6 Appendix

6.1 Selected CBC parameters

The CBC parameters are taken (mostly unchanged) from the CBC command line help. Only the CBC parameters that are useful in a CMPL context are described afterwards.

Usage CBC parameters:

```
%opt cbc solverOption [solverOptionValue]
```

Double parameters:

dualB(ound) *doubleValue*

Initially algorithm acts as if no gap between bounds exceeds this value

Range of values is 1e-20 to 1e+12, default 1e+10

dualT(olerance) *doubleValue*

For an optimal solution no dual infeasibility may exceed this value
Range of values is 1e-20 to 1e+12, default 1e-07

objective(Scale) *doubleValue*

Scale factor to apply to objective

Range of values is -1e+20 to 1e+20, default 1

primalT(olerance) *doubleValue*

For an optimal solution no primal infeasibility may exceed this value

Range of values is 1e-20 to 1e+12, default 1e-07

primalW(eight) *doubleValue*

Initially algorithm acts as if it costs this much to be infeasible

Range of values is 1e-20 to 1e+20, default 1e+10

rhs(Scale) *doubleValue*

Scale factor to apply to rhs and bounds

Range of values is -1e+20 to 1e+20, default 1

Branch and Cut double parameters:

allow(ableGap) *doubleValue*

Stop when gap between best possible and best less than this

Range of values is 0 to 1e+20, default 0

artif(icialCost) *doubleValue*

Costs >= these are treated as artificials in feasibility pump 0.0 off - otherwise variables with costs >= these are treated as artificials and fixed to lower bound in feasibility pump

Range of values is 0 to 1.79769e+308, default 0

cuto(ff) *doubleValue*

All solutions must be better than this value (in a minimization sense).

This is also set by code whenever it obtains a solution and is set to value of objective for solution minus cutoff increment.

Range of values is -1e+60 to 1e+60, default 1e+50

fix(OnDj) *doubleValue*

Try heuristic based on fixing variables with reduced costs greater than this

If this is set integer variables with reduced costs greater than this will be fixed before branch and bound - use with extreme caution!

Range of values is -1e+20 to 1e+20, default -1

fraction(forBAB) *doubleValue*

Fraction in feasibility pump

After a pass in feasibility pump, variables which have not moved about are fixed and if the pre-processed model is small enough a few nodes of branch and bound are done on reduced problem. Small problem has to be less than this fraction of original.

Range of values is 1e-05 to 1.1, default 0.5

inc(rement) *doubleValue*

A valid solution must be at least this much better than last integer solution

Whenever a solution is found the bound on solutions is set to solution (in a minimization sense) plus this. If it is not set then the code will try and work one out.

Range of values is -1e+20 to 1e+20, default 1e-05

inf(easibilityWeight) *doubleValue*

Each integer infeasibility is expected to cost this much

Range of values is 0 to 1e+20, default 0

integerT(olerance) *doubleValue*

For an optimal solution no integer variable may be this away from an integer value

Range of values is 1e-20 to 0.5, default 1e-06

preT(olerance) *doubleValue*

Tolerance to use in presolve

Range of values is 1e-20 to 1e+12, default 1e-08

pumpC(utoff) *doubleValue*

Fake cutoff for use in feasibility pump

0.0 off - otherwise add a constraint forcing objective below this value in feasibility pump

Range of values is -1.79769e+308 to 1.79769e+308, default 0

pumpI(ncrement) *doubleValue*

Fake increment for use in feasibility pump

0.0 off - otherwise use as absolute increment to cut off when solution found in feasibility pump

Range of values is -1.79769e+308 to 1.79769e+308, default 0

ratio(Gap) *doubleValue*

If the gap between best solution and best possible solution is less than this fraction of the objective value at the root node then the search will terminate.

Range of values is 0 to 1e+20, default 0

reallyO(bjectiveScale) *doubleValue*

Scale factor to apply to objective in place

Range of values is -1e+20 to 1e+20, default 1

sec(onds) *doubleValue*

maximum seconds

After this many seconds coin solver will act as if maximum nodes had been reached.

