

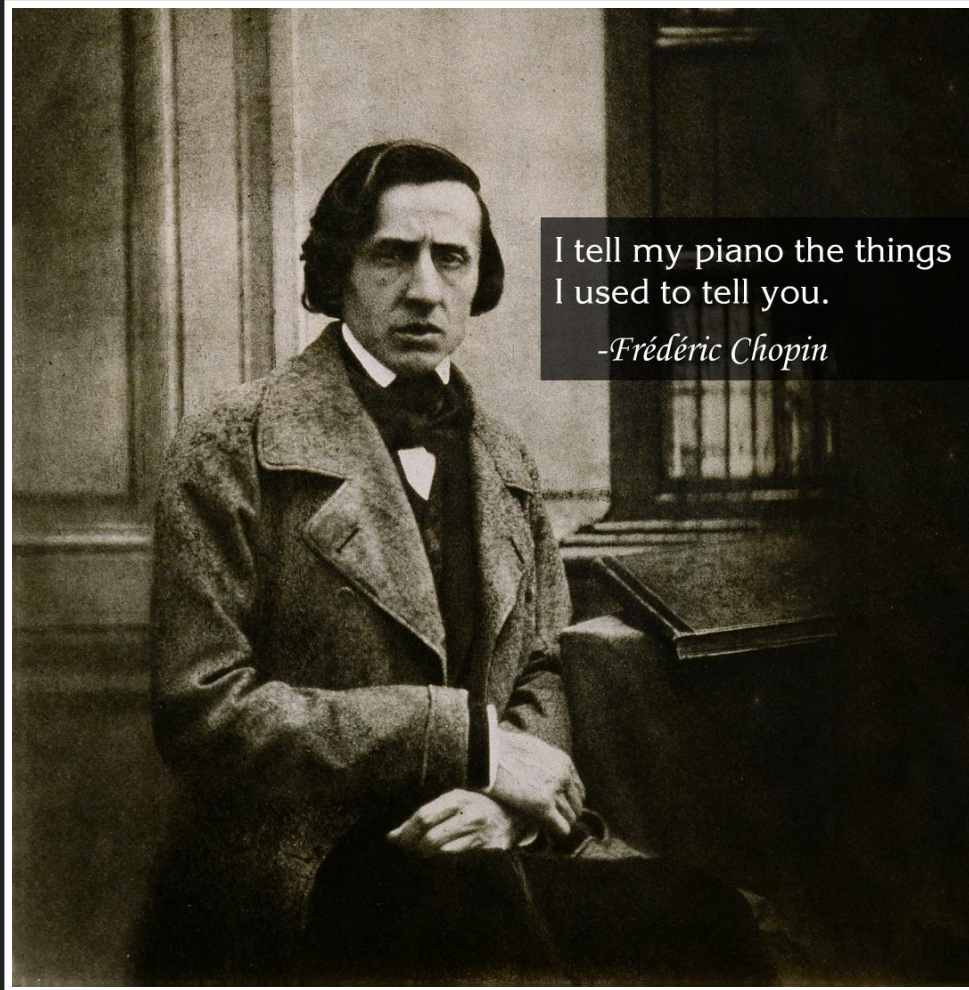
 MUSIC IS A LANGUAGE 

TALK



HEAR





I tell my piano the things
I used to tell you.

-Frédéric Chopin

SEE



COMMUNICATION



EMOTIONS



IT'S NOT ALWAYS SOFT!



SOFT BUT ...



FEEL THE ANGER...



