

Title: Tutorial 5A: Navigator examples and Skydiving examples in Hyperion setting

Speakers: Aike Liu

Collection: Mini-Course of Numerical Conformal Bootstrap

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URL: <https://pirsa.org/23040149>

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Hyperion Tutorial 4

Skydiving onto Ising Island

Bootstrap Mini Course: Tutorial 5a

Aike Liu

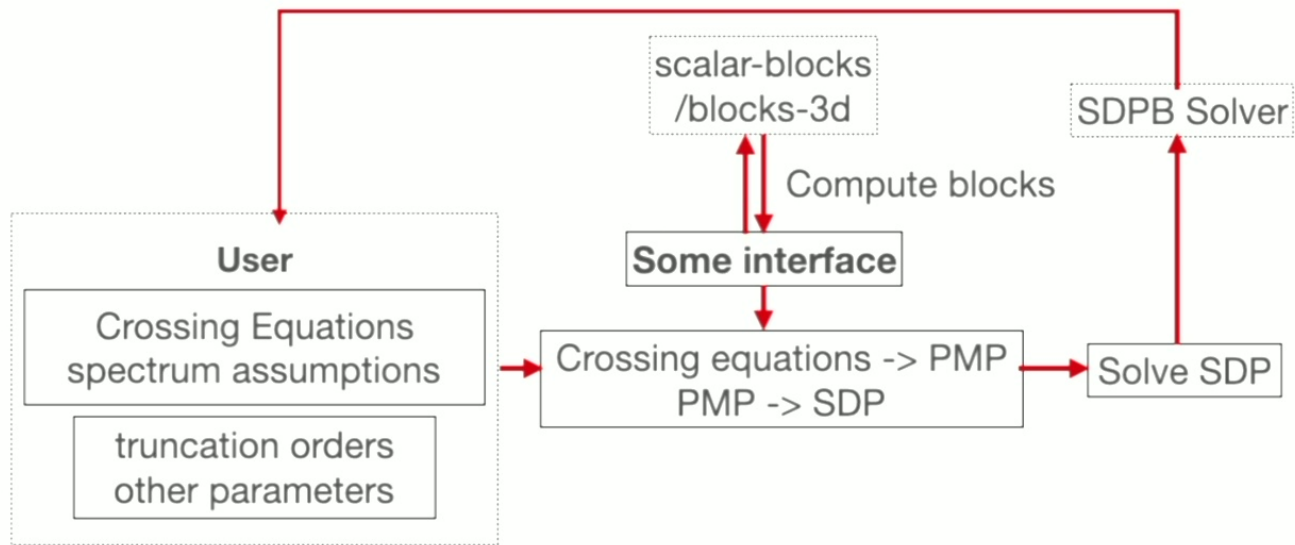
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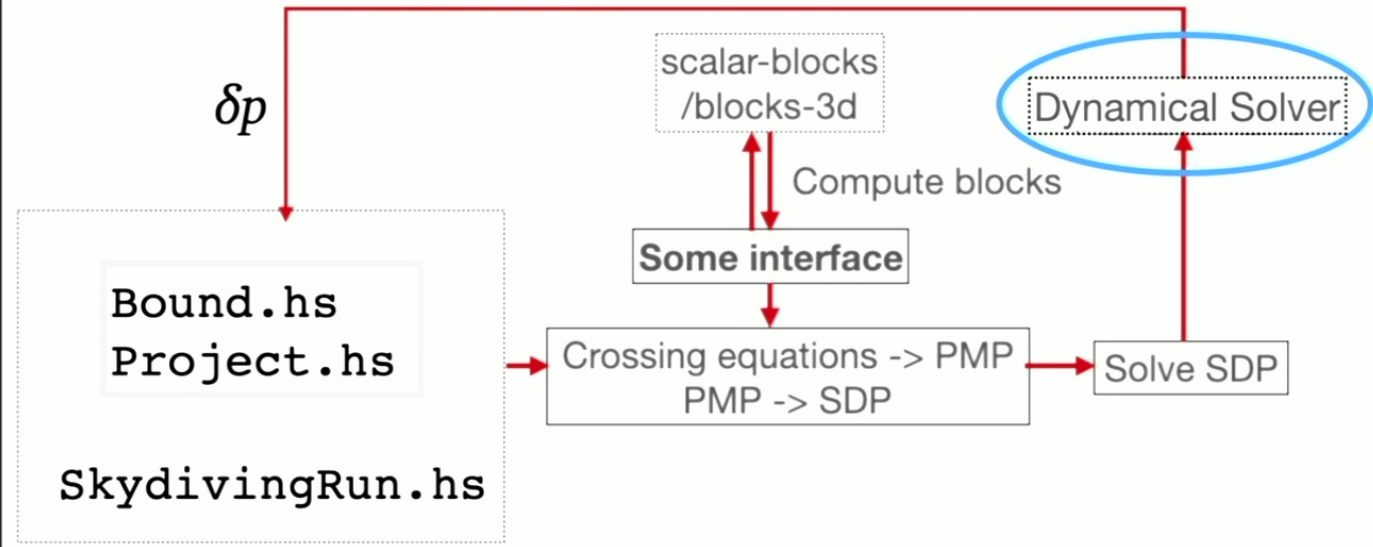


PMP: Positive Matrix Programming

SDP: Semidefinite Programming

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SkydivingRun.hs

```
data DynamicalConfig n a = DynamicalConfig  
defaultDynamicalConfig :: (Num a) => Int -> Dyna
```