Range of values is -1 to 1e+12, default 1e+08

tighten(Factor) *doubleValue*

Tighten bounds using this times largest activity at continuous solution

Range of values is 0.001 to 1e+20, default -1

Integer parameters:

idiot(Crash) *integerValue*

This is a type of 'crash' which works well on some homogeneous problems. It works best on problems with unit elements and rhs but will do something to any model. It should only be used before primal. It can be set to -1 when the code decides for itself whether to use it, 0 to switch off or n > 0 to do n passes.

Range of values is -1 to 99999999, default -1

maxF(actor) *integerValue*

Maximum number of iterations between refactorizations

Range of values is 1 to 999999, default 200

maxIt(erations) *integerValue*

Maximum number of iterations before stopping

Range of values is 0 to 2147483647, default 2147483647

passP(resolve) *integerValue*

How many passes in presolve

Range of values is -200 to 100, default 5

pO(ptions) *integerValue*

If this is > 0 then presolve will give more information and branch and cut will give statistics

Range of values is 0 to 2147483647, default 0

slp(Value) *integerValue*

Number of slp passes before primal

If you are solving a quadratic problem using primal then it may be helpful to do some sequential Lps to get a good approximate solution.

Range of values is -1 to 50000, default -1

slog(Level) *integerValue*

Level of detail in (LP) Solver output

Range of values is -1 to 63, default 1

subs(titution) *integerValue*

How long a column to substitute for in presolve

Normally Presolve gets rid of 'free' variables when there are no more than 3 variables in column. If you increase this the number of rows may decrease but number of elements may increase.

Range of values is 0 to 10000, default 3

Branch and Cut integer parameters:

cutD(epth) *integerValue*

Depth in tree at which to do cuts

Cut generators may be - off, on only at root, on if they look possible and on. If they are done every node then that is that, but it may be worth doing them every so often. The original method was every so many nodes but it is more logical to do it whenever depth in tree is a multiple of K. This option does that and defaults to -1 (off -> code decides).

Range of values is -1 to 999999, default -1

cutL(ength) *integerValue*

Length of a cut

At present this only applies to Gomory cuts. -1 (default) leaves as is. Any value >0 says that all cuts <= this length can be generated both at root node and in tree. 0 says to use some dynamic lengths. If value >=10,000,000 then the length in tree is value%10000000 - so 10000100 means unlimited length at root and 100 in tree.

Range of values is -1 to 2147483647, default -1

dense(Threshold) *integerValue*

Whether to use dense factorization

Range of values is -1 to 10000, default -1

depth(MiniBab) *integerValue*

Depth at which to try mini BAB

Rather a complicated parameter but can be useful. -1 means off for large problems but on as if -12 for problems where rows+columns<500, -2 means use Cplex if it is linked in. Otherwise if negative then go into depth first complete search fast branch and bound when depth>= -value-2 (so -3 will use this at depth>=1). This mode is only switched on after 500 nodes. If you really want to switch it off for small problems then set this to -999. If >=0 the value doesn't matter very much. The code will do approximately 100 nodes of fast branch and bound every now and then at depth>=5. The actual logic is too twisted to describe here.

Range of values is -2147483647 to 2147483647, default -1

diveO(pt) *integerValue*

Diving options

If >2 && <8 then modify diving options

–3 only at root and if no solution,

–4 only at root and if this heuristic has not got solution,

–5 only at depth <4,

–6 decay, 7 run up to 2 times

if solution found 4 otherwise.

Range of values is -1 to 200000, default 3

hOp(tions) *integerValue*

Heuristic options

1 says stop heuristic immediately allowable gap reached. Others are for feasibility pump - 2 says do exact number of passes given, 4 only applies if initial cutoff given and says relax after 50 passes, while 8 will adapt cutoff rhs after first solution if it looks as if code is stalling.