 **STILL A LANGUAGE** 

ALPHABET



NOTES



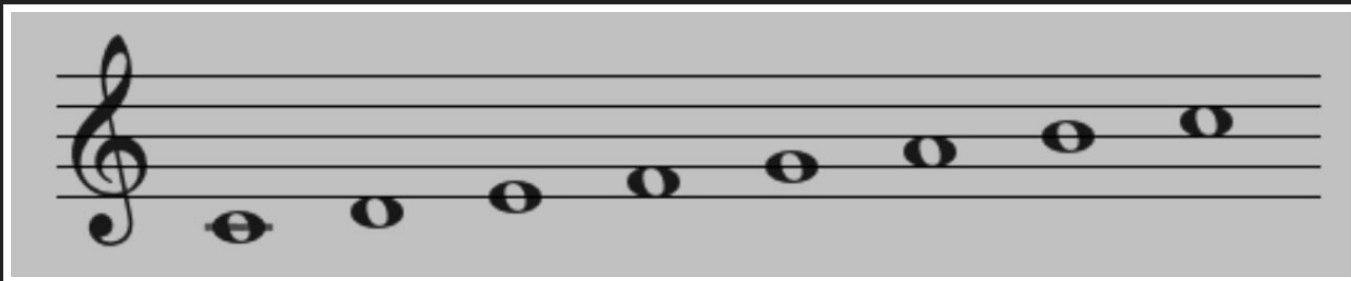
DO RE MI FA SOL LA SI



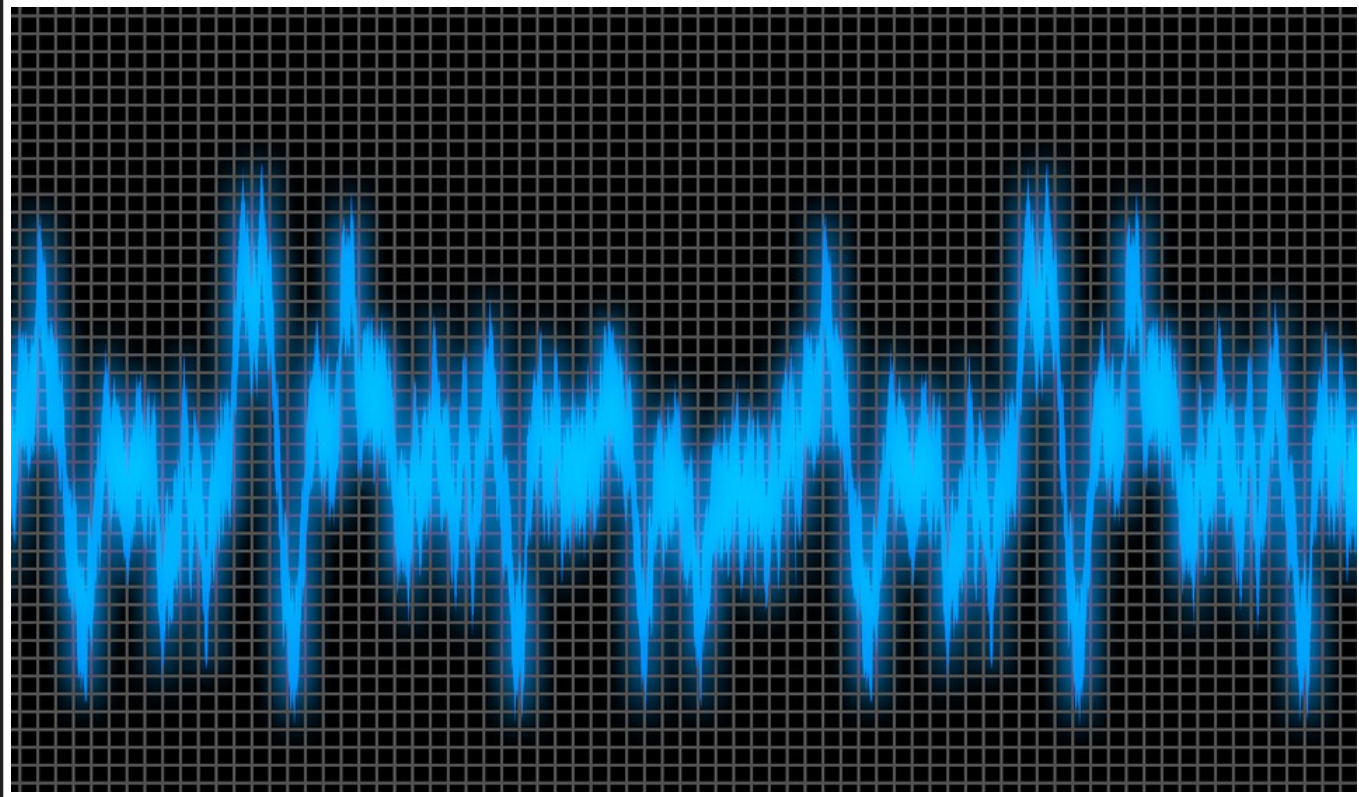
Do	Ré	Mi	Fa	Sol	La	Si
C	D	E	F	G	A	B
C	D	E	F	G	A	H

Mind As (Revue) - Harmony Search

SCALE



PITCH





HARMONY SEARCH ALGORITHM



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SAME OLD USUAL THINGS



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Near optimum solution

Reasonable time

Reasonable memory usage

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Reasonable time

Reasonable memory usage

Rules, Randomness

SAME OLD USUAL THINGS

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SA, GA, Tabu

**IS IT POSSIBLE TO DEVELOP A NEW HEURISTIC
ALGORITHM WITH BETTER PERFORMANCE**

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Better solutions!

