```
from __future__ import division
import sys, random, math
from sk import *
from sa import *
from mws import *
from ga import *
from de import *
from pso import *
from models import *
sys.dont_write_bytecode = True

@demo
def HW4part345(): #part 5 with part 3 and part4
  for klass in [Schaffer,Fonseca, Kursawe, ZDT1, ZDT3, Viennet3]:
    print "\n!!!!", klass.__name__
    for searcher in [sa, mws]:
      reseed()
      x, rrange=searcher(klass()) #rrange is a dic: key is range, value is the o
bj name
      for key in rrange.keys():
        print "# The range of objective "+ str(rrange[key])+" during %s repeats is %s " \
              % (Settings.other.repeats, str(key))
@demo
def HW4part6():
  def genvariants():
    Settings.sa.cooling = rand() # get variants of sa, mws
    Settings.mws.prob = rand()
    Settings.mws.max_changes = int(1000*rand())
  r = 20
  Settings.other.repeats = 1
  Settings.other.reportrange = False
  for klass in [ZDT1]:
    print "\n!!!!", klass.__name__
    for variant in range(1):
      genvariants()
      allEB = []
      searcher = { "sa": sa, "mws" :mws}
      for key in searcher.keys():
        lastera = []
        reseed()
        for _ in range(r):
          model = klass()
          x = searcher[key](klass())
          lastera += [x]
        label = key + str(variant)
        lastera.insert(0,label)
        allEB.append(lastera)
      rdivDemo(allEB)
@demo
def HW5():
  # for klass in [ Schaffer, Fonseca, Kursawe, ZDT1, ZDT3, Viennet3, DTLZ7]:
  for klass in [DTLZ7]:
    print "\n!!!!", klass.__name__
    allEB  = []
    searcher = {"sa":sa}
    #searcher = {"sa":sa, "mws":mws, "ga":ga}
    for key in searcher.keys():
      repeats = 5
      eb = 5*[0]
      name = klass.__name__
      reseed()
      for r in range(repeats):
        results=searcher[key](klass()) # lohi is a list containing [lo,hi] paris
 of f1&f2
        if Settings.other.reportrange:
          eb[r] = results[0]
        else:
          eb[r] = results
      eb.insert(0, key)
      allEB.append(eb)
      rdivDemo(allEB)
@demo
def HW6():
```



```
  for klass in [Schaffer, Fonseca, Kursawe, ZDT1, ZDT3, Viennet3]:
  # for klass in [ Schaffer]:
    print "\n!!!!", klass.__name__
    allEB  = []
    #searcher = {"ga":ga}
    searcher = {"sa":sa, "mws":mws, "ga":ga, "de": de}
    Settings.other.repeats = 1
    for key in searcher.keys():
      repeats = 5
      eb = repeats*[0]
      name = klass.__name__
      reseed()
      for r in range(repeats):
        results=searcher[key](klass()) # lohi is a list containing [lo,hi] paris
 of f1&f2
        eb[r] = results[0] if isinstance(results, tuple) else results
      eb.insert(0, key)
      allEB.append(eb)
      rdivDemo(allEB)
@demo
def HW7():
  for klass in [ Schaffer, Fonseca, Kursawe, ZDT1, ZDT3, Viennet3, DTLZ7,Schwefe
l, Osyczka]:
  # for klass in [Osyczka]:
    print "\n!!!!", klass.__name__
    allEB  = []
    # searcher = {"sa":sa}
    searcher = {"sa":sa, "mws":mws, "ga":ga, "de": de, "pso":pso}
    Settings.other.repeats = 1
    for key in searcher.keys():
      repeats = 1
      eb = repeats*[0]
      name = klass.__name__
      reseed()
      ShowDate = datetime.datetime.now().strftime
     # print "#", ShowDate("%Y-%m-%d %H:%M:%S")
      beginTime = time.time()
      for r in range(repeats):
        results=searcher[key](klass()) # lohi is a list containing [lo,hi] paris
 of f1&f2
        eb[r] = results[0] if isinstance(results, tuple) else results
      eb.insert(0, key)
      allEB.append(eb)
      endTime = time.time()
      # print "\n" +("-"*60)
      # dump(Settings, f.__name__)
      print "#"+key+" Runtime: %.3f secs" % (endTime-beginTime)
      # print "\n" +("-"*60)
    rdivDemo(allEB)
    dump(Settings,lvl = 0)

@demo
def testmodel():
  model = DTLZ7()
  # model = Osyczka()
  depen = model.getDepen(model.generate_x())
  print depen

if __name__ == "__main__": eval(cmd())
```

```
from __future__ import division
from log import *
from models import *
from xtile import *
from base import *
import sys,random, math, datetime, time,re, pdb, operator
sys.dont_write_bytecode = True

# @printlook
def ga(model):
  mutationRate = 1/model.n
  population = []
  solution =[]
  children = []
  fitness = {}
  history = {}
  mateNum = 20
  def selection(sortedFitness):