Range of values is -9999999 to 9999999, default 0

hot(StartMaxIts) *integerValue*

Maximum iterations on hot start

Range of values is 0 to 2147483647, default 100

log(Level) *integerValue*

Level of detail in Coin branch and Cut output

If 0 then there should be no output in normal circumstances. 1 is probably the best value for most uses, while 2 and 3 give more information.

Range of values is -63 to 63, default 1

maxN(odes) *integerValue*

Maximum number of nodes to do

Range of values is -1 to 2147483647, default 2147483647

maxS(olutions) *integerValue*

Maximum number of solutions to get

You may want to stop after (say) two solutions or an hour. This is checked every node in tree, so it is possible to get more solutions from heuristics.

Range of values is 1 to 2147483647, default -1

passC(uts) *integerValue*

Number of cut passes at root node

The default is 100 passes if less than 500 columns, 100 passes (but stop if drop small if less than 5000 columns, 20 otherwise

Range of values is -9999999 to 9999999, default -1

passF(easibilityPump) *integerValue*

How many passes in feasibility pump

This fine tunes Feasibility Pump by doing more or fewer passes.

Range of values is 0 to 10000, default 30

passT(reeCuts) *integerValue*

Number of cut passes in tree

Range of values is -9999999 to 9999999, default 1

small(Factorization) *integerValue*

Whether to use small factorization

If processed problem <= this use small factorization

Range of values is -1 to 10000, default -1

strong(Branching) *integerValue*

Number of variables to look at in strong branching

Range of values is 0 to 999999, default 5

thread(s) *integerValue*

Number of threads to try and use

To use multiple threads, set threads to number wanted. It may be better to use one or two more than number of cpus available. If 100+n then n threads and search is repeatable (maybe be somewhat slower), if 200+n use threads for root cuts, 400+n threads used in sub-trees.

Range of values is -100 to 100000, default 0

trust(PseudoCosts) *integerValue*

Number of branches before we trust pseudocosts

Range of values is -3 to 2000000, default 5

Keyword parameters:

bscale *option*

Whether to scale in barrier (and ordering speed)

Possible options: off on off1 on1 off2 on2, default off

chol(esky) *option*

Which cholesky algorithm

Possible options: native dense fudge(Long_dummy) wssmp_dummy

crash *option*

Whether to create basis for problem

If crash is set on and there is an all slack basis then Clp will flip or put structural variables into basis with the aim of getting dual feasible. On the whole dual seems to be better without it and there are alternative types of 'crash' for primal e.g. 'idiot' or 'sprint'.

Possible options: off on so(low_halim) ha(lim_solow(JJF mods)), dfeault off

cross(over) *option*

Whether to get a basic solution after barrier

Interior point algorithms do not obtain a basic solution (and the feasibility criterion is a bit suspect (JJF)). This option will crossover to a basic solution suitable for ranging or branch and cut. With the current state of quadratic it may be a good idea to switch off crossover for quadratic (and maybe presolve as well) - the option maybe does this.

Possible options: on off maybe presolve, default on

dualP(ivot) *option*

Dual pivot choice algorithm

Possible options: auto(matic) dant(zig) partial steep(est), default auto(matic)

fact(orization) *option*

Which factorization to use

Possible options: normal dense simple osl, default normal

gamma((Delta)) *option*

Whether to regularize barrier

Possible options: off on gamma delta onstrong gammastrong deltastrong, default off

KKT *option*

Whether to use KKT factorization

Possible options: off on, default off

perturb(ation) *option*

Whether to perturb problem

Possible options: on off, default on

presolve *option*

Presolve analyzes the model to find such things as redundant equations, equations which fix some variables, equations which can be transformed into bounds etc etc. For the initial solve of any problem this is worth doing unless you know that it will have no effect. on will normally do 5 passes while using 'more' will do 10. If the problem is very large you may need to write the original to file using 'file'.