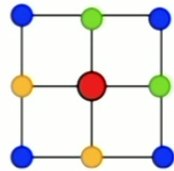
```
fig dim = DynamicalConfig
```

```
{ externalParamInfinitesimal= 1e-20  
  , centeringRThreshold      = 1e-20  
  , dualityGapUpperLimit    = 0.1  
  , betaScanMin              = 0.1 --Same as sdpb-skydi  
  , betaScanMax              = 1.01 --Same as sdpb-skydi  
  , betaScanStep             = 0.1 --Same as sdpb-skydi  
  , stepMinThreshold         = 0.1 --Same as sdpb-skydi  
  , stepMaxThreshold         = 0.6 --Same as sdpb-skydi  
  , primalDualObjWeight      = 0.2 --Same as sdpb-skydi  
  , maxClimbingSteps         = 1 --Same as sdpb-skydi  
  , betaClimbing              = 2 --Same as sdpb-skydi  
  , navigatorWithLogDetX     = False --Same as sdpb-skydi  
  , gradientWithLogDetX      = True --Same as sdpb-skydi  
  , finiteDualityGapTarget   = 0 --Same as sdpb-skydi  
  , findBoundaryDirection    = Nothing  
  , findBoundaryObjThreshold = Nothing  
  , useExactHessian          = False  
  , prevExternalStep         = Nothing  
  , prevGradient              = Nothing  
  , prevHessian               = Nothing  
  , totalIterationCount      = 0  
  , bBoxMax                   = initVec  
  , bBoxMin                   = initVec  
}
```

```
where
```

```
initVec = V $ V.fromList $ take dim (repeat 1)
```

```
initMat = M.fromListsUnsafe $ take dim (repeat $ take dim (repe
```



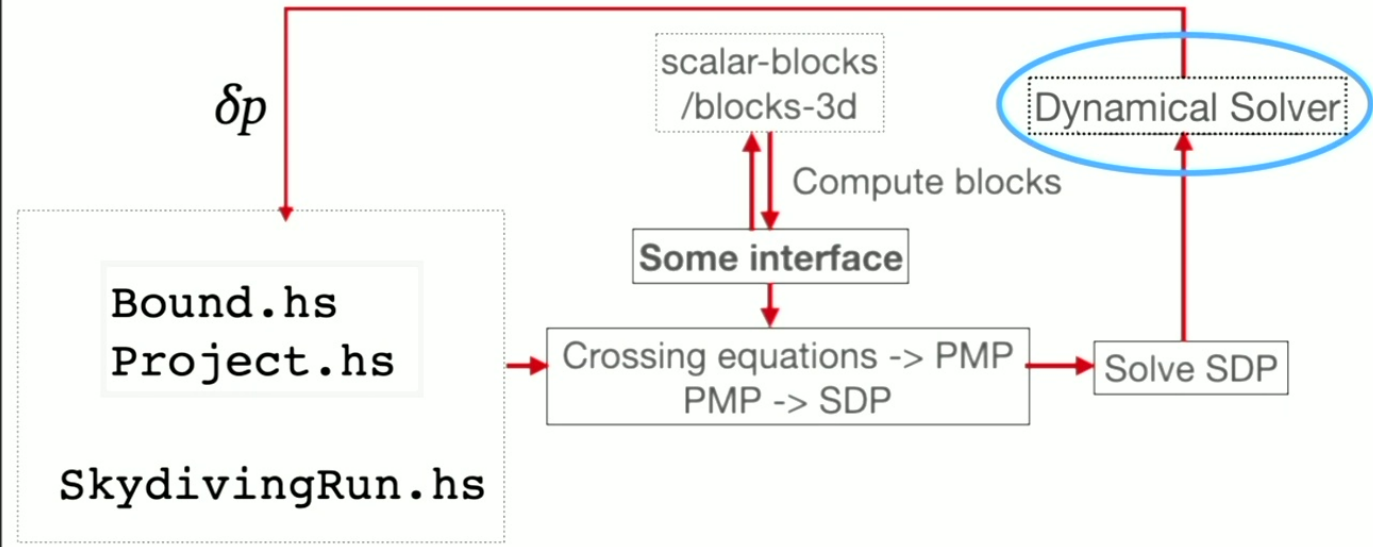
Quasi-Newton method
Rank 1 Hessian update
BFGS

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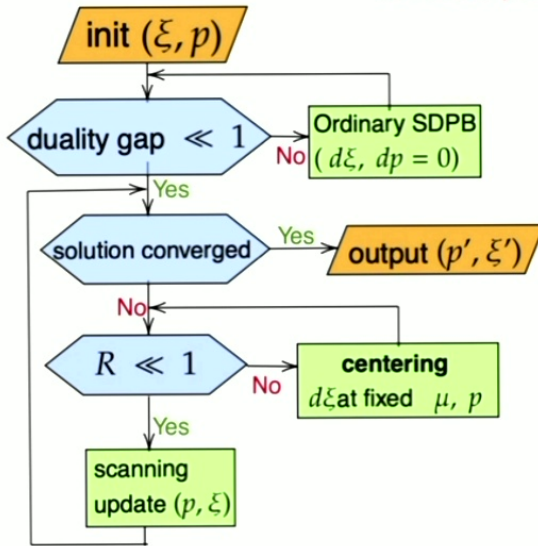
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SkydivingRun.hs



```

data DynamicalConfig n a = DynamicalConfig
defaultDynamicalConfig :: (Num a) => Int -> Dyna

```

```

= DynamicalConfig
{ externalParamInfinitesimal= 1e-20
, centeringRThreshold       = 1e-20
, dualityGapUpperLimit     = 0.1
, betaScanMin              = 0.1 -- Same as sdpb-skyd
, betaScanMax              = 1.01 -- Same as sdpb-skyd
, betaScanStep             = 0.1 -- Same as sdpb-skyd
, stepMinThreshold         = 0.1 -- Same as sdpb-skyd
, stepMaxThreshold         = 0.6 -- Same as sdpb-skyd
, primalDualObjWeight      = 0.2 -- Same as sdpb-skyd
, maxClimbingSteps         = 1 -- Same as sdpb-skyd
, betaClimbing             = 2 -- Same as sdpb-skyd
, navigatorWithLogDetX     = False -- Same as sdpb-skyd
, gradientWithLogDetX     = True -- Same as sdpb-skyd
, finiteDualityGapTarget   = 0 -- Same as sdpb-skyd
, findBoundaryDirection    = Nothing
, findBoundaryObjThreshold = Nothing
, useExactHessian          = False
, prevExternalStep         = Nothing
, prevGradient             = Nothing
, prevHessian              = Nothing
, totalIterationCount      = 0
, bBoxMax                  = initVec
, bBoxMin                  = initVec
}

