

Liste des développements possibles

```
> dev_possibles := {"LGN", "TCL", "TIL", "An_simple",
"Lemme_Borel", "Lemme_Morse", "Loi_Gamma", "Action_SOn_Sn-1",
"Borne_Bezout", "Cardinal_SO2q", "Ellipse_Steiner",
"Ensembles_Julia", "Etude_astroide", "Extrema_lies",
"Formule_Poisson", "Galton_Watson", "Geodesique_IH",
"Loi_even_rares", "Lp_inclus_Lq", "Methode_Newton",
"Nombres_Bell", "Nombres_normaux", "Pendule_amorti",
"Sev_fermes_Cab", "Simplicité_SO3", "Simplicité_SOn",
"Théoreme_Fejer", "Théoreme_Möliën", "Théoreme_Muntz",
"Algorithme_Faddeev", "Automorphismes_KX",
"Formule_complements", "Prolongement_gamma",
"Reduction_sym_cpct", "Serie_harmonique", "Sev_C01_normsup_2",
"Table_caracteres_S4", "Théoreme_Bernstein",
"Théoreme_Brouwer", "Théoreme_Burnside", "Théoreme_Chudnovsky",
"Théoreme_Jordan_C1", "Théoreme_Kronecker",
"Théoreme_Plancherel", "Algorithme_Wiedemann",
"Courbe_brachistochrone", "Couronnes_biholomorphes",
"Decomposition_Dunford", "Equation_Hill_Mathieu",
"Existence_corps_finis", "Inversion_Fourier_L1",
"Opérateur_hypercyclique", "Opérateurs_et_adjoint",
"Points_extremaux_BLE", "Polynomes_orthogonaux",
"Réciprocité_quadrique", "Reduction_endo_normaux",
"Sous_algebre_reduite", "Sous_groupes_finis_SO3",
"Théoreme_Abel_angulaire", "Théoreme_Browder_Goehde",
"Théoreme_Grothendieck", "Théoreme_Lie_Kolchin",
"Théoreme_Riesz_Fischer", "Théoreme_Sophie_Germain",
"Théoreme_boule_chevelue", "Théoreme_deux_carres",
"expu_diago_ssi_u_diago", "Algo_facteurs_invariants",
"Calcul_intégrale_Fresnel", "Inégalité_isoperimétrique",
"Inversion_Fourier_distrib", "Irreductibilité_pol_cyclo",
"Isométries_cube_tetraedre", "Methode_gradient_conjugué",
"Nombre_matrices_diago_Fq", "Opérateur_algebrique_Banach",
"Primalité_nombres_Mersenne", "Prolongement_appl_lipsch",
"Prolongement_dzeta_Re_pos", "Sev_dim_finie_C01_CVS_CVU",
"Suite_polygones_converge", "Théoreme_Cartan_vonNeumann",
"Théoreme_Cauchy_Lipschitz", "Théoreme_Chevalley_Warning",
"Théoreme_Frechet_Kolmogorov", "Théoreme_Rothstein_Trager",
"Théoreme_lacunes_Hadamard", "Classification_groupes_ordre_8",
"Definition_bifocale_coniques",
"Generateurs_groupe_orthogonal",
"Partition_entier_parts_fixees",
"Théoreme_Frobenius_Zolotarev",
"Transformée_Fourier_gaussienne",
"Composantes_connexes_fq_non_degen",
"Comptage_racines_forme_quadrique",
"Endomorphismes_MnC_stabilisent_GLnC",
"Etude_asymptotique_suite_polynomes",
"Exponentielle_MnC_GLnC_surjective",
"Groupes_distingués_table_caracteres",
"Semi_normes_invariantes_similitude",
"Théoreme_Hahn_Banach_geometrique",
"Densité_C01_fonctions_continues_nullepart_der"}:
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> dev_lecons_couplees := {[101, {"Action_SOn_Sn-1",
"Nombre_matrices_diago_Fq"}], [102, {"Irreductibilite_pol_cyclo",
"Suite_polygones_converge"}], [103, {"Theoreme_Lie_Kolchin",
"Simplicite_SO3"}], [104, {"Theoreme_Molien",