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Fewer iterations!

Than existing heuristic algorithms?

**MUSIC IS ONE OF THE MOST SATISFYING PROCESSES
GENERATED BY HUMAN ENDEAVORS**

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A new heuristic algorithm derived from an artificial phenomenon found in musical performance namely the process of "searching for better harmony", can be introduced.

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MELODY



A sequence of single notes that is musically satisfying.

HARMONY



When 2 or more notes play together at the same time in “harmony” with each other.

HARMONY

Music harmony is a combination of sounds considered pleasing from an aesthetic point of view.

FANTASTIC HARMONY

Musical performances
seek a best state determined by aesthetic estimation!

Optimization algorithms seek a best state.

BEST STATE?

BEST STATE?

Global optimum

BEST STATE?

Global optimum

Minimum cost

BEST STATE?

Global optimum

Minimum cost

Maximum benefit

BEST STATE?

Global optimum

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Maximum benefit

Determined by objective function

SOUNDS CAN BE IMPROVED FOR BETTER AESTHETIC ESTIMATION

SOUNDS CAN BE IMPROVED FOR BETTER AESTHETIC ESTIMATION

Through practice after practice

**VALUES FOR BETTER OBJECTIVE
FUNCTION EVALUATION CAN BE
IMPROVED**

VALUES FOR BETTER OBJECTIVE FUNCTION EVALUATION CAN BE IMPROVED

Iteration by iteration

COMPARISON BETWEEN OPTIMIZATION AND MUSICAL PERFORMANCE

COMPARISON FACTOR	OPTIMIZATION PROCESS	PERFORMANCE PROCESS
Best state	Global Optimum	Fantastic Harmony
Estimated by	Objective Function	Aesthetic Standard
Estimated with	Values of Variables	Pitches of Instruments
Process unit	Each Iteration	Each Practice

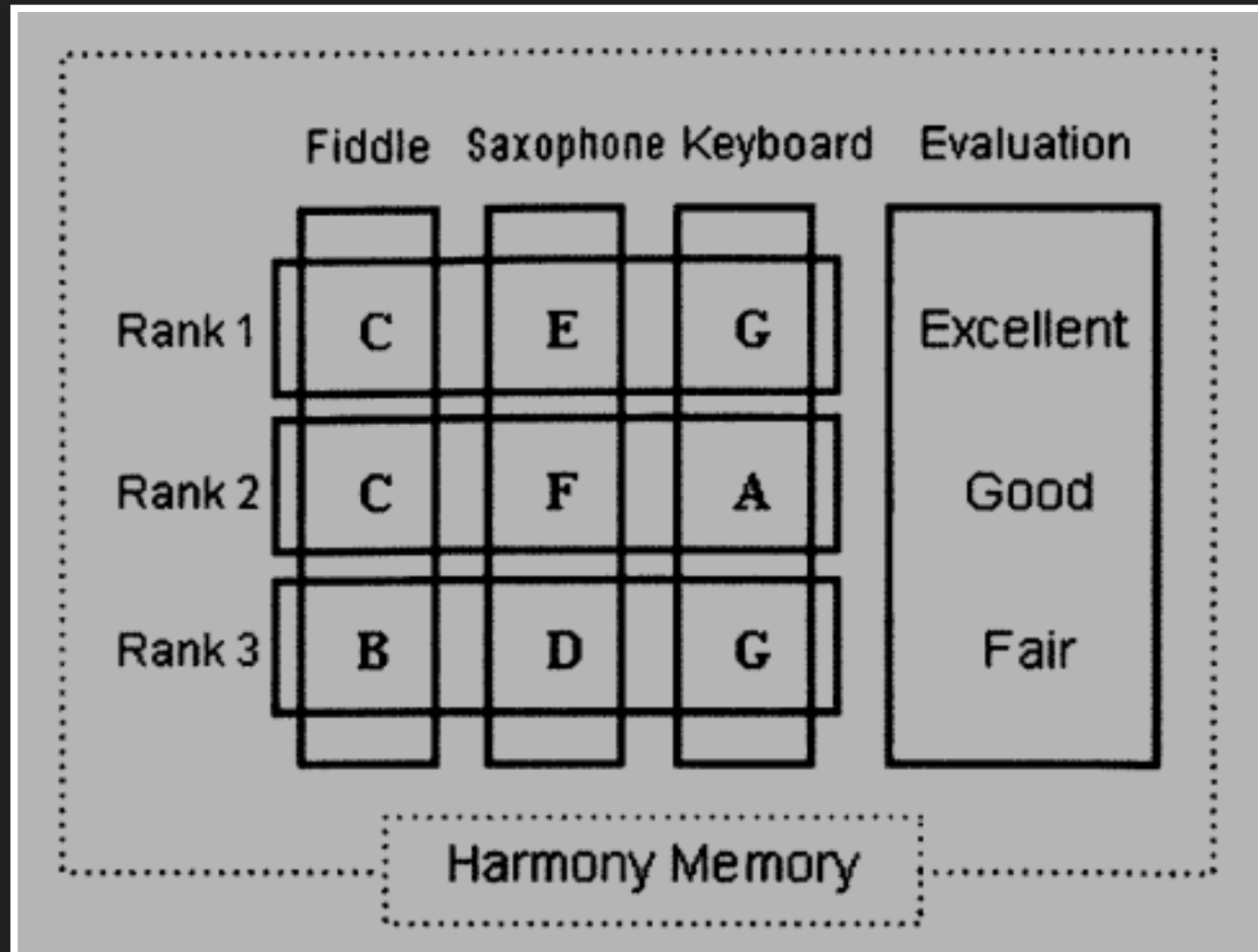
**STEPS IN THE PROCEDURE OF HS ARE AS
FOLLOWS:**