```

where

```

initVec = V $ V.fromList $ take dim (repeat 1)
initMat = M.fromListsUnsafe $ take dim (repeat $ take dim (rep

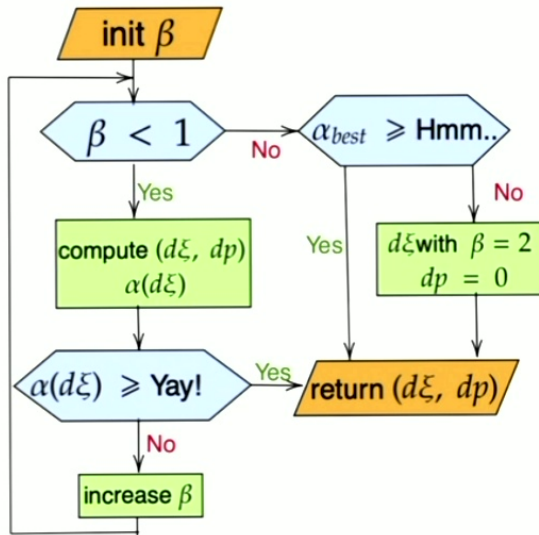
```

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SkydivingRun.hs

```
data DynamicalConfig n a = DynamicalConfig
defaultDynamicalConfig :: (Num a) => Int -> Dyna
```



Yay! \geq Hmm..
 $\alpha_{best} \equiv \max_{\beta} \{\alpha(\beta)\}$

```
= DynamicalConfig
{ externalParamInfinitesimal= 1e-20
, centeringRThreshold        = 1e-20
, dualityGapUpperLimit       = 0.1
, betaScanMin                 = 0.1
, betaScanMax                 = 1.01
, betaScanStep                = 0.1
, stepMinThreshold            = 0.1
, stepMaxThreshold            = 0.6
, primalDualObjWeight         = 0.2
, maxClimbingSteps            = 1
, betaClimbing                 = 2
, navigatorWithLogDetX        = False
, gradientWithLogDetX         = True
, finiteDualityGapTarget      = 0
, findBoundaryDirection       = Nothing
, findBoundaryObjThreshold    = Nothing
, useExactHessian              = False
, prevExternalStep            = Nothing
, prevGradient                 = Nothing
, prevHessian                  = Nothing
, totalIterationCount         = 0
, bBoxMax                      = initVec
, bBoxMin                      = initVec
}
```

```
where
initVec = V $ V.fromList $ take dim (repeat 1)
initMat = M.fromListsUnsafe $ take dim (repeat $ take dim (repeat 1))
```

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SkydivingRun.hs

```
data DynamicalConfig n a = DynamicalCo...
```

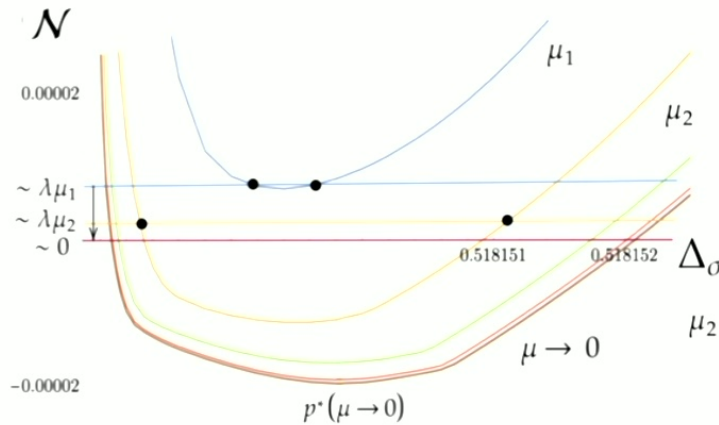
```
defaultDynamicalConfig :: (Num a) => Int
```

```
dim = DynamicalConfig
```

```
{ externalParamInfinitesimal= 1e-20
, centeringRThreshold      = 1e-20
, dualityGapUpperLimit    = 0.1
, betaScanMin              = 0.1 --Same as s
, betaScanMax              = 1.01 --Same as s
, betaScanStep             = 0.1 --Same as s
, stepMinThreshold         = 0.1 --Same as s
, stepMaxThreshold         = 0.6 --Same as s
, primalDualObjWeight      = 0.2 --Same as s
, maxClimbingSteps         = 1 --Same as s
, betaClimbing             = 2 --Same as s
, navigatorWithLogDetX     = False --Same as s
, gradientWithLogDetX     = True --Same as s
, finiteDualityGapTarget   = 0 --Same as s
, findBoundaryDirection    = Nothing
, findBoundaryObjThreshold = Nothing
, useExactHessian          = False
, prevExternalStep         = Nothing
, prevGradient             = Nothing
, prevHessian              = Nothing
, totalIterationCount     = 0
, bBoxMax                  = initVec
, bBoxMin                  = initVec
}
```

$$L_\mu = 0 \text{ and } \nabla_\xi L_\mu = 0 \text{ and } \lambda v = \nabla_p L_\mu \text{ and } \lambda > 0$$

$$L_\mu = 0 \Rightarrow L_\mu(x, y, X, Y) = \lambda \mu \dim(X)$$



where

```
initVec = V $ V.fromList $ take dim (repeat 1)
initMat = M.fromListsUnsafe $ take dim (repeat $ take
```

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SkydivingRun.hs

```
data DynamicalConfig n a = DynamicalCo...
```