"Nombre_matrices_diago_Fq"}], [105, {"Table_caracteres_S4",
"Theoreme_Frobenius_Zolotarev"}], [106, {"Action_SOn_Sn-1",
"Simplicite_SO3"}], [107, {"Theoreme_Molien",
"Table_caracteres_S4"}], [108, {"Simplicite_SO3",
"Sous_algebre_reduite"}], [109, {"Theoreme_Molien",
"Table_caracteres_S4"}], [120, {"Reciprocite_quadratique",
"Irreductibilite_pol_cyclo"}], [121, {"Reciprocite_quadratique",
"Irreductibilite_pol_cyclo"}], [122, {"Algo_facteurs_invariants",
"Theoreme_Rothstein_Trager"}], [123, {"Existence_corps_finis",
"Reciprocite_quadratique"}], [124, {"Theoreme_Molien",
"Partition_entier_parts_fixees"}], [125, {"Automorphismes_KX",
"Existence_corps_finis"}], [126, {"Reciprocite_quadratique",
"Partition_entier_parts_fixees"}], [140, {"Automorphismes_KX",
"Partition_entier_parts_fixees"}], [141,
{"Existence_corps_finis", "Irreductibilite_pol_cyclo"}], [142,
{"Borne_Bezout", "Theoreme_Molien"}], [143, {"Borne_Bezout",
"Theoreme_Rothstein_Trager"}], [144, {"Theoreme_Kronecker",
"Irreductibilite_pol_cyclo"}], [150, {"Simplicite_SO3",
"Nombre_matrices_diago_Fq"}], [151, {"Theoreme_Molien",
"Automorphismes_KX"}], [152, {"Borne_Bezout",
"Suite_polygones_converge"}], [153, {"Decomposition_Dunford",
"Sous_algebre_reduite"}], [154, {"Reduction_endo_normaux",
"Theoreme_Lie_Kolchin"}], [155, {"Equation_Hill_Mathieu",
"Reduction_endo_normaux"}], [156, {"Theoreme_Cartan_vonNeumann",
"Exponentielle_MnC_GLnC_surjective"}], [157,
{"Decomposition_Dunford", "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"}], [162,
{"Methode_gradient_conjugue", "Algo_facteurs_invariants"}], [170,
{"Lemme_Morse", "Reciprocite_quadratique"}], [171,
{"Lemme_Morse", "Composantes_connexes_fq_non_degen"}], [180,
{"Ellipse_Steiner", "Definition_bifocale_coniques"}], [181,
{"Ellipse_Steiner", "Suite_polygones_converge"}], [182,
{"Ellipse_Steiner", "Suite_polygones_converge"}], [183,
{"Action_SOn_Sn-1", "Ellipse_Steiner"}], [190,
{"Reciprocite_quadratique", "Nombre_matrices_diago_Fq"}], [201,
{"Polynomes_orthogonaux", "Theoreme_Riesz_Fischer"}], [202,
{"Theoreme_Fejer",
"Densite_C01_fonctions_continues_nullepart_der"}], [203,
{"Reduction_sym_cpct", "Theoreme_Jordan_C1"}], [204,
{"Simplicite_SO3", "Theoreme_Jordan_C1"}], [205,
{"Reduction_sym_cpct", "Theoreme_Cauchy_Lipschitz"}], [206,
{"TIL", "Theoreme_Cauchy_Lipschitz"}], [207,
{"Polynomes_orthogonaux", "Couronnes_biholomorphes"}], [208,
{"Reduction_sym_cpct", "Theoreme_Riesz_Fischer"}], [209,
{"Theoreme_Fejer", "Theoreme_Bernstein"}], [213,
{"Reduction_sym_cpct", "Polynomes_orthogonaux"}], [214,
{"Lemme_Morse", "TIL"}], [215, {"Theoreme_Cartan_vonNeumann",
"Extrema_lies"}], [216, {"Courbe_brachistochrone",
"Inegalite_isoperimetrique"}], [217, {"Extrema_lies",

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"Theoreme_Cartan_vonNeumann"}], [218, {"Methode_Newton",
"Decomposition_Dunford"}], [219, {"Extrema_lies",
"Courbe_brachistochrone"}], [220, {"Courbe_brachistochrone",
