Active Harmony's Plug-in Interface

A World of Possibilities

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Paradyn/Dyninst Week 2013
April 30, 2013

Overview and Motivation

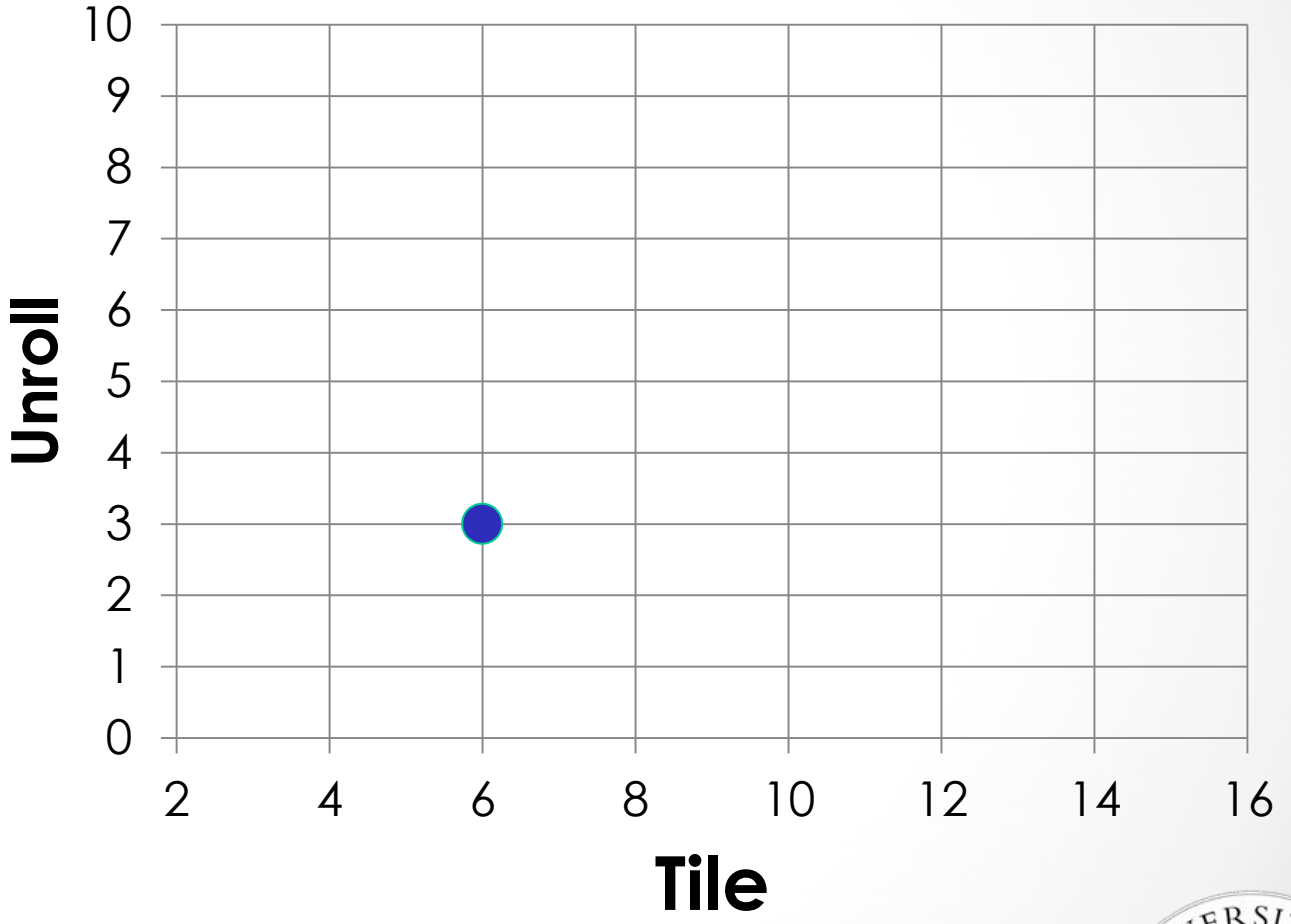
- Auto-tuning has a broad range of applications
  - Optimization of run-time, throughput, energy, etc.
- Supporting new features increasingly difficult due to monolithic internals
  - 10+ years of non-structured development
  - Core search logic implemented in Tcl
- Reorganization produced a generalized auto-tuning framework
  - Á la componentization of Dyninst API
  - Eases integration with other projects