STEP 1. INITIALIZE A HARMONY MEMORY (HM).

STEP 2. IMPROVISE A NEW HARMONY FROM HM.

**STEP 3. IF THE NEW HARMONY IS BETTER THAN
MINIMUM HARMONY IN HM, INCLUDE THE NEW
HARMONY IN HM, AND EXCLUDE THE MINIMUM
HARMONY FROM HM.**

**STEP 4. IF STOPPING CRITERIA ARE NOT SATISFIED,
GO TO STEP 2.**



CONSIDER THIS SIMPLE EXAMPLE

$$\text{Min } f(\mathbf{x}) = (x_1 - 2)^2 + (x_2 - 3)^4 + (x_3 - 1)^2 + 3$$

	X_1	X_2	X_3	F
Rank 1	2	2	1	4
Rank 2	1	3	4	13
Rank 3	5	3	3	16

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Rank 3	5	3	3	16

	X_1	X_2	X_3	F
Rank 1	2	2	1	4
Rank 2	1	2	3	9
Rank 3	1	3	4	13

PROBLEM!



HMCR



HMCR



Harmony memory consideration rate

PAR



PAR



[1, 2, 4, {6}, 7, 9]

AN EXAMPLE

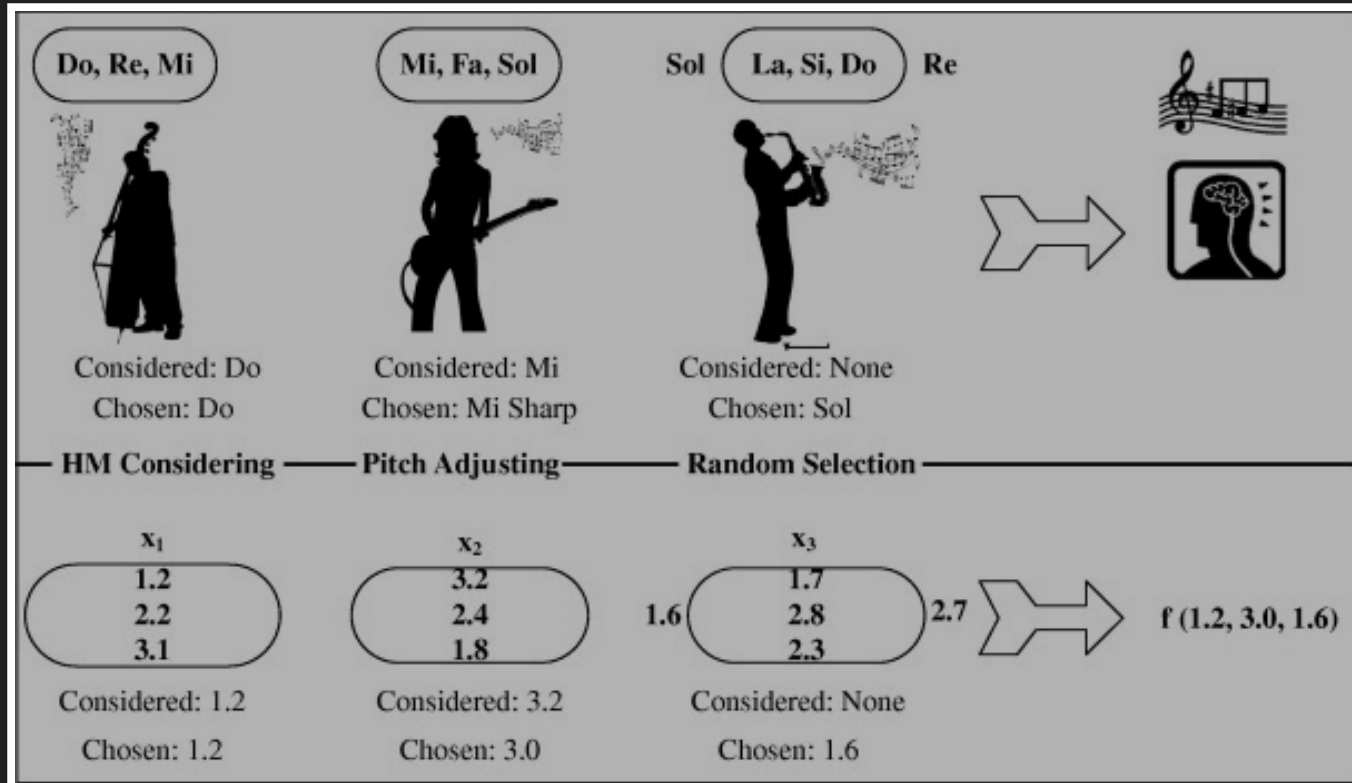
Possible values of an instrument (a variable) is:

$\{C, D, E, F, G\}$

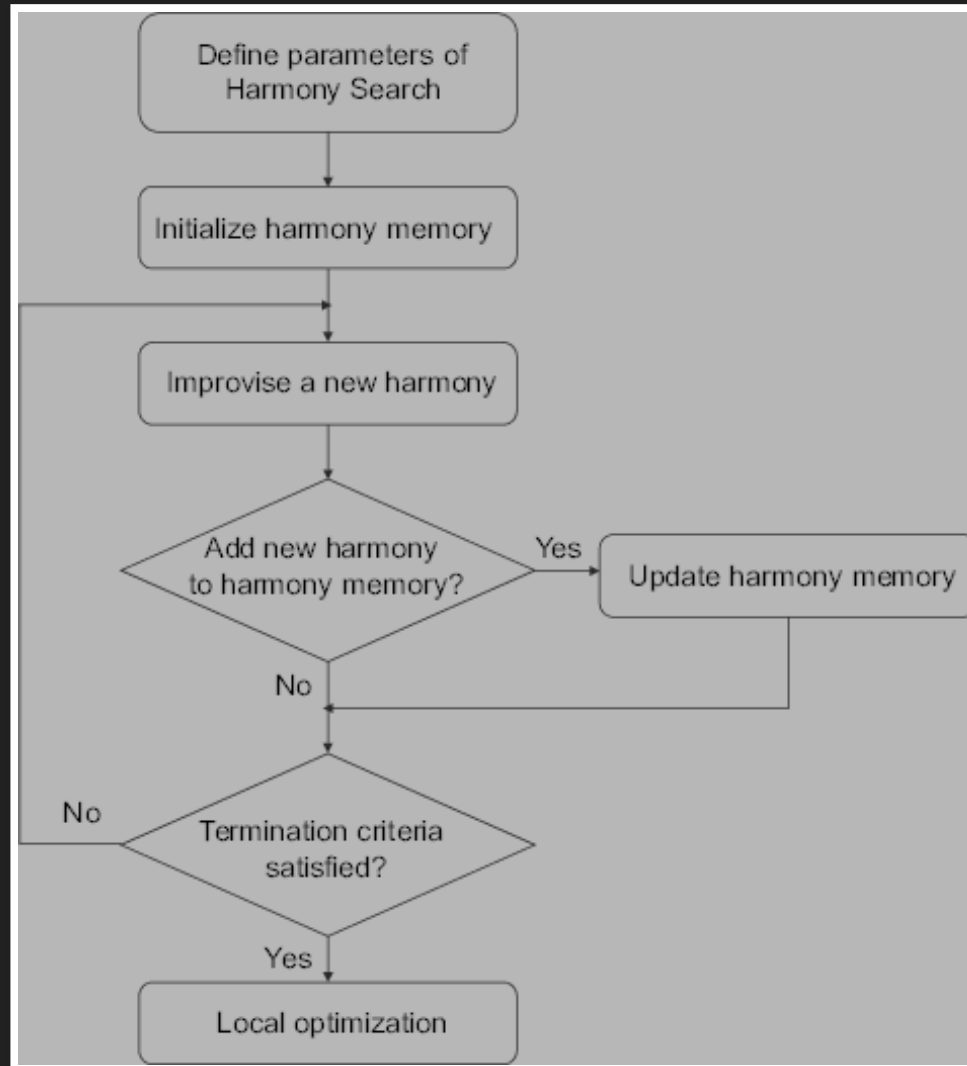
HMCR is 0.95, PAR is 0.10

The instrument now has: $\{C, E, G\}$ in HM.

