GARNET

Thursday Update

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```
////////////////////////////////////////
//                                    //
//   POINT-WISE FUNCTION DEFINITIONS  //
//                                    //
////////////////////////////////////////

auto porosity_evolution = [&]( double P_t, double P_f )
    { return ( P_f - P_t ) / η_φ; };

auto total_density = [&]( double& φc )
    { return ρ_s * ( 1 - φc ) + ρ_f * φc; };

auto bulk_constitutive = [&]( double ϵ )
    { return 2 * η_s * ϵ; };

auto bulk_momentum_balance = [&]( double Δτ, double ΔP_t, double ρ_t, double g )
    { return Δτ - ΔP_t + ρ_t * g; };

auto bulk_mass_balance = [&]( double Δv_s, double P_t, double P_f, double φ )
    { return Δv_s + ( P_t - P_f ) / ( 1 - φ ) / η_φ ); };

auto darcy_flux = [&]( double ΔP_f, double φc, double g )
    { return  -k0 / η_f * std::pow(φc/φ0,3) * ( ΔP_f - ρ_f * g ); };

auto fluid_mass_momentum_balance = [&]( double Δq_D, double P_t, double P_f, double φ )
    { return Δq_D - ( P_t - P_f ) / ( 1 - φ ) / η_φ ); };
```

__host__ __device__

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```
////////////////////////////////////////
//                                    //
//   OBJECTIVE FUNCTION DEFINITION    //
//                                    //
////////////////////////////////////////

auto residual_evaluation = [&]( auto& Rv_s, auto& RP_t, auto& RP_f )
{
    // Porosity evolution
    φ.SetAlpha( 0. );
    φ.SetBeta ( porosity_evolution, P_t[0], P_f[0] );
    φ.TrivialSolve<BDF<1>>();

    φc.IsInterpolationOf( φ[0] );

    // Bulk momentum balance
    τ   .Set( bulk_constitutive, ϵ().RemoveTrace() );
    ρ_t .Set( total_density, φc );
    Rv_s.Set( bulk_momentum_balance, Δτ(), ΔP_t(), ρ_t, g );

    // Bulk mass balance
    RP_t.Set( bulk_mass_balance, Δv_s(), P_t[0], P_f[0], φ[0] );

    // Fluid mass and momentum balance
    q_D .Set( darcy_flux, ΔP_f(), φc, g );
    RP_f.Set( fluid_mass_momentum_balance, Δq_D(), P_t[0], P_f[0], φ[0] );
};
```

Working on GPU

GARNET

```
//////////////////////////////////////
//                                  //
//   OBJECTIVE FUNCTION DEFINITION  //
//                                  //
//////////////////////////////////////

auto residual_evaluation = [&]( auto& Rv_s, auto& RP_t, auto& RP_f )
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    // Bulk mass balance
    RP_t.Set( bulk_mass_balance, Δv_s(), P_t[0], P_f[0], φ[0] );

    // Fluid mass and momentum balance
    q_D .Set( darcy_flux, ΔP_f(), φc, g );
    RP_f.Set( fluid_mass_momentum_balance, Δq_D(), P_t[0], P_f[0], φ[0] );
};
```
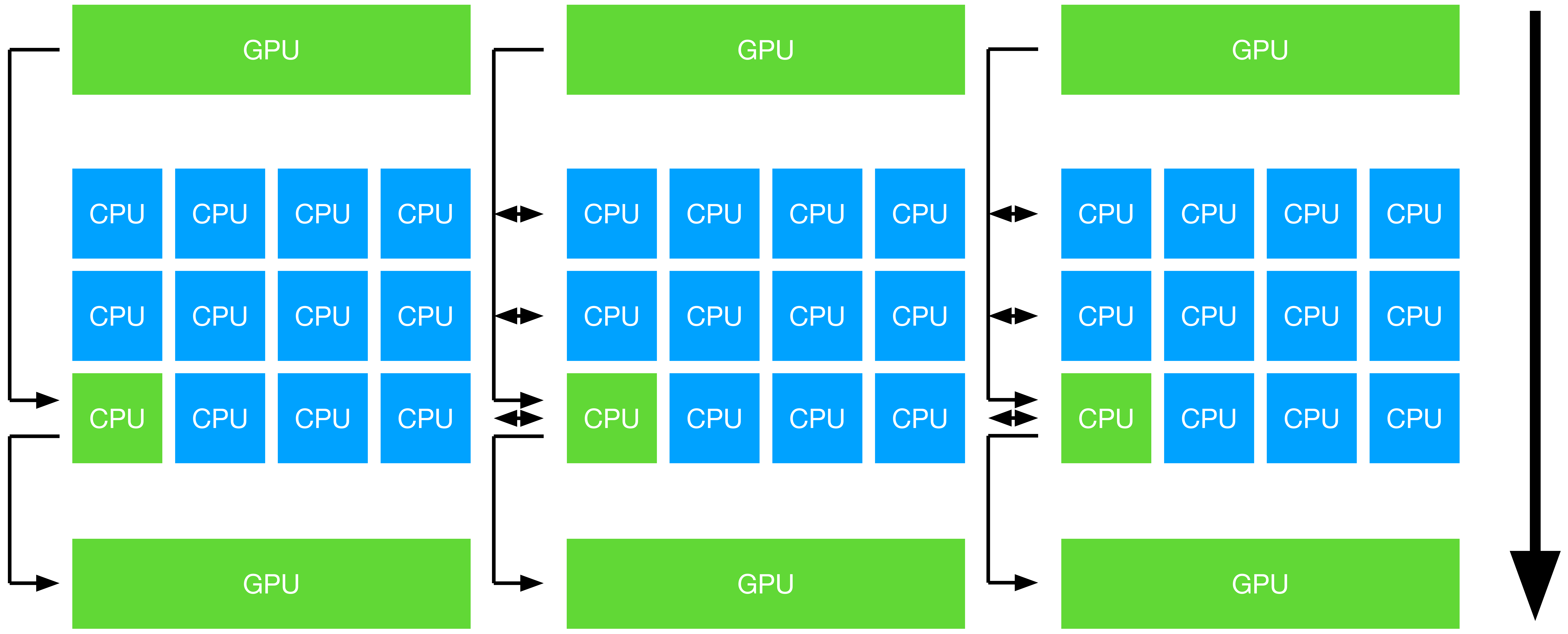

Working on it!

GARNET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- **We are using GPUs from Garnet!** Via C++ lambdas and Thrust

  Via class to manage both MPI3 shared memory and device memory (rank 0 dispatches GPU work)

  - Made GPU-aware version of `std::array (float3` [...] `)`
  - Based on `thrust::device_vectors` and pointers to host memory
- Status: Implementing whole User Interface functionality Thrust-aware
- After this week: merge CPU- and GPU-capable versions into one code.

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