"Equation_Hill_Mathieu"}], [221, {"Equation_Hill_Mathieu",
"Etude_asymptotique_suite_polynomes"}], [223, {"Methode_Newton",
"Couronnes_biholomorphes"}], [224, {"Serie_harmonique",
"Etude_asymptotique_suite_polynomes"}], [226, {"Methode_Newton",
"Decomposition_Dunford"}], [228, {"Theoreme_Bernstein",
"Densite_C01_fonctions_continues_nullepart_der"}], [229,
{"Galton_Watson", "Courbe_brachistochrone"}], [230,
{"Serie_harmonique", "Theoreme_Abel_angulaire"}], [232,
{"Methode_Newton", "Methode_gradient_conjugué"}], [234,
{"Polynomes_orthogonaux", "Theoreme_Riesz_Fischer"}], [235,
{"Theoreme_Fejer", "Theoreme_Riesz_Fischer"}], [236,
{"Inegalite_isoperimetrique", "Transformee_Fourier_gaussienne"}],
[239, {"Theoreme_Jordan_C1", "Transformee_Fourier_gaussienne"}],
[240, {"Transformee_Fourier_gaussienne",
"Inversion_Fourier_distrib"}], [241, {"Theoreme_Fejer",
"Theoreme_Riesz_Fischer"}], [243, {"Nombres_Bell",
"Theoreme_Abel_angulaire"}], [244, {"Nombres_Bell",
"Theoreme_Abel_angulaire"}], [245, {"Couronnes_biholomorphes",
"Transformee_Fourier_gaussienne"}], [246, {"Theoreme_Fejer",
"Inegalite_isoperimetrique"}], [247, {"Theoreme_Abel_angulaire",
"Serie_harmonique"}], [249, {"Nombres_normaux",
"Theoreme_Bernstein"}], [253, {"Methode_gradient_conjugué",
"Courbe_brachistochrone"}], [254, {"Formule_Poisson",
"Inversion_Fourier_distrib"}], [255, {"Formule_Poisson",
"Inversion_Fourier_distrib"}], [260, {"Galton_Watson",
"Theoreme_Bernstein"}], [261, {"Transformee_Fourier_gaussienne",
"Galton_Watson"}], [262, {"TCL", "Theoreme_Riesz_Fischer"}],
[263, {"TCL", "Transformee_Fourier_gaussienne"}], [264,
{"Nombres_normaux", "Theoreme_Bernstein"}]}:
> select(y -> evalb(y[2] < 2), map(x -> [x[1], nops(x[2])], %));
      {}
> dev := `union`(op(map(x -> x[2], dev_lecons_couplees)); dev
subset dev_possibles; nops(dev);
dev := {"TCL", "TIL", "Lemme_Morse", "Action_SOn_Sn-1", "Borne_Bezout",
"Ellipse_Steiner", "Extrema_lies", "Formule_Poisson", "Galton_Watson",
"Methode_Newton", "Nombres_Bell", "Nombres_normaux", "Simplicite_SO3",
"Theoreme_Fejer", "Theoreme_Molien", "Automorphismes_KX", "Reduction_sym_cpct",
"Serie_harmonique", "Table_caracteres_S4", "Theoreme_Bernstein",
"Theoreme_Jordan_C1", "Theoreme_Kronecker", "Courbe_brachistochrone",
"Couronnes_biholomorphes", "Decomposition_Dunford", "Equation_Hill_Mathieu",
"Existence_corps_finis", "Polynomes_orthogonaux", "Reciprocite_quadratique",
"Reduction_endo_normaux", "Sous_algebre_reduite", "Theoreme_Abel_angulaire",
"Theoreme_Lie_Kolchin", "Theoreme_Riesz_Fischer", "Algo_facteurs_invariants",
"Inegalite_isoperimetrique", "Inversion_Fourier_distrib", "Irreductibilite_pol_cyclo",
"Methode_gradient_conjugué", "Nombre_matrices_diago_Fq",
"Suite_polygones_converge", "Theoreme_Cartan_vonNeumann",
"Theoreme_Cauchy_Lipschitz", "Theoreme_Rothstein_Trager",
"Definition_bifocale_coniques", "Partition_entier_parts_fixees",

