", 0],

["Theoreme_Chudnovsky", 0], ["Theoreme_Burnside", 0], ["Sev_C01_normsup_2",

0], ["Formule_complements", 0], ["Algorithme_Faddeev", 0], ["Theoreme_Muntz",

0], ["Simplicite_SOn", 0], ["Sev_fermes_Cab", 0], ["Pendule_amorti", 0],

["Lp_inclus_Lq", 0], ["Loi_even_rares", 0], ["Geodesique_IH", 0],

$["Ensembles\_Julia", 0], ["Cardinal\_SO2q", 0], ["Lemme\_Borel", 0], ["An\_simple", 0]]$

Le principe est le suivant : on décide d'apprendre les développements qui ont le nombre associé le plus élevé (stratégie gloutonne). Attention, une fois un développement choisi il faut modifier dev_connus et relancer les calculs. En particulier, la ligne de code suivante retourne les développements avec le nombre associé le plus élevé.

```
> select(x -> evalb(x[2] = max(map(y -> y[2], (2.6)))), %);
```

$[["Methode\_gradient\_conjugue", 4], ["Theoreme\_Abel\_angulaire", 4],$ **(2.7)**
$\quad ["Formule\_Poisson", 4]]$

La ligne suivante retourne les mêmes développements que précédemment mais avec l'ensemble des leçons qui lui sont associées (il peut y avoir des leçons déjà prêtes, ainsi on peut penser à changer des couplages déjà prêts).

```
> map(x -> [x[1], hash(x[1])], %);
```

$[["Methode\_gradient\_conjugue", \{158, 162, 170, 229, 232, 253\}],$ **(2.8)**
$\quad ["Theoreme\_Abel\_angulaire", \{207, 223, 230, 241, 243, 244, 247\}],$
$\quad ["Formule\_Poisson", \{230, 240, 246, 254, 255\}]]$

La même chose mais en enlevant les leçons prêtes.

```
> map(x -> [x[1], `minus`(x[2], lecons_pret)], %);
```

$[["Methode\_gradient\_conjugue", \{162, 229, 232, 253\}], ["Theoreme\_Abel\_angulaire",$ **(2.9)**
$\quad \{230, 243, 244, 247\}], ["Formule\_Poisson", \{230, 246, 254, 255\}]]$