    return [population[sortedFitness[0][0]], population[sortedFitness[1][0]]] # sroted[0] and [1] are the smallest two we preferred
  def crossover(selected):
    '''crossover will do this way: offsprint1 = p* parent 1+ (1-p)* parent2 for numbers between two points '''
    def what(lst):
      return lst[0] if isinstance(lst, list) else lst
    children1 = []
    if rand()> Settings.ga.crossRate:
      return selected[0]
    else:
      if model.n ==1:
        children1 = [(what(selected[0]) + what(selected[1]))*0.5]
      else:
        index = sorted([random.randint(0, model.n - 1) for _ in xrange(Settings.ga.crossPoints)])
        parent1 = selected[0]
        parent2 = selected[1]
        children1 = parent1[:]
        children1[index[0]:index[1]] = parent2[index[0]:index[1]]
      return children1
  def mutate(children, selected):
    # print children
    for k, n in enumerate(children):
      if rand()< mutationRate:
        children[k]= selected[random.randint(0,1)][random.randint(0, model.n-1)] # pick value from mom or dad
    # print children
    return children
  def tournament(sortedFitness, m=10): # do tornament selection, select the best daddy or mom in  m = 10 candidates
    index = []
    for _ in range(m):
      index.append(random.randint(0, Settings.ga.pop-1))
    betterIndex = list(set(sorted(index)))
    parentlst = [population[sortedFitness[betterIndex[0]][0]], population[sortedFitness[betterIndex[1]][0]]]
    return parentlst
  def fit(fitness):
    sortedFitness = sorted(fitness.items(), key = lambda x:x[1]) # a sorted list

    return sortedFitness[:Settings.ga.pop] # just return the top 50 candidates as new populatioin
  def produce(selected):
        children = crossover(selected)
        children = mutate(children, selected)
        return children

  min_energy, max_energy = model.baseline()
  eb= 0
  solution = []
  control = Control(model, history)
  for _ in xrange(Settings.ga.pop):
    temp = model.generate_x()
    population.append(temp)
  # for num in Settings.ga.genNum:
```



```
  t = 0
  while(t < Settings.ga.genNum): # figure stop out
    stopsign = control.next(t) #true ---stop
    if stopsign:
      break
    for (k, xlst) in enumerate(population):
      fitness[k] = model.getDepen(xlst)
    newpopfitness = fit(fitness)
    for n, k in newpopfitness:
      population[n] = population[newpopfitness[0][0]] # new generation
      control.logxy(population[n])
    # for n, k in population:
    #   control.logxy(k) # log new generation
    eb = model.norm(newpopfitness[0][1])
    solution = population[newpopfitness[0][0]]
    for _ in range(mateNum):
      selected = tournament(newpopfitness)
      children.append(produce(selected))
    population.extend(children)
    t +=1
  # print "best solution : %s" % str(solution)
  # print "best normalized results: %s" % str(eb)
  # print "-"*20
  # printReport(model)
  # lohi=printRange(model)
  # return eb,lohi
  if Settings.other.xtile:
    printReport(model, history)
    print "\n"
    printSumReport(model, history)
  if Settings.other.reportrange:
    rrange=printRange(model, history)
    return eb,rrange
  else:
    return eb

def startga():
  for klass in [Schaffer, Fonseca, Kursawe, ZDT1, ZDT3, Viennet3]:
  # for klass in [DTLZ7]:
    print "="*50
    print "!!!!", klass.__name__,
    print "\nSearcher: GA"
    reseed()
    ga(klass())


if __name__ == "__main__":startga()
    # print sortedFitness
```

```
from __future__ import division
import sys, random, math
from models import *
from base import *
#this is a test
sys.dont_write_bytecode = True
# @printlook
def sa(model):
  def P(old, new, t):
    prob = math.e**((old - new)/(t+0.00001))
    return prob
  history = {}
  eb =0.0
  for _ in xrange(Settings.other.repeats):
    #reseed()
    min_energy, max_energy = model.baseline()
    s = model.generate_x()
    e = model.norm(model.getDepen(s))
    sb = s[:]
    eb = e
    k = 1
    icontrol = Control(model, history)
    while k < Settings.sa.kmax:
      stopsign = icontrol.next(k) #true ---stop
      if stopsign:
        break
      sn = model.sa_neighbor(s)
      en = model.norm(model.getDepen(sn))
      icontrol.logxy(sn)
      temp = (k/Settings.sa.kmax)**Settings.sa.cooling
      if en < eb:
        sb = sn[:] ###!!!!! can't do sb = sn for lists, because
        eb = en
        if Settings.other.show: say('!')