Possible options for presolve are: on off more file, default on

primalP(ivot) *option*

Primal pivot choice algorithm

Possible options: auto(matic) exa(ct) dant(zig) part(ial) steep(est) change sprint, default auto(matic)

scal(ing) *option*

Whether to scale problem

Possible options: off equi(librium) geo(metric) auto(matic) dynamic rows(only), default auto(matic)

spars(eFactor) *option*

Whether factorization treated as sparse

Possible options: on off, default on

timeM(ode) *option*

Whether to use CPU or elapsed time

cpu uses CPU time for stopping, while elapsed uses elapsed time. (On Windows, elapsed time is always used).

Possible options: cpu elapsed, default cpu

vector *option*

If this parameter is set to on ClpPackedMatrix uses extra column copy in odd format.

Possible options: off on, default off

Branch and Cut keyword parameters:

clique(Cuts) *option*

Whether to use Clique cuts

Possible options: off on root ifmove forceOn onglobal, default ifmove

combine(Solutions) *option*

Whether to use combine solution heuristic

This switches on a heuristic which does branch and cut on the problem given by just using variables which have appeared in one or more solutions. It obviously only tries after two or more solutions. See Rounding for meaning of on,both,before

Possible options: off on both before, default on

combine2(Solutions) *option*

Whether to use crossover solution heuristic

This switches on a heuristic which does branch and cut on the problem given by fixing variables which have same value in two or more solutions. It obviously only tries after two or more solutions. See Rounding for meaning of on,both,before

Possible options: off on both before, default off

cost(Strategy) *option*

How to use costs as priorities

This orders the variables in order of their absolute costs - with largest cost ones being branched on first. This primitive strategy can be surprsingly effective. The column order option is obviously not on costs but easy to code here.

Possible options: off pri(orities) column(Order?) 01f(irst?) 01l(ast?) length(?), default off

cuts(OnOff) *option*

Switches all cuts on or off

This can be used to switch on or off all cuts (apart from Reduce and Split). Then you can do individual ones off or on See branchAndCut for information on options.

Possible options: off on root ifmove forceOn,   default on

Dins *option*

This switches on Distance induced neighborhood Search. See Rounding for meaning of on,both,before

Possible options: off on both before often, default off

DivingS(ome) *option*

This switches on a random diving heuristic at various times. C - Coefficient, F - Fractional, G - Guided, L - LineSearch, P - PseudoCost, V - VectorLength. You may prefer to use individual on/off See Rounding for meaning of on,both,before

Possible options: off on both before, default off

DivingC(oefficient) *option*

Whether to try DiveCoefficient

Possible options: off on both before, default on

DivingF(ractional) *option*

Whether to try DiveFractional

Possible options: off on both before, default off

DivingG(uided) *option*

Whether to try DiveGuided

Possible options: off on both before, default off

DivingL(ineSearch) *option*

Whether to try DiveLineSearch

Possible options: off on both before, default off

DivingP(seudoCost) *option*

Whether to try DivePseudoCost

Possible options: off on both before, default off

DivingV(ectorLength) *option*

Whether to try DiveVectorLength

Possible options: off on both before, default off

feas(ibilityPump) *option*

This switches on feasibility pump heuristic at root. This is due to Fischetti, Lodi and Glover and uses a sequence of Lps to try and get an integer feasible solution. Some fine tuning is available by passFeasibilityPump and also pumpTune. See Rounding for meaning of on,both,before

Possible options: off on both before, default on

flow(CoverCuts) *option*

This switches on flow cover cuts (either at root or in entire tree)

See branchAndCut for information on options.

Possible options: off on root ifmove forceOn onglobal, default ifmove

gomory(Cuts) *option*

Whether to use Gomory cuts

The original cuts - beware of imitations! Having gone out of favor, they are now more fashionable as LP solvers are more robust and they interact well with other cuts. They will almost always give cuts (although in this executable they are limited as to number of variables in cut). However the cuts may be dense so it is worth experimenting (Long allows any length). See branchAndCut for information on options.