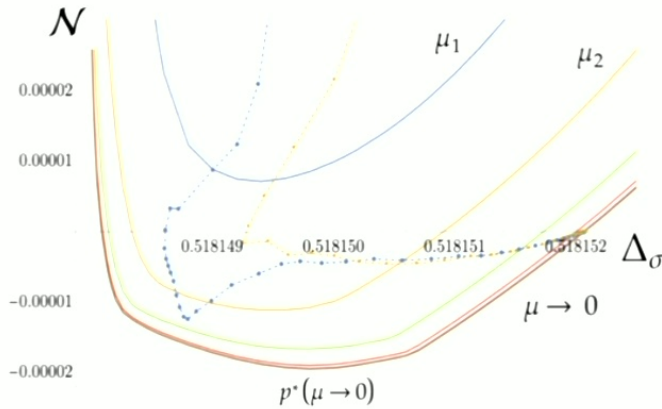
```
defaultDynamicalConfig :: (Num a) => Int
```

```
dim = DynamicalConfig
```

```
{ externalParamInfinitesimal= 1e-20
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  , dualityGapUpperLimit     = 0.1
  , betaScanMin              = 0.1 --Same as s
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  , betaScanStep             = 0.1 --Same as s
  , stepMinThreshold         = 0.1 --Same as s
  , stepMaxThreshold         = 0.6 --Same as s
  , primalDualObjWeight      = 0.2 --Same as s
  , maxClimbingSteps         = 1 --Same as s
  , betaClimbing             = 2 --Same as s
  , navigatorWithLogDetX     = False --Same as s
  , gradientWithLogDetX     = True --Same as s
  , finiteDualityGapTarget   = 0 --Same as s
  , findBoundaryDirection    = Nothing
  , findBoundaryObjThreshold = Nothing
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  , prevExternalStep         = Nothing
  , prevGradient              = Nothing
  , prevHessian               = Nothing
  , totalIterationCount     = 0
  , bBoxMax                   = initVec
  , bBoxMin                   = initVec
}
```

$$L_\mu = 0 \text{ and } \nabla_\xi L_\mu = 0 \text{ and } \lambda v = \nabla_p L_\mu \text{ and } \lambda > 0$$

$$L_\mu = 0 \Rightarrow L_\mu(x, y, X, Y) = \lambda \mu \dim(X) - \mu \log \det X$$



where

```
initVec = V $ V.fromList $ take dim (repeat 1)
initMat = M.fromListsUnsafe $ take dim (repeat $ take
```

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SkydivingRun.hs

```
data DynamicalConfig n a = DynamicalConfig
defaultDynamicalConfig :: (Num a) => Int -> DynamicalConfig

dim = DynamicalConfig
  { externalParamInfinitesimal= 1e-20
  , centeringRThreshold       = 1e-20
  , dualityGapUpperLimit     = 0.1
  , betaScanMin              = 0.1 --Same as sdpb-skydiving
  , betaScanMax              = 1.01 --Same as sdpb-skydiving
  , betaScanStep             = 0.1 --Same as sdpb-skydiving
  , stepMinThreshold         = 0.1 --Same as sdpb-skydiving
  , stepMaxThreshold         = 0.6 --Same as sdpb-skydiving
  , primalDualObjWeight      = 0.2 --Same as sdpb-skydiving
  , maxClimbingSteps         = 1 --Same as sdpb-skydiving
  , betaClimbing             = 2 --Same as sdpb-skydiving
  , navigatorWithLogDetX     = False --Same as sdpb-skydiving
  , gradientWithLogDetX      = True --Same as sdpb-skydiving
  , finiteDualityGapTarget   = 0 --Same as sdpb-skydiving
  , findBoundaryDirection    = Nothing
  , findBoundaryObjThreshold = Nothing
  , useExactHessian          = False
  , prevExternalStep         = Nothing
  , prevGradient             = Nothing
  , prevHessian              = Nothing
  , totalIterationCount      = 0
  , bBoxMax                  = initVec
  , bBoxMin                  = initVec
  }

where
  initVec = V $ V.fromList $ take dim (repeat 1)
  initMat = M.fromListsUnsafe $ take dim (repeat $ take dim (repeat 0
```

To be implemented

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DynamicalSdpTest.hs

dynamicalSdpBoundLoop

```
:: forall n a . (KnownNat n, RealFloat a, Show a, ToJSON a, FromJSON a, Typeable a)
=> BoundFiles
-> DynamicalConfig n a
-> V n a
-> (V n a -> Bound Int IsingSigEps)
-> Int
-> Job (V n a)
```

```
dynamicalSdpBoundLoop boundFiles dynConfig startPoint mkBound numIters = do
```

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DynamicalSdpTest.hs

```
go p 0 _ = pure p
go p n dynconfig = do
  dynSdpOut <- runDynamicalSdpBound srunDynamicalSdpPath boundFiles dynconfig p mkBound
  let p' = p + externalParamStep dynSdpOut
  Log.info "dynamicalSdpBoundLoop: Computed" dynSdpOut
  Log.info "dynamicalSdpBoundLoop: Testing point" p'
  DB.insert prevDynamicalMap (numIters::Int) $
    DynamicalDBOutput
      { prevIterations = totalIterations dynSdpOut
      , bfgsGradient = gradientBFGS dynSdpOut
      , bfgsHessian = hessianBFGS dynSdpOut
      , extPara = p'
      , extStep = externalParamStep dynSdpOut
      }
  let dynconfig' = dynconfig { totalIterationCount = totalIterations dynSdpOut
                              , prevExternalStep = Just (externalParamStep dynSdpOut)
                              , prevGradient = Just (gradientBFGS dynSdpOut)
                              , prevHessian = Just (hessianBFGS dynSdpOut)
                              --, useExactHessian = (n < 201)
                              }
```

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DynamicalSdpTest.hs

```
testDynamicalSdpIsing3dSigEpsTheta :: Int -> Job (V 3 (BigFloat 512))
testDynamicalSdpIsing3dSigEpsTheta numIters = do
  workDir <- newWorkDir (isingNavBound externalStart)
  let isingNavBoundFiles = (Bound.defaultBoundFiles workDir) {Bound.initialCheckpointDir = Nothing}
      dynamicalSdpBoundLoop isingNavBoundFiles dynConfig externalStart isingNavBound numIters
  where
    dynConfig = (defaultDynamicalConfig 3) { bBoxMax = toV (0.530, 1.5, 0.99)
      , bBoxMin = toV (0.517, 1.2, 0.95)
      , useExactHessian = False
      , prevHessian = Just $ toM ((1000000.0,0.0,0.0),(0.0,10000.0,0.0), (0.0,0.0,10000.0))
    }
    externalStart = toV (0.519, 1.4, 0.956)
    nmax = 6

isingNavBound :: V 3 (BigFloat 512) -> Bound Int IsingSigEps
isingNavBound (L.V3 deltaSig deltaEps theta) = Bound
  { boundKey = boundKey' {spins = specialSpinSet, blockParams = blockParams' {keptPoleOrder = 12, order = 48}}
  , precision = SB.precision (blockParamsNmax nmax :: SB.ScalarBlockParams)
  , solverParams = (optimizationParams nmax) {feasibleCenteringParameter = 0.3, precision = 768, writeSolution = True}
  , boundConfig = defaultBoundConfig
  }
  where
    boundKey' = isingGFFNavigatorDefaultGaps (toV ((realToFrac deltaSig), (realToFrac deltaEps))) lambda nmax
    specialSpinSet = [0 .. 20] ++ [49, 52]
    blockParams' = blockParams boundKey'
    lambda = Just $ flip approxRational 1e-200 <$> toV (cos theta, sin theta)
```