Auto-tuning Basics

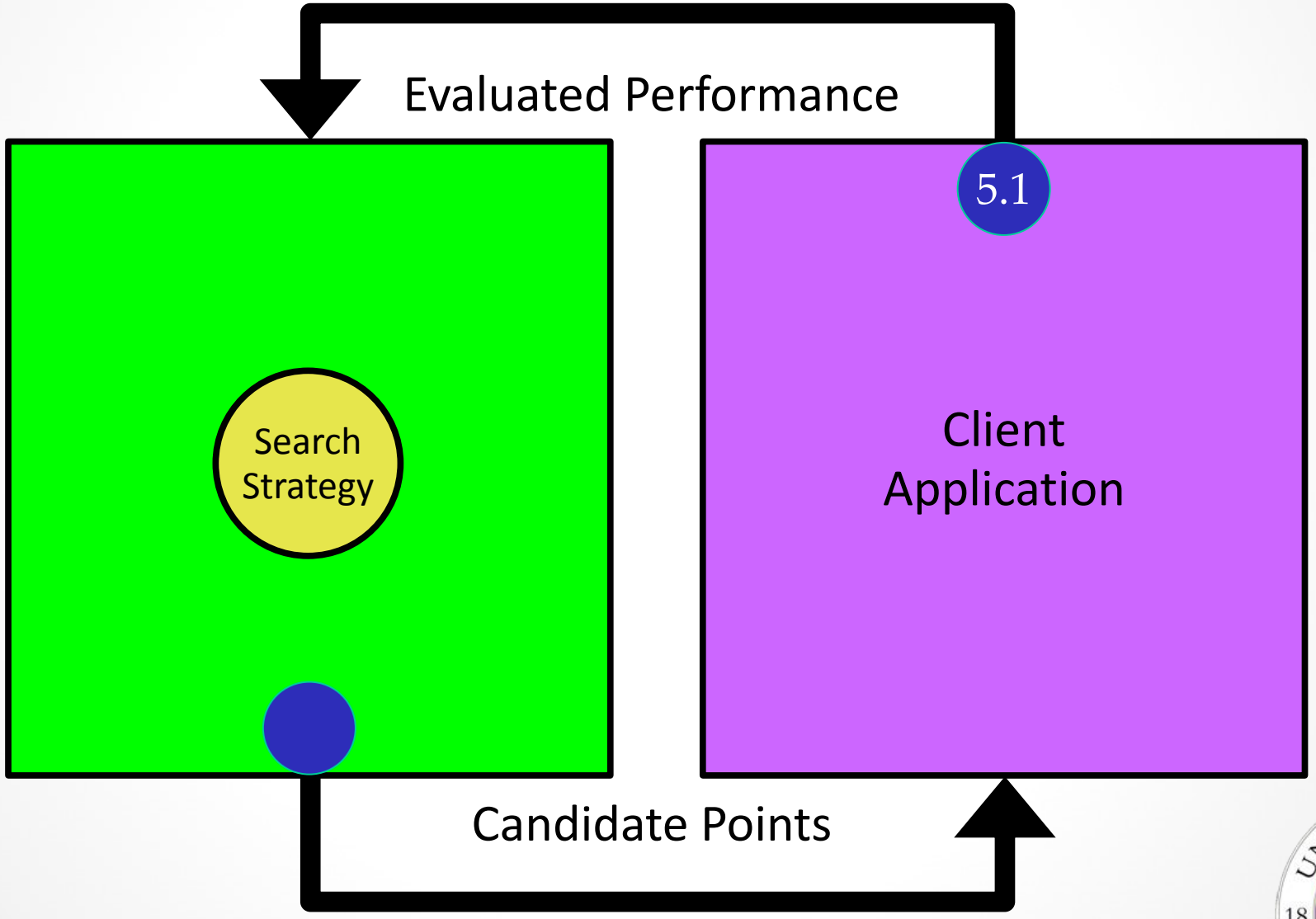
- Empirically test configurations for performance
  - Searches a set of valid configurations for optimal
- Valid configurations defined by tuning variables
  - Variables can be integer, real, or enumerated strings
  - Each variable bound by minimum, maximum, and step
- Set of tuning variables define a parameter space
  - N variables create an N-dimensional space
  - Cartesian coordinates represent unique configurations

Parameter Space Example

- Variable 1
  - Name: Tile
  - Min: 2
  - Max: 16
  - Step: 2
- Variable 2
  - Name: Unroll
  - Min: 0
  - Max: 10
  - Step: 1