Possible options: off on root ifmove forceOn onglobal forceandglobal forceLongOn long, default ifmove

greedy(Heuristic) *option*

Whether to use a greedy heuristic

Switches on a greedy heuristic which will try and obtain a solution. It may just fix a percentage of variables and then try a small branch and cut run. See Rounding for meaning of on,both,before

Possible options: off on both before, default on

heur(isticsOnOff) *option*

Switches most heuristics on or off

Possible options: off on, default on

knapsack(Cuts) *option*

This switches on knapsack cuts (either at root or in entire tree)

Possible options: off on root ifmove forceOn onglobal forceandglobal, default ifmove

lift(AndProjectCuts) *option*

Whether to use Lift and Project cuts

Possible options: off on root ifmove forceOn, default off

local(TreeSearch) *option*

This switches on a local search algorithm when a solution is found. This is from Fischetti and Lodi and is not really a heuristic although it can be used as one. When used from Coin solve it has limited functionality. It is not switched on when heuristics are switched on.

Possible options: off on, default off

mixed(IntegerRoundingCuts) *option*

This switches on mixed integer rounding cuts (either at root or in entire tree) See branchAndCut for information on options.

Possible options: off on root ifmove forceOn onglobal, default ifmove

naive(Heuristics) *option*

Really silly stuff e.g. fix all integers with costs to zero!. Do option does heuristic before preprocessing

Possible options: off on both before, default off

node(Strategy) *option*

What strategy to use to select nodes

Normally before a solution the code will choose node with fewest infeasibilities. You can choose depth as the criterion. You can also say if up or down branch must be done first (the up down choice will carry on after solution). Default has now been changed to hybrid which is breadth first on small depth nodes then fewest.

Possible options: hybrid fewest depth upfewest downfewest updepth downdepth, default fewest

pivotAndC(omplement) *option*

Whether to try Pivot and Complement heuristic

Possible options: off on both before, default off

pivotAndF(ix) *option*

Whether to try Pivot and Fix heuristic

Possible options: off on both before, default off

preprocess *option*

This tries to reduce size of model in a similar way to presolve and it also tries to strengthen the model - this can be very useful and is worth trying. Save option saves on file presolved.mps. equal will turn <= cliques into ==. sos will create sos sets if all 0-1 in sets (well one extra is allowed) and no overlaps. trysos is same but allows any number extra. equalall will turn all valid inequalities into equalities with integer slacks.

Possible options: off on save equal sos trysos equalall strategy aggregate forcesos, default sos

probing(Cuts) *option*

This switches on probing cuts (either at root or in entire tree) See branchAndCut for information on options. but strong options do more probing

Possible options: off on root ifmove forceOn onglobal forceonglobal forceOnBut forceOnStrong forceOnButStrong strongRoot, default forceOnStrong

rand(omizedRounding) *option*

Whether to try randomized rounding heuristic

Possible options: off on both before, default off

reduce(AndSplitCuts) *option*

This switches on reduce and split cuts (either at root or in entire tree) See branchAndCut for information on options.

Possible options: off on root ifmove forceOn, default off

residual(CapacityCuts) *option*

Residual capacity cuts. See branchAndCut for information on options.

Possible options: off on root ifmove forceOn, default off

Rens *option*

This switches on Relaxation enforced neighborhood Search. on just does 50 nodes 200 or 1000 does that many nodes. Doh option does heuristic before preprocessing

Possible options: off on both before 200 1000 10000 dj djbefore, default off

Rins *option*

This switches on Relaxed induced neighborhood Search. Doh option does heuristic before preprocessing

Possible options: off on both before often, default on

round(ingHeuristic) *option*

This switches on a simple (but effective) rounding heuristic at each node of tree. On means do in solve i.e. after preprocessing, Before means do if doHeuristics used, off otherwise, and both means do if doHeuristics and in solve.