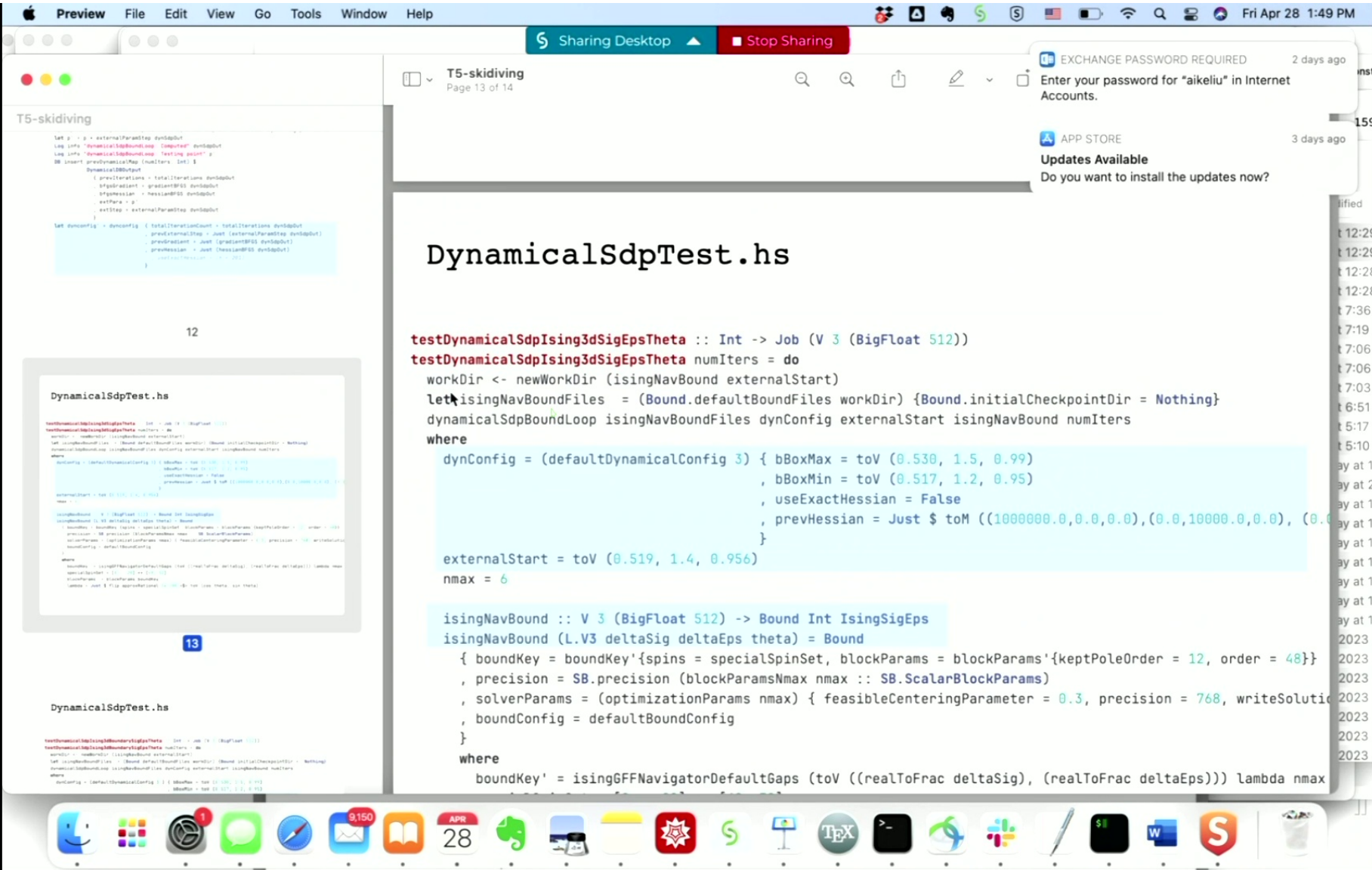
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DynamicalSdpTest.hs

```
testDynamicalSdpIsing3dSigEpsTheta :: Int -> Job (V 3 (BigFloat 512))
testDynamicalSdpIsing3dSigEpsTheta numIters = do
  workDir <- newWorkDir (isingNavBound externalStart)
  let isingNavBoundFiles = (Bound.defaultBoundFiles workDir) {Bound.initialCheckpointDir = Nothing}
      dynamicalSdpBoundLoop isingNavBoundFiles dynConfig externalStart isingNavBound numIters
  where
    dynConfig = (defaultDynamicalConfig 3) { bBoxMax = toV (0.530, 1.5, 0.99)
      , bBoxMin = toV (0.517, 1.2, 0.95)
      , useExactHessian = False
      , prevHessian = Just $ toM ((1000000.0,0.0,0.0),(0.0,10000.0,0.0), (0.0,0.0,10000.0))
      }
    externalStart = toV (0.519, 1.4, 0.956)
    nmax = 6

isingNavBound :: V 3 (BigFloat 512) -> Bound Int IsingSigEps
isingNavBound (L.V3 deltaSig deltaEps theta) = Bound
  { boundKey = boundKey' { spins = specialSpinSet, blockParams = blockParams' { keptPoleOrder = 12, order = 48 }
  , precision = SB.precision (blockParamsNmax nmax :: SB.ScalarBlockParams)
  , solverParams = (optimizationParams nmax) { feasibleCenteringParameter = 0.3, precision = 768, writeSolution = True }
  , boundConfig = defaultBoundConfig
  }
  where
    boundKey' = isingGFFNavigatorDefaultGaps (toV ((realToFrac deltaSig), (realToFrac deltaEps))) lambda nmax
```