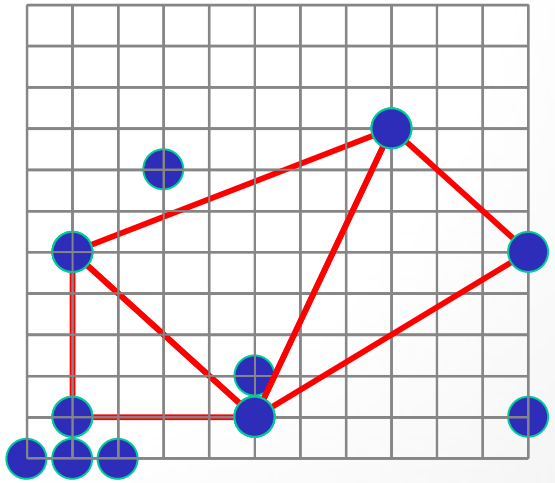


Auto-Tuning Feedback Loop

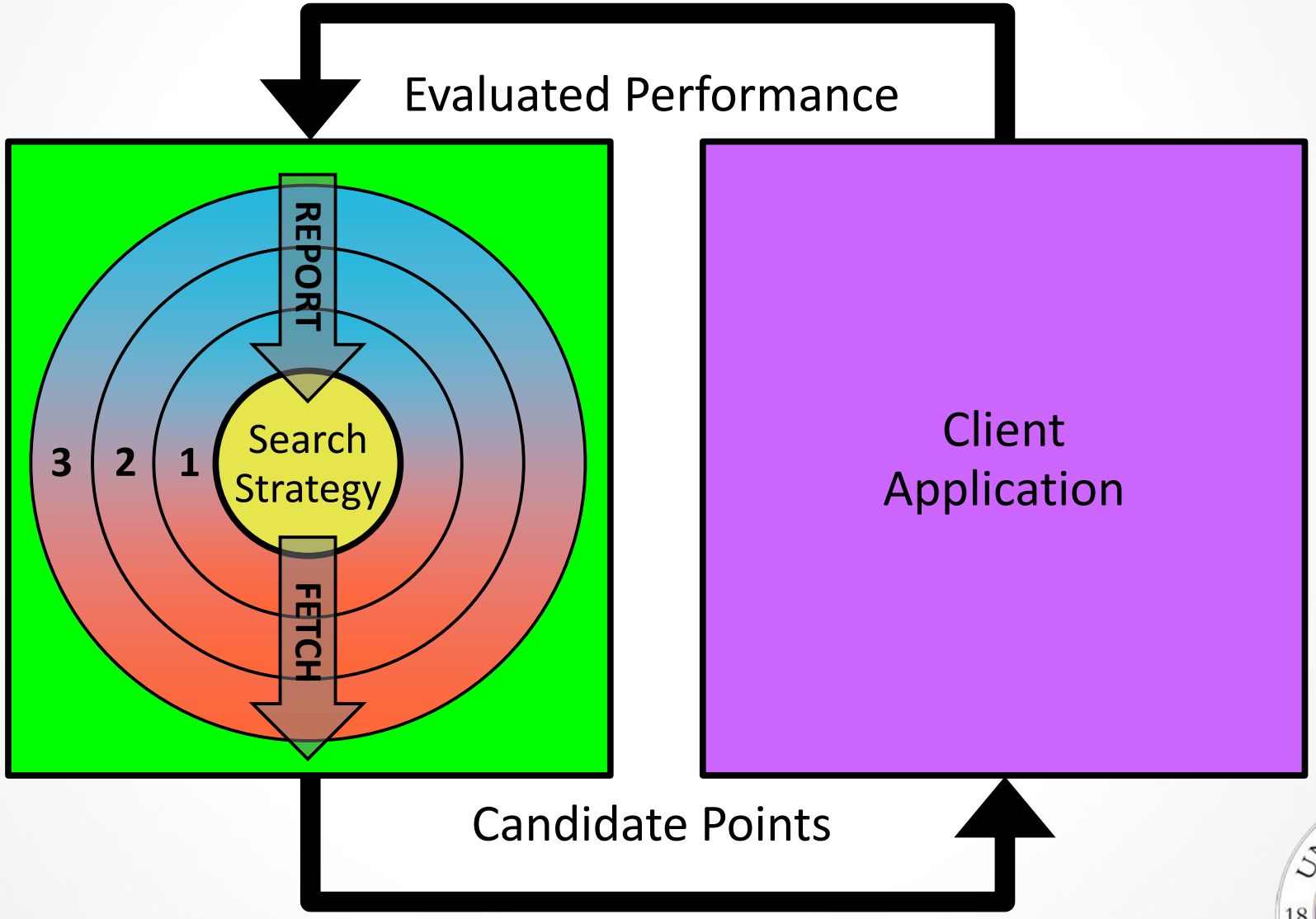


Search Strategies

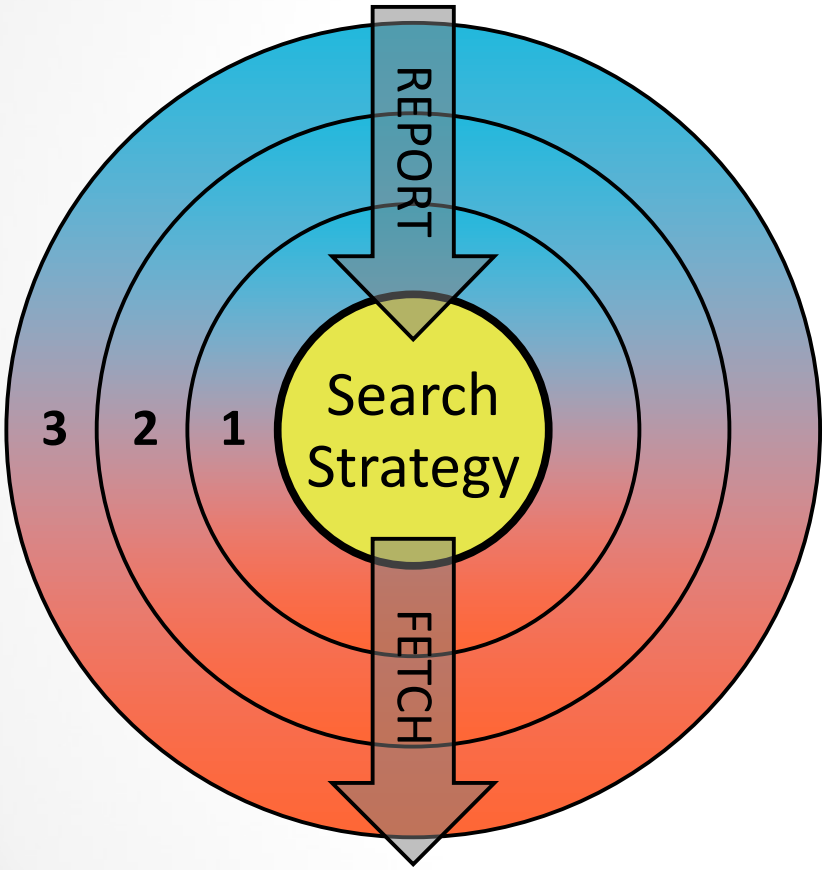
- Drives the feedback loop
- Pluggable module with two major interfaces
  - Fetch: Generates a new point for client
  - Report: Accepts a point/performance pair from client
- Four strategies included in Active Harmony
  - Brute Force
  - Random
  - Nelder-Mead
  - Parallel Rank Order (PRO)



