

Inline IPLD

 **IPLD: Now for Humans™** 

Inline IPLD

Brooklyn Zelenka @expede

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github.com/expede

Inline IPLD

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- ◆ It's me, again 🙋
- ◆ PLT, DSys, LoFi, capability systems
- ◆ Code & community (UCAN, IPVVM, EIPs, etc etc)



github.com/expede

DAGs are awesome!

Structural sharing are incredibly useful!

IPLD makes data distributed!

DAGs are awesome!

Structural sharing are incredibly useful!

IPLD makes data distributed!

...and yet...

IPLD Link Challenges

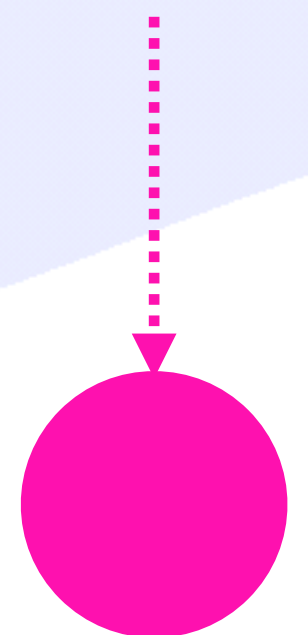
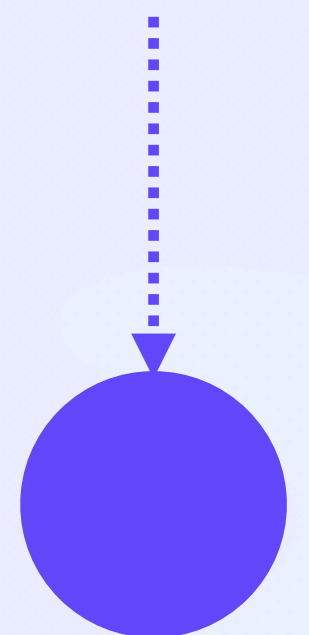


IPLD Link Challenges

Links Unlink

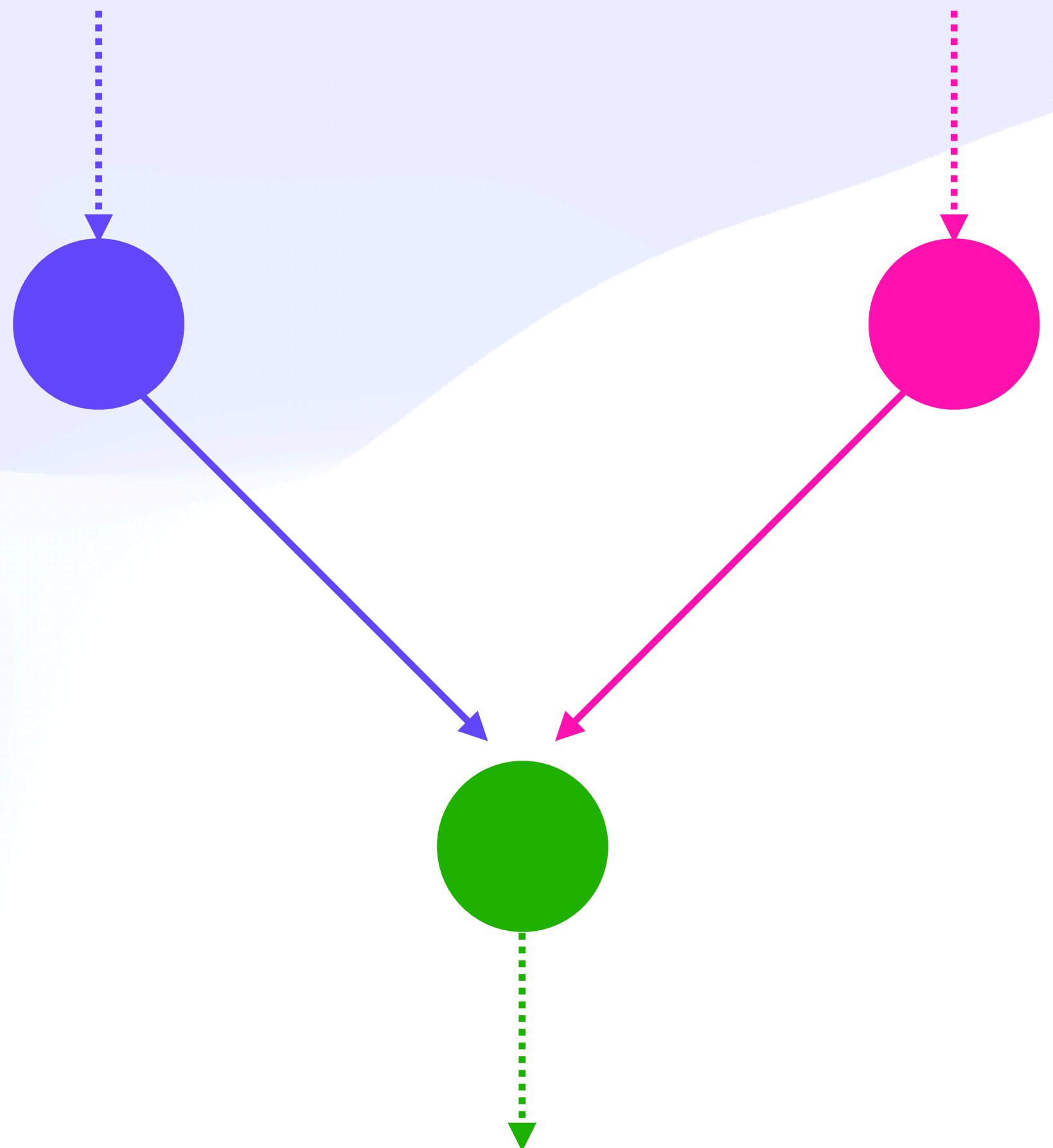
IPLD Link Challenges

Links Unlink



IPLD Link Challenges

Links Unlink



IPLD Link Challenges

Blockstores / CAR Files Aren't Human-Friendly

```
{
  "bafyreiak65ilmsanfzxgihqmwufw6u3w2iwoti7j7kwzouodwyyjnaxvru": {
    "name": "Protocol Labs",
    "conferences": [
      {"/": "bafyreidqynoke7wagaefq3lrtdz2oe4pxs762h7gptvtcwvmyu3qfokflu"},
      {"/": "bafyreie6q6lklsqnonjk4xyc3yudclqy4w7z4rxhrplzp2nnjsbt3pntga"},
      {"/": "bafyreiaav5xknihixvvelsby3qvwrlf2t7gyljgclcgq7ix566676lajyhly"}
    ]
  },
  "bafyreiaav5xknihixvvelsby3qvwrlf2t7gyljgclcgq7ix566676lajyhly": {
    "name": "FIL Dev Summit",
    "location": "Brussels"
  },
  "bafyreicygnfdf2bphngipad6oocjva7w5yaucaitxn3uysarcpmwgu6f4": {
    "name": "Juan Benet",
    "company": {"/": "bafyreiak65ilmsanfzxgihqmwufw6u3w2iwoti7j7kwzouodwyyjnaxvru"}
  },
  "bafyreidqynoke7wagaefq3lrtdz2oe4pxs762h7gptvtcwvmyu3qfokflu": {
    "name": "IPFS Camp",
    "location": "Brussels"
  },
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  }
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IPLD Link Challenges

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  },
  "bafyreie6q6lklsqnonjk4xyc3yudclqy4w7z4rxhrplzp2nnjsbt3pntga": {
    "name": "IPFS ping",
    "location": "Reykjavík"
  }
}
```

A diagram illustrating IPLD link challenges. It features a JSON structure with several nodes. A blue arrow points from the left to the node with key "bafyreicygnfdf2bphngipad6oocjva7w5yaucaitxn3uysarcpwxmwgu6f4". A green arrow points from the right to the node with key "bafyreiak65ilmsanfzxgihqmwufw6u3w2iwoti7j7kwzouodwyyjnaxvru".

IPLD Link Challenges

Blockstores / CAR Files Aren't Human-Friendly

```
{
  "bafyreiak65ilmsanfzxgihqmwufw6u3w2iwoti7j7kwzouodwyyjnaxvru": {
    "name": "Protocol Labs",
    "conferences": [
      {"/": "bafyreidqynoke7wagaefq3lrtdz2oe4pxs762h7gptvtcwvmyu3qfokflu"},
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    ]
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    "name": "IPFS ping",
    "location": "Reykjavík"
  }
}
```

The diagram illustrates the challenge of navigating IPLD links. A blue arrow points to the node for 'Juan Benet', which contains a 'company' link to the 'Protocol Labs' node. A green arrow points to the 'Protocol Labs' node, which contains a list of conference links. An orange arrow points to the first conference link in the list, 'IPFS Camp', which in turn links to the 'FIL Dev Summit' node. This shows how a single node can link to multiple other nodes, and how these links are represented as raw IPLD keys rather than human-readable names.

IPLD Link Challenges

Blockstores / CAR Files Aren't Human-Friendly

```
{
  "bafyreiak65ilmsanfzxgihqmwufw6u3w2iwoti7j7kwzouodwyyjnaxvru": {
    "name": "Protocol Labs",
    "conferences": [
      {"/": "bafyreidqynoke7wagaefq3lrtdz2oe4pxs762h7gptvtcwvmyu3qfokflu"},
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  },
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    "name": "IPFS ping",
    "location": "Reykjavík"
  }
}
```

The diagram illustrates the challenge of navigating IPLD links. It shows a JSON structure where a parent node (Protocol Labs) contains a list of child nodes (conferences). A blue arrow points to the parent node, and a green arrow points to one of the child nodes. An orange arrow points from the parent node to the first child node, and a red arrow points from the parent node to the second child node. This highlights the difficulty of finding specific data within a large, unstructured dataset.

IPLD Link Challenges

Blockstores / CAR Files Aren't Human-Friendly

```
{
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    "name": "IPFS ping",
    "location": "Reykjavík"
  }
}
```

The diagram shows a JSON structure representing IPLD links. A blue arrow points to the root node. A pink arrow points to the 'conferences' array. A green arrow points to the first conference node. An orange arrow points to the second conference node. A red arrow points to the third conference node. A purple arrow points to the 'company' field of the 'Juan Benet' node.

IPLD Link Challenges

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    "name": "IPFS ping",
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  }
}
```

🤖 efficient

😭 hard to read

😭 hard to debug

IPLD Link Challenges

Concrete Links Force Early Decisions

```
{
  "bafyreiak65ilmsanfzxgihqmwufw6u3w2iwoti7j7kwzouodwyyjnaxvru": {
    "name": "Protocol Labs",
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      {"/": "bafyreidqynoke7wagaefq3lrtdz2oe4pxs762h7gptvtcwvmyu3qfokflu"},
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    "name": "IPFS Camp",
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 concrete

 inflexible

IPLD Link Challenges

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    "conferences": [
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      {"name": "IPFS ping", "location": "Reykjavík"},
      {"name": "FIL Dev Summit", "location": "Brussels"}
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  },
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    "company": {"name": "Protocol Labs", "location": "Brussels"}
  },
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    "name": "IPFS ping",
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  }
}
```

DAG-CBOR

 concrete

 inflexible

The Solution



The Solution



(Hint: it's really simple)

The Solution

What We Want


- Human-readable DAGs
- Context aware config for CIDs & sub-DAGs
- Absolutely no change to existing tools & specs
- Round-trippable with "vanilla" IPLD
- Work with any IPLD variant
- Be acceptable as a wire format
 - i.e. don't throw space efficiency **completely** out the window

The Solution

How Do?

The Solution

How Do?

- Encode to a tree  (JSON, CBOR, etc)

The Solution

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 - `{"/" : {".": IpId}}`

The Solution

How Do?

- Encode to a tree 🌲 (JSON, CBOR, etc)
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 - `{"/" : {".": IpId}}`
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The Solution

How Do?

- Encode to a tree 🌲 (JSON, CBOR, etc)
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 - {"/": {".": IpId}}
 - {"/": {".": IpId, "&": Cid}}

*Not DAG-JSON!
"just" a regular IPLD map*



The Solution

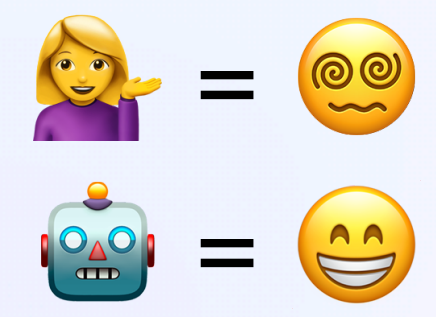
Assume Humans Read JSON

The Solution

Assume Humans Read JSON

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}
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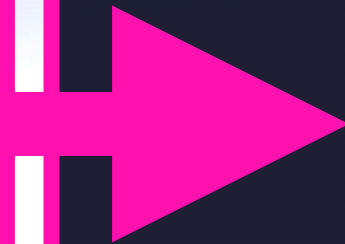
Blockstore / CAR File



The Solution

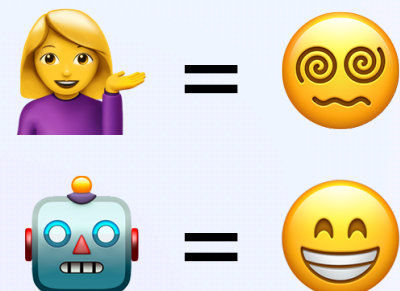
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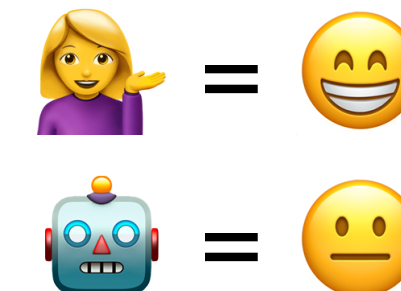


```
{
  "name": "Juan Benet",
  "company": {
    "/": {
      ".": {
        "name": "Protocol Labs",
        "conferences": [
          {"/": {".": {"name": "IPFS Camp", "location": "Brussels"}}},
          {"/": {".": {"name": "IPFS ping", "location": "Reykjavík"}}},
          {"/": {".": {"name": "FIL Dev", "location": "Brussels"}}}
        ]
      }
    }
  }
}
```

Blockstore / CAR File



Inline IPLD



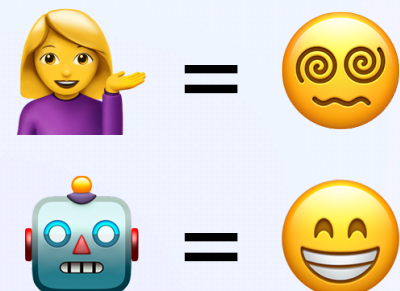
The Solution

Assume Humans Read JSON

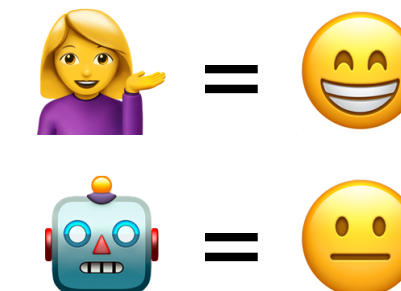
```
{
  "bafyreiak65ilmsanfzxiqmmufw6u3w2iwoti7j7kwzouodwyyjnaxvru": {
    "name": "Protocol Labs",
    "conferences": [
      {"/": "bafyreidqynoke7wagaefq3lrtdz2oe4pxs762h7gptvtcwmyu3qfokflu"},
      {"/": "bafyreie6q6lklsqnonjk4xyc3yudclqy4w7z4rxhrplzp2nnjsbt3pntga"},
      {"/": "bafyreia5xknihihvvelsby3qvwr1f2t7gyljglcgq7ix566676lajyhly"}
    ]
  },
  "bafyreia5xknihihvvelsby3qvwr1f2t7gyljglcgq7ix566676lajyhly": {
    "name": "FIL Dev Summit",
    "location": "Brussels"
  },
  "bafyreicygnfdf2bphgipad6oocjva7w5yaucaitxn3uysarcpwxmgu6f4": {
    "name": "Juan Benet",
    "company": {"/": "bafyreiak65ilmsanfzxiqmmufw6u3w2iwoti7j7kwzouodwyyjnaxvru"}
  },
  "bafyreidqynoke7wagaefq3lrtdz2oe4pxs762h7gptvtcwmyu3qfokflu": {
    "name": "IPFS Camp",
    "location": "Brussels"
  },
  "bafyreie6q6lklsqnonjk4xyc3yudclqy4w7z4rxhrplzp2nnjsbt3pntga": {
    "name": "IPFS ping",
    "location": "Reykjavík"
  }
}
```

```
{
  "name": "Juan Benet",
  "company": {
    "/": {
      ".": {
        "name": "Protocol Labs",
        "conferences": [
          {"/": {".": {"name": "IPFS Camp", "location": "Brussels"}}},
          {"/": {".": {"name": "IPFS ping", "location": "Reykjavík"}}},
          {"/": {".": {"name": "FIL Dev", "location": "Brussels"}}}
        ]
      }
    }
  }
}
```

Blockstore / CAR File



Inline IPLD



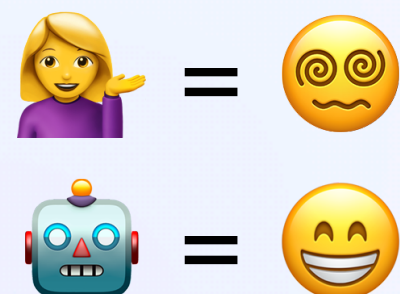
The Solution

Assume Humans Read JSON

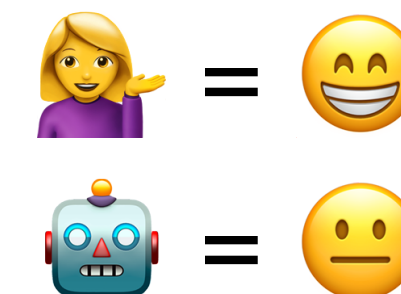
```
{
  "bafyreiak65ilmsanfzqxgihqmwufw6u3w2iwoti7j7kwzouodwyyjnaxvru": {
    "name": "Protocol Labs",
    "conferences": [
      {"/": "bafyreidqynoke7wagaefq3lrtdz2oe4pxs762h7gptvtcwmyu3qfokflu"},
      {"/": "bafyreie6q6lklsqnonjk4xyc3yudclqy4w7z4rxhrplzp2nnjsbt3pntga"},
      {"/": "bafyreia5xknihihvvelsby3qvwr1f2t7gyljglcgq7ix566676lajyhly"}
    ]
  },
  "bafyreia5xknihihvvelsby3qvwr1f2t7gyljglcgq7ix566676lajyhly": {
    "name": "FIL Dev Summit",
    "location": "Brussels"
  },
  "bafyreicygnfdf2bphgipad6oocjva7w5yaucaitxn3uysarcpwxmgu6f4": {
    "name": "Juan Benet",
    "company": {"/": "bafyreiak65ilmsanfzqxgihqmwufw6u3w2iwoti7j7kwzouodwyyjnaxvru"}
  },
  "bafyreidqynoke7wagaefq3lrtdz2oe4pxs762h7gptvtcwmyu3qfokflu": {
    "name": "IPFS Camp",
    "location": "Brussels"
  },
  "bafyreie6q6lklsqnonjk4xyc3yudclqy4w7z4rxhrplzp2nnjsbt3pntga": {
    "name": "IPFS ping",
    "location": "Reykjavík"
  }
}
```