ObjGet, ObjSet

```

In[34] = Clear@ObjSet;
SetAttributes[ObjSet, HoldFirst];
ObjSet[object_, itemname_, value_, newItemB_:False] := Module[
{rule},
rule = itemname -> value;

If[FreeQ[object, {itemname -> _}], {1}],
If[newItemB == False, Print["ObjSet warning:", itemname, " was not in object set. ObjSet will add this member to the object"]];

AppendTo[object, rule];
Return[object];
];

object = Replace[object, {itemname -> _} -> {itemname -> value}, {1}];

Return[value];
];

ObjSet/: Set[ObjSet[obj_, item_, val_] := ObjSet[obj, item, val];

In[5] = Clear@PartSpecListQ;
PartSpecListQ[_List] := True;
PartSpecListQ[_Span] := True;
PartSpecListQ[_All] := True;
PartSpecListQ[_] := False;

```

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configuration

gap configuration

```

In[ ] = Clear@GapConfiguration;
GapConfiguration[dim_, lset_] := {
  /on[on_ v[1_ _]1_ 1_ 1_ 1_ SetProc@3_ A]

```

Delete All Messages

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ObjGet, ObjSet

```

In[34]= Clear@ObjSet;
SetAttributes[ObjSet, HoldFirst];
ObjSet[object_, itemname_, value_, newitemB_:False]:=Module[
{rule},
rule=itemname->value;

If[FreeQ[object, {itemname->_}], {1}],
If[newitemB==False, Print["ObjSet warning:", itemname, " was not in object set. ObjSet will add this member to the object"];];

AppendTo[object, rule];
Return[object];
];

object=Replace[object, {itemname->_}>{itemname->value}, {1}];

Return[value];
];

ObjSet/: Set[ObjSet[obj_, item_, val_]:=ObjSet[obj, item, val];

In[35]= Clear@PartSpecListQ;
PartSpecListQ[_List]:=True;
PartSpecListQ[_Span]:=True;
PartSpecListQ[_All]:=True;
PartSpecListQ[_]:=False;

```

```

"RunMMA_job_amd.sh",
"RunMMA_job_amd_debug.sh"
];

```

configuration

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```

parseHyperionLogList[text_]:=If[Head[#]==List,#,List]&@parseHyperionLog[text];

parseHyperionLog[text_String];StringMatchQ[text,WhitespaceCharacter...--(var:LetterCharacter...)--WhitespaceCharacter...]:=StringCases[text,WhitespaceChar
parseHyperionLog[text_String];StringMatchQ[text,WhitespaceCharacter...--(time:NumberString)--WhitespaceCharacter...--"s"--WhitespaceCharacter...]:=StringCa
parseHyperionLog[text_String]:=Quiet@Check[ImportString[text,"JSON"],ImportString[text]];

In[38]> outputtext = Import["/Users/aikelu/dynamic/test.log"];
In[39]> output$pt$list =
StringCases[outputtext, Shortest["dynamicalSdpBoundLoop: Testing point: V" -- WhitespaceCharacter .. -- output : ("{" -- (arg1_ /; balancedBracesQ[arg1]) -- "}")] >
output];
In[40]> run$output$pt$test = parseHyperionLog /@ output$pt$list;
In[41]> outputlist =
StringCases[outputtext,
Shortest["dynamicalSdpBoundLoop: Computed: DynamicalSdpOutput" -- WhitespaceCharacter .. -- output : ("{" -- (arg1_ /; balancedBracesQ[arg1]) -- "}")] >
output];
run$output$test = parseHyperionLog /@ outputlist;
Save["/Users/aikelu/dynamic/test.txt", run$output$test];
In[42]> run$output$test = Get["/Users/aikelu/dynamic/test.txt"];
run$output$pt$test[[1]] /. a_Real > N[a]
{toVector -> {0.51723, 1.39749, 0.95535}}

run$output$test[[1]] /. a_Real > N[a]
{sdpOutput -> Output -> {terminateReason -> UpdateSDPs, primalObjective -> 0.836771,
dualObjective -> -5.73927, dualityGap -> 1., primalError -> 3.89737 x 10-213, dualError -> 4.46395 x 10-198, runtime -> 357},
externalParamStep -> V -> {toVector -> {-0.00177003, -0.00250983, -0.000649621}}, lagMultiplierOutput -> 0., totalIterations -> 143,
muDirectionModeOut -> 1, gradientBFGS -> V -> {toVector -> {56.9074, -9.4896, 2.16515}},

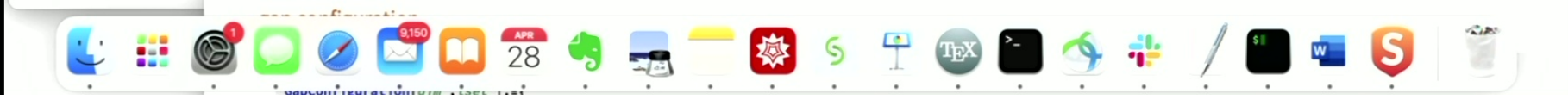
```

RunMMA_job_amd.sh",
RunMMA_job_amd_debug.sh"
);

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configuration



```

run$output$test = parseHyperionLog /@ outputList;
Save["/Users/aikelu/dynamic/test.txt", run$output$test];
(41) run$output$test = Get["/Users/aikelu/dynamic/test.txt"];
run$output$pt$test[1] /. a_Real -> N[a]
{toVector -> {0.51723, 1.39749, 0.95535}}

run$output$test[1] /. a_Real -> N[a]
{sdpbOutput -> Output -> {terminateReason -> UpdateSDPs, primalObjective -> 0.836771,
dualObjective -> -5.73927, dualityGap -> 1., primalError -> 3.89737 x 10^213, dualError -> 4.46395 x 10^198, runtime -> 357},
externalParamStep -> V -> {toVector -> {-0.00177003, -0.00250983, -0.000649621}}, lagMultiplierOutput -> 0., totalIterations -> 143,
muDirectionModeOut -> 1, gradientBFGS -> V -> {toVector -> {56.9074, -9.4896, 2.16515}},
hessianBFGS -> {{5005.87, -1776.2, 899.075}, {-1776.2, 1120.17, -768.23}, {899.075, -768.23, 810.413}},
hessianExact -> {{-25575.8, 5196.57, -1633.16}, {5196.57, -597.865, 90.6414}, {-1633.16, 90.6414, 168.989}}