Generalized Auto-Tuning

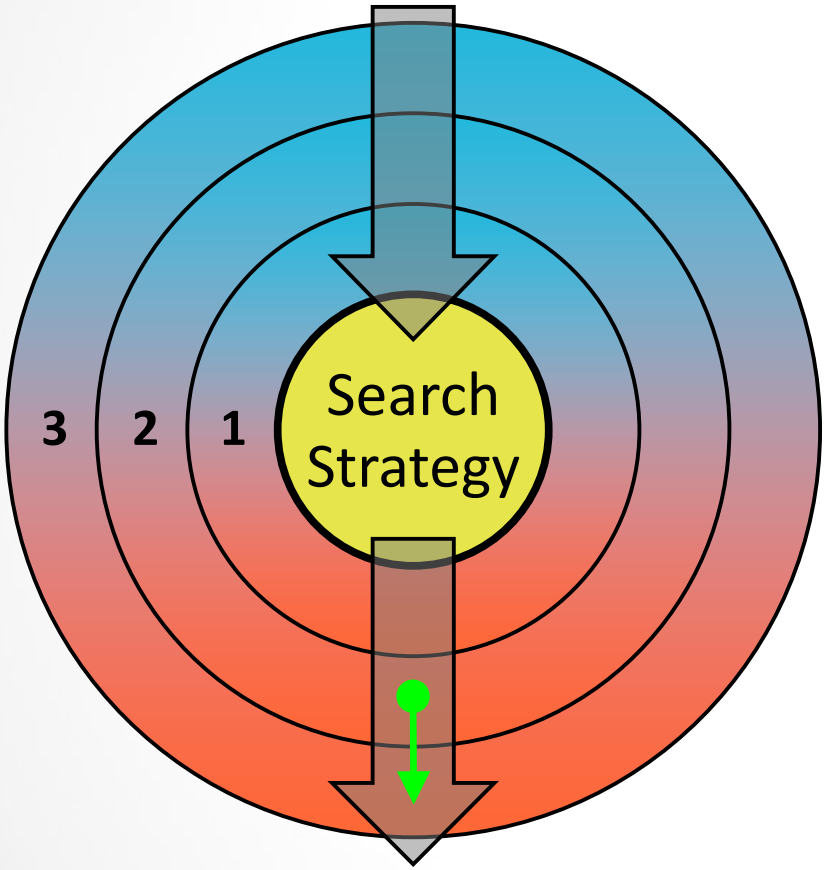


Onion Model Workflow



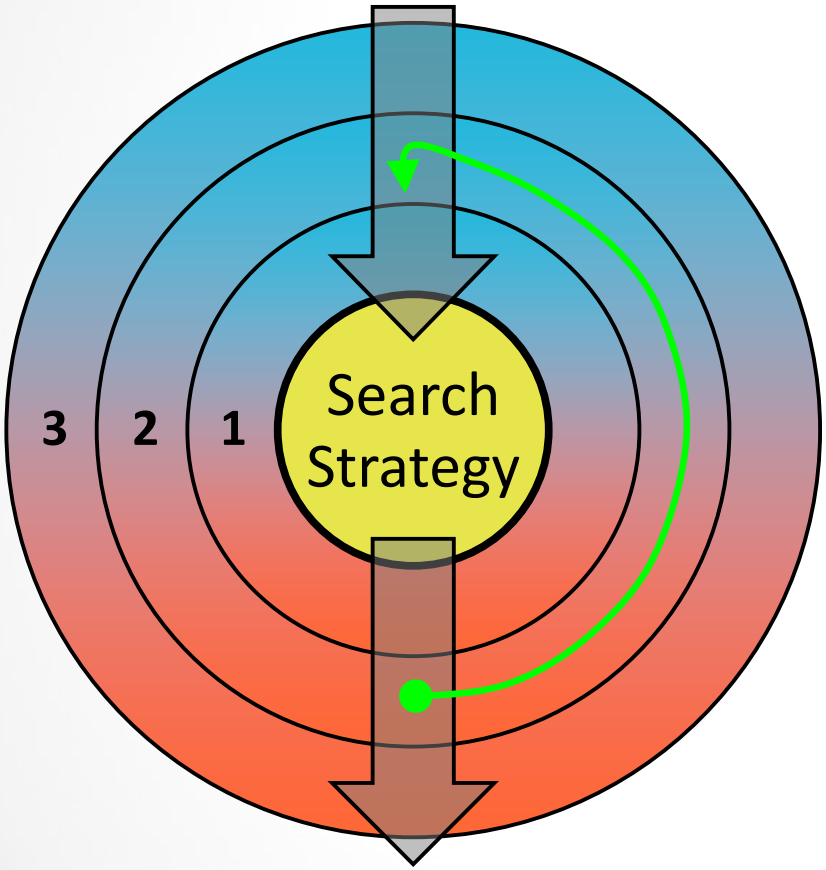
- Allows for paired functionality, but either hook is optional.
- Fetch hooks executed in ascending order.
- Report hooks executed in descending order.
- Point values cannot be modified (directly).