```

(1)

```
"Theoreme_Frobenius_Zolotarev", "Transformee_Fourier_gaussienne",  
"Composantes_connexes_fq_non_degen", "Etude_asymptotique_suite_polynomes",  
"Exponentielle_MnC_GLnC_surjective",  
"Densite_C01_fonctions_continues_nullepart_der"}  
true  
52
```

(2)

```
> #analyse : 24 algèbre : 22 deux : 7
```

```
> dev_lecons_utile := sort([seq([dev_courant, map(y -> y[1], select  
(x -> evalb(dev_courant in x[2]), dev_lecons_couplees))],  
dev_courant in dev)], (x, y) -> nops(x[2]) > nops(y[2]));
```

```
dev_lecons_utile := [{"Reciprocite_quadratique", {120, 121, 123, 126, 159, 170, 190}},
```

(3)

```
["Simplicite_SO3", {103, 106, 108, 150, 160, 161, 204}],  
["Transformee_Fourier_gaussienne", {236, 239, 240, 245, 261, 263}],  
["Theoreme_Riesz_Fischer", {201, 208, 234, 235, 241, 262}], ["Theoreme_Molien",  
{104, 107, 109, 124, 142, 151}], ["Irreductibilite_pol_cyclo", {102, 120, 121, 141, 144}],  
["Courbe_brachistochrone", {216, 219, 220, 229, 253}], ["Theoreme_Bernstein", {209,  
228, 249, 260, 264}], ["Theoreme_Fejer", {202, 209, 235, 241, 246}],  
["Suite_polygones_converge", {102, 152, 181, 182}], ["Nombre_matrices_diago_Fq",  
{101, 104, 150, 190}], ["Theoreme_Abel_angulaire", {230, 243, 244, 247}],  
["Reduction_endo_normaux", {154, 155, 160, 161}], ["Polynomes_orthogonaux", {201,  
207, 213, 234}], ["Decomposition_Dunford", {153, 157, 218, 226}],  
["Reduction_sym_cpct", {203, 205, 208, 213}], ["Methode_Newton", {218, 223, 226,  
232}], ["Extrema_lies", {159, 215, 217, 219}], ["Ellipse_Steiner", {180, 181, 182, 183}],  
["Lemme_Morse", {158, 170, 171, 214}], ["Partition_entier_parts_fixees", {124, 126,  
140}], ["Theoreme_Cartan_vonNeumann", {156, 215, 217}],  
["Methode_gradient_conjugue", {162, 232, 253}], ["Inversion_Fourier_distrib", {240,  
254, 255}], ["Inegalite_isoperimetrique", {216, 236, 246}], ["Sous_algebre_reduite",  
{108, 153, 157}], ["Existence_corps_finis", {123, 125, 141}], ["Equation_Hill_Mathieu",  
{155, 220, 221}], ["Couronnes_biholomorphes", {207, 223, 245}],  
["Theoreme_Jordan_C1", {203, 204, 239}], ["Table_caracteres_S4", {105, 107, 109}],  
["Serie_harmonique", {224, 230, 247}], ["Automorphismes_KX", {125, 140, 151}],  
["Galton_Watson", {229, 260, 261}], ["Borne_Bezout", {142, 143, 152}],  
["Action_SOn_Sn-1", {101, 106, 183}],  
["Densite_C01_fonctions_continues_nullepart_der", {202, 228}],  
["Etude_asymptotique_suite_polynomes", {221, 224}],  
["Composantes_connexes_fq_non_degen", {158, 171}], ["Theoreme_Rothstein_Trager",  