(42) run$output$pt = run$output$pt$test;
run$output = run$output$test;

(56) Flatten /@ Transpose[{Range[1, Length@run$output],
Prepend[Differences@ObjGet[run$output, All, "totalIterations"], ObjGet[run$output, 1, "totalIterations"]],
ObjGet[run$output, All, "sdpbOutput", "Output", "dualityGap"] /. a_Real -> NumberForm[a, 10],
v@@@ObjGet[run$output$pt, All, "toVector"] /. a_Real -> NumberForm[a, 6]
{v@@@ObjGet[run$output, All, "externalParamStep", "V", "toVector"] /. a_Real -> NumberForm[a, 6],
v@@@ObjGet[run$output, All, "gradientBFGS", "V", "toVector"] /. a_Real -> NumberForm[a, 6],
Norm@ObjGet[run$output, All, "hessianBFGS"]; ObjGet[run$output, All, "hessianExact"] /. a_Real -> NumberForm[a, 6]}];
}] // Prepend[#, {"step", "iter", "dualityGap", "(Δo, Δe, θ)"}] & // TableForm

step  iter  dualityGap  (Δo, Δe, θ)
1      138    0.08717930312  v{0.518977, 1.40040, 0.955188}

```

```

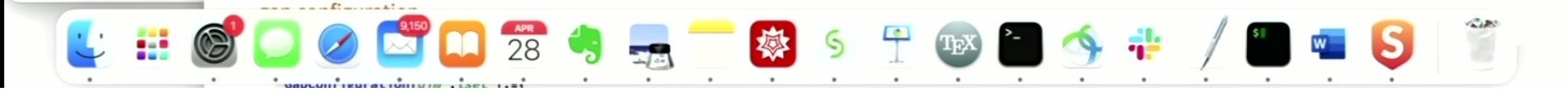
"RunMMA_job_amd.sh",
"RunMMA_job_amd_debug.sh"
};

```

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```

In[42]:= run$Output$pt = run$Output$pt$test;
run$Output = run$Output$test;

In[57]:= Flatten /@ Transpose[{Range[1, Length@run$Output],
Prepend[Differences@ObjGet[run$Output, All, "totalIterations"], ObjGet[run$Output, 1, "totalIterations"]],
ObjGet[run$Output, All, "sdpbOutput", "Output", "dualityGap"] /. a_Real -> NumberForm[a, 10],
v <<< ObjGet[run$Output$pt, All, "toVector"] /. a_Real -> NumberForm[a, 6]
{-v <<< ObjGet[run$Output, All, "externalParamStep", "V", "toVector"] /. a_Real -> NumberForm[a, 6],
v <<< ObjGet[run$Output, All, "gradientBFGS", "V", "toVector"] /. a_Real -> NumberForm[a, 6],
Norm @ ObjGet[run$Output, All, "hessianBFGS"]; ObjGet[run$Output, All, "hessianExact"] /. a_Real -> NumberForm[a, 6];
}] // Prepend[#, {"step", "iter", "dualityGap", "( $\Delta_o, \Delta_e, \theta$ )"}] & // TableForm

```

Out[57]:= TableForm

step	iter	dualityGap	($\Delta_o, \Delta_e, \theta$)
1	138	0.08717930312	v[0.518977, 1.40040, 0.955188]
2	4	0.08973379600	v[0.518955, 1.40078, 0.954438]
3	4	0.09245803804	v[0.518934, 1.40114, 0.953745]
4	4	0.09536990641	v[0.518914, 1.40147, 0.953112]
5	4	0.09532004688	v[0.518895, 1.40179, 0.952544]
6	4	0.09489738642	v[0.518878, 1.40208, 0.952036]
7	4	0.09449663964	v[0.518861, 1.40234, 0.951581]
8	4	0.09411554917	v[0.518846, 1.40259, 0.951174]
9	4	0.09374992985	v[0.518831, 1.40282, 0.950805]
10	4	0.09339396813	v[0.518818, 1.40303, 0.950467]
11	4	0.09304120125	v[0.518804, 1.40324, 0.950155]
12	4	0.09268513482	v[0.518791, 1.40344, 0.949864]
13	4	0.09231924600	v[0.518778, 1.40364, 0.949590]
14	4	0.09193661096	v[0.518765, 1.40384, 0.949331]
15	4	0.09153302137	v[0.518753, 1.40403, 0.949092]
16	4	0.09112837036	v[0.518741, 1.40421, 0.948870]
17	4	0.09071110758	v[0.518728, 1.40440, 0.948659]
18	4	0.09026895055	v[0.518716, 1.40458, 0.948462]

```

"RunMMA_job_amd.sh",
"RunMMA_job_amd_debug.sh"
};