ALL IN ONE



BASIC FLOWCHART



**HS INCORPORATES THE STRUCTURE OF EXISTING
HEURISTIC METHODS.**

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Preserve history of past vectors

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Vary HMCR

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Preserve history of past vectors

Vary HMCR

Manages several vectors simultaneously

RESULTS OBTAINED FROM VARIOUS HS APPLICATIONS

EXAMPLE	VAR. #	COMBINATION #	MAX. ITER. #	MIN. SOLUTION	COMMENTS
Problem 1 (TSP)	20	$(20-1)! / 2 = 6.08 \times 10^{16}$	5,000	117	Global Optimum
Problem 2 (Function)	2	$3000^2 = 9.0 \times 10^6$	40,000	1.3771	GA=1.4339 EP=1.3772
Problem 3 (Pipe Design)	34	$6^{34} = 2.87 \times 10^{26}$	200,000	\$6.056M	GA=\$6.073M NLPG=\$6.320M

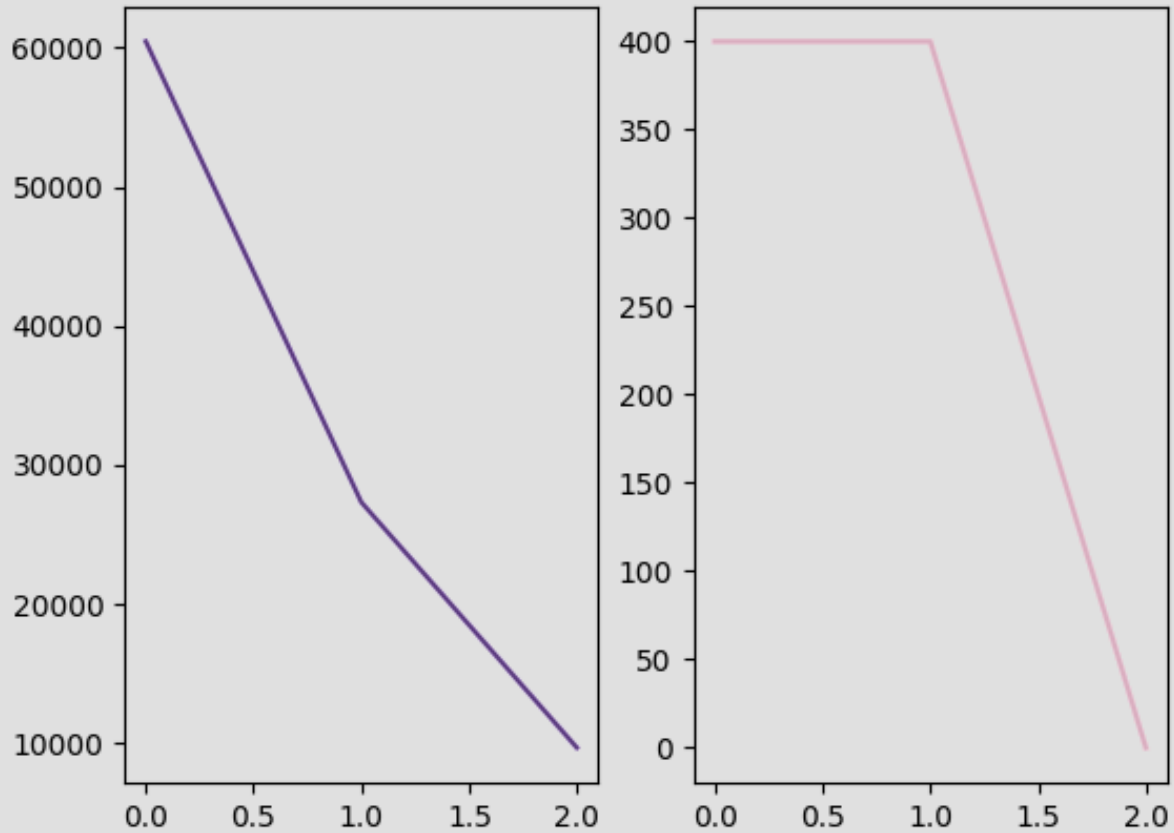
ANY QUESTION?