{122, 143}], ["Theoreme_Cauchy_Lipschitz", {205, 206}], ["Algo_facteurs_invariants",  
{122, 162}], ["Theoreme_Lie_Kolchin", {103, 154}], ["Nombres_normaux", {249,  
264}], ["Nombres_Bell", {243, 244}], ["Formule_Poisson", {254, 255}], ["TIL", {206,  
214}], ["TCL", {262, 263}], ["Exponentielle_MnC_GLnC_surjective", {156}],  
["Theoreme_Frobenius_Zolotarev", {105}], ["Definition_bifocale_coniques", {180}],  
["Theoreme_Kronecker", {144}]]
```

```
> dev_nb_lecons_utile := map(x -> [x[1], nops(x[2])],
```

```
dev_lecons_utile);
```

```
dev_nb_lecons_utile := [{"Reciprocite_quadratique", 7}, {"Simplicite_SO3", 7},  
  ["Transformee_Fourier_gaussienne", 6}, {"Theoreme_Riesz_Fischer", 6},  
  ["Theoreme_Molien", 6}, {"Irreductibilite_pol_cyclo", 5}, {"Courbe_brachistochrone", 5},  
  ["Theoreme_Bernstein", 5}, {"Theoreme_Fejer", 5}, {"Suite_polygones_converge", 4},  
  ["Nombre_matrices_diago_Fq", 4}, {"Theoreme_Abel_angulaire", 4},  
  ["Reduction_endo_normaux", 4}, {"Polynomes_orthogonaux", 4},  
  ["Decomposition_Dunford", 4}, {"Reduction_sym_cpct", 4}, {"Methode_Newton", 4},  
  ["Extrema_lies", 4}, {"Ellipse_Steiner", 4}, {"Lemme_Morse", 4},  
  ["Partition_entier_parts_fixees", 3}, {"Theoreme_Cartan_vonNeumann", 3},  
  ["Methode_gradient_conjuge", 3}, {"Inversion_Fourier_distrib", 3},  
  ["Inegalite_isoperimetrique", 3}, {"Sous_algebre_reduite", 3}, {"Existence_corps_finis",  
  3}, {"Equation_Hill_Mathieu", 3}, {"Couronnes_biholomorphes", 3},  
  ["Theoreme_Jordan_C1", 3}, {"Table_caracteres_S4", 3}, {"Serie_harmonique", 3},  
  ["Automorphismes_KX", 3}, {"Galton_Watson", 3}, {"Borne_Bezout", 3},  
  ["Action_SOn_Sn-1", 3}, {"Densite_C01_fonctions_continues_nullepart_der", 2},  
  ["Etude_asymptotique_suite_polynomes", 2}, {"Composantes_connexes_fq_non_degen",  
  2}, {"Theoreme_Rothstein_Trager", 2}, {"Theoreme_Cauchy_Lipschitz", 2},  
  ["Algo_facteurs_invariants", 2}, {"Theoreme_Lie_Kolchin", 2}, {"Nombres_normaux", 2},  
  ["Nombres_Bell", 2}, {"Formule_Poisson", 2}, {"TIL", 2}, {"TCL", 2},  
  ["Exponentielle_MnC_GLnC_surjective", 1}, {"Theoreme_Frobenius_Zolotarev", 1},  
  ["Definition_bifocale_coniques", 1}, {"Theoreme_Kronecker", 1}]
```

(4)

```
> Statistics[Mean](map(x -> x[2], dev_nb_lecons_utile));  
3.307692308
```

(5)

```
> Statistics[Median](map(x -> x[2], dev_nb_lecons_utile));  
3.
```

(6)

```
> Statistics[StandardDeviation](map(x -> x[2], dev_nb_lecons_utile)  
);
```

```
1.46245109237428
```

(7)