      if en < e:
        s = sn[:]
        e = en
        if Settings.other.show:say('+')
      elif P(e, en, temp) < random.random():
        s = sn[:]
        e = en
        if Settings.other.show:say('?')
      if Settings.other.show:say('.')
      k = k + 1
      if k % 30 == 0:
        if Settings.other.show:print "\n"
        if Settings.other.show:say(str(round(eb,3)))
  if Settings.other.xtile:
    printReport(model, history)
    print "\n"
    printSumReport(model, history)
  # print "\n------\n:Normalized Sum of Objectives : ",str(round(eb,3)),"\n:Solu
tion",sb
  if Settings.other.reportrange:
    rrange=printRange(model, history)
    return eb,rrange
  else:
    return eb
```

```
   from __future__ import division
   import sys, random, math
   from models import *
   from base import *
5  sys.dont_write_bytecode = True
   # @printlook
   def mws(model):
     eraScore = []
     control = Control(model)
10   optimalsign = False
     eb = 100.0
     norm_energy = 10**5
     history = {}
     for _ in xrange(Settings.other.repeats):
15     min_energy, max_energy = model.baseline()
       control = Control(model, history)
       total_changes = 0
       total_tries = 0
       for k in xrange(Settings.mws.max_tries):
20       if control.lives ==0:
           break
         solution = model.generate_x()
         total_tries += 1
         for _ in range(Settings.mws.max_changes):
25         stopsign = control.next(total_changes) #true ---stop
           if stopsign:
             break
           norm_energy = model.norm(model.getDepen(solution))
           if norm_energy < Settings.mws.threshold:
30           optimalsign = True
             break
           if  random.random()<Settings.mws.prob:
             solution[random.randint(0,model.n-1)] = model.generate_x()[random.rand
int(0,model.n-1)]
             control.logxy(solution)
35           if Settings.other.show:say("+")
           else:
             solution = model.mws_neighbor(solution)
             control.logxy(solution)
             if Settings.other.show:say("!")
40         if Settings.other.show:say(".")
           if total_changes % 30 == 0:
             if Settings.other.show:print "\n"
             if Settings.other.show:say(str(round(model.norm(model.getDepen(solutio
n)), 3)))
           total_changes +=1
45     # if optimalsign or k == Settings.mws.max_tries-1:
     if Settings.other.xtile:
       say("\n")
       say(str(round(model.norm(model.getDepen(solution)), 3)))
       print "\n"
50     printReport(model, history)
       print "\n"
       printSumReport(model, history)
     if Settings.other.reportrange:
       rrange =printRange(model, history)
55     return norm_energy, rrange
     else:
       return norm_energy
```

```
from __future__ import division
import sys, random, math, pdb
from models import *
from base import *

def de(model):
  eb = 100.0
  np = Settings.de.np
  repeats = Settings.de.repeats
  fa = Settings.de.f
  cr = Settings.de.cr
  threshold = Settings.de.threshold
  min_e, max_e = model.baseline()
  # s = model.generate_x()
  # e = model.norm(model.getDepen(s))
  # sb = s[:]
  # eb = e
  indices = []
  scores = {}
  def evaluate(pop):
    for n, x in enumerate(pop):
      scores[n] = model.norm(model.getDepen(x))
    # print scores
    ordered = sorted(scores.items(), key=lambda x: x[1]) # alist of turple
    # print ordered
    return  pop[ordered[0][0]], ordered[0][1]
  def gen3(n,f,frontier):
    seen = [n]
    def gen1(seen):
      while 1:
        k = random.randint(0, np -1)
        if k ¬ in seen:
          seen += [k]
          break
      return frontier[k]
    a = gen1(seen)
    b = gen1(seen)
    c = gen1(seen)
    return a, b, c

  def update(n,f,frontier):
    newf = []
    a, b, c = gen3(n,f,frontier)
    for n in xrange(len(f)):
      if cr <rand():
        newf.append(f[n])
      else:
        newf.append(model.trim(a[n]+fa*(b[n]-c[n]), n))  # adapt to the Osyzcka
model, pass n
    return newf

  frontier = [model.generate_x() for _ in xrange(np)]
  sb, eb = evaluate(frontier)
  for k in xrange(repeats):
    if eb < threshold:
      break
    nextgen = []
    for n,f in enumerate (frontier):
      new = update(n, f, frontier)
      if model.norm(model.getDepen(new)) < model.norm(model.getDepen(f)):
        nextgen.append(new)
      else:
        nextgen.append(f)
    frontier = nextgen
    sb, eb = evaluate(frontier)
  #print eb
  if Settings.other.reportrange:
    rrange=printRange(model, history) # no history right now!