```
{
  "name": "Juan Benet",
  "company": {
    "/": {
      ".": {
        "name": "Protocol Labs",
        "conferences": [
          {"/": {".": {"name": "IPFS Camp", "location": "Brussels"}}},
          {"/": {".": {"name": "IPFS ping", "location": "Reykjavík"}}},
          {"/": {".": {"name": "FIL Dev", "location": "Brussels"}}}
        ]
      }
    }
  }
}
```

Blockstore / CAR File



Inline IPLD



Construction



Construction

Strategies

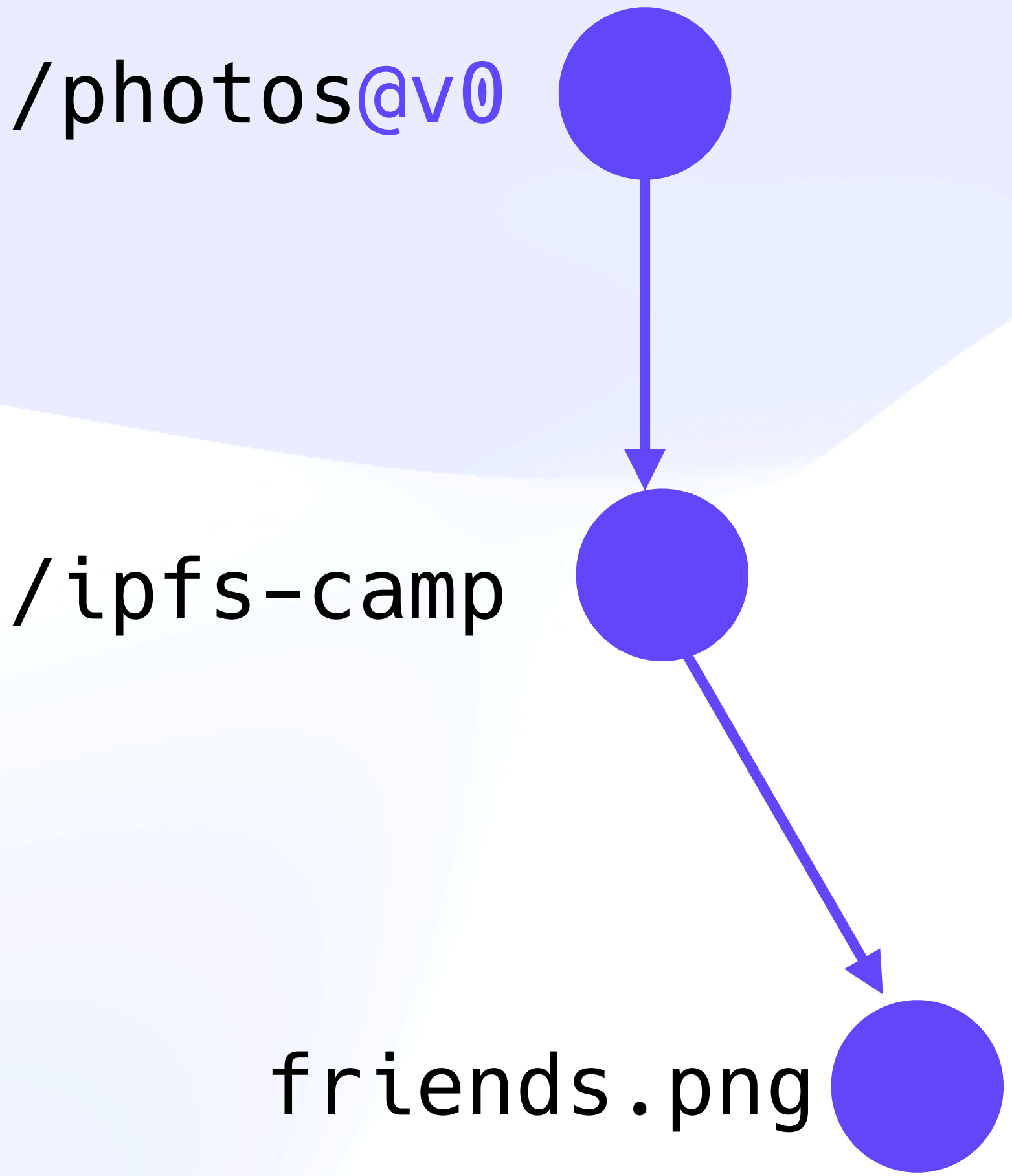
- Left-leaning spanning tree
- Saturation (inline everywhere)