```

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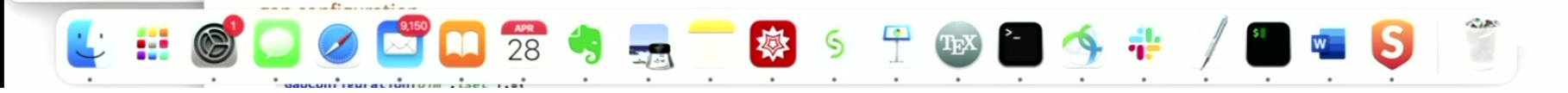
201	1	$1.029294678 \times 10^{33}$	$v\{0.518268, 1.41470, 0.972211\}$
202	1	$1.382485383 \times 10^{33}$	$v\{0.518268, 1.41470, 0.972211\}$
203	1	$2.655142021 \times 10^{33}$	$v\{0.518268, 1.41470, 0.972211\}$
204	1	$9.913973699 \times 10^{34}$	$v\{0.518268, 1.41470, 0.972211\}$
205	1	$1.937047397 \times 10^{33}$	$v\{0.518268, 1.41470, 0.972211\}$
206	1	$3.781996092 \times 10^{35}$	$v\{0.518268, 1.41470, 0.972211\}$
207	1	$1.997853208 \times 10^{34}$	$v\{0.518268, 1.41470, 0.972211\}$
208	1	$3.152869231 \times 10^{34}$	$v\{0.518268, 1.41470, 0.972211\}$
209	1	$5.231799430 \times 10^{34}$	$v\{0.518268, 1.41470, 0.972211\}$
210	1	$7.670527223 \times 10^{34}$	$v\{0.518268, 1.41470, 0.972211\}$
211	1	$2.655942787 \times 10^{33}$	$v\{0.518268, 1.41470, 0.972211\}$
212	1	$3.295533658 \times 10^{32}$	$v\{0.518268, 1.41470, 0.972211\}$
213	1	$3.133000696 \times 10^{33}$	$v\{0.518268, 1.41470, 0.972211\}$
214	1	$1.545481621 \times 10^{31}$	$v\{0.518268, 1.41470, 0.972211\}$
215	1	$7.891540419 \times 10^{32}$	$v\{0.518268, 1.41470, 0.972211\}$
216	1	$3.411639145 \times 10^{31}$	$v\{0.518268, 1.41470, 0.972211\}$
217	1	$1.549117102 \times 10^{31}$	$v\{0.518268, 1.41470, 0.972211\}$
218	1	$7.810271553 \times 10^{33}$	$v\{0.518268, 1.41470, 0.972211\}$
219	1	$7.151796615 \times 10^{31}$	$v\{0.518268, 1.41470, 0.972211\}$
220	1	$2.051686626 \times 10^{31}$	$v\{0.518268, 1.41470, 0.972211\}$
221	1	$5.370786322 \times 10^{32}$	$v\{0.518268, 1.41470, 0.972211\}$
222	1	$1.716447433 \times 10^{31}$	$v\{0.518268, 1.41470, 0.972211\}$
223	1	$1.545252214 \times 10^{32}$	$v\{0.518268, 1.41470, 0.972211\}$
224	1	$2.324218102 \times 10^{32}$	$v\{0.518268, 1.41470, 0.972211\}$
225	1	$3.763091659 \times 10^{32}$	$v\{0.518268, 1.41470, 0.972211\}$
226	1	$2.388861137 \times 10^{33}$	$v\{0.518268, 1.41470, 0.972211\}$
227	1	$1.084081620 \times 10^{32}$	$v\{0.518268, 1.41470, 0.972211\}$
228	1	$4.273419289 \times 10^{33}$	$v\{0.518268, 1.41470, 0.972211\}$
229	1	$1.478469904 \times 10^{33}$	$v\{0.518268, 1.41470, 0.972211\}$

```
"RunMMA_job_amd.sh",
"RunMMA_job_amd_debug.sh"
};
```

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```

Return[object];
];

object=Replace[object,(itemname->)(itemname->value),(1)];

Return[value];
];

ObjSet/: Set[ObjSet[obj_,item_,val]:=ObjSet[obj,item,val];

(*S*)
Clear@PartSpecListQ;
PartSpecListQ[_List]:=True;
PartSpecListQ[_Span]:=True;
PartSpecListQ[All]:=True;
PartSpecListQ[_]:=False;

Clear@ObjGet;

ObjGet[object_List,itemname_?PartSpecListQ,rest__]:=ObjGet[#,rest]&/@object[[itemname]];

ObjGet[object_List,itemname_,rest__]:=ObjGet[ObjGet[object,itemname],rest];
ObjGet[itemname->item_,itemname_,rest__]:=ObjGet[item,rest];

ObjGet[object_List,itemname_Integer]:=object[[itemname]];
ObjGet[object_List,itemname_?PartSpecListQ]:=object[[itemname]];
ObjGet[itemname->item_,itemname_]:=item;

ObjGet[object_List,itemname_]:=Module[
{item},
item=Cases[object,HoldPattern[itemname->_]];

```

```

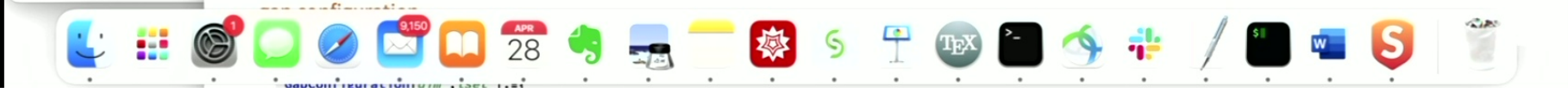
"RunMMA_job_amd.sh",
"RunMMA_job_amd_debug.sh"
];

```

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```

Return[object];
];

object=Replace[object,(itemname->)(itemname->value),(1)];

Return[value];
];

ObjSet/: Set[ObjSet[obj_,item_,val]:=ObjSet[obj,item,val];

(*S)- Clear@PartSpecListQ;
PartSpecListQ[_List]:=True;
PartSpecListQ[_Span]:=True;
PartSpecListQ[All]:=True;
PartSpecListQ[_]:=False;

Clear@ObjGet;

ObjGet[object_List,itemname_?PartSpecListQ,rest_]:=ObjGet[#,rest]&@object[[itemname]];

ObjGet[object_List,itemname_,rest_]:=ObjGet[ObjGet[object,itemname],rest];
ObjGet[itemname->item_,itemname_,rest_]:=ObjGet[item,rest];

ObjGet[object_List,itemname_Integer]:=object[[itemname]];
ObjGet[object_List,itemname_?PartSpecListQ]:=object[[itemname]];
ObjGet[itemname->item_,itemname_]:=item;

ObjGet[object_List,itemname_]:=Module[
{item},
item=Cases[object,HoldPattern[itemname->_]];

```

```

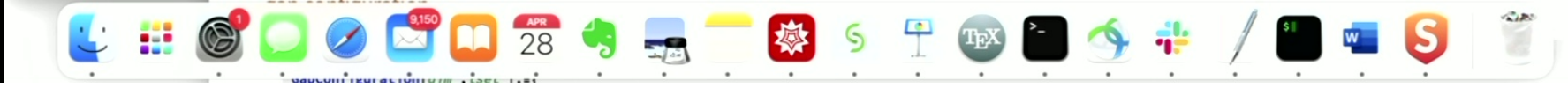
"RunMMA_job_amd.sh",
"RunMMA_job_amd_debug.sh"
];

```

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