    return eb,rrange
  else:
    return eb

def deDemo():
```



```
  for klass in [Schaffer]:
  # for klass in [DTLZ7]:
    print "="*50
    print "!!!!", klass.__name__,
    print "\nSearcher: DE"
    reseed()
    de(klass())
if __name__ == "__main__": deDemo()
```

```
from __future__ import division
from log import *
from models import *
from xtile import *
from base import *
import sys,random, math, pdb, operator
sys.dont_write_bytecode = True

# @printlook
def pso(model):
  vel = []
  pos = []
  lbest = [] # local best position for each
  gbest = model.generate_x() # global best position for all
  min_e, max_e = model.baseline()
  eb = 10**5
  N = Settings.pso.N
  w = Settings.pso.w
  repeats = Settings.pso.repeats
  threshold = Settings.pso.threshold
  phi1 = Settings.pso.phi1
  phi2 = Settings.pso.phi2
  phi = phi2 + phi1
  K = 2/(abs(2 - (phi) -math.sqrt(phi **2) -4*phi))
  fitness =lambda x: model.norm(model.getDepen(x))
  trim = lambda x : max(model.lo, min(x, model.hi))
  def init(gbest = gbest):
    for n in xrange(N):
      vel.append([0 for _ in xrange(model.n)])
      pos.extend([model.generate_x() for _ in xrange(model.n)])
      lbest.append(pos[n])
      if fitness(pos[n]) < fitness(gbest): #??why I should pass gbest
        gbest = pos[n]
        eb = fitness(gbest)
  def velocity(v, p, l, g):
    newVel = [K*(w*v[i]+phi1*rand()*(l[i]-p[i])+phi2*rand()*(g[i]-p[i])\
           )for i in xrange(model.n)]
    # print v
    # print '\n'
    # print newVel
    return [model.trim(i,n) for n, i in enumerate(newVel)] # velosity should be
in the range

  def move(v, p):
    newp = [v[i] + p[i] for i in xrange(model.n)]
    return [model.trim(i,n) for n, i in enumerate(newp)] # movements should be i
n the range


  init() # init all parameters
  # print vel
  # print lbest
  # print gbest
  for k in xrange(repeats):
    if eb < threshold:
      break
    for n in xrange(N):
      vel[n] = velocity(vel[n], pos[n], lbest[n], gbest)
      pos[n] = move(vel[n], pos[n])
      if fitness(pos[n]) < fitness(lbest[n]):
        lbest[n] = pos[n]
        if fitness(pos[n]) < fitness(gbest):
          gbest = pos[n]
    eb = fitness(gbest)
  return eb

def start():
  # for klass in [Schaffer, Fonseca, Kursawe, ZDT1, ZDT3, Viennet3]:
  for klass in [Kursawe, ZDT1, DTLZ7]: # these three can't find optimal values
    print "="*50
    print "!!!!", klass.__name__,
    print "\nSearcher: PSO"
    reseed()
```



```
    pso(klass())

#test

if __name__ == "__main__":start()
    # print sortedFitness
```

```
from __future__ import division
from log import *
import sys, random, math, datetime, time,re, pdb
sys.dont_write_bytecode = True


exp = math.e
sqrt = math.sqrt
sin = math.sin
cos = math.cos
pi = math.pi

class Model:
  def name(i):
    return i.__class__.__name__
  def setup(i):
    # i.min = 10**(5)
    # i.max = -10**(5)
    i.xy = Options(x = [i.generate_x], y = [i.f1, i.f2]) # cahnge i.generate_x()
 to i.generate_x, any issues hereafter??