- Do nothing; CAR Files(!) are fully compatible
- Any mix of the above

Construction

Strategies

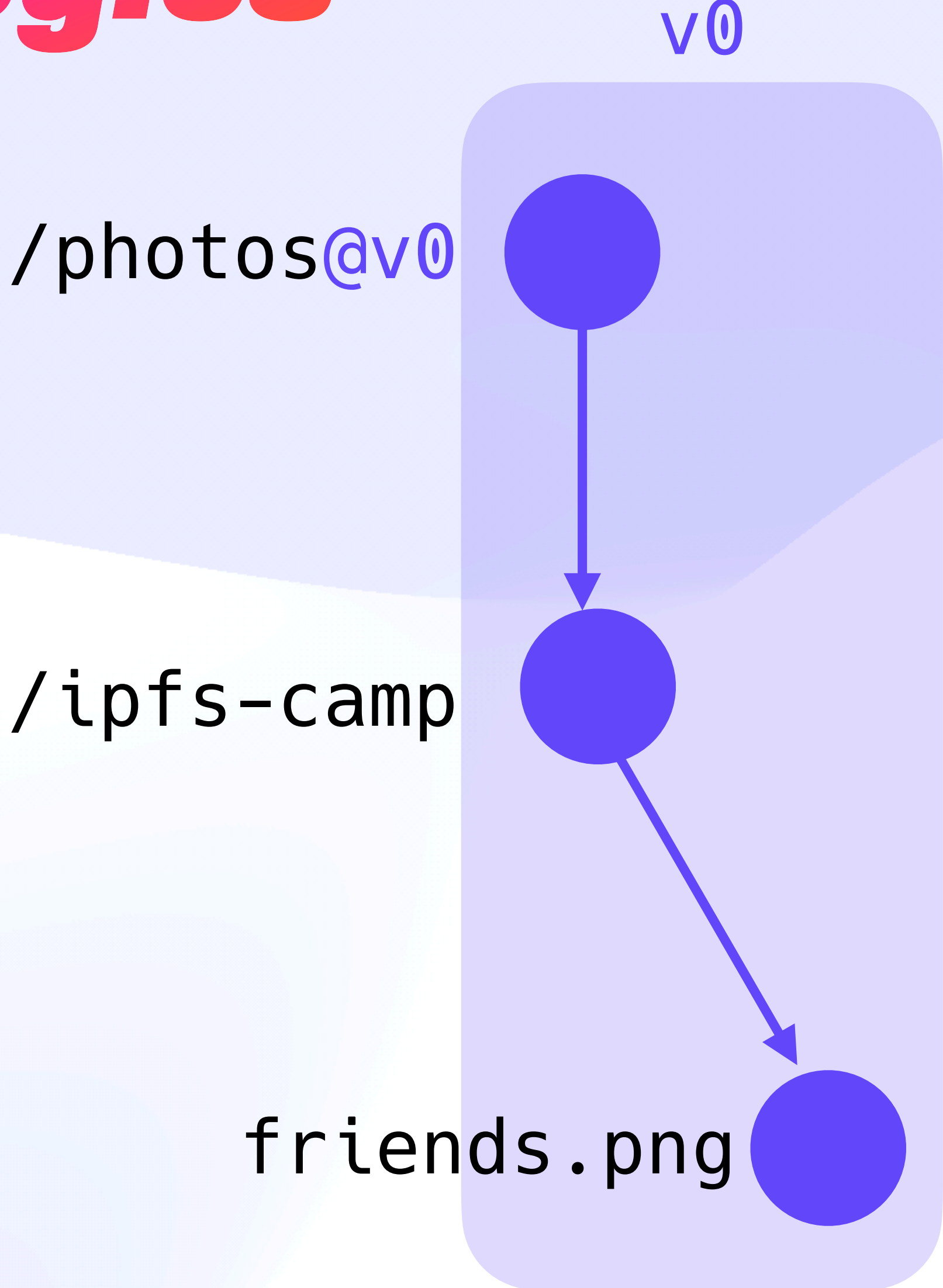
Construction

Strategies



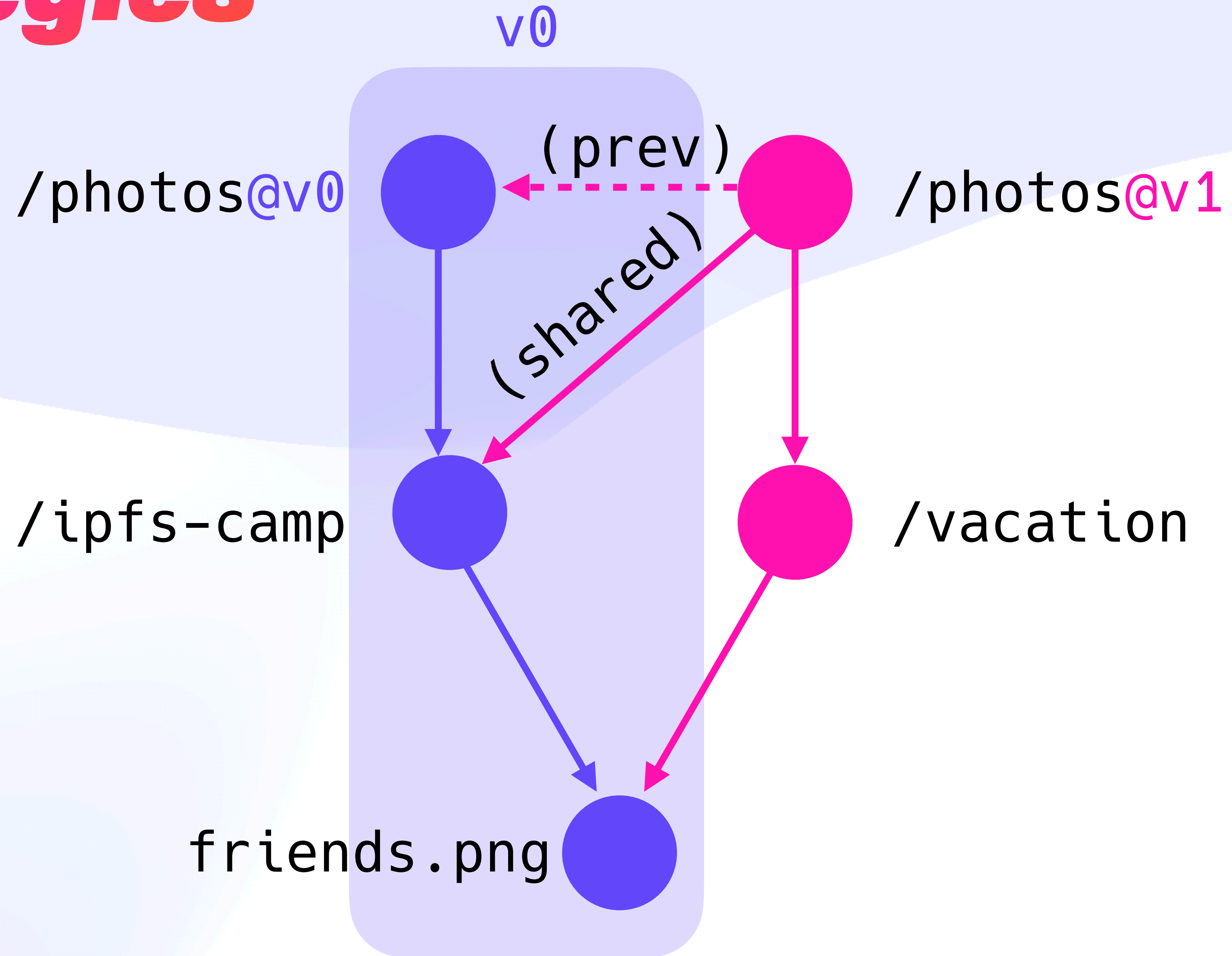
Construction

Strategies



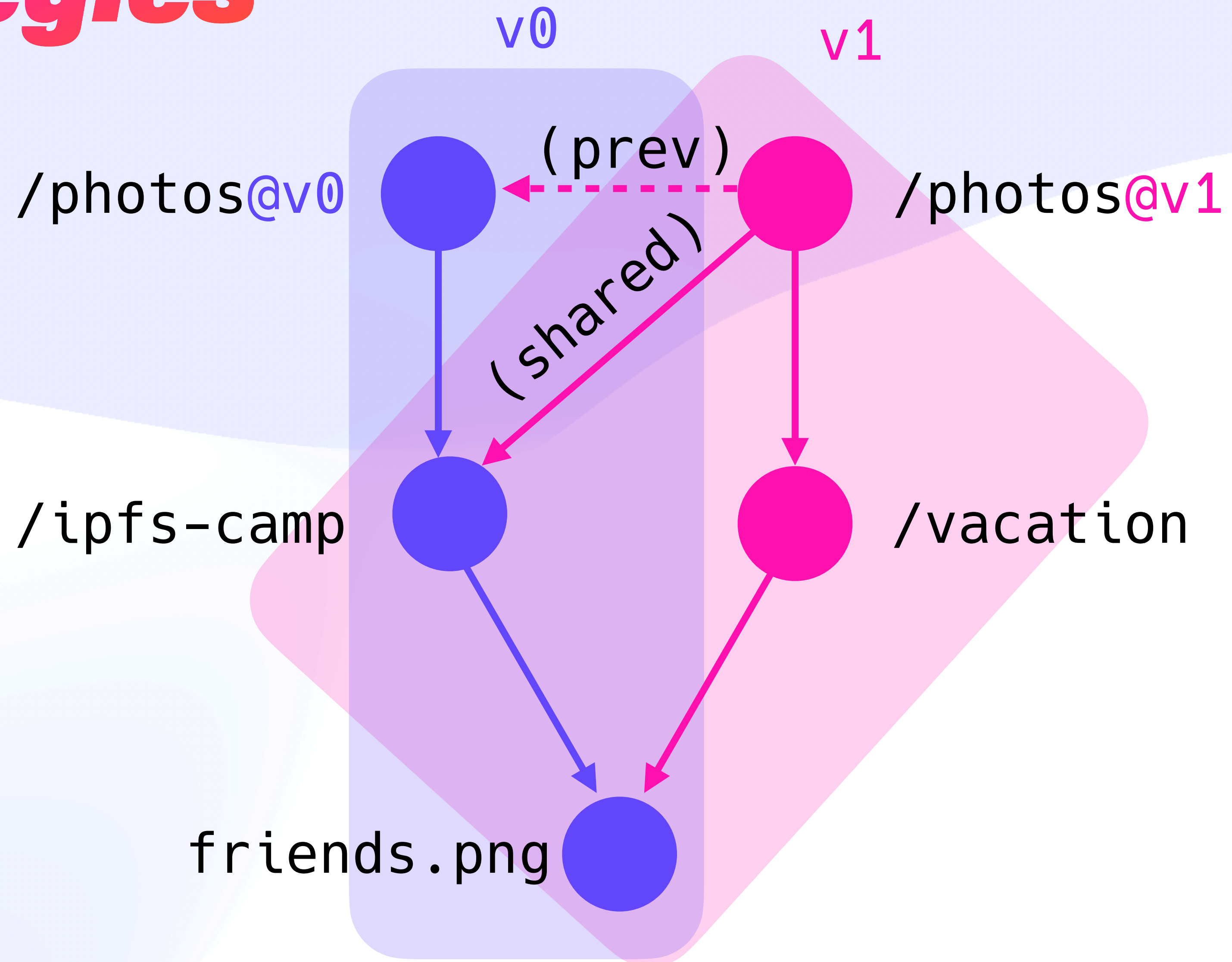
Construction

Strategies



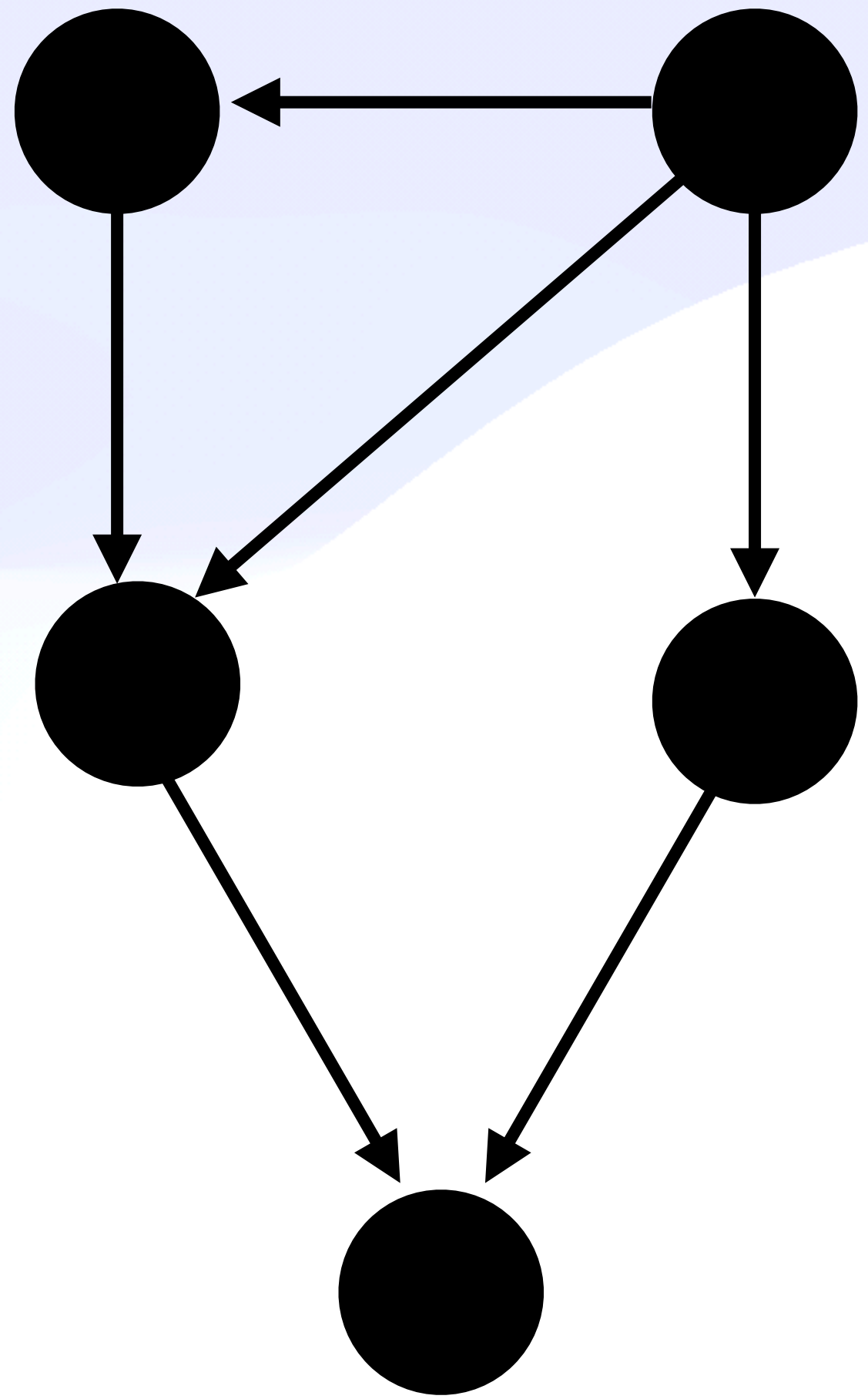
Construction

Strategies



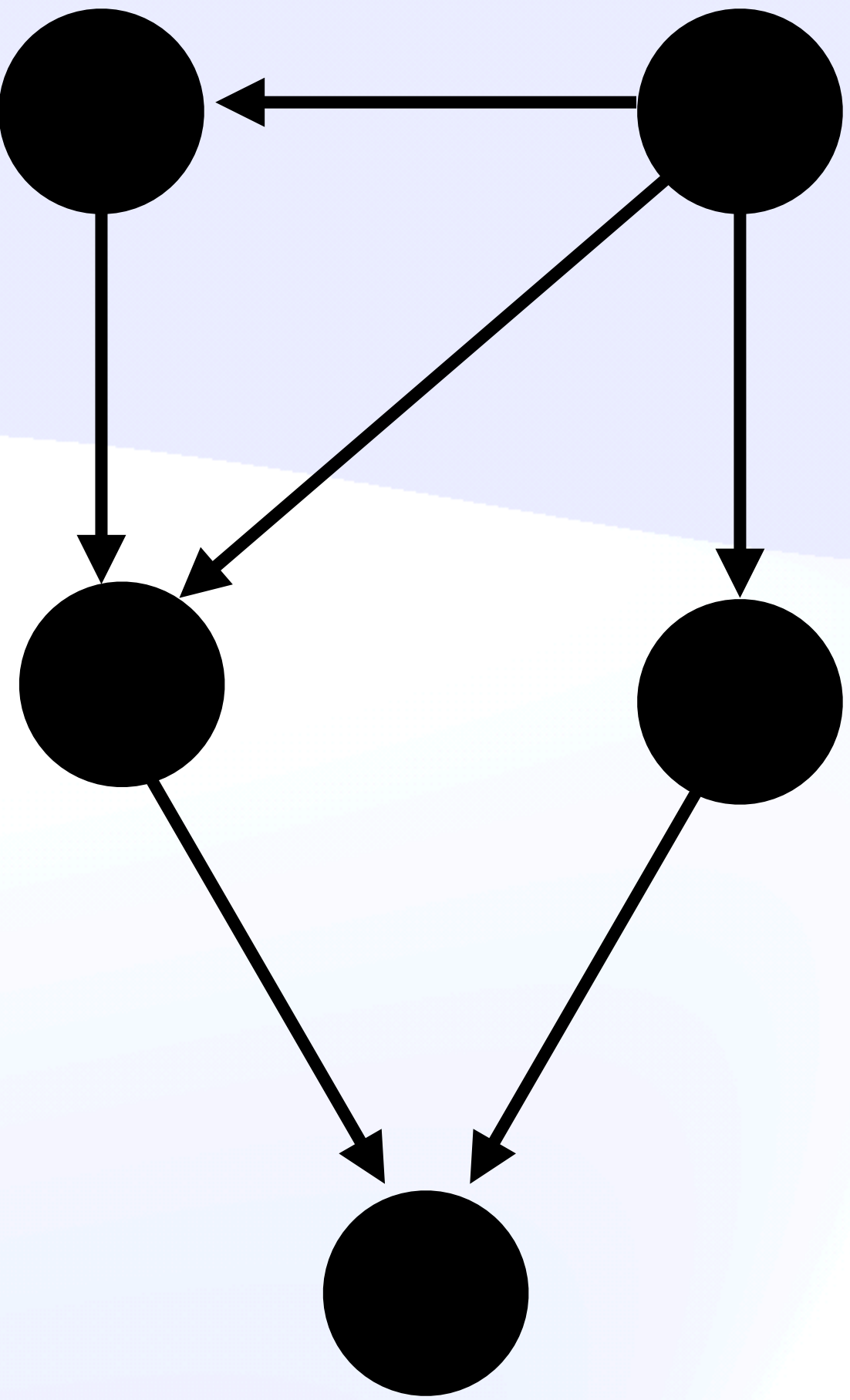
Construction

Strategies



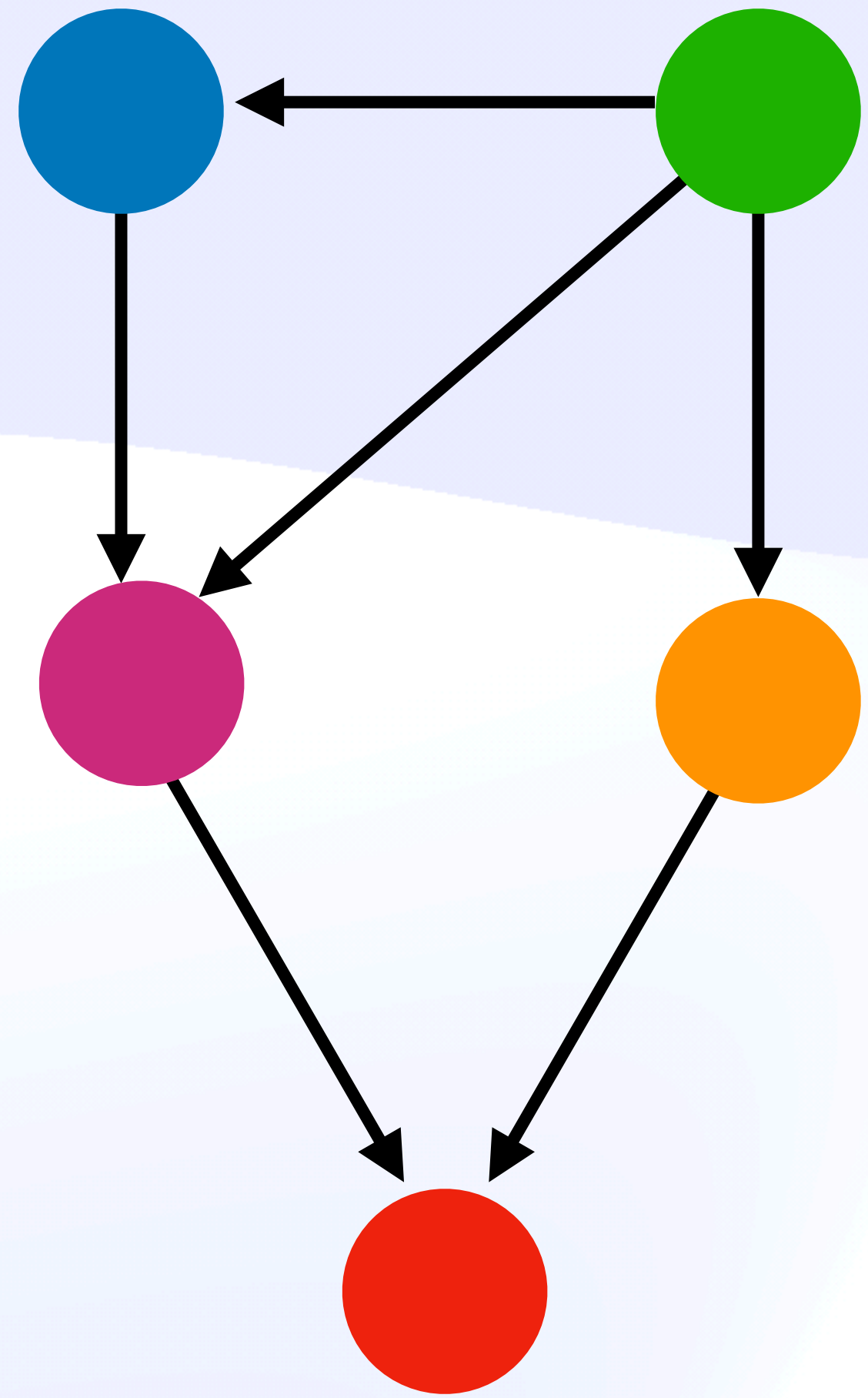
Construction

Strategies



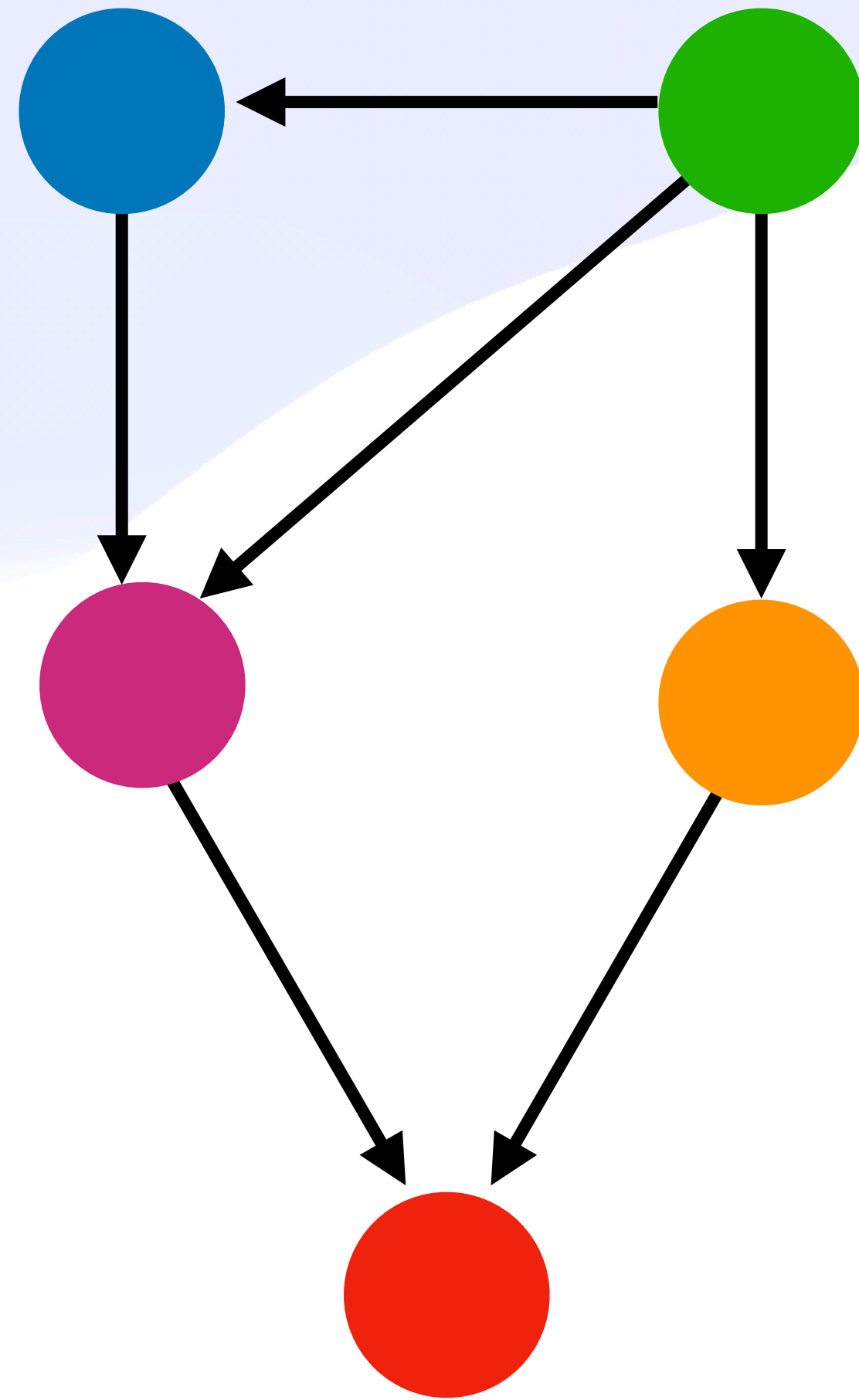