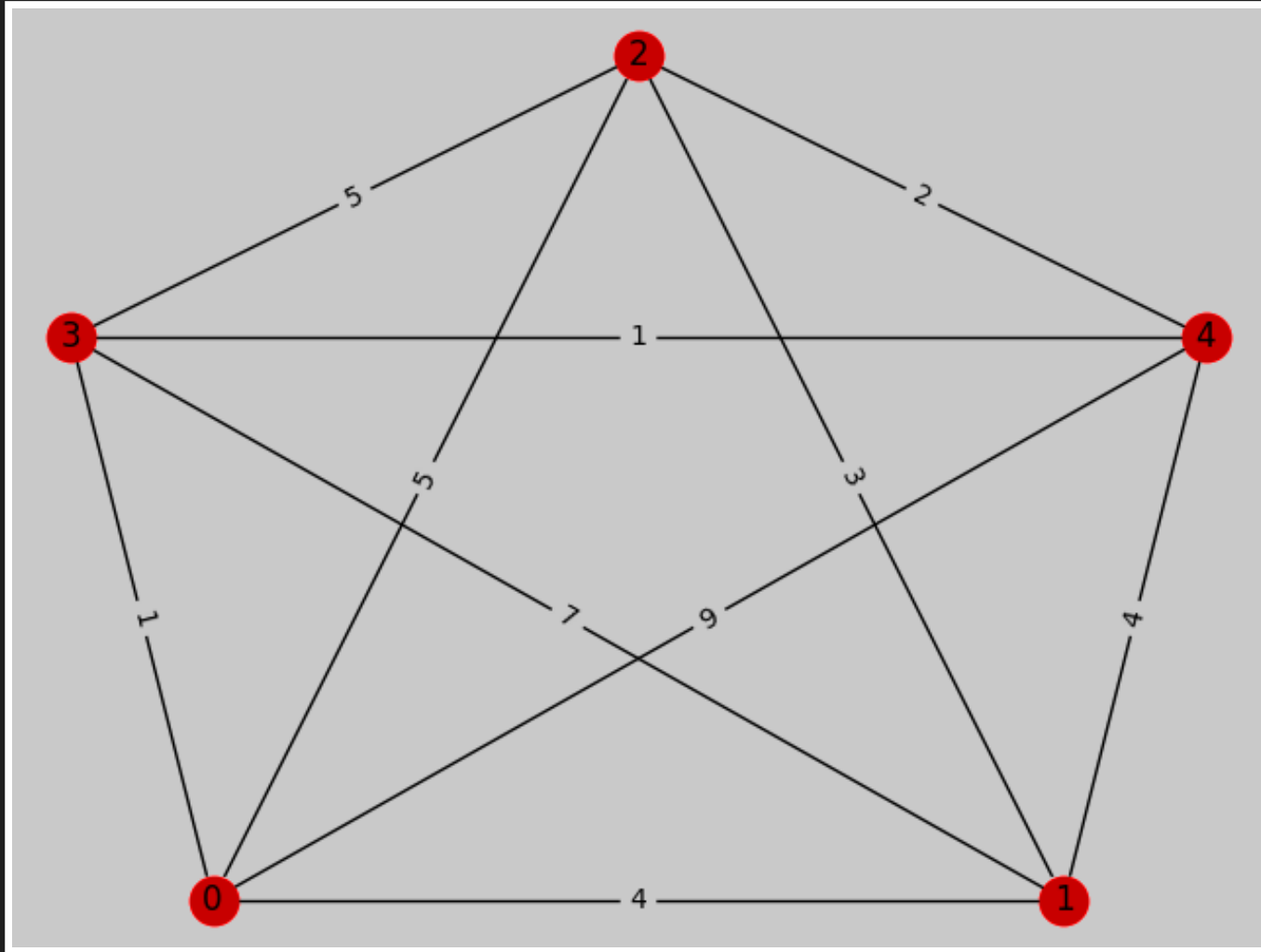
CODE

```
177         },
178         default="v",
179     )
180     global_scale_setting = FloatProperty(
181         name="Scale",
182         min=0.01, max=1000.0,
183         default=1.0,
184     )
185
186     def execute(self, context):
187
188         # get the folder
189         folder_path = (os.path.dirname(self.filepath))
190
191         # get objects selected in the viewport
192         viewport_selection = bpy.context.selected_objects
193
194         # get export objects
195         obj_export_list = viewport_selection
196         if self.use_selection_setting == False:
197             obj_export_list = [i for i in bpy.context.scene.objects]
198
199         # deselect all objects
200         bpy.ops.object.select_all(action='DESELECT')
201
202         for item in obj_export_list:
203             item.select = True
204             if item.type == 'MESH':
205                 file_path = os.path.join(folder_path, "{}.obj".format(item.name))
206                 bpy.ops.export_scene.obj(
207                     filepath=file_path, use_selection=True,
208                     axis_forward=self.axis_forward_setting,
209                     axis_up=self.axis_up_setting,
210                     use_animation=self.use_animation_setting,
211                     use_mesh_modifiers=self.use_mesh_modifiers_setting,
212                     use_edges=self.use_edges_setting,
213                     use_smooth_groups=self.use_smooth_groups_setting,
214                     use_smooth_groups_bitflags=self.use_smooth_groups_bitflags_setting,
215                     use_normals=self.use_normals_setting,
216                     use_uvs=self.use_uvs_setting,
217                     use_materials=self.use_materials_setting,
```