Plug-in Workflow: ACCEPT



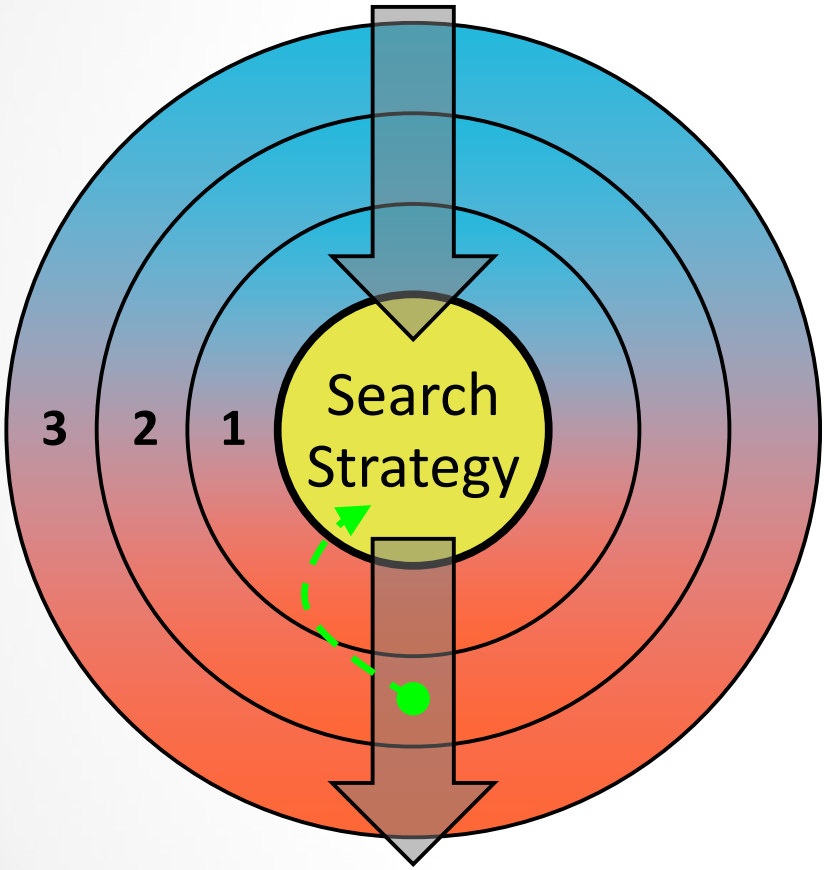
- Indicates successful processing at this level.
- Plug-in relinquishes control of the point to entity below.

Plug-in Workflow: RETURN



- Allows a short-circuit in the feedback loop.
- Plug-in must provide the performance value.
- Processing resumes at the same level from the report workflow.

Plug-in Workflow: REJECT

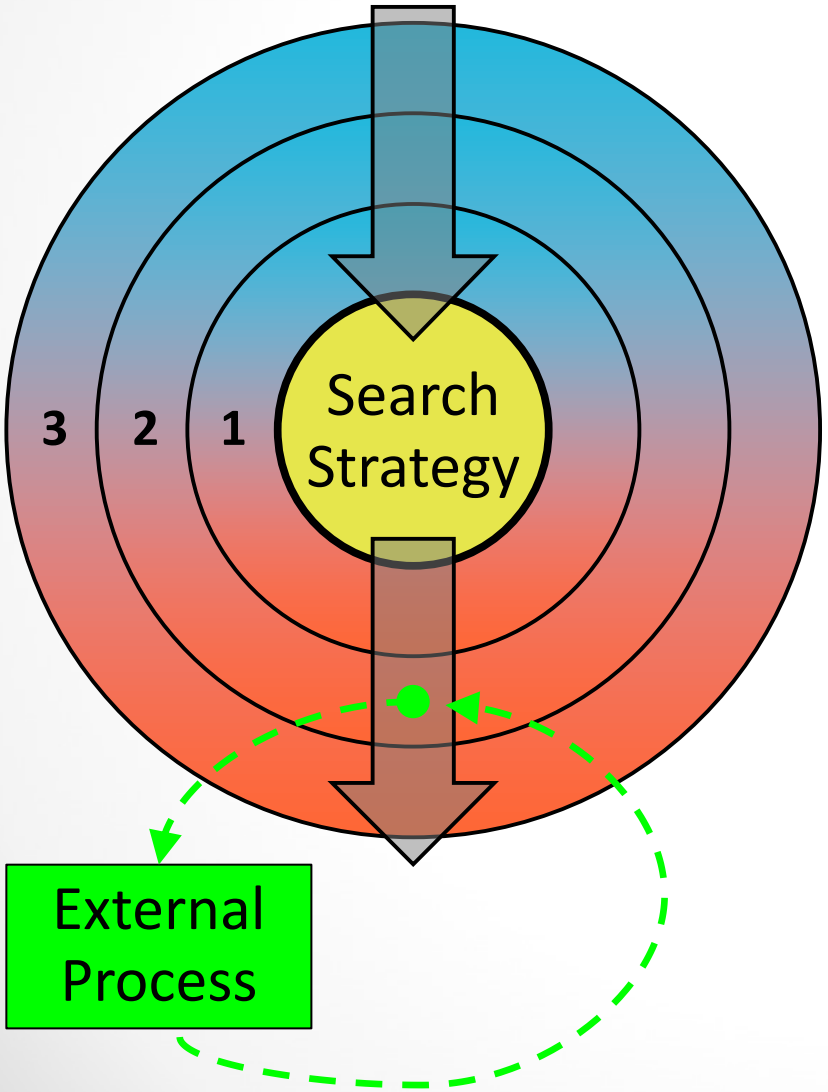


- Allows modification of the search indirectly.
- Plug-in must provide an alternate valid point.
  - Search strategy is not obligated to use it.
- Processing jumps directly back to search strategy.