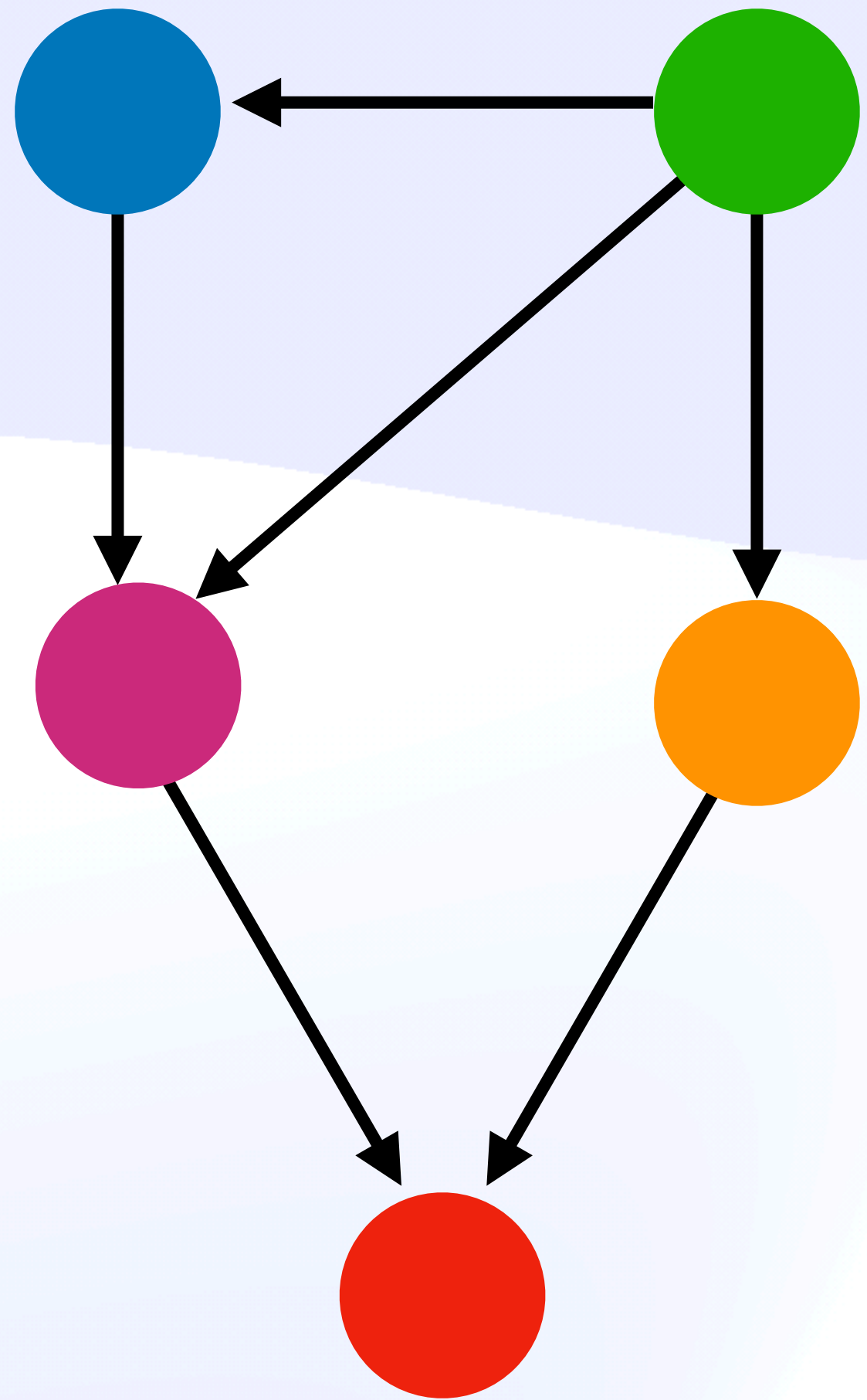
Construction

Spanning Tree



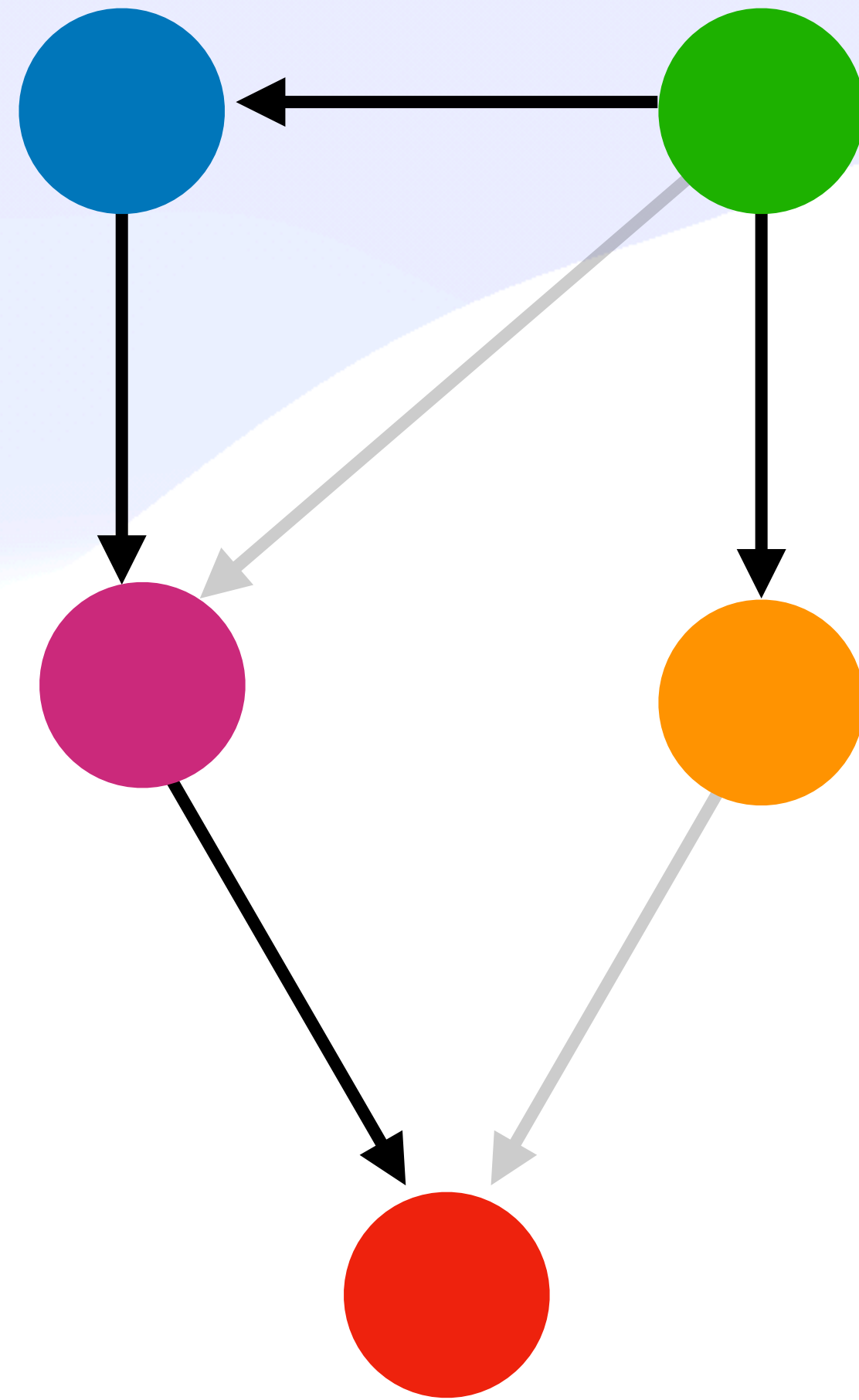
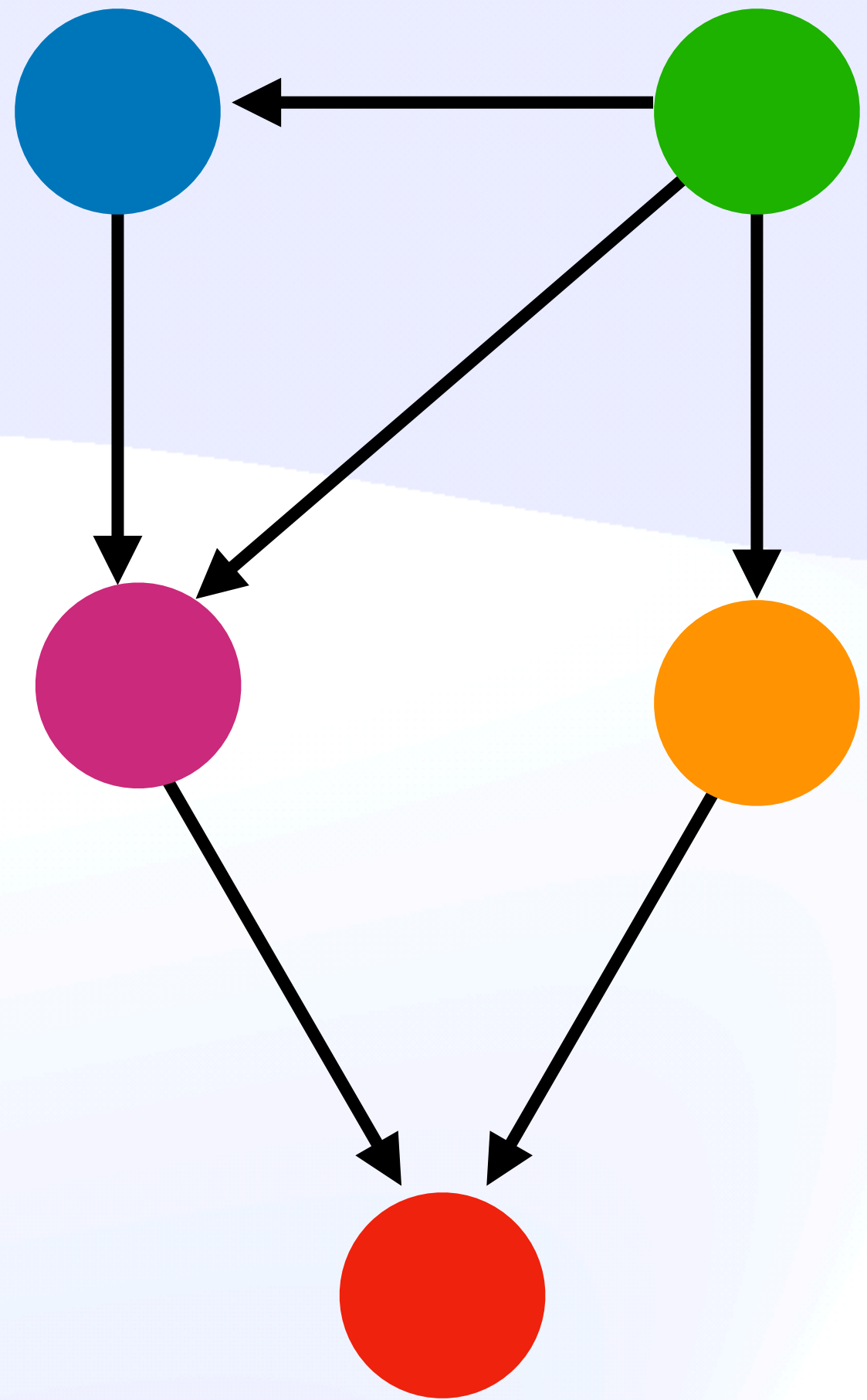
Construction

Spanning Tree



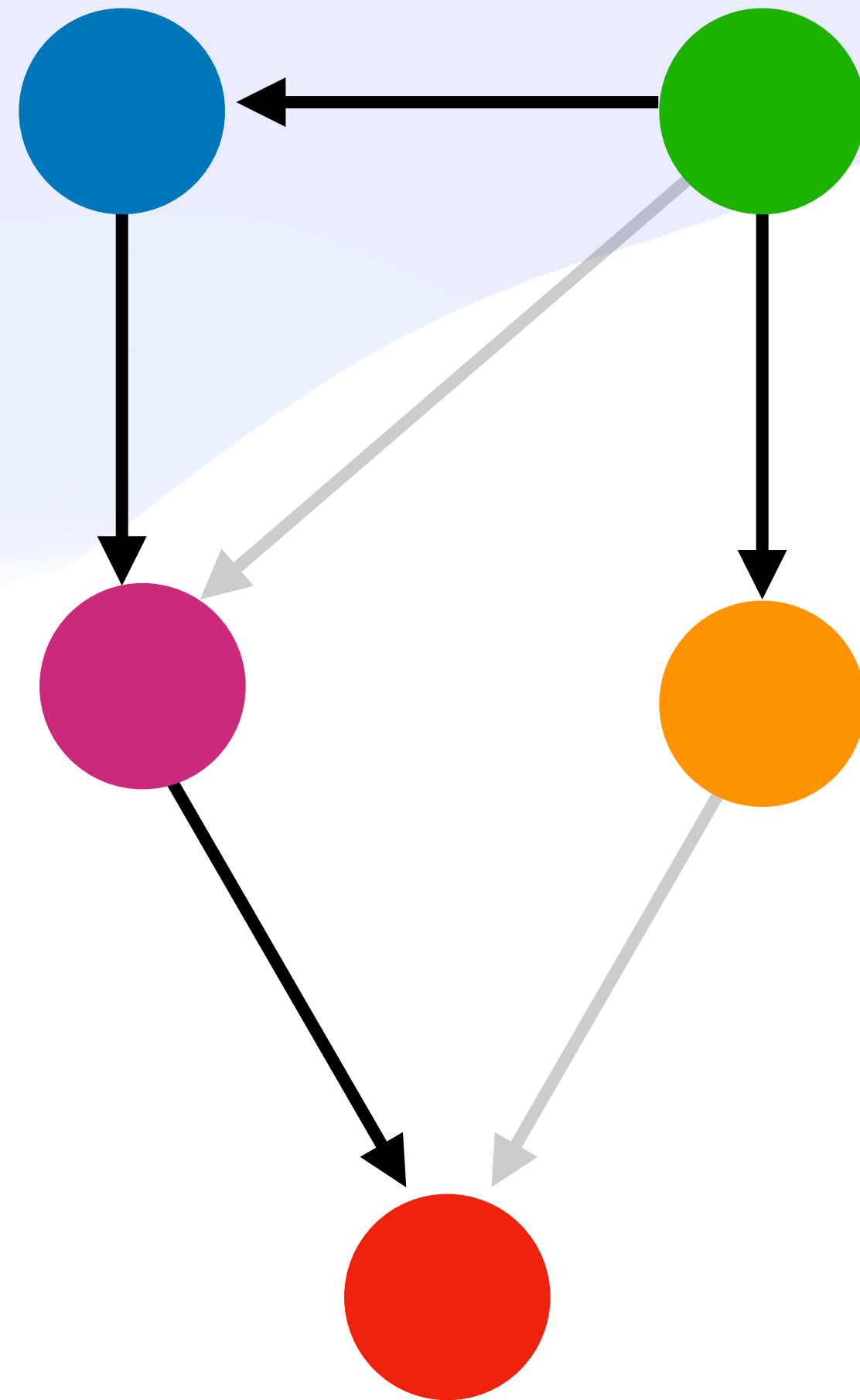
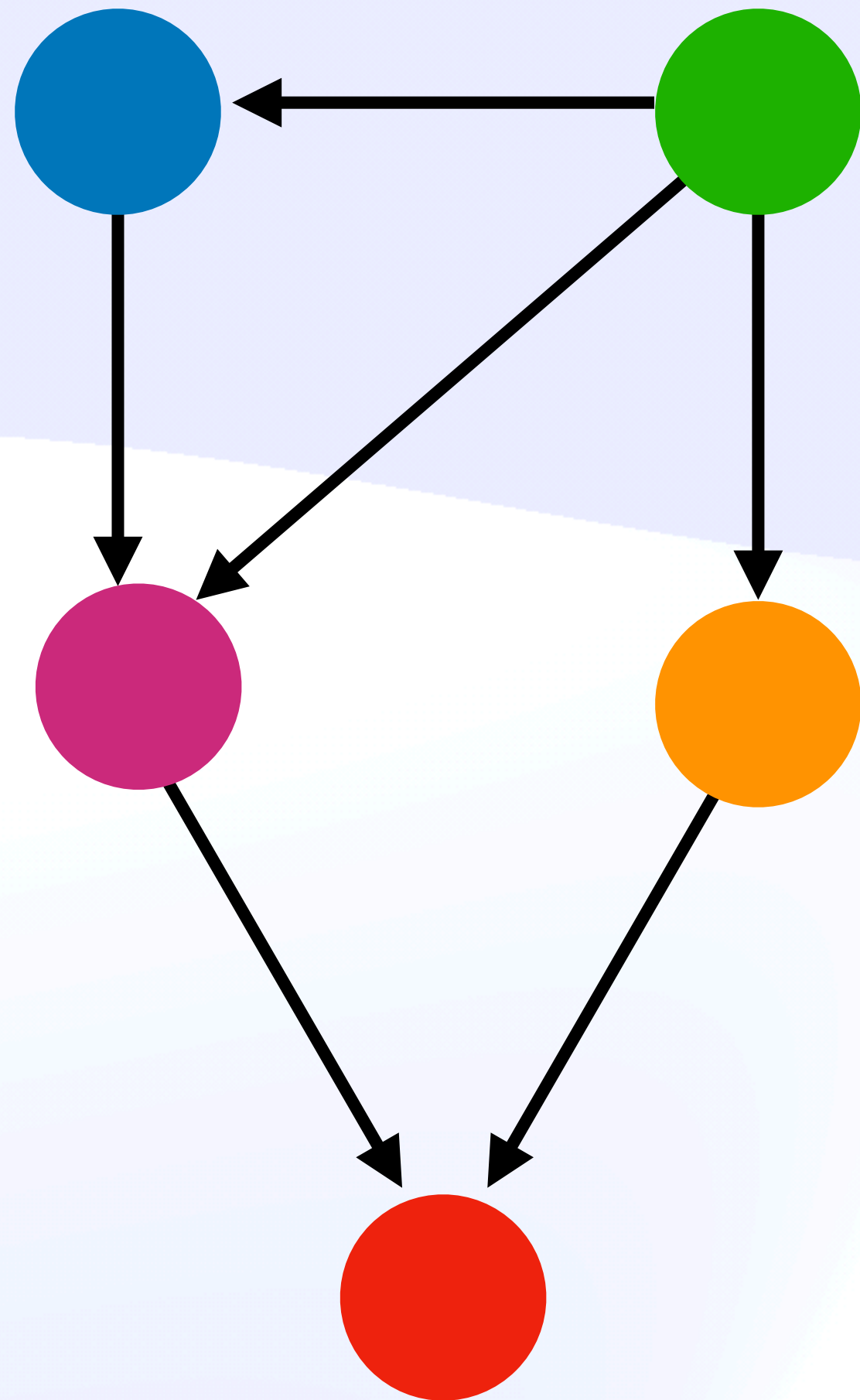
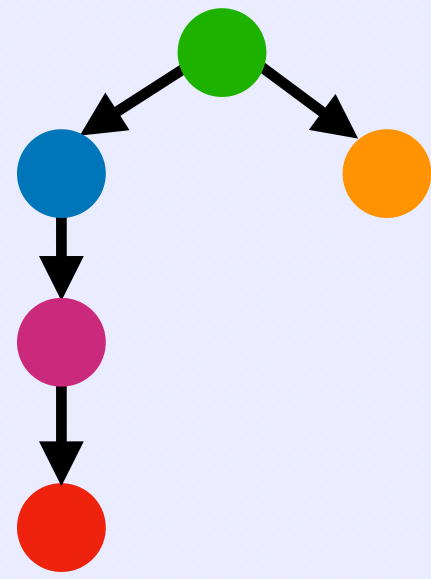
Construction

Spanning Tree



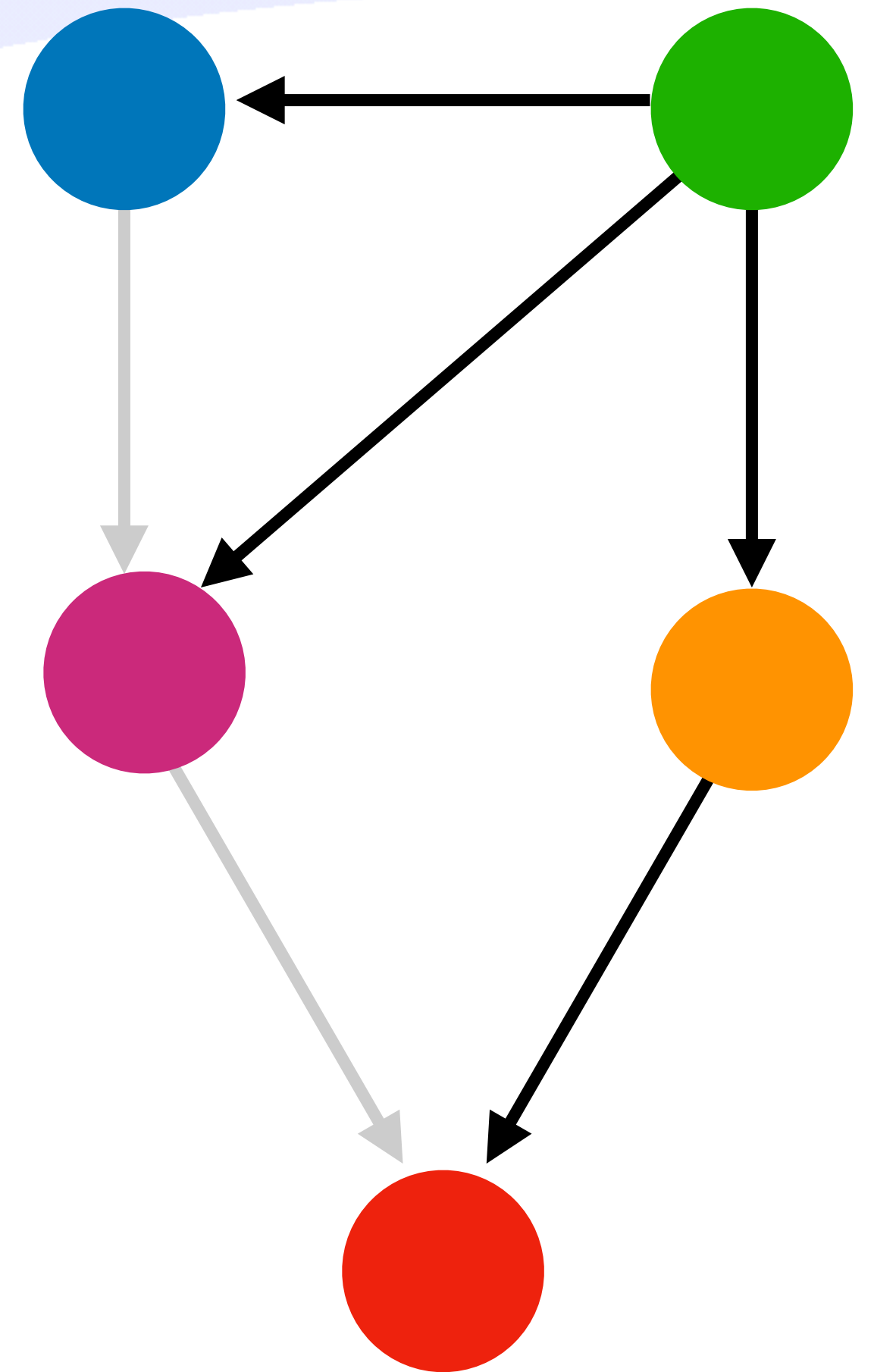
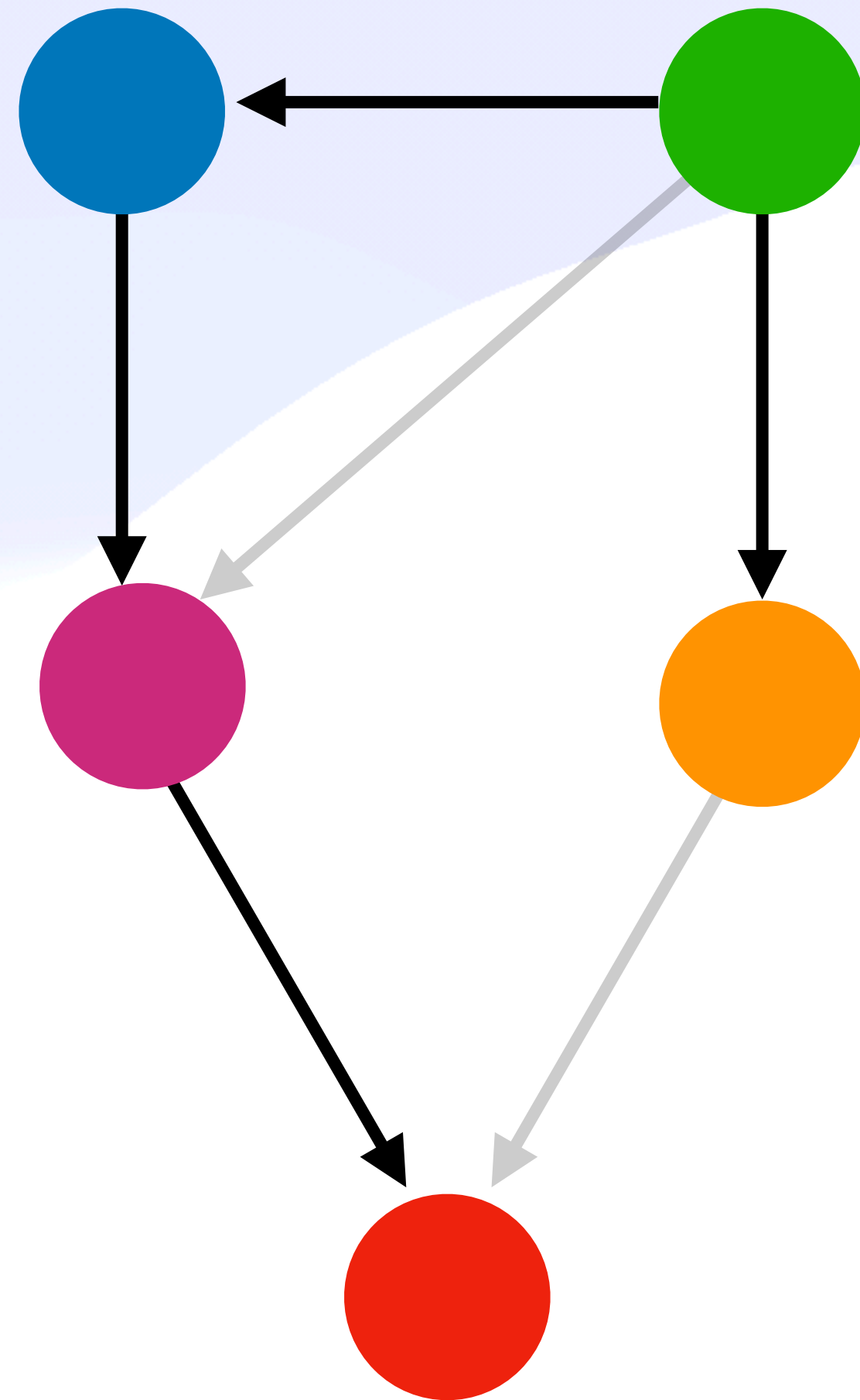
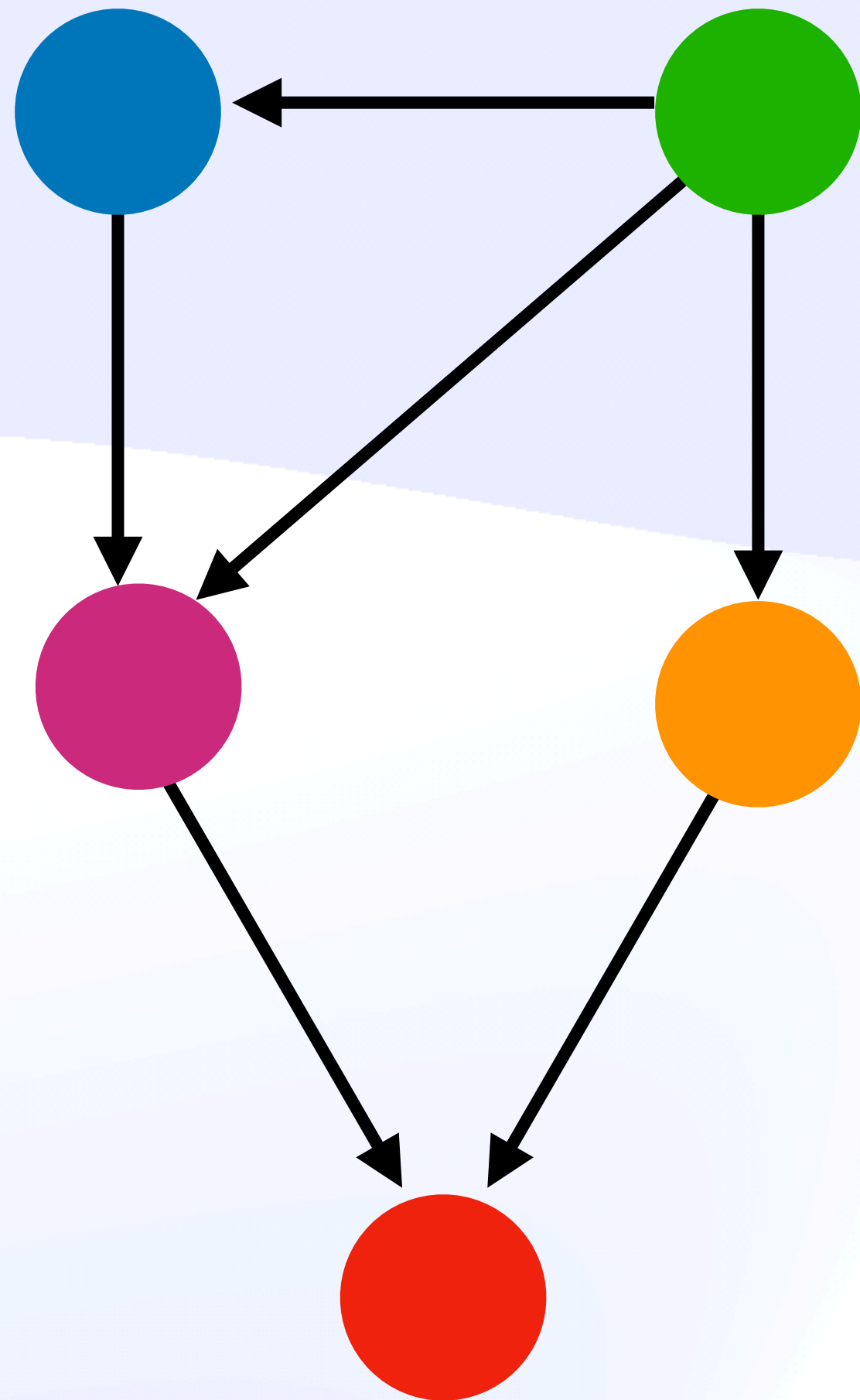
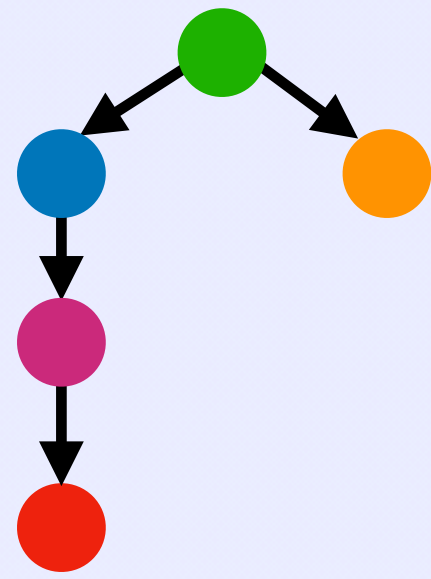
Construction

Spanning Tree



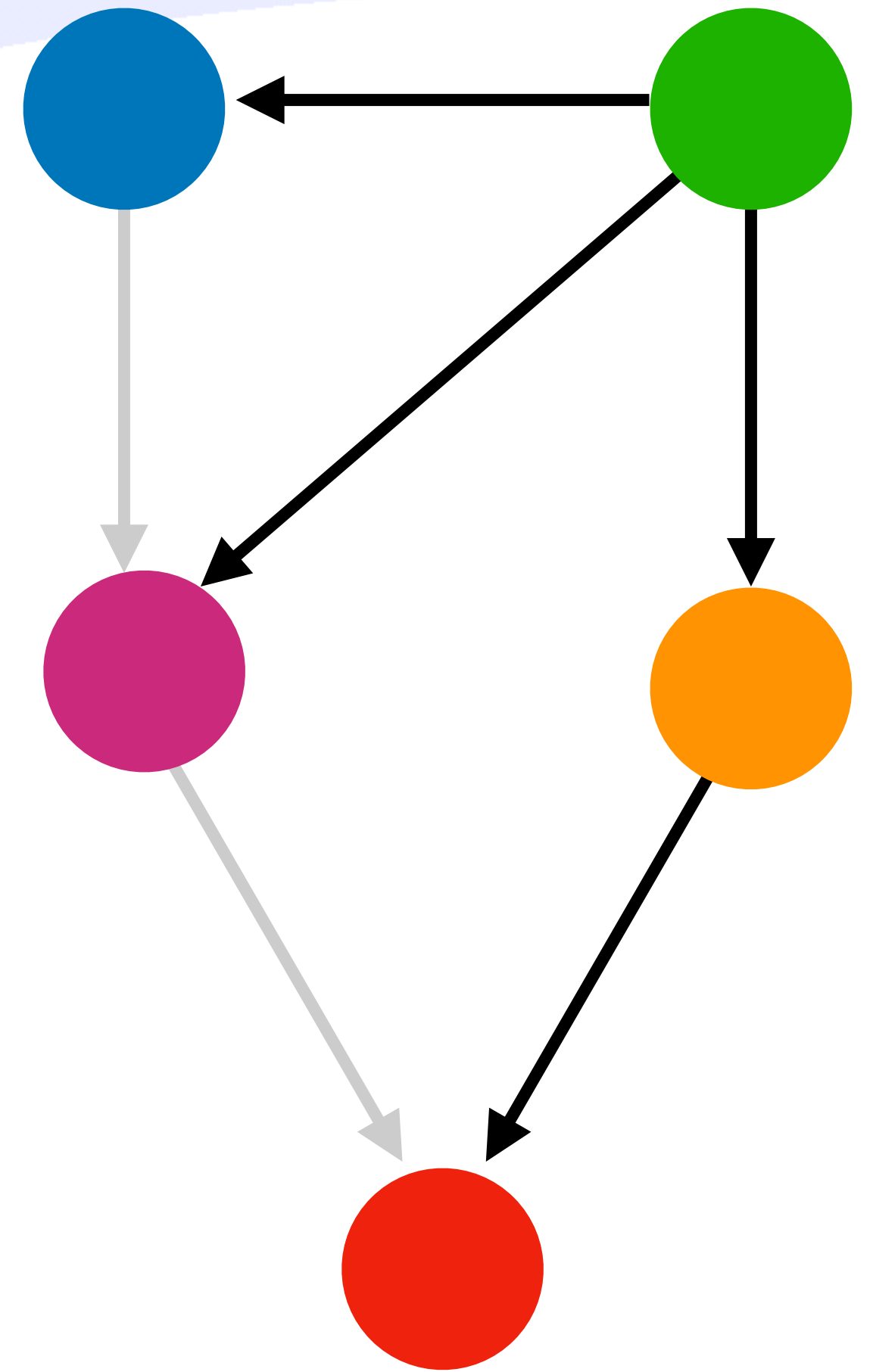