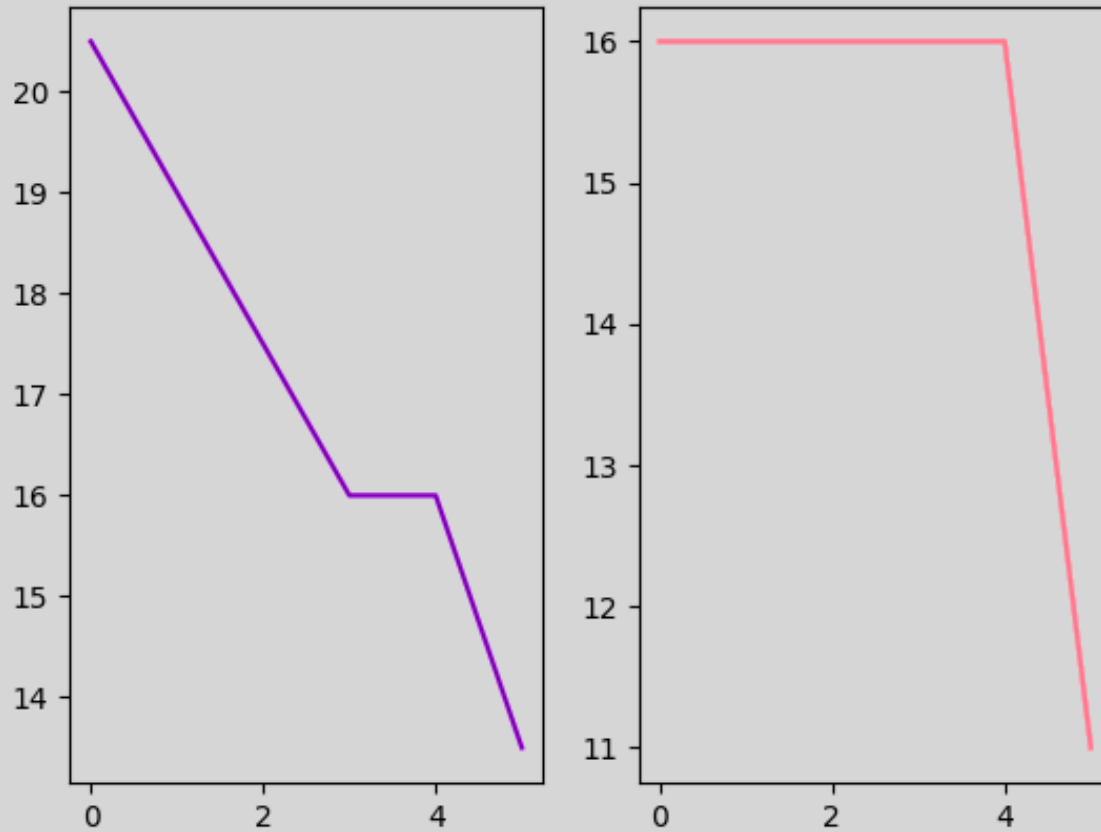
MIN



TSP



TSP RESULTS



REFERENCE:

Geem, Zong W. Kim, Joong H. Loganathan, G.V. "A New Heuristic Optimization Algorithm: Harmony Search." Simulation [USA] 2001. Print.

THANK YOU FOR YOUR ATTENTION