    i.log = Options(x = [ Num() for _ in range(i.n)], y = [ Num() for _ in range
(i.fn)]) # hardcode 2
    i.history = {} # hold all logs for eras
  def generate_x(i):
    x= [i.lo + (i.hi-i.lo)*random.random() for _ in range(i.n)]
    return x
  def getDepen(i, xlst):
    # y = [i.f1, i.f2]
    return sum([f(xlst) for f in i.xy.y])
  def getDepenlst(i, xlst):
    return [f(xlst) for f in i.xy.y]
  def cloneModel(i): # from Dr.Menzies'
    return i.__class__()
  def logxy(i, x):
    for val, log in zip(x, i.log.x): log += val
    y = i.getDepenlst(x)
    for val, log in zip(y, i.log.y): log += val
  def better(news,olds): # from Dr.Menzies'
    def worsed():
      return  ((same     ∧ ¬ betterIqr) ∨
               (¬ same ∧ ¬ betterMed))
    def bettered():
      return  ¬ same ∧ betterMed
    out = False
    for new,old in zip(news.log.y, olds.log.y):
      betterMed, same, betterIqr = new.better(old)
      # print betterMed, same, betterIqr
      # pdb.set_trace()
      if worsed()  : return False # never any worsed
      if bettered(): out= out ∨ True # at least one bettered
    return out
  def sa_neighbor(i, old):
    p = 1/i.n
    new = old[:]
    for j in range(len(old)):
      if random.random() < p:
        new_gen = i.generate_x()
        new[j] = new_gen[random.randint(0, i.n-1)]
    return new
  def mws_neighbor(i,solution):
    lo = 10**5
    hi = -10**5
    optimized_index = random.randint(0, len(solution)-1)
    if isinstance(i.hi,int):
      hi = i.hi
      lo = i.lo
    if isinstance(i.hi, list):
      hi = i.hi[optimized_index]
      lo = i.lo[optimized_index]
    increment = (hi - lo) /10
    temp_min = i.norm(i.getDepen(solution))
    temp_solution = solution[:]
    # print "old solution : %s" % solution
```



```
    # print "old norm energy : %s" % i.norm(i.getDepen(solution))
    for _ in range(10):
      temp_solution[optimized_index] = lo + increment
      temp = i.norm(i.getDepen(temp_solution))
      if temp < temp_min:
        temp_min = temp
        solution = temp_solution[:]
    # print "new solution : %s" % solution
    # print "new norm energy : %s" %i.norm(i.getDepen(solution))
    return solution
  def baseline(i):
  # model = eval(model+"()")
    i.min = 10**(5)
    i.max = -10**(5)
    for _ in xrange(Settings.other.baseline):
      temp = i.getDepen(i.generate_x())
      if temp > i.max:
        i.max = temp
      if temp < i.min:
        i.min = temp
    return i.min, i.max
  def norm(i, x):
    e = (x - i.min)/(i.max - i.min)
    return max(0, min(e,1)) #avoid values <0 or >1
  def trim(i, x, n ):
    return max(i.lo, min(x, i.hi))

class Control(object): # based on Dr.Menzies' codes
  def __init__(i, model, history = None):
    i.kmax = Settings.sa.kmax
    i.era = Settings.other.era
    i.lives = Settings.other.lives
    i.history = {} if history ≡ None else history
    i.logAll = {}
    i.model = model
  def __call__(i, k):
    i.next(k)
  def logxy(i, results):
    both = [i.history, i.logAll, i.model.history]
    for log in both:
      if ¬ i.era in log:
        log[i.era] = i.model.cloneModel()
    for log in both:
      log[i.era].logxy(results)
  def checkimprove(i):
      if len(i.logAll) ≥ 2:
        current = i.era
        before = i.era - Settings.other.era
        currentLog = i.logAll[current]
        beforeLog = i.logAll[before]
        # pdb.set_trace()
        if ¬ currentLog.better(beforeLog):
          pass
        else:
          i.lives += 1
  def next(i, k):
    if k ≥ i.era:
      i.checkimprove()
      i.era +=Settings.other.era
      if i.lives ≡ 0:
        return True
      else:
        i.lives -=1
        return False



'''Schaffer'''
class Schaffer(Model):
  def __init__(i):
    i.lo = -5
    i.hi = 5
    i.n = 1
```

```
    i.fn = 2
    i.setup()
  def f1(i, x):
    return x[0] * x[0]
  def f2(i, x):
    return (x[0]-2) ** 2

'''Fonseca'''
class Fonseca(Model):
  def __init__(i):
    i.lo = -4
    i.hi = 4
    i.n = 3
    i.fn = 2
    i.setup()
  # def f1(i, xlst):
  #   return (1 - exp**(-1 * sum([(xlst[k] - 1/sqrt(i.n))**2 for k in xrange(i.n
)])))
  # def f2(i, xlst):
  #   return (1 - exp**(-1 * sum([(xlst[k] + 1/sqrt(i.n))**2 for k in xrange(i.n
)])))
  def f1(i, xlst):
    def f1_sum(x_list, n):
      value = []
      for item in x_list:
        value.append((item - 1/math.sqrt(n))**2)
      return sum(value)
    return 1 - math.e ** (-1* f1_sum(xlst, i.n))
  def f2(i,xlst):
    def f2_sum(x_list, n):
      value = []
      for item in x_list:
        value.append((item + 1/math.sqrt(n))**2)
      return sum(value)
    return 1 - math.e ** (-1* f2_sum(xlst, i.n))

'''Kusarvs'''
class Kursawe(Model):