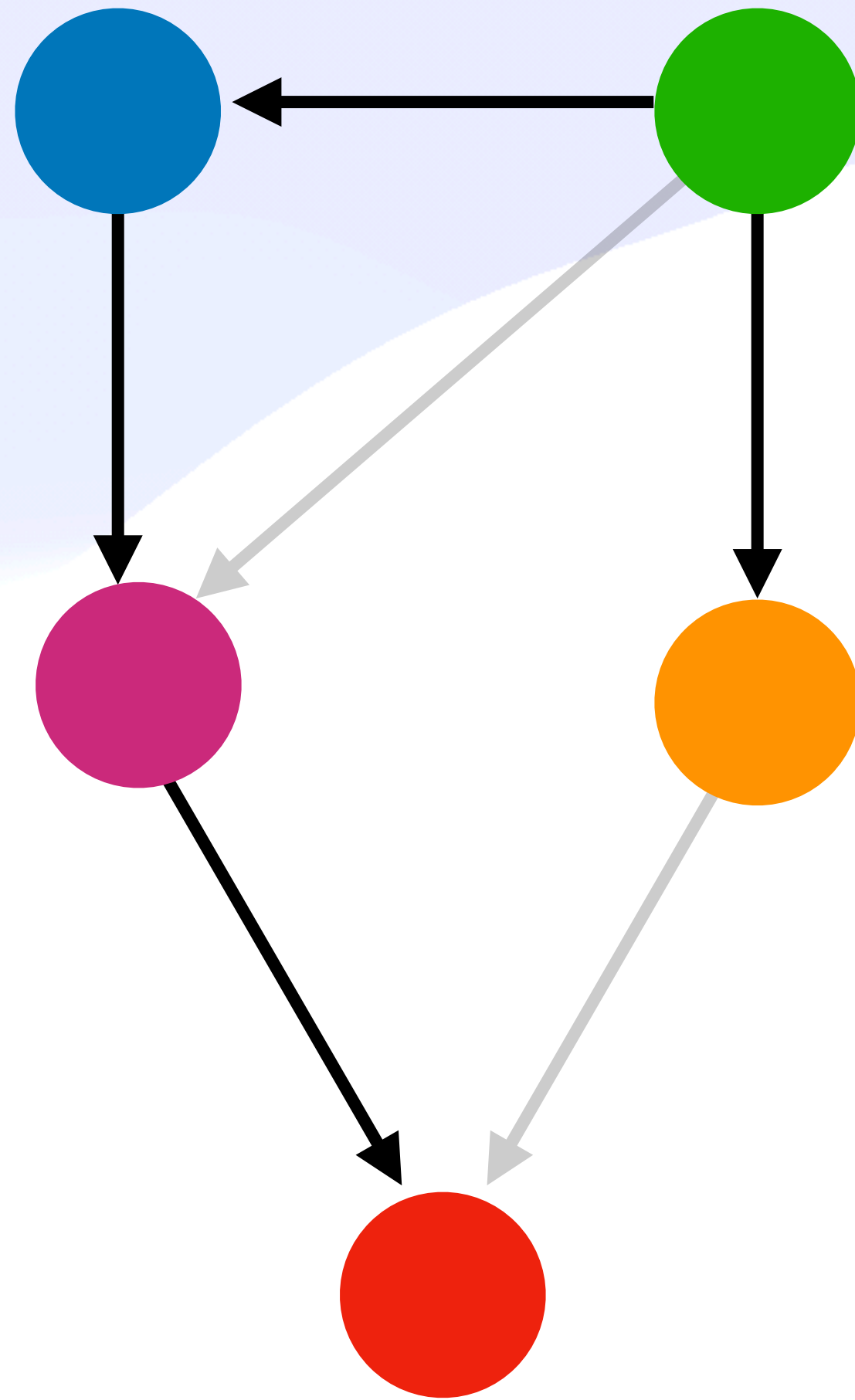
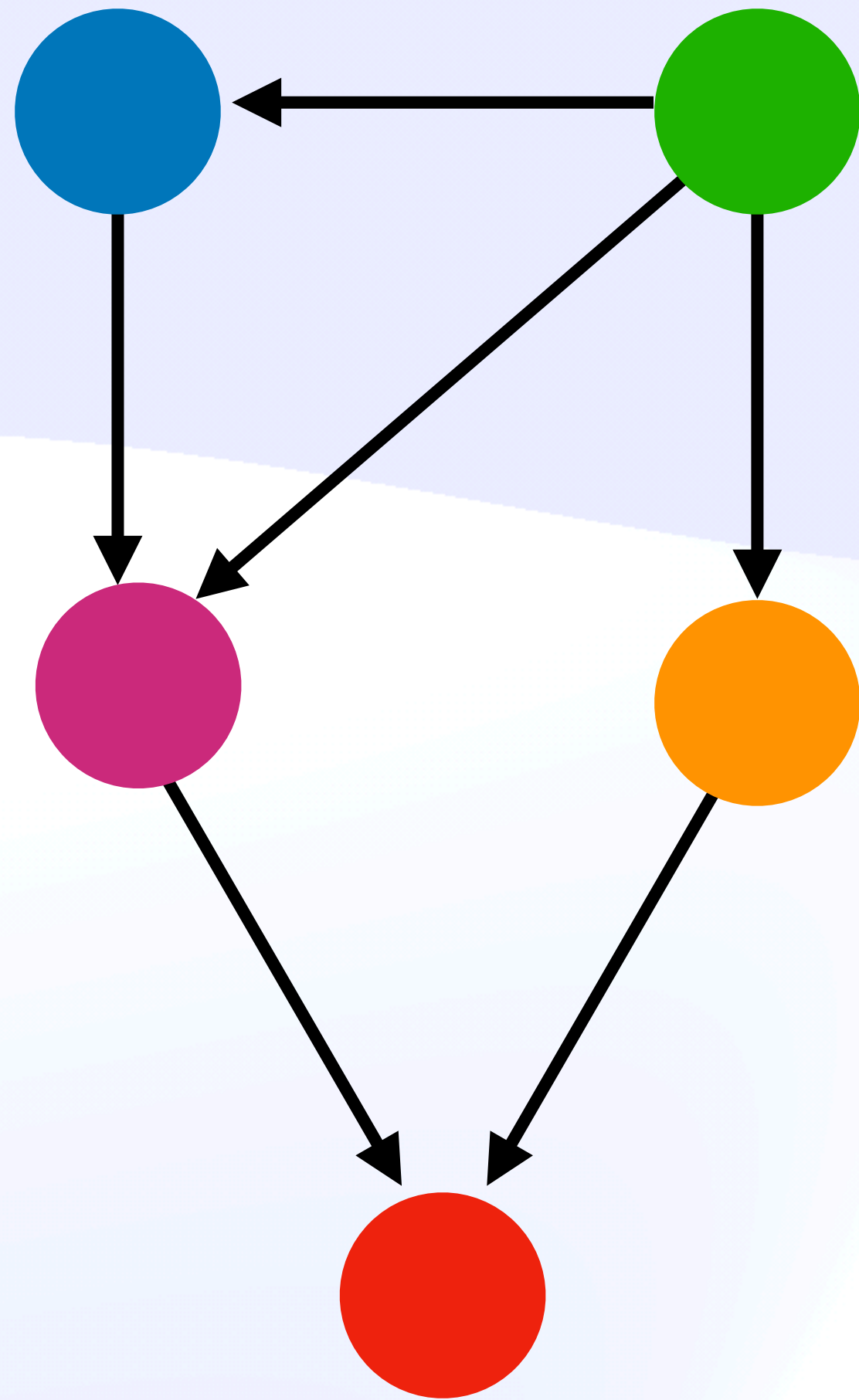
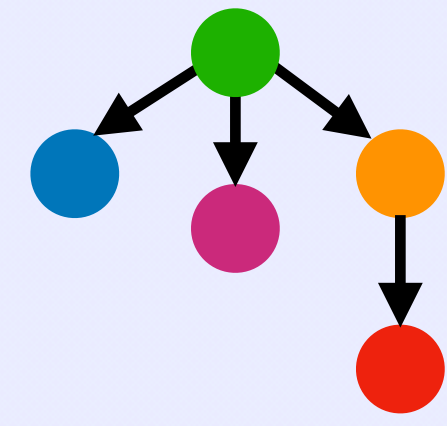
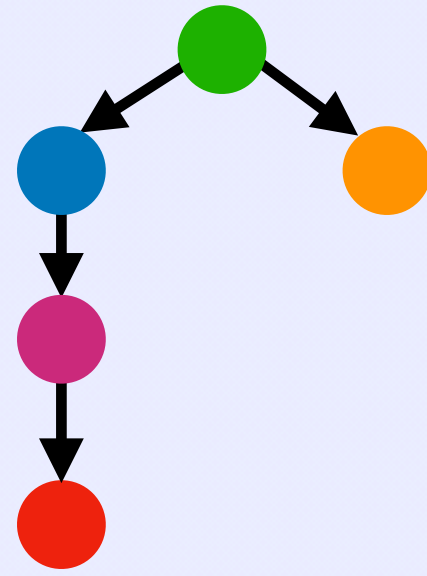
Construction

Spanning Tree



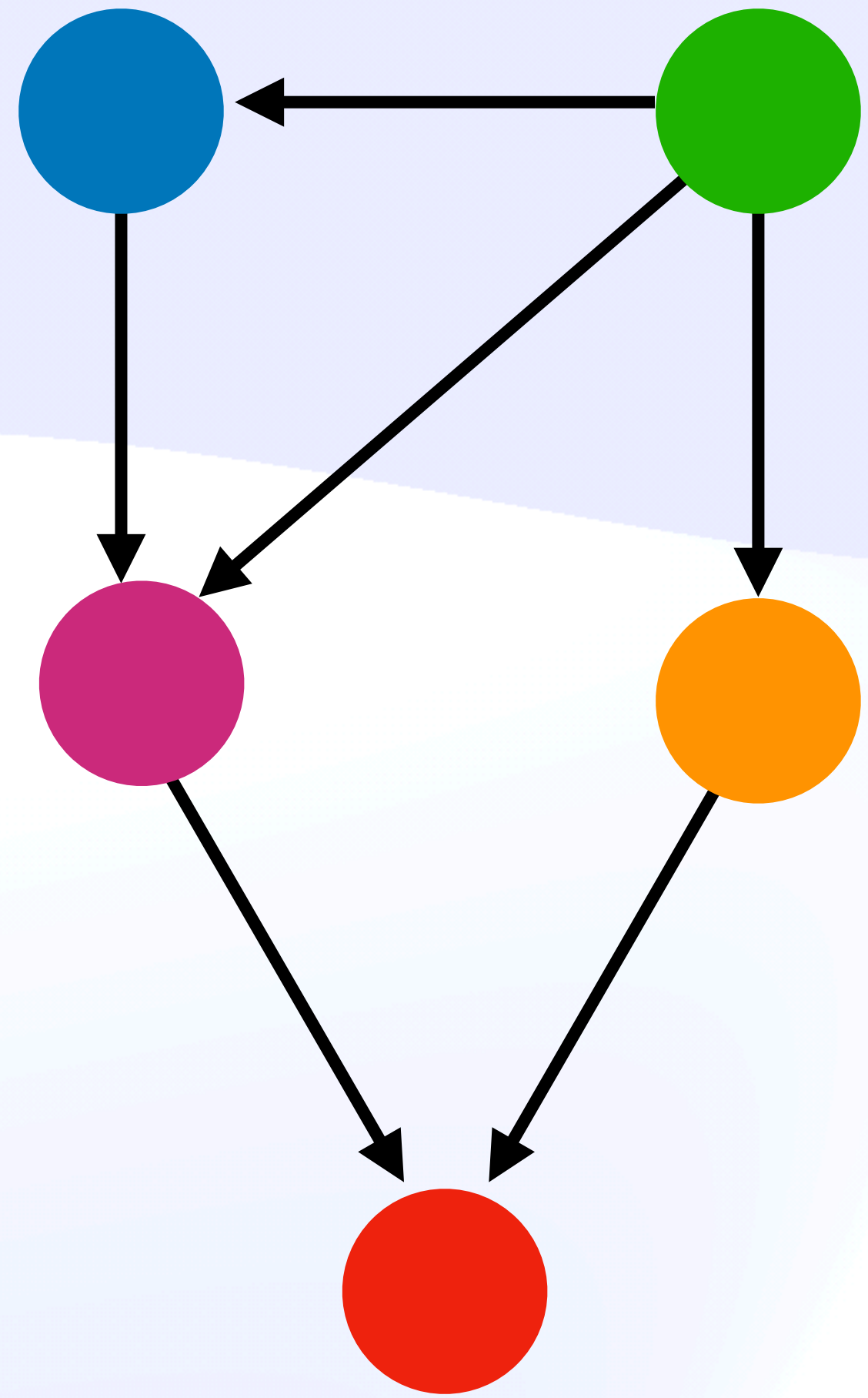
Construction

Spanning Tree



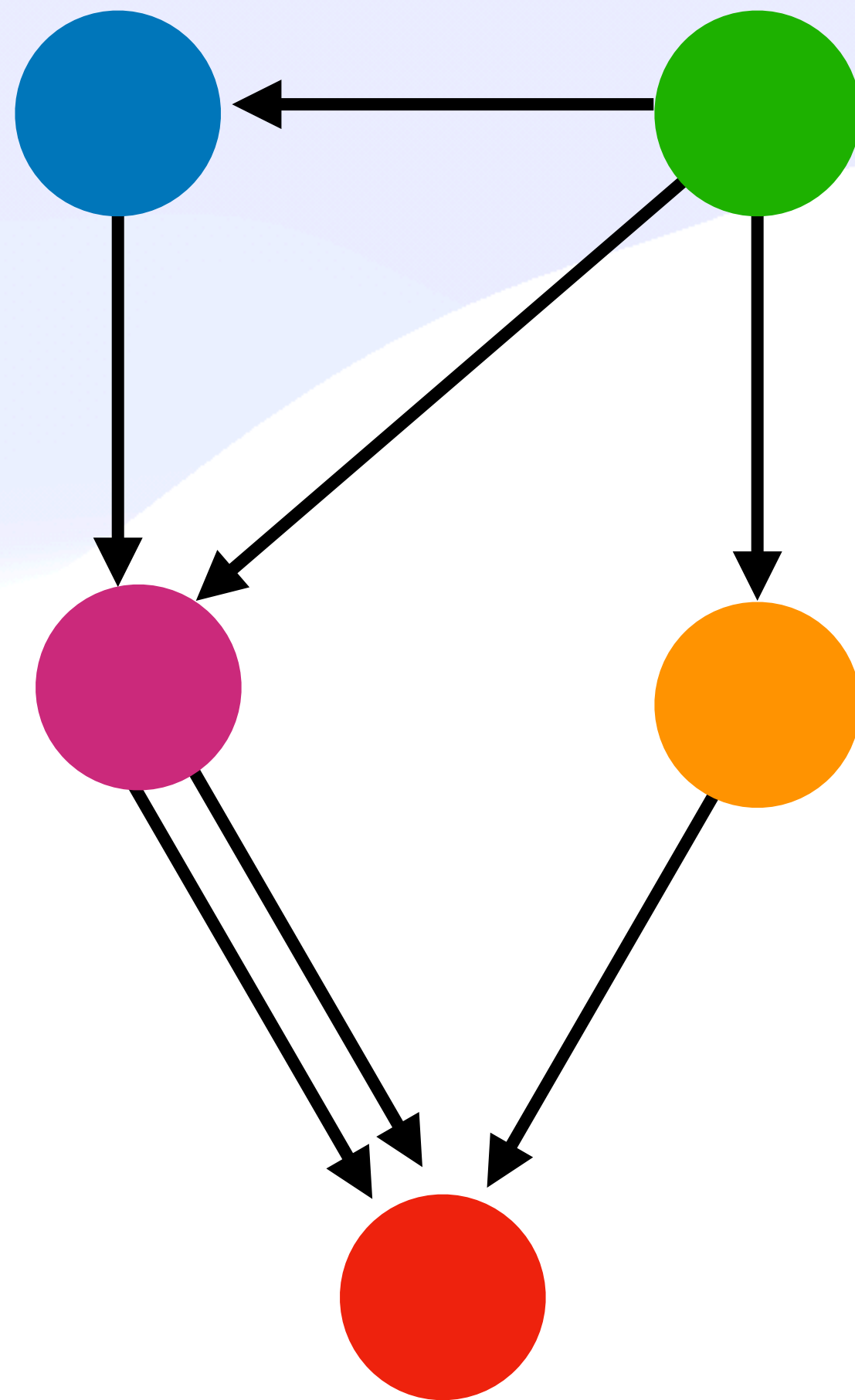
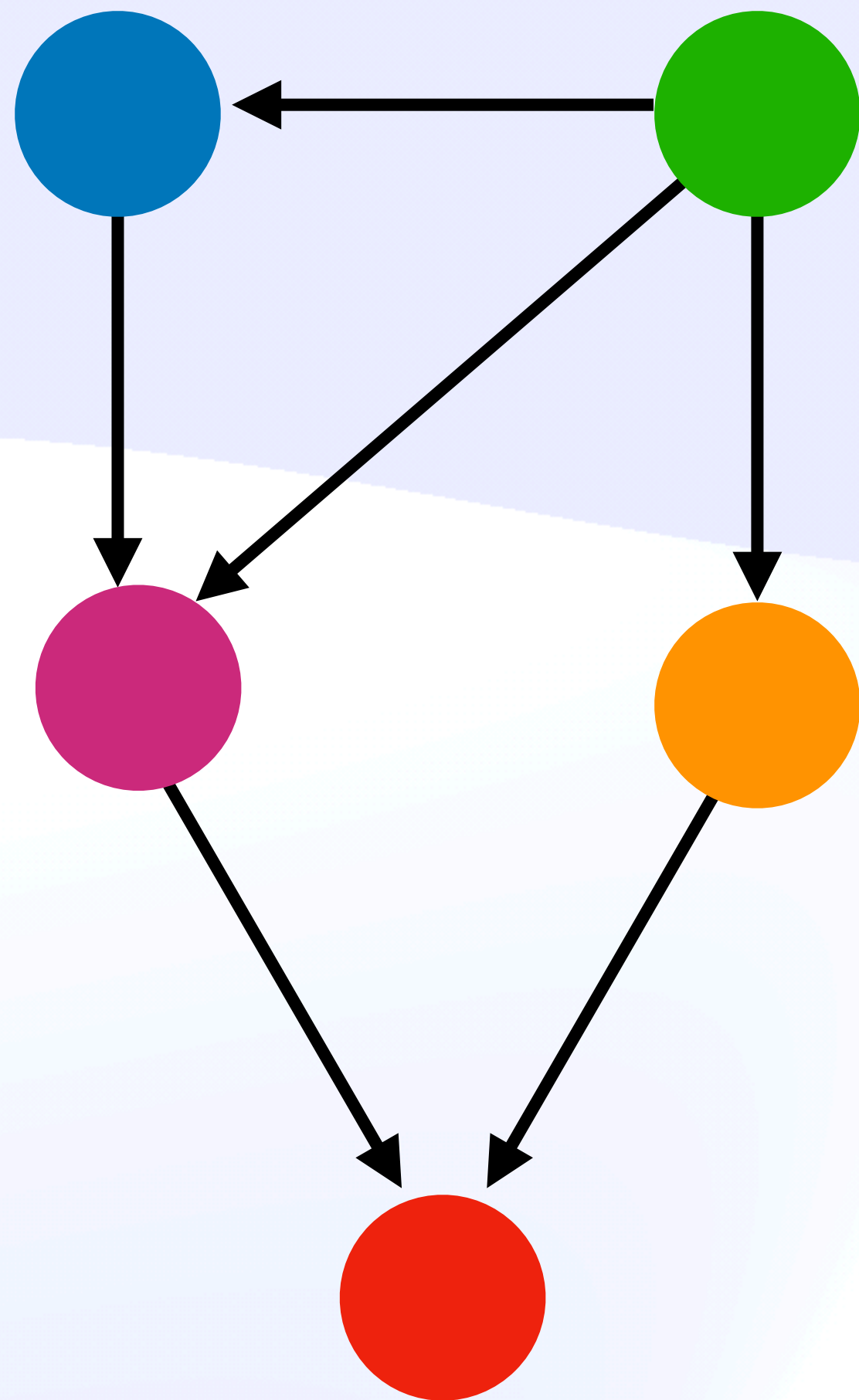
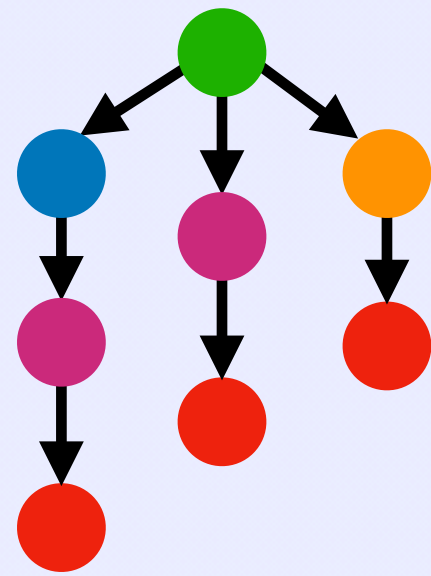
Construction

Saturation



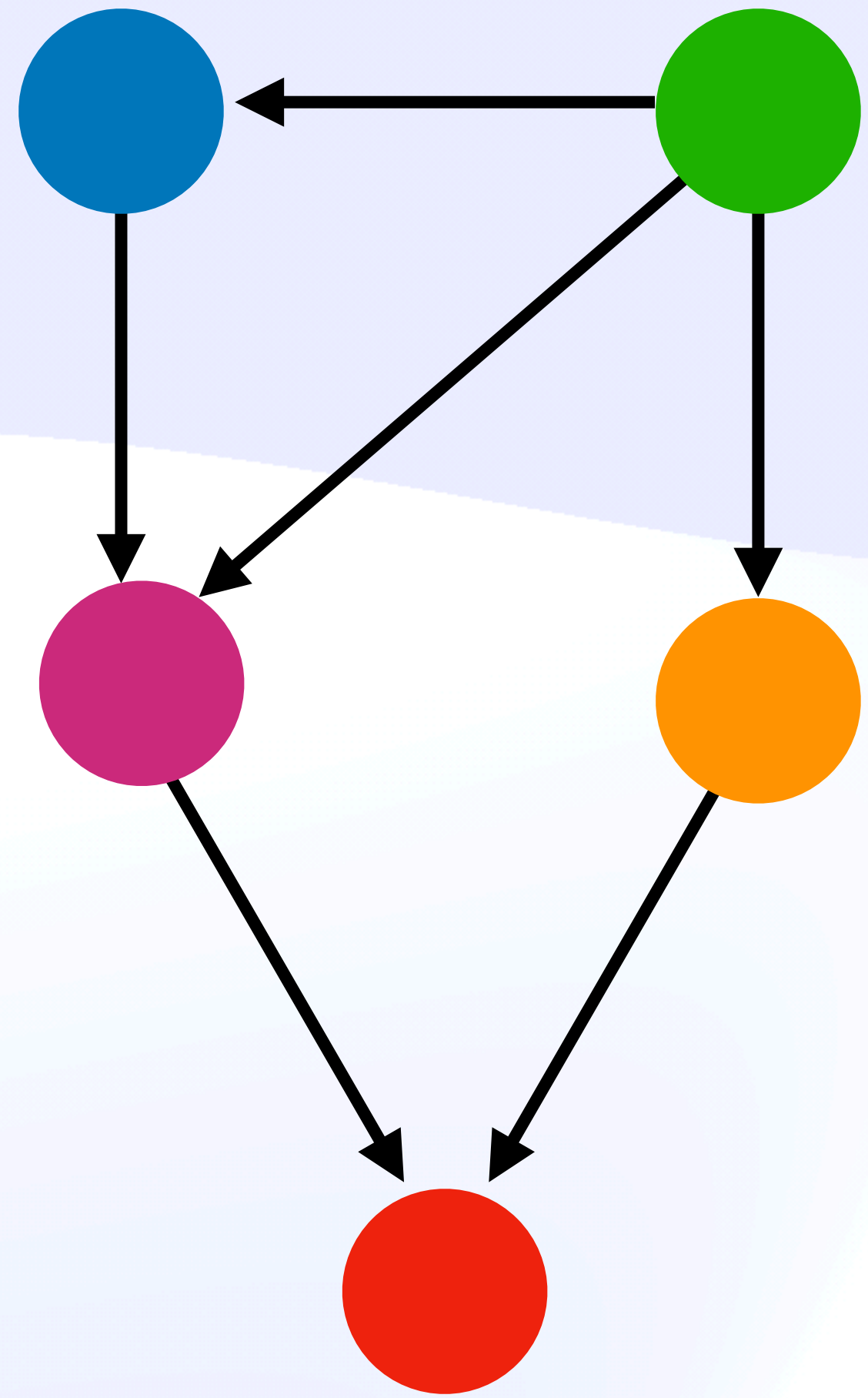
Construction

Saturation



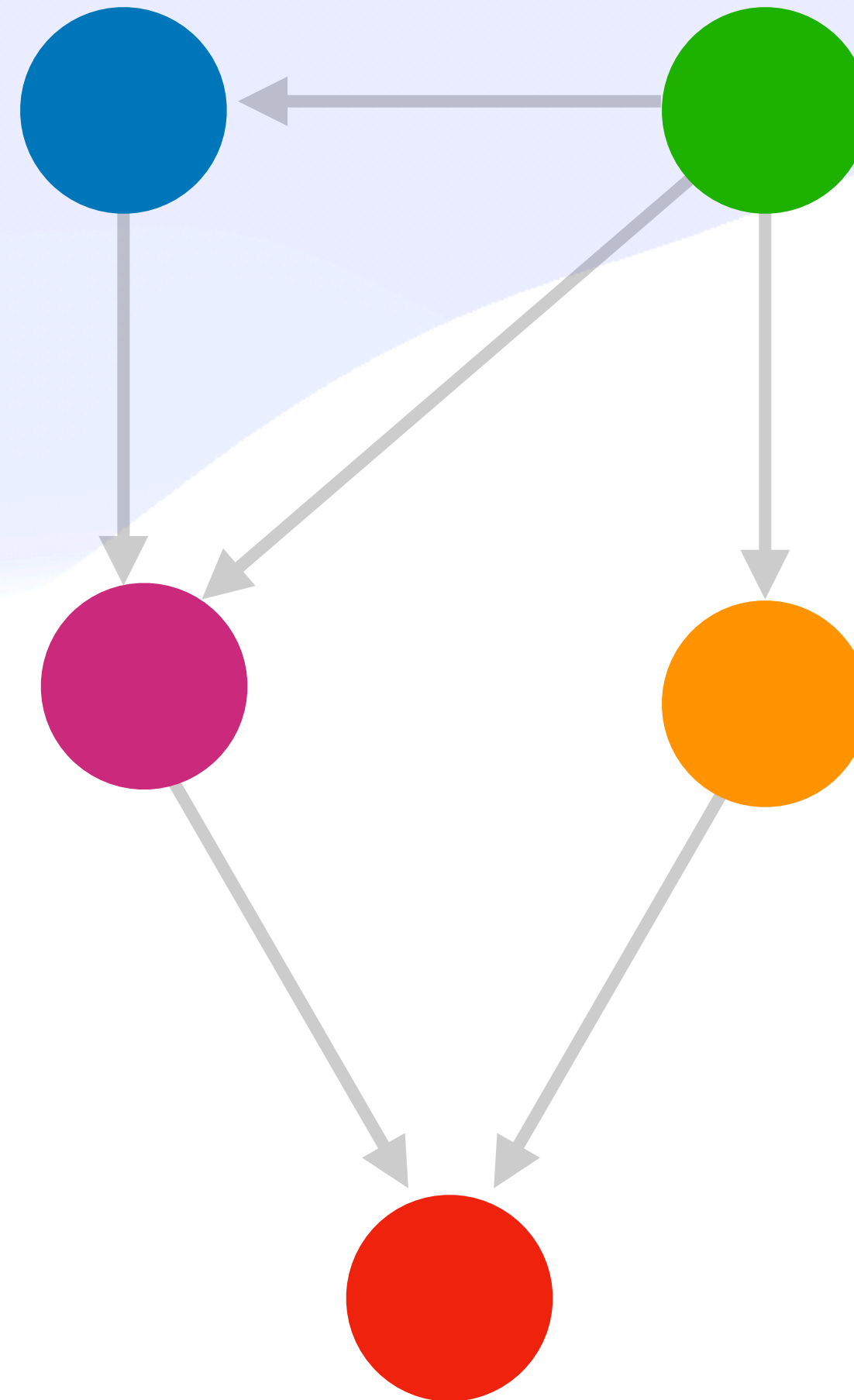
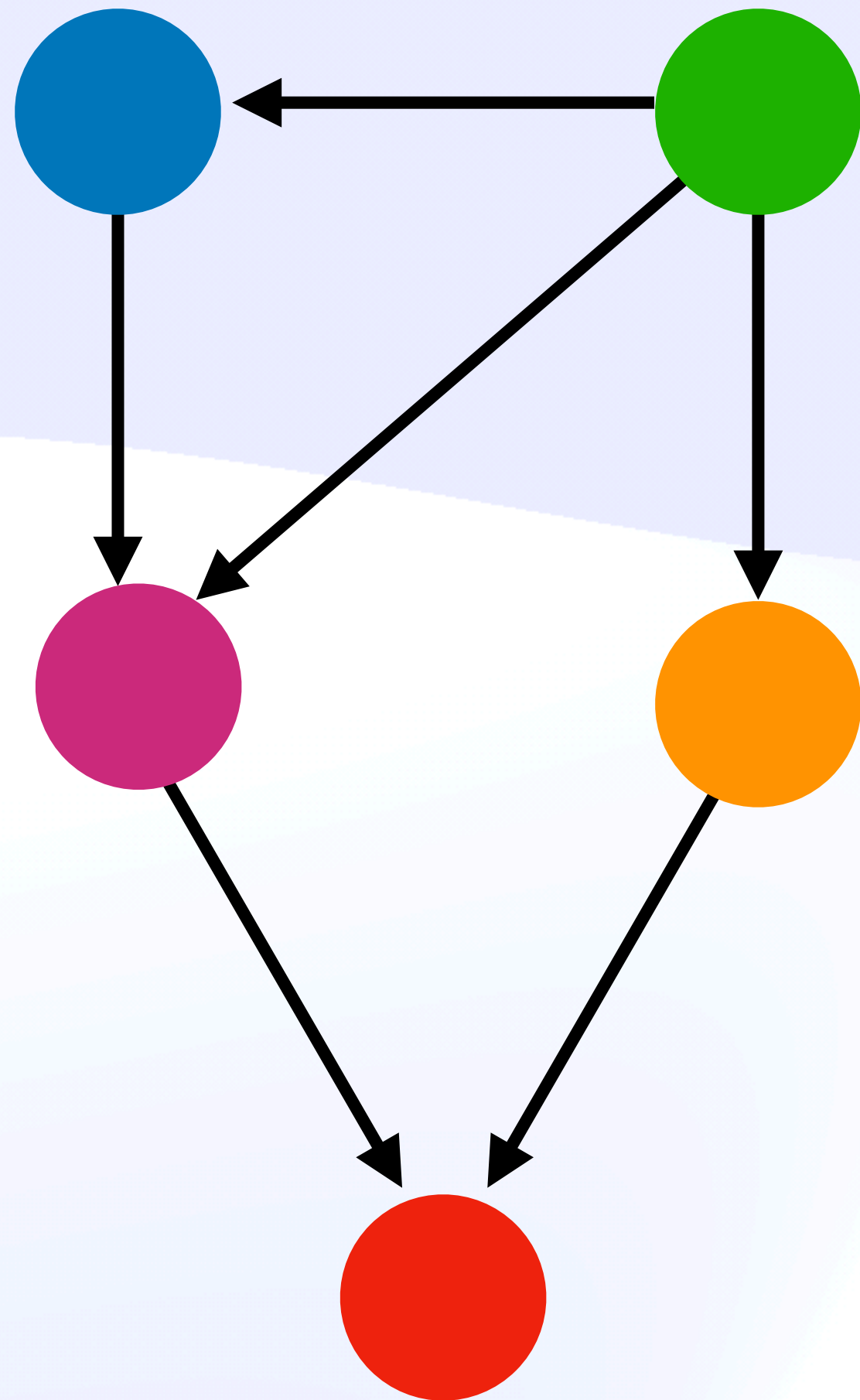