Plug-in Example: Point Logger

```
logger_init()
{
    outfd = open("performance.log");
}

logger_report(flow_t *flow, point_t *pt, double perf)
{
    fprintf(outfd, "%s -> %lf\n", string(pt), perf);
    flow->type = ACCEPT;
}

logger_fini()
{
    close(outfd);
}
```

Plug-in Workflow: WAIT



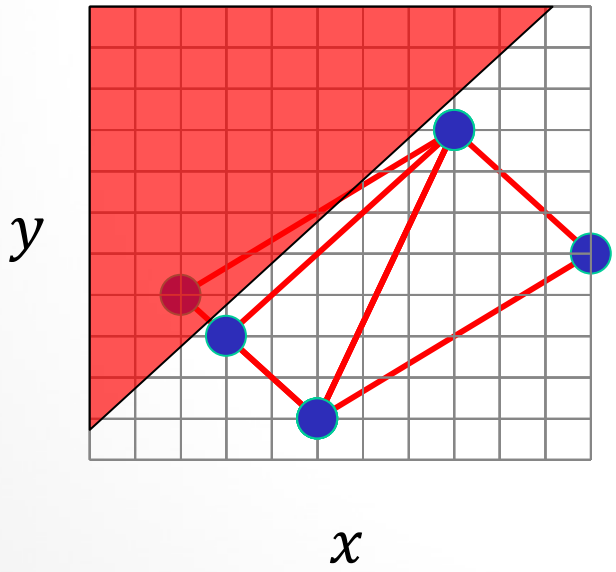
- Allows asynchronous point processing
- Plug-in sends point to external process
- Other points processed in the mean time
- Processing resumes at the same level upon return

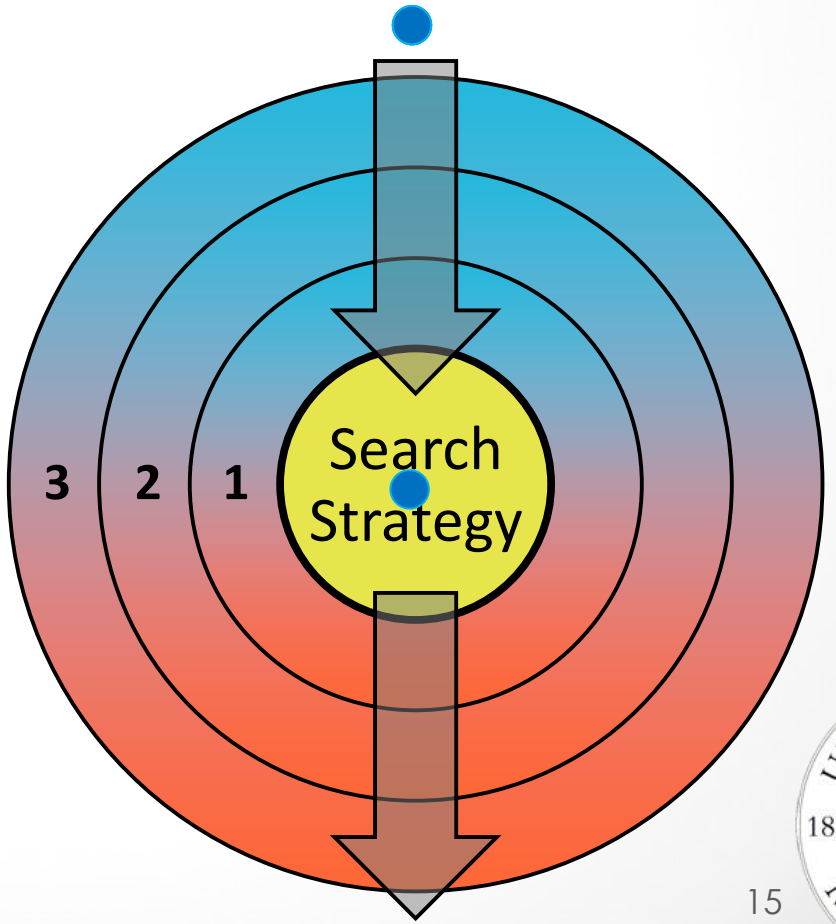
Plug-in Example: Code Server

```
cs_init()
{
    sockfd = tcp_connect(CODE_SERVER);
    register_fetch_callback(sockfd, code_ready);
}

cs_fetch(flow_t *flow, hpoint_t *pt)
{
    send_point(sockfd, pt);
    flow->type = WAIT;
}

code_ready(flow_t *flow, hpoint_t *pt_list[])
{
    recv_completed_id(sockfd, id);
    flow->point = find_point_in_list(pt_list, id);
    flow->type = ACCEPT;
}
```