Possible options: off on both before, default on

two(MirCuts) *option*

This switches on two phase mixed integer rounding cuts (either at root or in entire tree) See branchAndCut for information on options.

Possible options: off on root ifmove forceOn onglobal forceandglobal forceLongOn, default root

Vnd(VariableNeighborhoodSearch) *option*

Whether to try Variable Neighborhood Search

Possible options: off on both before intree, default off

Actions:

barr(ier)	Solve using primal dual predictor corrector algorithm
dualS(implex)	Do dual simplex algorithm
either(Simplex)	Do dual or primal simplex algorithm
initialS	Solve to continuous This just solves the problem to continuous - without adding any cuts
outDup	takes duplicate rows etc out of integer model
primalS	Do primal simplex algorithm
reallyS	Scales model in place
stat	Print some statistics
tightLP	Poor person's preSolve for now

Branch and Cut actions:

branch	Do Branch and Cut

6.2 Selected GLPK parameters

The following parameters are taken from the GLPK command line help.

Only the GLPK parameters that are useful in a CMPL context are described afterwards.

Usage GLPK parameters:

```
%opt glpk solverOption [solverOptionValue]
```

General options:

simplex	use simplex method (default)
interior	use interior point method (LP only)
scale	scale problem (default)
noscale	do not scale problem
ranges *filename*	write sensitivity analysis report to filename in printable format (simplex only)

tmlim *nnn*	limit solution time to nnn seconds
memlim *nnn*	limit available memory to nnn megabytes
wlp *filename*	write problem to filename in CPLEX LP format
wglp *filename*	write problem to filename in GLPK format
wcnf *filename*	write problem to filename in DIMACS CNF-SAT format
log *filename*	write copy of terminal output to filename

LP basis factorization options:

luf	LU + Forrest-Tomlin update (faster, less stable; default)
cbg	LU + Schur complement + Bartels-Golub update (slower, more stable)
cgr	LU + Schur complement + Givens rotation update (slower, more stable)

Options specific to simplex solver:

primal	use primal simplex (default)
dual	use dual simplex
std	use standard initial basis of all slacks
adv	use advanced initial basis (default)
bib	use Bixby's initial basis
steep	use steepest edge technique (default)
nosteep	use standard "textbook" pricing
relax	use Harris' two-pass ratio test (default)
norelax	use standard "textbook" ratio test
presol	use presolver (default; assumes scale and adv)
nopresol	do not use presolver
exact	use simplex method based on exact arithmetic
xcheck	check final basis using exact arithmetic

Options specific to interior-point solver:

nord	use natural (original) ordering
qmd	use quotient minimum degree ordering

amd	use approximate minimum degree ordering (default)
symamd	use approximate minimum degree ordering

Options specific to MIP solver:

nomip	consider all integer variables as continuous (allows solving MIP as pure LP)
first	branch on first integer variable
last	branch on last integer variable
mostf	branch on most fractional variable
drtom	branch using heuristic by Driebeck and Tomlin (default)
pcost	branch using hybrid pseudocost heuristic (may be useful for hard instances)
dfs	backtrack using depth first search
bfs	backtrack using breadth first search
bestp	backtrack using the best projection heuristic
bestb	backtrack using node with best local bound (default)
intopt	use MIP presolver (default)
nointopt	do not use MIP presolver
binarize	replace general integer variables by binary ones (assumes intopt)
fpump	apply feasibility pump heuristic
gomory	generate Gomory's mixed integer cuts
mir	generate MIR (mixed integer rounding) cuts
cover	generate mixed cover cuts
clique	generate clique cuts
cuts	generate all cuts above
mipgap *tol*	set relative mip gap tolerance to tol
minisat	translate integer feasibility problem to CNF-SAT and solve it with MiniSat solver
objbnd *bound*	add inequality obj <= bound (minimization) or obj >= bound (maximization) to integer feasibility problem (assumes minisat)