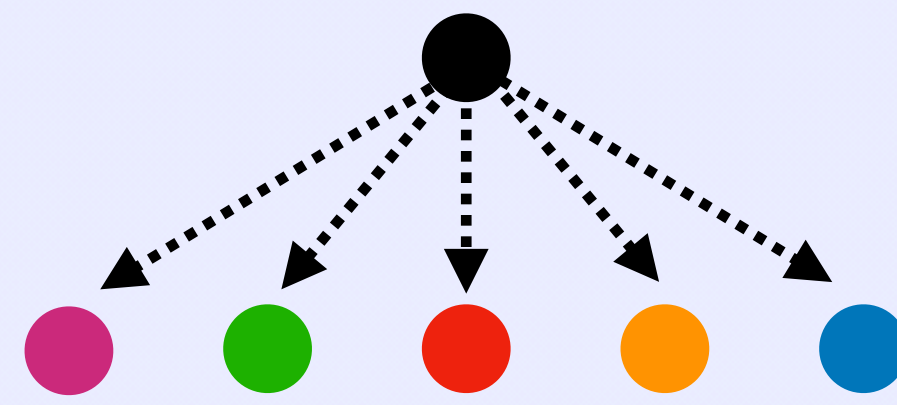
Construction

CAR File(!?)



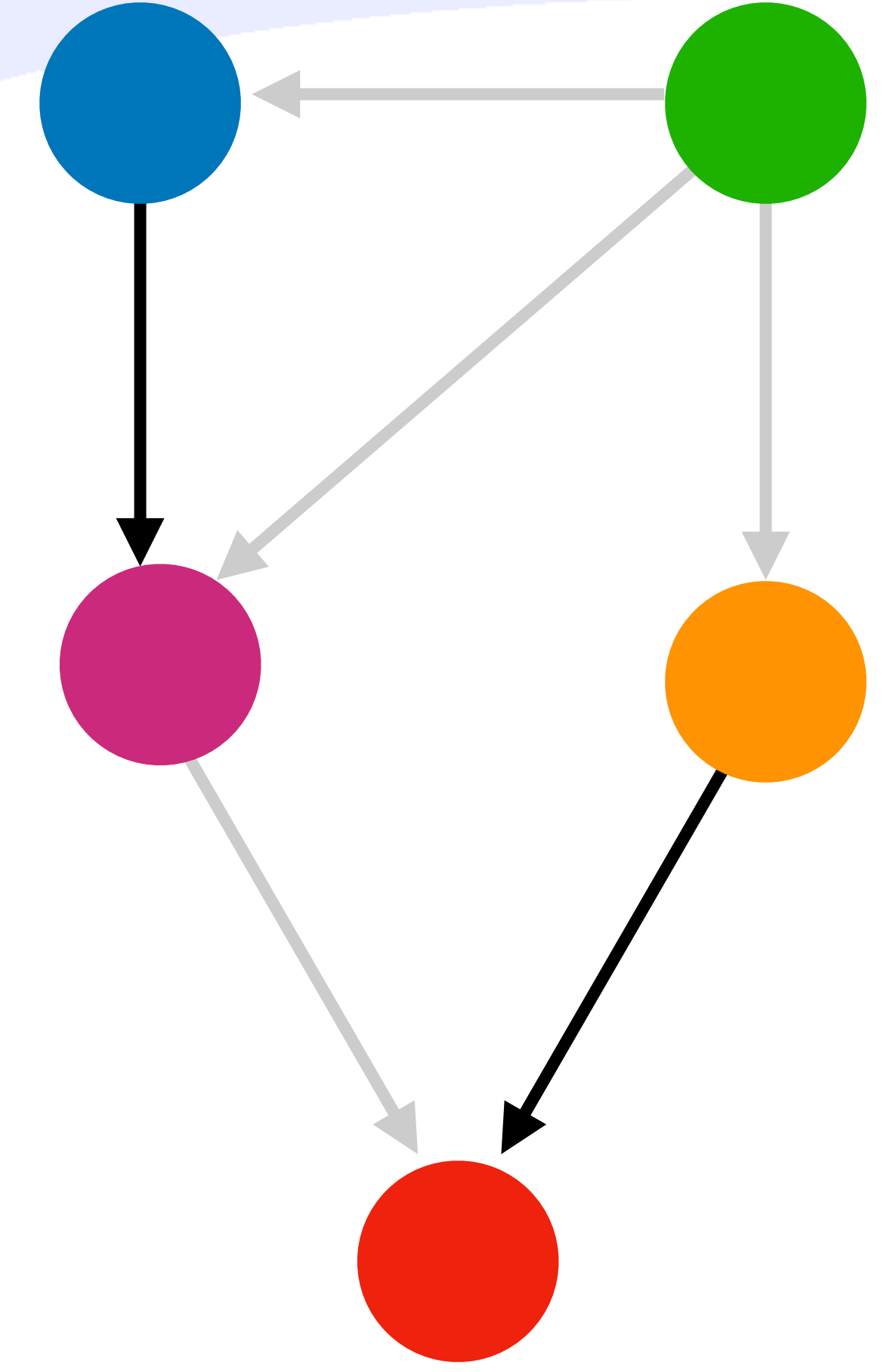
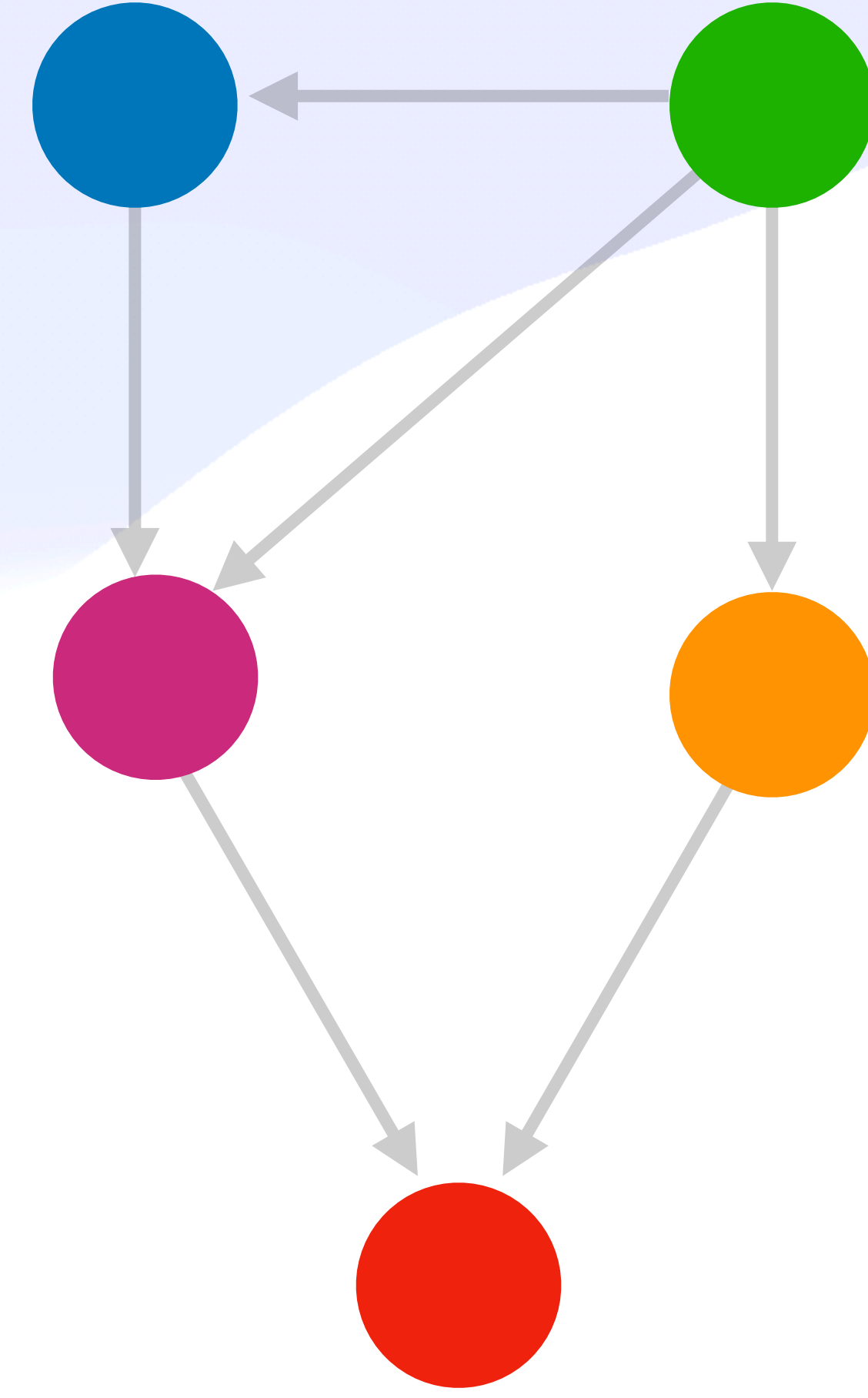
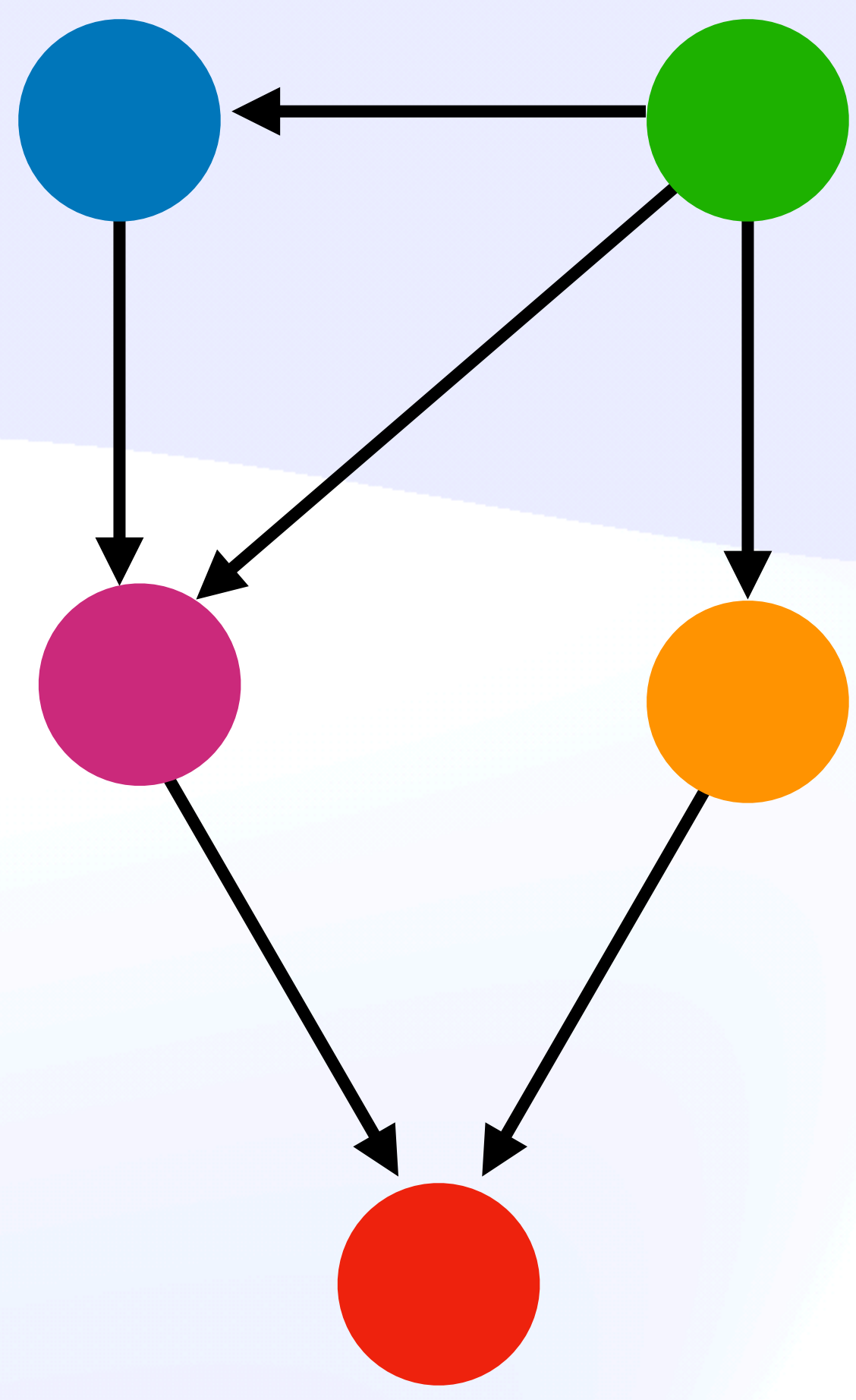
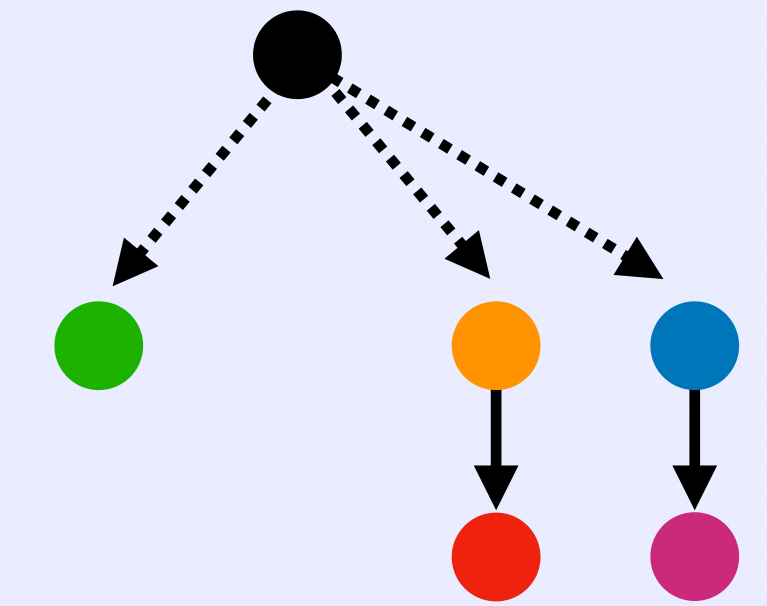
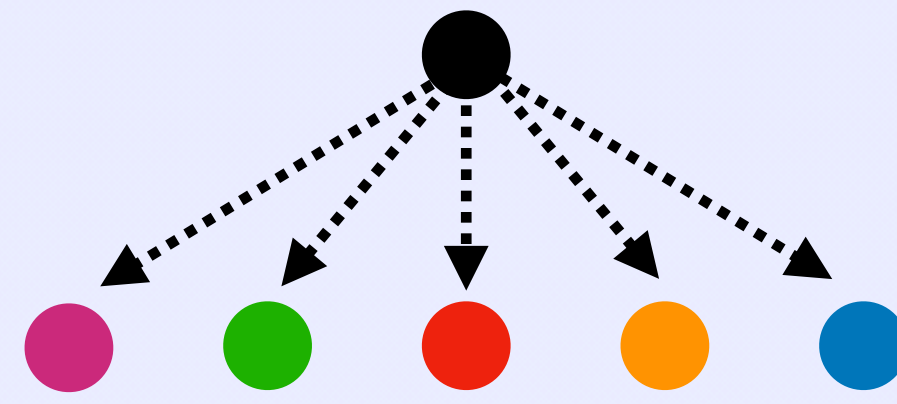
Construction

CAR File(!?)



Construction

CAR File(!?)



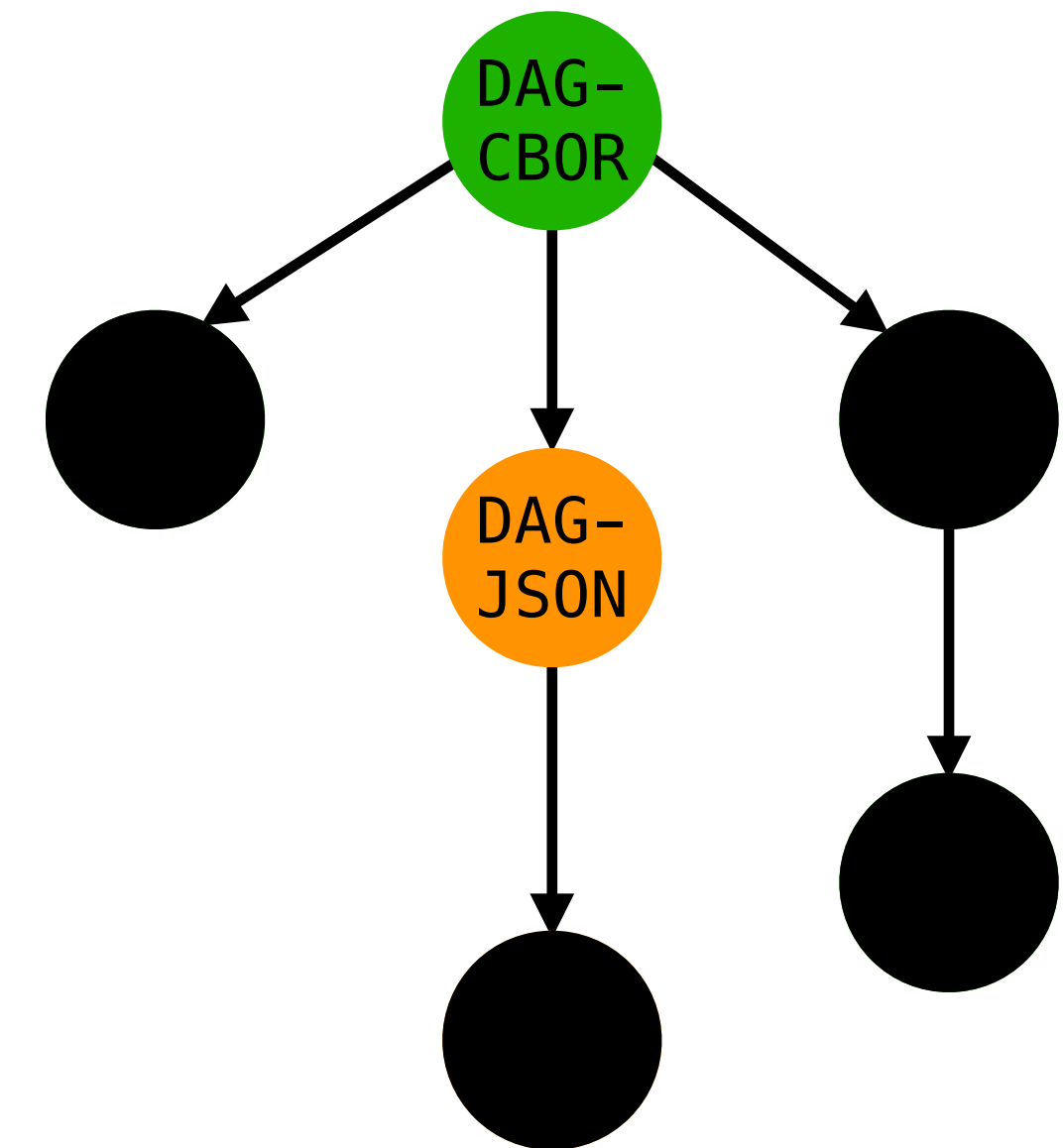
Extraction



Extraction

Run It In Reverse

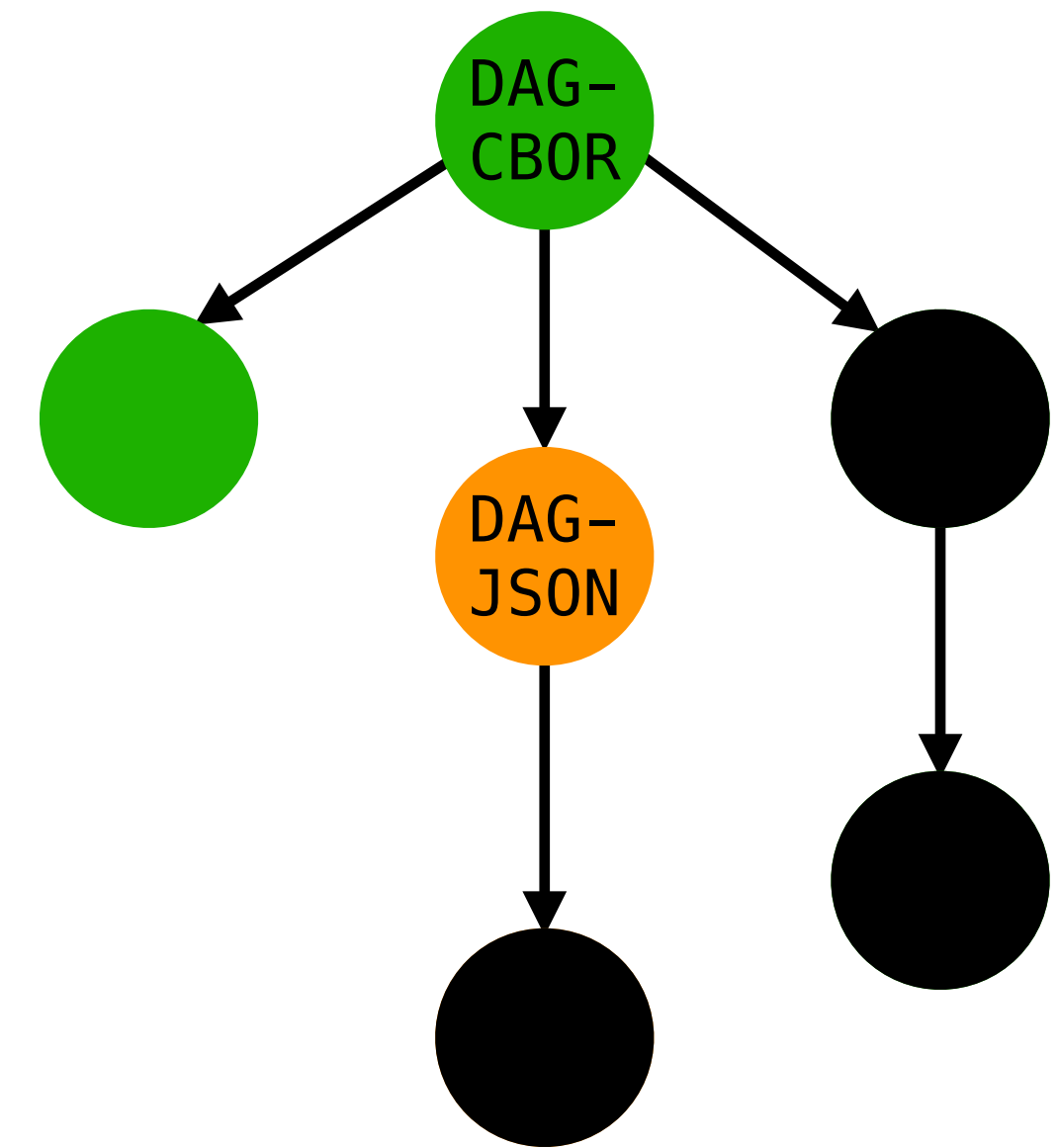
- `extract : InlineIpId → Map Cid IpId`
 - If the inline node has a `&:CID` field
 - Then: use that config