Plug-in Example: Constraints

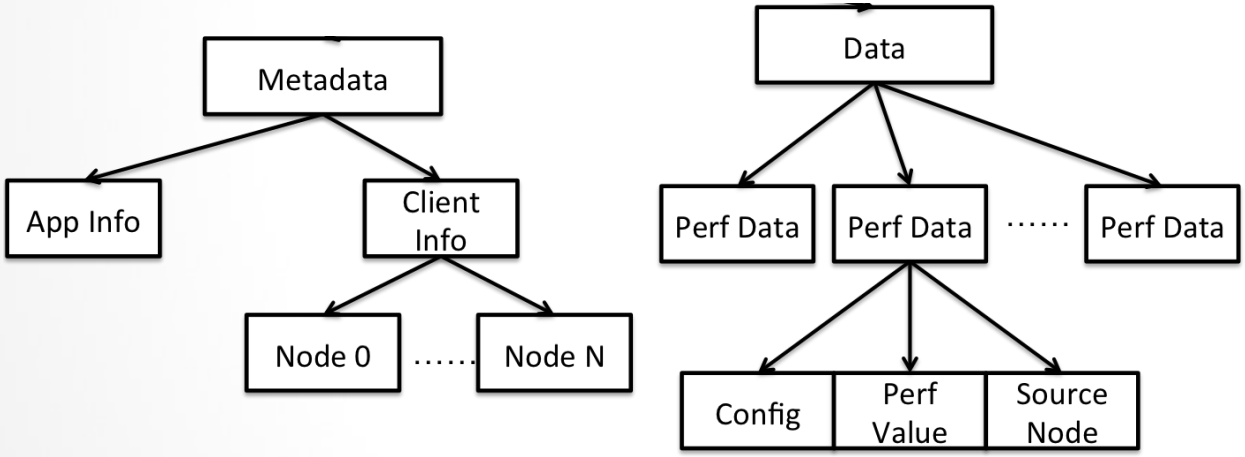
- Support for non-rectangular parameter spaces.
  - Implemented as plug-in #2 using REJECT workflow.
  - $y \leq x$

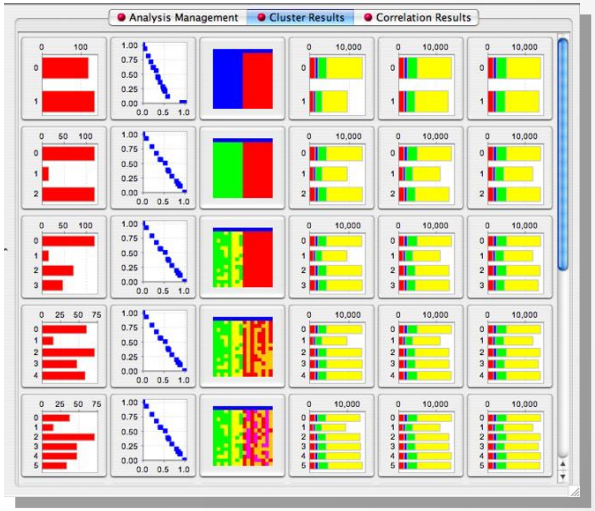




Plug-in Example: TAUdb

- Integration with TAU via TAUdb.
  - Tuning and Analysis Utilities
- Search data stored in persistent database





- Adds parameter analysis to any tuning session.
- Can potentially be used as result cache

Specifying Plug-ins

- Pluggable modules read from configuration
  - Unstructured key/value pair system queried at launch

```
> cat harmony.cfg
SESSION_STRATEGY=pro.so
SESSION_PLUGIN_LIST=logger.so:taudb.so
```

- Directly from the command-line
  - Tuna to accept in-line configuration directives
  - Syntax to be determined

Availability

- Current release is Active Harmony 4.0
  - Includes Tuna and preliminary plug-in interface
- Upcoming release to include
  - Improved plug-in interface
  - Library of basic strategies and plug-ins
  - No more Tcl code!

Summary and Next Steps

- Generalized auto-tuning framework presented
  - Variety of systems possible with minimal coding
  - Functionality encapsulated to simplify development
- Next steps
  - Develop library of search strategies and plug-ins
    - Hierarchical search?
    - We could use your help!
  - Investigation of further abstractions
    - Parameter spaces