Rationale for Map-Reduce
Map-reduce idea: An Example (part 1)

This example uses JavaScript.

// A trivial example:
alert("I’d like some Spaghetti!");
alert("I’d like some Chocolate Mousse!");

The above can be improved to the following code:
Map-reduce idea: An Example (part 1)

This example uses JavaScript.

    // A trivial example:
    alert("I’d like some Spaghetti！");
    alert("I’d like some Chocolate Mousse！");

The above can be improved to the following code:

    function SwedishChef( food )
    {
        alert("I’d like some " + food + "!");
    }

    SwedishChef("Spaghetti");
    SwedishChef("Chocolate Mousse");
Map-reduce idea: An Example (part 2)

```javascript
alert("get the lobster");
PutInPot("lobster");
PutInPot("water");

alert("get the chicken");
BoomBoom("chicken");
BoomBoom("coconut");
```

The above can be improved to the following code using function pointers!
Map-reduce idea: An Example (part 2)

```javascript
alert("get the lobster");
PutInPot("lobster");
PutInPot("water");

alert("get the chicken");
BoomBoom("chicken");
BoomBoom("coconut");

The above can be improved to the following code using function pointers!

```javascript
function Cook( i1, i2, f )
{
    alert("get the " + i1);
    f(i1);
    f(i2);
}

Cook( "lobster", "water", PutInPot );
Cook( "chicken", "coconut", BoomBoom );
```
Map-reduce idea: An Example (part 3)

Functions can be anonymous (like classes)

Cook( "lobster",
    "water",
    function(x) { alert("pot " + x); } );
Cook( "chicken",
    "coconut",
    function(x) { alert("boom " + x); } );
Map-reduce idea: An Example (part 4)

```javascript
var a = [1,2,3];
for (i=0; i<a.length; i++) {
    a[i] = a[i] * 2;
}
for (i=0; i<a.length; i++) {
    alert(a[i]);
}
```

Doing something to every element of an array can be done by a function using a function pointer for what needs to be done.
Map-reduce idea: An Example (part 4)

```javascript
var a = [1,2,3];
for (i=0; i<a.length; i++) {
    a[i] = a[i] * 2;
}
for (i=0; i<a.length; i++) {
    alert(a[i]);
}

Doing something to every element of an array can be done by a function using a function pointer for what needs to be done.

```javascript
function map(fn, a) {
    for (i = 0; i < a.length; i++) {
        a[i] = fn(a[i]);
    }
}

map( function(x){return x*2;}, a );
map( alert, a );
```
function sum(a)
{
    var s = 0;
    for (i = 0; i < a.length; i++)
        s += a[i];
    return s;
}

function join(a)
{
    var s = "";
    for (i = 0; i < a.length; i++)
        s += a[i];
    return s;
}

alert(sum([1,2,3]));
alert(join(["a","b","c"]));
function reduce(fn, a, init)
{
    var s = init;
    for (i = 0; i < a.length; i++)
        s = fn( s, a[i] );
    return s;
}

function sum(a)
{
    return reduce( function(a, b){ return a + b; }, a, 0 );
}

function join(a)
{
    return reduce( function(a, b){ return a + b; }, a, "" );
}
Map-reduce idea

- The map function is embarrassingly parallel.
Map-reduce idea

- The map function is embarrassingly parallel.
- The reduce function is nearly embarrassingly parallel.
Map-reduce idea

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- The reduce function is nearly embarrassingly parallel.
- Someone else can write generic map and reduce code that scales to thousands of systems with massive data sets that span thousands of disks and can tolerate failures of components.... How do we go around doing that?
Map-reduce idea

- The map function is embarrassingly parallel.
- The reduce function is nearly embarrassingly parallel.
- Someone else can write generic map and reduce code that scales to thousands of systems with massive data sets that span thousands of disks and can tolerate failures of components.... How do we go around doing that?
- Now as long as we can recast our problem as a map-reduce problem, it will automatically scale to thousands of processes!
Map-reduce implementation

- How to scale a parallel program to thousands of processes successfully?
Map-reduce implementation

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- How to deal with massive amounts of data that doesn’t fit on one system?
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  - Distributed file system.
  - Move code to data instead of the other way around.
Map-reduce implementation

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- How to deal with massive amounts of data that doesn’t fit on one system?
  - Distributed file system.
  - Move code to data instead of the other way around.
- How to deal with machines and components failing while the program is running?
Reference

- *Can Your Programming Language Do This?* by Joel Spolsky.
  http://www.joelonsoftware.com/items/2006/08/01.html