 - Else: use the parent's



Extraction

Run It In Reverse

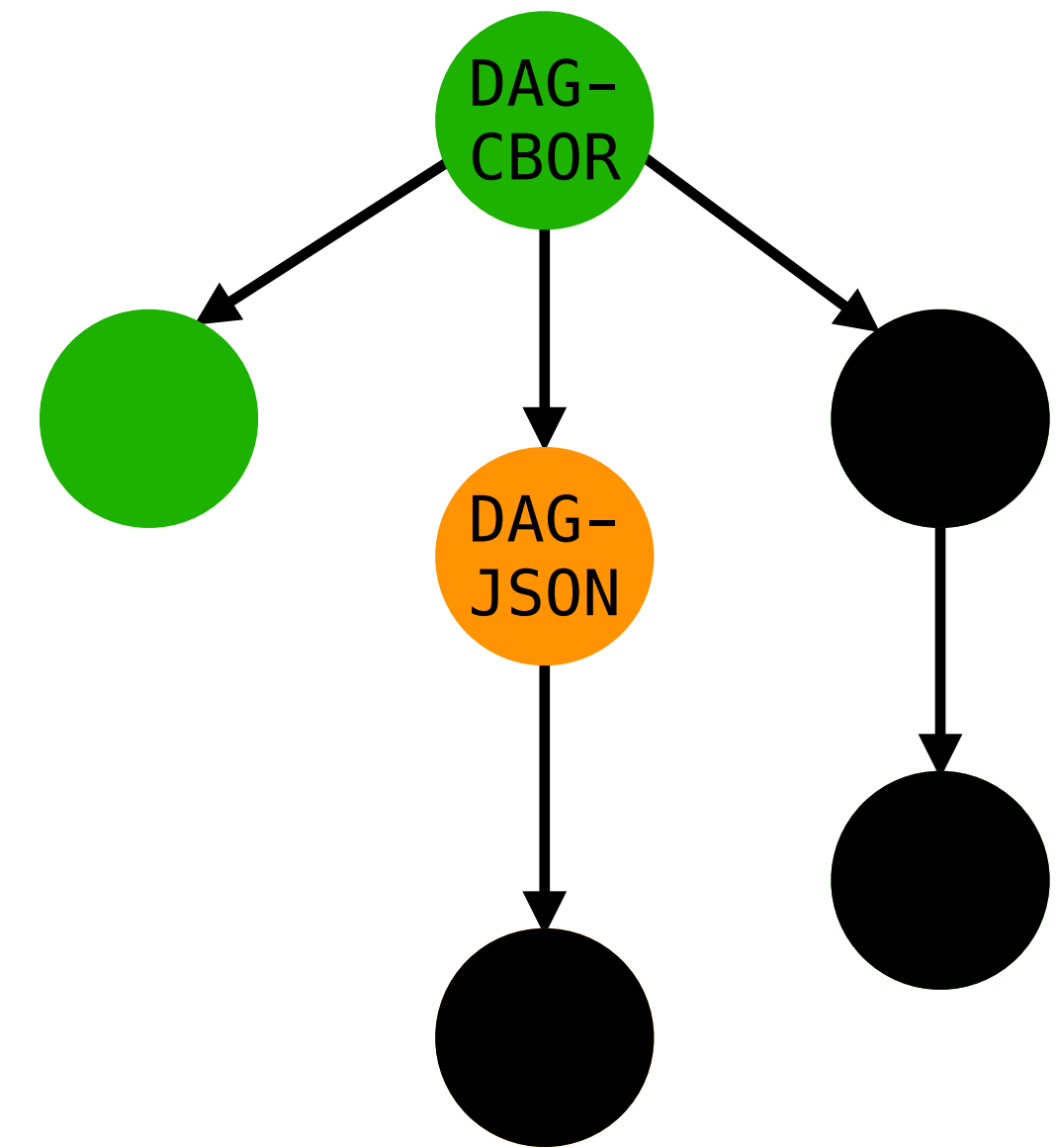
- `extract : InlineIpId → Map Cid IpId`
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Extraction

Run It In Reverse

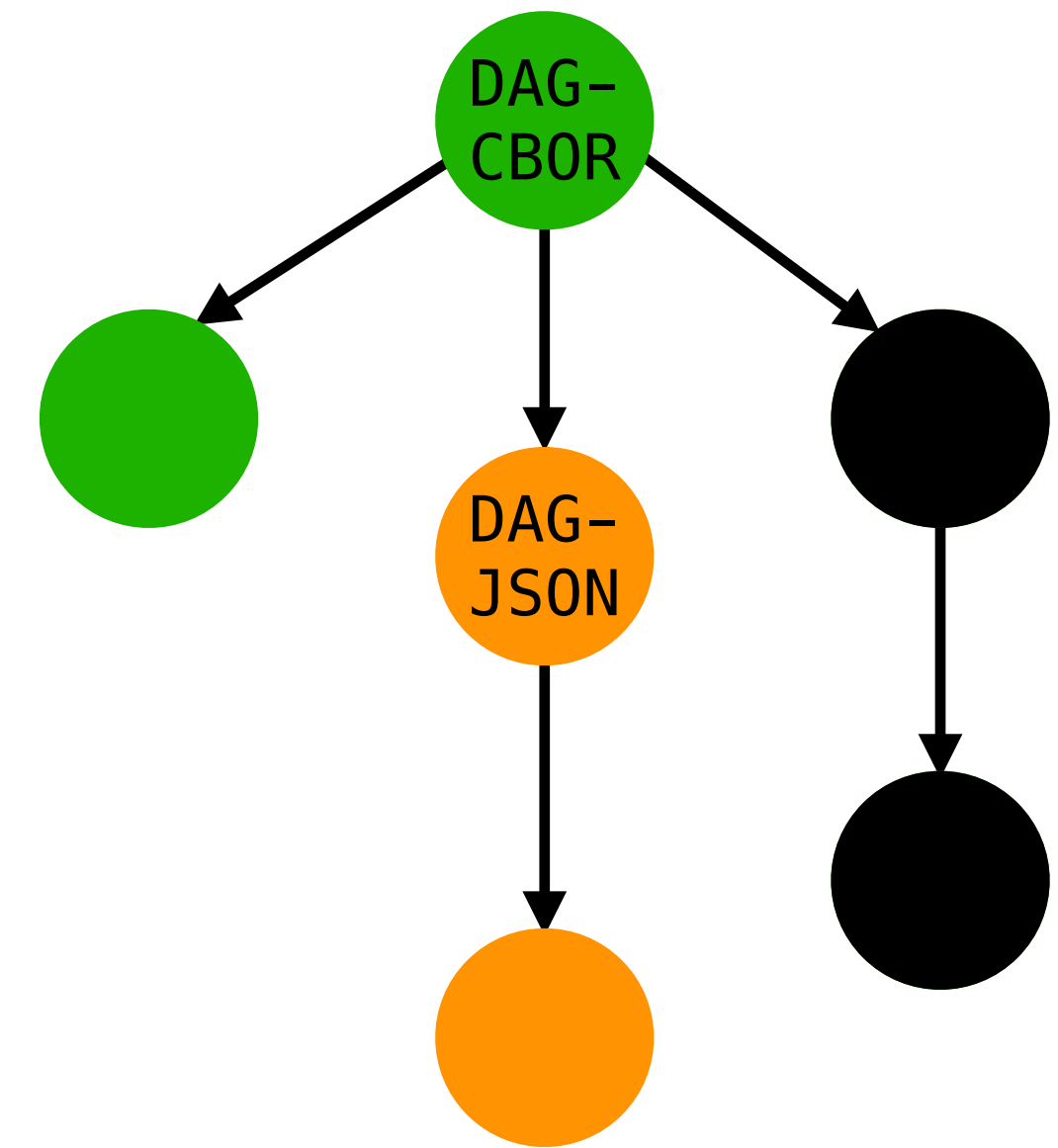
- `extract : InlineIpId → Map Cid IpId`
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Extraction

Run It In Reverse

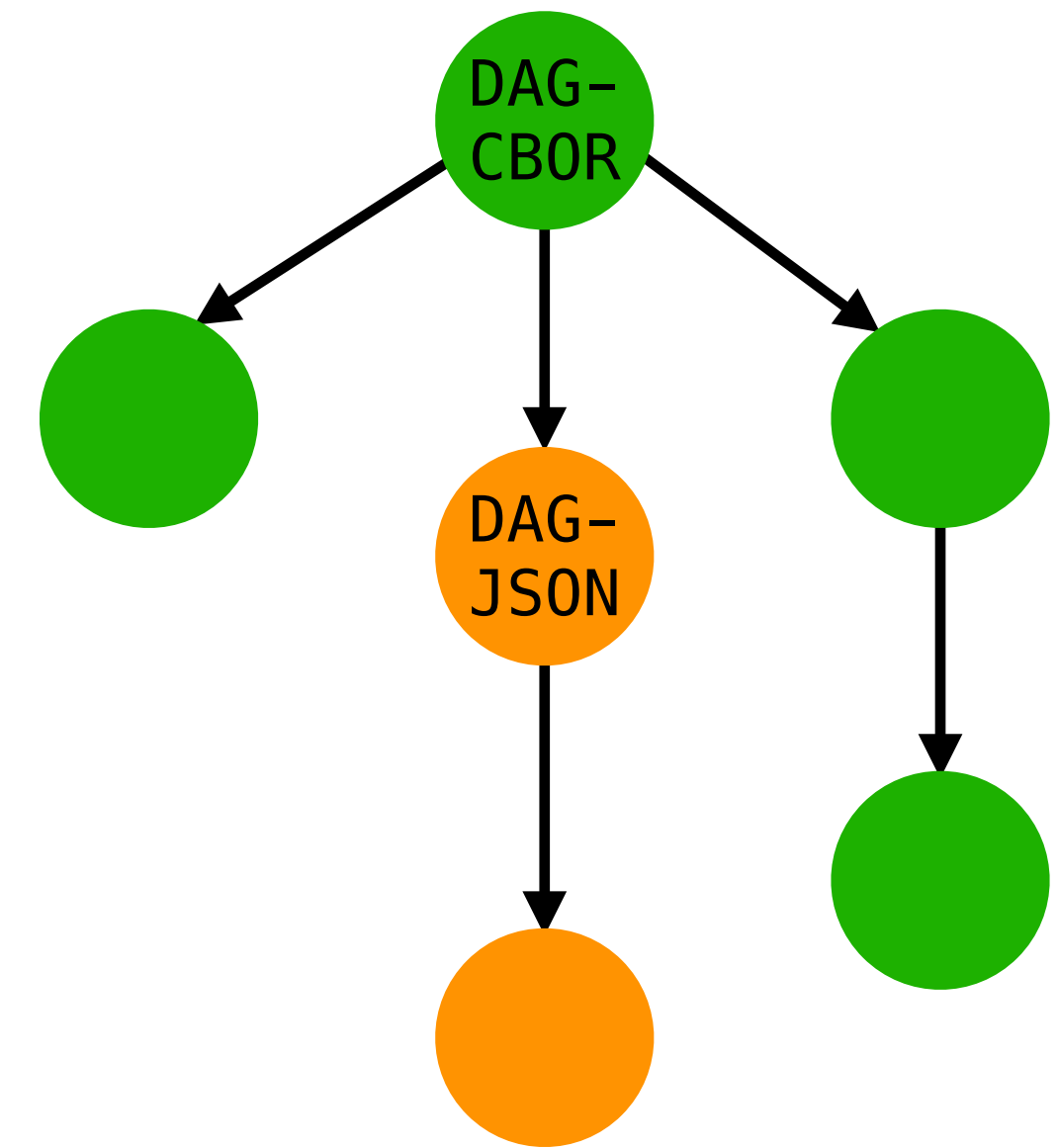
- `extract : InlineIpId → Map Cid IpId`
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Extraction

Run It In Reverse

- `extract : InlineIpId → Map Cid IpId`
 - If the inline node has a `&:CID` field
 - Then: use that config
 - Else: use the parent's



Wrap Up



Wrap Up

Where to Find More

- 📖 Spec — github.com/ucan-wg/ipld-inline-links/blob/first-draft/README.md
- 🦀 Rust
 - Updated to `ipld-core`!
 - (Holding off on `crates` for a bunch of upstream updates to merge)
 - Code: github.com/expede/ipld-inline/tree/wip
- 🇨🇦 Wasm (Vanilla & Components) — coming soon™



Thank You, IPFS Camp!



 @expede.wtf

 @expede@octodon.social

 hello@brooklynzelenka.com

 notes.brooklynzelenka.com