Stack-Based Genetic Improvement

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RIP Larry Tesler 1945–2020: inventor of cut/copy & paste (and more)

In a Nutshell

Solution representation in GI:

- Software itself
- Diff patch
- Sequence of edits

Current GI edits:

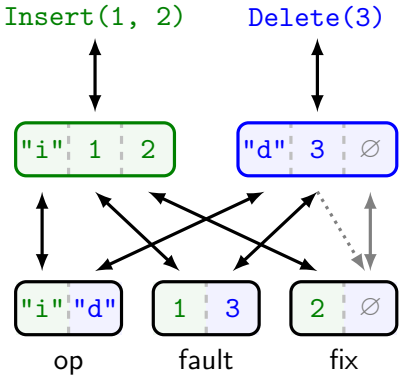
- `Delete(l)`
- `Replace(l1, l2)`
- `Insert(l1, l2)` (x2)
- ...

Proposed GI edits:

- `Cut(l)`
- `Copy(l)`
- `Paste(l)` (x3)
- ...

Petke et al., IEEE Transactions on Evolutionary Computation, 2018 (literature review)

Why? Are Current Edits Not Good Enough?



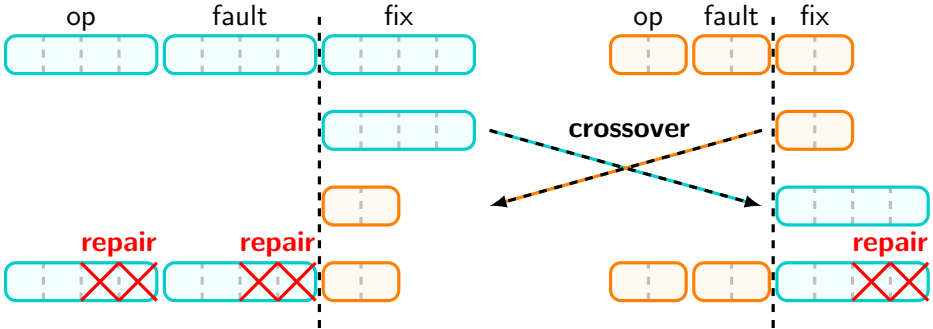
Advantages:

- Focus on the changes only
- Easy creation/mutation/crossover
- Close to human understanding

Limitations:

- Complex high granularity recombination
- *Type* constraints

High Granularity Recombination



Example: *One Point Across All Subspaces*

- Issue: invalid, incomplete genes
- Solution: individual caches

Ensuring “Type” Validity

Consistency is important!

- `Replace([statement], [statement])` will work
- `Replace([condition], [condition])` will work
- `Replace([condition], [statement])` will fail horribly

Possible solutions?

- Disable high granularity recombination
- Multiple decoupled sub-representations
- Any other complex bespoke mechanism

Equivalent Stack-Based Edits

Initial state: Cut(1) Copy(2) Paste(3) Paste(4) Copy(5)

$\rightsquigarrow$ empty patch + empty stack: [ ]

Cut: **Cut(1)** Copy(2) Paste(3) Paste(4) Copy(5)

$\rightsquigarrow$ **Delete(1)** + stack: [1]

Copy: **Cut(1)** **Copy(2)** Paste(3) Paste(4) Copy(5)

$\rightsquigarrow$ **Delete(1)** + stack: [1, 2]

Paste: **Cut(1)** **Copy(2)** **Paste(3)** Paste(4) Copy(5)

$\rightsquigarrow$ **Delete(1)** **Replace(3, 2)** + stack: [1]

Final patch: **Cut(1)** **Copy(2)** **Paste(3)** **Paste(4)** **Copy(5)**

$\rightarrow$ **Delete(1)** **Replace(3, 2)** **Replace(4, 1)** + discarded stack

"It Just Works"™

Insertion?

- replace = paste *in place*
- insert *before* = paste *before*
- insert *after* = paste *after*

High granularity recombination?

- Simple "non-decoupled" crossover
- Full decoupling with `Target(1)` (x3), `Copy(1)`, `Cut(1)`, `Paste(1)`

Type validity?

- Pop and push to type-specific stacks

Conclusion

Idea:

- Replacement set of edits
- Equivalent, backward compatible

Advantages:

- Same features but simpler
- Built-in memorisation mechanism
- Automatic *type* separation (multiple stacks)

Selected References

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Genetic programming and autoconstructive evolution with the push programming language.

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