  def __init__(i):
    i.lo = -5
    i.hi = 5
    i.n = 3
    i.fn = 2
    i.setup()
  def f1(i, xlst):
    return sum([-10*exp**(-0.2 * sqrt(xlst[k]**2 + xlst[k+1]**2)) for k in xrang
e(i.n -1)])
  def f2(i, xlst):
    a = 0.8
    b = 3
    return sum([abs(x)**a + 5*sin(x)**b for x in xlst])

'''ZDT1'''
class ZDT1(Model):
  def __init__(i):
    i.lo = 0
    i.hi = 1
    i.n = 30
    i.fn = 2
    i.setup()
  def f1(i, xlst):
    return xlst[0]
  def f2(i, xlst):
    return (1 + 9 * (sum(xlst[1:]))/(i.n-1))
  # def f2(i,xlst):
  #   g1 = i.g(xlst)
  #   return g1*(1-sqrt(xlst[0]/g1))

'''ZDT3'''
class ZDT3(Model):
  def __init__(i):
    i.lo = 0
    i.hi = 1
```



```
    i.n = 30
    i.fn = 2
    i.setup()
  def f1(i, xlst):
    return xlst[0]
  def g(i, xlst):
    return (1 +  (9/(i.n-1)) * sum(xlst[1:]))
  def h(i,f1,g):
    return (1 - sqrt(f1/g) - f1/g) * sin(10 * pi * f1)
  def f2(i, xlst):
    return i.g(xlst) * i.h(i.f1(xlst),i.g(xlst))

'''Viennet3'''
class Viennet3(Model):
  def __init__(i):
    i.lo = -3
    i.hi = 3
    i.n = 2
    i.fn = 3
    i.setup1()
  def setup1(i):
    i.min = 10**(5)
    i.max = -10**(5)
    i.xy = Options(x = [i.generate_x()], y = [i.f1, i.f2, i.f3])
    i.log = Options(x = [ Num() for _ in range(i.n)], y = [ Num() for _ in range
(i.fn)]) # hardcode 2
    i.history = {} # hold all logs for eras
  def f1(i, xlst):
    xy2 = xlst[0]**2 + xlst[1]**2
    return 0.5* (xy2) + sin(xy2)
  def f2(i, xlst):
    x = xlst[0]
    y = xlst[1]
    return ((3*x -2*y +4)**2/8 + (x-y+1)**2/27 + 15)
  def f3(i, xlst):
    xy2 = xlst[0]**2 + xlst[1]**2
    return (1/(xy2+1) - 1.1* exp**(-xy2))

  '''DTLZ7'''
class DTLZ7(Model):
  def __init__(i):
    i.M = 20
    i.K = 20
    i.lo = 0
    i.hi = 1
    i.n = i.M + i.K -1
    i.fn = i.M
    i.setup()
  def fi(i, x): # the frist one is x[0]
    return x
  def fm(i, xh=0):
    return (1 + i.g())*i.h()
  def g(i):
    return 1 + (9/i.K) * sum(i.xy.x[:i.M-1])
  def h(i):
    sumtemp = 0
    for n,x in enumerate(i.xy.x):
      if n ==i.M-2:
        break
      sumtemp +=(i.xy.y[n](x)/(1.0+i.g()))*(1+sin(3.0*pi*i.xy.y[n](x)))
    return (i.M - sumtemp)# k = 0,...., M-2
  def setup(i):
    tempx = i.generate_x()
    tempy = [i.fi for k in tempx[:-1]]
    tempy.append(i.fm)
    i.xy = Options(x = tempx, y = tempy)
    i.log = Options(x = [ Num() for _ in range(i.n)], y = [ Num() for _ in range
(i.fn)])
    i.history = {} # hold all logs for eras
    # i.min = 10**(5)
    # i.max = -10**(5)
  def getDepen(i, xlst):
    temp = i.fm()
```

```
        return sum(xlst[:i.M])+temp

      def getDepenlst(i, xlst):
        return xlst[:i.M]+ [i.fm()]

290
        '''Schwefel's'''
    class Schwefel(Model):
      def __init__(i):
        i.lo = -pi
295     i.hi = pi
        i.n = [10,20, 40][0]
        i.f_bias = -460
        i.fn = 1
        i.randI = lambda x: random.randint(-x, x)
300     i.randF = lambda x: random.uniform(-x, x)
        i.a = [[i.randI(100) for _ in xrange(i.n)] for _ in xrange(i.n)] # matrix for a
        i.b = [[i.randI(100) for _ in xrange(i.n)] for _ in xrange(i.n)] # matrix for b
        i.alpha = [i.randF(pi) for _ in xrange(i.n)] # alpha
        i.setup()
305   def f(i, x):
        F = sum([(i.A(n) - i.B(x,n))**2 for n in xrange(i.n)]) + i.f_bias
        return F
      def A(i,n):
        sumA = sum([i.a[n][j]*sin(i.alpha[j]) + i.b[n][j] * cos(i.alpha[j]) for j in xrange(i.n)])
310     return sumA
      def B(i, x,n):
        sumB = sum([i.a[n][j]*sin(s) + i.b[n][j]* cos(s) for j,s in enumerate(x)])
        return sumB
      def setup(i):
315     i.min = 10**(5)
        i.max = -10**(5)
        i.xy = Options(x = [i.generate_x()], y = [i.f])
        i.log = Options(x = [ Num() for _ in range(i.n)], y = [ Num() for _ in range(i.fn)])
        i.history = {} # hold all logs for eras
320
    '''Osyczka'''
    class Osyczka(Model):
      def __init__(i):
        i.lo = [0, 0, -1, 0, 1, 0]
325     i.hi = [10, 10, 5, 6, 5, 10]
        i.fn = 2
        i.n = 6
        i.setup()

330   def generate_x1x2(i):
        def g1(x):
          return x[0] + x[1] - 2 >= 0
        def g2(x):
          return 6 - x[0] - x[1] >= 0
335     def g3(x):
          return 2 - x[1] + x[0] >= 0
        def g4(x):
          return 2 - x[0] + 3* x[1] >= 0
        while 1:
340       x= [i.lo[n] + (i.hi[n]-i.lo[n])*random.random() for n in range(2)]
          if g1(x) and g2(x) and g3(x) and g4(x):
            return x
          else:
            continue
345
      def generate_x3456(i):
        def g5(x):
          return 4 - (x[0]- 3)**2 - x[1] >= 0
        def g6(x):
350       return (x[2] - 3)**2 + x[3] - 4 >= 0
        while 1:
          x= [i.lo[n] + (i.hi[n]-i.lo[n])*random.random() for n in range(2,6)]
          if g5(x) and g6(x):
            return x
355       else:
            continue

      def generate_x(i):
```



```
        x12 = i.generate_x1x2()
360     x3456 = i.generate_x3456()
        x = x12 + x3456
        return x

      def f1(i, x):
365     result = -25*(x[0] -2) **2 - (x[1] - 2)**2 - (x[2] - 1)**2 - (x[3] - 4) **2 -(x[4] -1) **2
        return result

      def f2(i, x):
        result = sum([i**2 for i in x])
370     return result
      def trim(i, x, n):
        return max(i.lo[n], min(x, i.hi[n]))


375
```

```
from __future__ import division
import sys, random, math,pdb
from base import *
from a12 import *
sys.dont_write_bytecode = True


'''All these are based on Dr.Menzies' tricks ∧ sample codes'''

class Log():
  def __init__(i, tolog = []):
    i._cache, i.n, i._report = [], 0, None
    i.setup()
    map(i.__iadd__, tolog)
  def __iadd__(i, tolog):
    if tolog == None: return tolog
    i.n += 1
    updated = False
    if len(i._cache) < Settings.other.keep:
      i._cache +=[tolog]
      updated = True
    else:
      if rand() <= Settings.other.keep/i.n:
        i._cache[int(rand()*Settings.other.keep)] = tolog
        updated = True
    if updated:
      i._report = None
      i.updateLoHi(tolog)
    return i
  def has(i):
    if i._report == None:
      i._report = i.report()
    return i._report

class Num(Log):
  def setup(i):
    i.lo = 10**5
    i.hi = -10**5
  def updateLoHi(i,x):
    i.lo = min (i.lo, x)
    i.hi = max(i.hi, x)
  def median(i):
    n = len(i._cache)
    p = n//2
    if (n % 2) : return i._cache[p]
    q = p +1
    q = max(0, min(q,n))
    return (i._cache[p] + i._cache[q])/2
  def better(new,old):
    "better if (1)less median or (2)same and less iqr"
    t = Settings.other.a12
    betterIqr = new.has().iqr < old.has().iqr
    new.lessp = False
    if new.lessp:
      betterMed = new.has().median >= old.has().median
      same      = a12(old._cache, new._cache)  <= t
    else:
      betterMed = new.has().median <= old.has().median
      same      = a12(new._cache, old._cache) <= t
    return betterMed, same, betterIqr
  def report(i):
    sortedCache = sorted(i._cache)
    n = len (sortedCache)
    return Options(
          median = i.median(),
          iqr = sortedCache[int(n*0.75)- int(n*0.5)],
          lo = i.lo,
          hi = i.hi)

@demo
def demoNum():
  for size in [16,32, 64,128, 256]:
    Settings.other.keep = size
```



```
    log = Num()
    for x in xrange(100000): log +=x
    print size, ":", log.has().median

if __name__ == "__main__": eval(cmd())
```

```
from __future__ import division
import sys, random, math, datetime, time,re, pdb
from xtile import *
sys.dont_write_bytecode = True

rand= random.random


class Options: #"Thanks for Peter Norvig's trick"
  def __init__(i, **d): i.__dict__.update(d)

Settings = Options(sa = Options(kmax = 1000,
                                cooling = 0.6),
                   mws = Options(threshold = 0.0001,
                                max_tries = 20,
                                max_changes = 1000,
                                prob = 0.25,
                                ),
                   ga = Options(pop = 50,
                                crossRate = 0.6,
                                crossPoints = 2,
                                genNum = [100, 200, 400, 800]
                                ),
                   de = Options(np= 100,
                                repeats = 100,
                                f = 0.75,
                                cr = 0.3,
                                threshold = 0.000001
                                ),
                   pso = Options(N = 30,
                                 w = 1,
                                 phi1 = 2.8,
                                 phi2 = 1.3,
                                 threshold = 0.000001,
                                 repeats = 1000,
                                ),
                   other = Options(keep = 64,
                                   baseline = 1000,
                                   era = 50,
                                   lives = 1,
                                   show = False,
                                   xtile = False,
                                   a12 = [0.56, 0.64, 0.71][0],
                                   repeats = 30,
                                   reportrange =False))
def atom(x):
  try : return int(x)
  except ValueError:
    try : return float(x)
    except ValueError : return x

def cmd(com="demo('-h')"):
  "Convert command line to a function call."
  if len(sys.argv) < 2: return com
  def strp(x): return isinstance(x,basestring)
  def wrap(x): return "'%s'"%x if strp(x) else str(x)
  words = map(wrap,map(atom,sys.argv[2:]))
  return sys.argv[1] + '(' + ','.join(words) + ')'

def demo(f=None,cache=[]):
  def doc(d):
    return '# '+d.__doc__ if d.__doc__ else ""
  if f == '-h':
    print '# sample demos'
    for n,d in enumerate(cache):
      print '%3s) ' %(n+1),d.func_name,doc(d)
  elif f:
    cache.append(f);
  else:
    s='|'+'='*40 +'\n'
    for d in cache:
      print '\n==|',d.func_name,s,doc(d),d()
  return f
```



```
def reseed():
        seed = 1
        return random.seed(seed)

def say(mark):
  sys.stdout.write(mark)
  sys.stdout.flush()

def printlook(f):
  def wrapper(*lst): #tricks from Dr.Menzies
    ShowDate = datetime.datetime.now().strftime
    print "\n###", f.__name__, "#" * 50
    print "#", ShowDate("%Y-%m-%d %H:%M:%S")
    beginTime = time.time()
    x = f(*lst)
    endTime = time.time()
    print "\n" +("-"*60)
    dump(Settings, f.__name__)
    print "\n# Runtime: %.3f secs" % (endTime-beginTime)
    return x # return the searcher name and the results
  return wrapper

def dump(d, searchname=" ", lvl = 0): # tricks from Dr. Menzies
  d = d if isinstance(d, dict) else d.__dict__
  callableKey, line , gap = [], "", " "*lvl
  for k in sorted(d.keys()):
    val= d[k]
    if isinstance(val, (dict, Options)):
      callableKey += [k]
    else:
      #if callable(val):
      # val = val.__name__
      line +=(" {0} :{1}".format(k, val))
  print gap + line
  for k in callableKey:
    print gap + (" :{0} {1}".format(k, "options"))
    dump(d[k], lvl+1)

def printReport(m, history):
  for i, f in enumerate(m.log.y):
    print "\n <f%s" %i
    for era in sorted(history.keys()):
      # pdb.set_trace()
      log = history[era].log.y[i]
      print str(era).rjust(7), xtile(log._cache, width = 33, show = "%5.2f", lo
= 0, hi = 1)


def printSumReport(m, history):
  # for i, f in enumerate(m.log.y):
  print "\n Objective Value"
  for era in sorted(history.keys()):
    # pdb.set_trace()
    log = [history[era].log.y[k] for k in range (len(m.log.y))]
    ss = []
    ss.extend([log[s]._cache for s in range(len(log))])
    logsum = map(sum, zip(*ss))
    minvalue = min(logsum)
    maxvalue = max(logsum)
    normlog = [(x - minvalue)/(maxvalue - minvalue +0.00001) for x in logsum]
    print str(era).rjust(7), xtile(normlog, width = 33, show = "%5.2f", lo = 0,
hi = 1)

def printRange(m, history):
  rrange = {}
  # print sorted(m.history.keys())
  for i, f in enumerate(m.log.y):
    tlo=10**5
    thi=-10**5
    for era in sorted(history.keys()):
      # pdb.set_trace()
      if history[era].log.y[i].lo < tlo:
```

```
145           tlo= history[era].log.y[i].lo
            if history[era].log.y[i].hi > tlo:
              thi= history[era].log.y[i].hi
          temp = (round(tlo, 3), round(thi, 3))
          rrange[temp] =rrange.get(temp, 'f') +str(i) #{(0.0, 24.826): 'f0'}
150     return  rrange
```